On *Inquiry*:

Human Concept Formation and Construction of Meaning through Library and Information Science Intermediation

By

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Abstract

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Library and Information Science (LIS) is centrally concerned with providing instruments
(documents, organization, bibliographies, indexes) to enable people to become better
informed through use of documents. The relationship between *how people become
informed* and LIS intermediation, the Basic Relationship, is fundamental to the theory,
practice, and professional education of LIS.

This Basic Relationship and how it is understood in the field is investigated through
analysis of selected LIS texts according to criteria derived from principles of
Assimilation Theory, grounded in educational psychology, integrated with
complementary ideas from the cognate fields of ancient rhetoric, cognitive linguistics,
philosophy, and communications studies. These criteria were applied in the analysis of
413 LIS texts. Distinct from the "interdisciplinary" trend in our field, to utilize ideas
from other fields *as* LIS concepts, here, ideas from other fields are used to *reveal* LIS
core concepts that are innate and uniquely central to LIS.

The primary finding is that LIS texts express dissonance with Assimilation Theory to a small extent (5.6%), consonance with Assimilation Theory to a small extent (5.6%), and silence to most Assimilation Theory criteria (88.8%). Overall, LIS theory, practice, and education are found to be *not consonant* with principles of Assimilation Theory.

This primary finding leads to recommendations (Part IV) for a path to an Assimilation Theory-consonant LIS comprised of: (1) conceptual indexing as a complement to present indexing and information service, (2) constructive retrieval (CR) as an alternative to information retrieval (IR), (3) an LIS curriculum and research program grounded upon a core concern of virtually all facets of the field of information: humans *becoming informed* (constructing meaning) via intermediation between inquirers and instrumented records, and (4) core concepts that differentiate the field from all others. A set of skills (5) common to researchers, service providers, students, and educators in the field is described.

These recommendations can have a favorable impact in two ways: (1) inquirers have the benefit of a "retrieval" paradigm that takes into account their prior knowledge (as urged by Ausubel), and (2) important explanations never apparently known to any specific person might be discovered by detection of explanatory concept paths among disjunct literatures as shown through a worked example of conceptual indexing and constructive retrieval applied to Swanson's discovery of "undiscovered public knowledge" associated with dietary fish oil and Raynaud's disease.

Professor Michael K. Buckland (Chair)

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In Memory of
my father

Herbert Konrad

with infinite gratitude

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Research is not performed in isolation. Any undertaking such as this reflects contributions from, and engagement with, many individuals, communities, and events. I offer my sincere apologies for any whom I inadvertently overlook here.

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Part I

Introduction

I.1   Preface

This investigation originates from the belief that improvement in the theory, practice, and professional education in library and information science (LIS) results from a better understanding of the relationship between *how people become informed* and the intermediating role of LIS, the Basic Relationship.

To examine this Basic Relationship a plausible operational explanation of how people become informed is required. Assimilation Theory is selected for this purpose, although the fields of educational psychology, communications theory and rhetoric, and cognitive linguistics offer much that might have served as a point of departure.

Assimilation Theory is a system of ideas from educational psychology by David Ausubel and his followers. The notion of *meaningful learning*, central to Assimilation Theory, is interpreted as comparable to the LIS concern with *how people become informed*. Correspondingly, meaningful *reception* learning is understood to mirror *how people become informed through LIS systems and practice* (i.e., service *received*). This investigation anticipates improved LIS theory and practice through projection of relevant elements from Assimilation Theory onto LIS concepts and doctrine.

The Primary Finding reveals a substantially inadequate LIS understanding of the Basic Relationship according to the criteria derived from Assimilation Theory. Specifically, LIS texts express consonance with Assimilation Theory to a small degree (5.6%), dissonance with Assimilation Theory to a small degree (5.6%), and predominant (about

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90%) obliviousness to most Assimilation Theory criteria. Overall, LIS theory, practice, and education are found to be *not consonant* with principles of Assimilation Theory.

The Primary Finding leads to a speculative section (Part IV) describing an Assimilation Theory-consonant LIS comprising conceptual indexing as a complement to present indexing and description, constructive retrieval (CR) as an alternative to information retrieval (IR), and an LIS curriculum and research program that advance these ideas. The portions describing conceptual indexing and constructive retrieval are accompanied by a worked example of Swanson's work in "undiscovered public knowledge" associated with dietary fish oil and Raynaud's disease.

Part I provides the general framework for the study. Part II develops the examination criteria of the evidence examined, LIS texts, in Part III. Part IV derives an Assimilation Theory-consonant framework for LIS theory, practice, and education.

I.2   Motivations for the study

The primary motivation for this study is the ongoing pursuit of a better understanding of the Basic Relationship between *an inquirer becoming informed* [Buckland 1988 Ch. 9], i.e., one's thought becoming shaped through knowing, believing, or drawing conclusions, and, *LIS intermediation*. LIS intermediation operates between an inquirer and *instrumented records*, that is, objects under LIS (bibliographic or other) control to provide documents and services through which the inquirer can satisfy his or her inquiry. This Basic Relationship is taken to be essential to our field of study, library and information science (LIS), and as such, justification for its study is self-evident.

LIS has a dual identity as both a field of intellectual inquiry and as a professional practice. Consequently, no simplistic characterization satisfactorily accounts for the variety of influences that make LIS an interesting field and thus motivate its study.

Research nowadays is understood to be laden with personal and political interests. The reader is entitled to full disclosure of the investigator's motivations beyond the generally accepted warrant for improvement of knowledge in a given field. The most influential of these are summarized here.

Among the motivations for this project are the potential impacts on both LIS theoretical understanding and practice: First, critical analysis of LIS principles based upon Assimilation Theory can reveal inconsistencies in, and unexplored aspects of, current LIS understandings of the Basic Relationship. Second, recognition of inconsistencies and their mitigation, can lead to better LIS practice.

A challenge is passed to us from prominent writers in our field stemming from their frustration with approaches to LIS which do not account for meaning, nor how meanings are constructed and used by inquirers. These are found particularly in the information retrieval (IR) literature. A brief review of a sample of these views is worthwhile (*emphases* in passages below are mine):

Van Rijsbergen finds that theoretical progress in IR is stymied without attention to *meaning*:

> In the last few years, I have become increasingly dissatisfied with the state-of-the-art in information retrieval. I have reluctantly concluded that the fundamental basis of all the previous work is wrong. Almost all of the previous work in Information Retrieval (including my own) has been based on the assumption that a formal *notion of meaning* is not required to solve the information retrieval problem. . . . [I]t has become clear that

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further advances in the effectiveness of retrieval by such techniques [estimation of relevance based upon statistical distribution of words, term frequency, inverted document frequency, etc.] are not possible. My observation is that performance based on statistical techniques has reached its theoretical limit and any attempts to achieve further improvements are a waste of time. . . . to build a new generation of Information Retrieval systems, a new theory will be needed.
[van Rijsbergen 1986 (annotation added)]

Maron expresses befuddlement as to *how* to take cognitive issues into account, but acknowledges that they are essential to the "central concern of our field":

Implicit in such a view [as he proposes] is a picture of the monumental conceptual gap that now separates what we now know and what we would like to know. . . .

The central concern of our field is . . . how to get access to the best current recorded information on a given subject or problem. . . .

. . . consider first the human being as an information retrieval system. The intelligent human with his marvelous memory and powerful cognitive systems can read the running text of a document, *understand* what it says, *what it means and what it is about* . . . He can take what the document says and relate it to other things he believes in order to synthesize a more current representation of what has been said. . . .

How is the human able to do what he does with information? How is he able to read ordinary language text and comprehend its content? How is he able to use received information in order to update and modify his internal cognitive map of his world? How is that cognitive map, which represents his current states of knowledge and belief, constructed? . . . I don't have any answers to these nor dozens of other such basic questions. I venture to . . . [say] bluntly that no one has the foggiest idea of those general principles which must underlie language comprehension.
[Maron 1983]

Swanson, renowned for finding concepts in one literature which are professionally and bibliographically disconnected from cognate literatures, joins the chorus:

> Bar Hillel's warning . . . that Mooers had confused IR with literature
> searching led to Mooers' rebuttal that Bar Hillel had confused IR with
> question-answering, both failing to notice that the bird-dog was neither
> searching literature nor answering questions.
>
> . . . what I call the 'conceptual' problems of IR -- the problems of
> *meaning*.
>
> . . . I know of no solutions that have been offered to the problems of
> *meaning* . . .
>
> . . . Karen Sparck Jones who [observed] 'Overall, the impressions must be
> of how comparatively little the non-negligible amount of work done has
> told us about the real nature of retrieval systems' [citation omitted]. In the
> same book, Bill Cooper, commenting on the state of theorizing in
> document retrieval, says pretty much the same thing: 'Deep down . . . it's
> shallow' [citation omitted].
> [Swanson 1988].

Foskett reinforces the theoretical standstill:

> At present, we do not know enough about the way in which the human
> mind works to be able to give computers the right instructions to enable
> them to perform intellectual operations; these must still be done by human
> effort. [Foskett 1996 30].

Finally, Wilson expresses the unmet challenge concisely:

> What we would like, for its possible help in improving techniques for
> content representation, is deeper understanding of the phenomenon of
> understanding itself . . .. [WilsonP 1983a 397]

These views are easy to summarize: how meaning emerges within human inquirers must
be taken into account for LIS theory to advance. Such consensus by luminaries in our
field is motivation enough to recruit knowledge from neighboring disciplines about how
people construct meaning, especially as it pertains to objects instrumented by LIS.

But the philosophical desire for better understanding is not the only motivation at work. In their everyday reliance on LIS intermediation, inquirers are continuously confronted by obstacles and interruptions to inquiry. In contemporary computationally-oriented LIS, these are nearly always viewed as isolated technical problems. These include:

Inquirer's failure to find records wanted or needed (poor *recall* (relevant documents retrieved / relevant documents in collection) or choice of collection);

"Information noise," i.e., too many irrelevant records (i.e., poor *precision* (relevant documents retrieved / all documents retrieved)) interferes with the inquirer's sense-making capacity;

Inquirer receives more records than they can read, use, or understand ("information overload" or "information firehose" effect); records received saturate the inquirer's cognitive processing capacity;

Inquirer cannot determine which records are relevant, and/or cannot filter relevant from non-relevant information;

Relevance of particular records to an inquirer is dynamic, but treated as static by the LIS intermediary;

Inquirer is unable to use retrieved materials on account of problems in interpreting expressions in the records, for example, on account of unfamiliarity with language or format;

Inquirer is unable to use retrieved materials because they do not have appropriate subject matter knowledge, and thus expressions in the document do not evoke the ideas either intended or desired;

Inquirer has inadequate economic access to or control of informing services;

Inquirer lacks mastery of information systems technology.

Such phenomena are interpreted here, not as isolated technical challenges, but as *potential* evidence of a common theoretical flaw: a poor understanding of the Basic Relationship. It is not the primary intention of this study to solve any of these technical challenges. Rather, their characteristics are analyzed and their affinity with the Basic Relationship is investigated.

I.3   The Research Question

The research question underlying this study is tripartite:

(1) How has the relationship between *how inquirers become informed* and *how LIS systems intermediate to serve that inquirer* (the Basic Relationship) been understood in LIS theory and practice?

(2) How might this Basic Relationship be interpreted according to Assimilation Theory?

(3) How might the contrast between these two understandings suggest an improved LIS theoretical framework and better practice?

Component (1) provides a baseline against which the findings from (2) are contrasted in (3). Component (2) operationalizes the analysis by attempting to distinguish which aspects of conventional LIS theory and practice pertaining to the Basic Relationship are

consonant with Assimilation Theory, which are dissonant with Assimilation Theory, and which are silent as to principles of Assimilation Theory.

Component Question (3) prompts the primary work product intended for this project: a framework of specific proposals for improvement of LIS theory and practice, including clarifications of the Basic Relationship through transfer from *meaningful reception learning*, improved understandings of how inquirers construct new understandings from LIS intermediation with documents, classifications, and other service modes.

Adjacent to Assimilation Theory are various systems of ideas about how people read, write, understand through engagement with texts. How might these ideas, in concert with Assimilation Theory, amplify understanding of the Basic Relationship?

For (3), <u>Implications for LIS Theoretical Framework and Practical Application:</u> What does the *meaningful reception learning* portion of Assimilation Theory suggest can be done by specialists, e.g., LIS agents, designers, and systems, to assist an inquirer in becoming informed? What principles of *meaningful reception learning* theory transfer to organization and representation of an LIS-instrumented collection? In what ways might Assimilation Theory-compliant LIS systems differ from those designed according to present LIS conventions? Even if ascertainment and representation of an *inquirer's* knowledge structure and cognitive assimilation processes are possible, how might LIS agents and services produce comparable representations of documents and collections, i.e., in an Assimilation Theory-compliant manner. Assimilation Theory teaches that knowledge is not *in* a representation of a document or collection, nor even *in* a document or collection itself, but only arises in the mind of an author, cataloger, or reader who constructs meaning from the document or collection and from his or her existing

knowledge. How might Assimilation Theory-compliant LIS representation of documents and collections, and LIS service, reflect this understanding?

I.4   Central hypothesis

Hypotheses are propositions to be tested in the course of the study, and thus distinct from assumptions. This study is founded upon a two-fold hypothesis:

> Critical review of LIS theory and convention according to the tenets of Assimilation Theory can reveal inconsistencies in, and unexplored aspects of, current LIS understandings of the Basic Relationship.

I.5   Context and assumptions

The focus of this report is upon principles underlying intermediation between inquirers and LIS-instrumented collections. Assumptions and corollaries, i.e., untested hypotheses, about LIS underlying this study can never be *completely* expressed, but include:

Assumption: The Basic Relationship is a central concern of LIS. The relationship between *how inquirers become informed* and *how LIS systems operate to serve an inquirer* (the Basic Relationship) is taken here to be, in part, one of cause and effect: Inadequate understanding of the Basic Relationship is a cause of weakness of LIS theory, and gives rise to misunderstood events and results, unsolved riddles, and inconsistencies.

Corollary: Improvement of current LIS *theory* might result from achieving a better understanding of the Basic Relationship.

Limiting assumption: inquirer's *only* objective is *becoming informed*. This study assumes that an inquirer's use of LIS services is confined to the objective of becoming informed. Other uses of LIS resources are conceivable, even common, for example, for entertainment, for rote use of documents (e.g., "I have to get a book so I can do a book report" or "I just need some stuff to put in my social studies report"), as a source for collectibles, as sources for forms for business or legal transactions, or even use of library facilities for shelter. A function in the middle of this spectrum is the operation of "literacy programs" in which libraries promote reading, in the face of reports of dramatically declining national literacy [NEA #46 2004]. Despite these, a simplifying assumption is made for the present study that an inquirer's motivation in engagement with LIS systems and services is to become informed.

Corollary: LIS' concern with an inquirer's *becoming informed* is distinct from many operational LIS objectives. Concern for systems, manipulation of records, document delivery, and other technical services is, at best, only indirectly related to a concern for an inquirer's *becoming informed*. With regard to intellectual inquiries, inquirers evaluate LIS service according to the extent to which they *become informed*, not merely based upon being directed to indexes to published articles, receipt of database search results, or even receipt of documents from a collection. The inquirer knows that access to these external materials is not the same as having *become informed*.

Corollary: "First person data" are assumed valid. LIS understanding as to events and objects that comprise the mind of an inquirer are relevant because it is the inquirer's mind that is *becoming informed*. What inquirers know and the cognitive and mental processes they perform cannot be ignored in favor of external surrogates (data, measurements, survey responses, interviews), even if those surrogates appear more easily measurable, more instrumentable, or more "scientific."

A common objection to the use of cognitive phenomena or mentalisms as data in scientific investigations is their irreproducibility and unverifiability by other researchers. This objection discounts the fact that, in daily life, using language, people continuously substantially reproduce ideas held by others, and verify that they have done so. This is the very purpose of communication.

The phenomenological position taken here is that minds, ideas, and relationships among ideas, are real to the inquirer. Concepts, conceptual structures, mental models, and metaphysical cognitive phenomena are assumed to be appropriate objects for study.

This report uses the notions of *concept* and *relations among concepts*. In this, it continues a long established tradition in philosophy, education, and, library and information science (LIS). Concepts are regarded as in the mental realm, not the physical tangible world. Strong disagreements about the nature of concepts in the form of contrasting epistemological positions (e.g., realism, idealism, constructivism, phenomenalism , etc.) leave theory built on any one open to criticism from the others. A working assumption upon which this report is grounded is that a notion of concepts is useful for theoretical and practical purposes. The report intends to be agnostic regarding the *nature* of concepts to the extent possible given Ausubel's characterization of concepts (Part II.1). In this way, commitment to any specific theory of cognition or mentalistic position is avoided. Theory is purposive. Here, the purposes are to relate theory to reality and to draw practical and professional conclusions based on empirical evidence (published texts). In so doing, theory is acknowledged to be *provisional*, to be discarded in the event better theory is encountered or constructed, and *incomplete*.

Assumption: Constructivism is a useful metaphor for understanding the Basic Relationship. In embracing Assimilation Theory, one inherits the paradigm of

constructivism. Constructivism refers to the idea that people *construct* knowledge *structure*, thoughts are *formed*, and minds are *shaped*, all through cognitive processes. *Construction*, as intended here, refers to *forming a new object by combining elements in a suitable order,* and is associated with material and labor. It can be messy, grimy, and dirty. Progress can be slow. Construction requires planning.

Constructivism is an imperfect metaphor in several ways. For example, connections between conceptual nodes are more like triggers than bolts or nails used for erecting a house or skyscraper. Yet the metaphor of construction is an improvement over the notions that becoming informed consumes no cognitive labor, that receipt of "information" equates to becoming informed, that concepts exist outside of minds in the physical realm, or that knowledge can be *transmitted* into peoples' minds *as knowledge*. All these lead to ignoring or discounting cognitive labor and its nature, and, in turn, thwart attempts to understand how humans learn and communicate.

Construction is not the only possible metaphor that might be chosen to guide thinking about the research question underlying this study. Figures of *growth*, of *triggers*, or connectionist approaches perhaps might facilitate understanding as well. Nevertheless, the predominant trope embraced by the originators of Assimilation Theory and many of the adjacent ideas used here inherit characteristics from the concept of *construction*.

Assumption: Concerns of Assimilation Theory are *comparable* to LIS concerns.

The notion of *meaningful learning*, central to Assimilation Theory, is interpreted as comparable to the LIS concern of *how people become informed*, and correspondingly, meaningful *reception* learning is understood to mirror *how people become informed through LIS systems and practice* (i.e., service *received*).

Corollary: Assimilation Theory is *applicable* to LIS concerns. Because the primary concern of LIS is how inquirers become informed through use of LIS intermediation, it follows that knowledge of how people become informed *per se* is (logically) relevant. Thus, LIS leverages upon the efforts of a larger enterprise encompassing cognitive science, rhetoric, philosophy, and educational psychology, of which Assimilation Theory is part, for ideas applicable to the subset of these concerns which are also central to LIS.

The assumption that Assimilation Theory is *applicable* to the research question here is based on the above assumption that their respective elements are *comparable*. Nevertheless, this leap deserves further explanation. The purposes of education (and educational psychology) and LIS are manifestly distinguishable from one another: Education's primary concern is clearly with learners. LIS is often regarded as primarily concerned with connecting inquirers to documents and managing collections in anticipation of inquiries. A different assumption of LIS purpose is made here: LIS is concerned with whether and how inquirers become informed, albeit through use of documents and supporting LIS resources, such as catalogs, databases, and indexes.

Both LIS and education (and by extension, educational psychology) promote the same objective: people becoming informed, although through different types of labor and systems. Education may be seen as broader, being concerned with aspects of meaning construction beyond those of finding and using documents, instead including construction, organization and presentation of explanations, curriculum design and development, classroom technique, and school administration, to name just a few. Nevertheless, the concern for how people construct meaning from use of documents, and principles for determining which documents to recommend to an inquirer or learner, are closely aligned, if not identical in both domains. LIS subject matter is not wholly

circumscribed by educational nor communication theory, but is *centrally* concerned with organizing documents and expressing their concepts for retrieval and use.

Just as learning, construction of meaning, does not occur only *after* delivery of curricular material to a student or learner, so too does an LIS inquirer's process of becoming informed not remain dormant until document delivery, digital or otherwise. Indeed, both student/learner and LIS inquirer construct meaning throughout the course of their "conversation" with teacher or LIS resources respectively. LIS research has not advanced this idea much beyond the notion of relevance feedback and the reference interview. Educational theorists have, however, integrated this principle into much of their work and obtained useful results. Thus, LIS theory might benefit from the projection of ideas from educational theory onto questions, gaps, and inconsistencies still at-large in LIS.

In sum, Assimilation Theory is assumed to be *applicable* to LIS concerns.

Assumption: Assimilation Theory is assumed valid.

This assumption is addressed in detail at the end of Part II.1 (Validity; critical evaluation of Assimilation Theory).

Assumption: Use of adjacent theory is apt: Understanding how inquirers read, write, and think *also* pertains to understanding the Basic Relationship. If LIS is a discipline of bibliographic instruments, systems, and other intermediation that operate, in part, upon documents which inquirers use to become informed, then it must be important to understand the relationships among their physical structure, linguistic expressions, and the structure of the concepts they provoke, and the role these structures play in becoming informed. That is, understanding the relationships between people and documents is indispensable to understanding the Basic Relationship. Such people-document

relationships include reading, writing, language, the nature of communication, physical manifestations of these, and non-written modalities such as images and maps. An underlying assumption in this study is that, because LIS is a discipline of intermediation between inquirers and documents, bibliographic instruments, and systems, understanding what people do as they interact with documents is indispensable to understanding how they become informed *through LIS intermediation*.

Corollary: How people *become informed*, is the primary focus of other fields, not LIS. In LIS, one is concerned with intermediation between inquirers and document collections. LIS does not purport to conduct research in cognitive science, linguistics, psychology, although individual LIS researchers qualified in these fields might do so.

Assumptions specific to Assimilation Theory. Assumptions pertaining to, and also those inherent in, Assimilation Theory are articulated in the next Part. Among the more important of these are that one person's knowledge *can* be partially ascertained by another, but never *completely* apprehended nor thoroughly expressed by linguistic terms.

I.6   Approach and methodology

Overview

Four preparatory tasks

Five Stages and work products

> Stage One: Principles of Assimilation Theory identified
>
> Stage Two: Derivation of analytic criteria
>
> Stage Three: Analysis and findings
>
> Stage Four: Implications
>
> Stage Five: An improved LIS framework

Study methodology differs from current LIS convention

Overview

This investigation is organized into nine Tasks. Of these, four (Tasks 1, 2, 3, and 6) were essentially completed during proposal preparation. The other five are designated as post-proposal <u>Stages</u>. Some Tasks result in intermediate work products, e.g., descriptions, assessments, or other interim records. Tasks which are <u>Stages</u>, result in chapters appearing in this report, and, in some instances, intermediate work products as well. Figure I.1 illustrates the connections among these nine Tasks and how future research might flow from the implications of this study.

3 Hypothesis: Principles of Assimilation Theory can instrument the inquiry

Assimilation Theory and Adjacent Fields (Selection of Texts)

4 First Stage: Principles summarized

Working Summary (Description of Concepts and Principles)

5 Second Stage: Criteria for examination constructed

Criteria for Examination

1 Recognition of symptoms motivates hypothesis: A better understanding of the Basic Relationship is needed.

The LIS understanding of 'how people become informed' can be improved

2 Research Question designed to explain Basic Relationship

Root Research Question and Stems

6 LIS texts for examination selected

Bibliography of texts representative of LIS theory and practice

7 Stage Three Examination of LIS texts according to criteria

Findings

8 Stage Four Findings synthesized to produce implications

Implications

Current relationship

Quest for Improved Theory

obstacles encountered by inquirers

Proposed Framework might lead to future engineering efforts that favorably impact present adverse symptoms

Recommendations for an improved LIS theoretical framework

9 Stage Five An improved LIS theoretical framework derived from findings and implications

Legend
1 (arabic numerals) Steps in the overall dissertation research project
first stage (underlined) Stages resulting in dissertation chapters
→ Progression of tasks in the cycle of research

Figure I.1

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Four preparatory tasks

Referring to the Arabic numerals in Figure I.1, Task 1, illustrates the motivations for this study, *viz.*, a continuous pursuit for improved theory and the desire to understand and mitigate obstacles encountered by inquirers in their use of LIS systems. From these two motivations, the research question and testable hypothesis were formulated, Task 2.

As Figure I.1 shows, selection of Assimilation Theory to instrument this inquiry (Task 3) does not originate within the intra-LIS cycle of "research question-research-engineering-use-new research question," but instead enters from outside. Yet, an important relationship between the research question and the use of Assimilation Theory obtains: that the idea of *meaningful learning*, developed in Assimilation Theory, may be understood as comparable to the LIS concern of *how people become informed*, and thus, that Assimilation Theory's notion of meaningful *reception* learning parallels LIS' concern, *how people become informed through LIS intermediation* (service *received*).

Task 6 resulted in characterization of thematic literature clusters and selection of representative LIS texts from each thematic cluster to be examined according to the analysis criteria (Stage Two). Of course, analysis of only a limited number of texts from each thematic group is feasible within the scope of the study. Future investigations may extend analytic coverage of LIS texts not examined in the course of this study.

Five Stages and work products

Each of the five stages represents a task that culminates in a section of this report.

Stage One: Principles of Assimilation Theory identified

In Stage One, (Task 4), the work products consist of chapters summarizing the essential principles of Assimilation Theory and selected adjacent literatures, primarily ancient rhetoric, linguistics, and philosophy of language.

Stage Two: Derivation of analytic criteria

The work from Stage One is used in Stage Two (Task 5) to develop a set of criteria for examination of the selected LIS texts. These criteria appear as Appendix I in this report.

The 569 Stage Two criteria perform two analytic functions: First, they instrument, or make visible for study, LIS understandings of each text much as staining biological samples with dye or labeling with tritium make particular matter visible within an organism. Second, they prompt a separate Assimilation Theory-based understanding of each LIS text, in turn, revealing LIS consonance with, and deviations from (dissonance between or silence as to) the tenets of Assimilation Theory.

Each Stage Two criterion is formulated as a question to facilitate the analysis of the text and referred to by a siglum, e.g., the ascertainment criterion is denoted as [Criterion 122].

Stage Three: Analysis and findings

The purpose of Stage Three, (Task 7), is to produce findings through analyzing selected texts according to Stage Two examination criteria.

Stage Three consists of two stages: (1) selecting texts for analysis, then (2) performing analysis by applying the criteria to each text.

In (2) analysis, as a text is read, passages that reflect Stage Two criteria are recognized. In that event, a notation is made on the working data document (itself a miniaturized version of the Stage Two criteria) immediately adjacent to the criterion recognized as to the page number and any annotations deemed appropriate. An indicator of "+" is generally used to indicate consonance, "-" indicates dissonance. At the conclusion of the analysis for each text, an overall summary is indicated at the top of the working data document ("+", "-", or "0" indicating that the text generally was silent as to Stage Two criteria). If a significant number of consonant or dissonant observations were made from analysis of a "0" text, as was frequently the case, a summary indication of "0/+" or "0/-" is inscribed on the working document header.

The analyses of texts is an interpretative exercise, both in constructing meaning of the text and in application of the Stage Two criteria. Use of "first person" data, the investigator's own interpretations, assumes that the analyst is capable of (1) evoking ideas reflective of LIS theory, teachings, or practice; (2) imaginatively constructing an Assimilation Theory-compliant interpretation, and then (3) contrasting these understandings.

Although no guarantee can be given that these interpretations are reachable nor reproducible by other investigators, a senior faculty member replicated the analyses of approximately a half-dozen texts with generally consistent findings.

In principle, each Stage Two criterion is applied in Stage Three (2) analysis to each selected LIS text. Operationally, however, a fairly sparse matrix is found. That is, many texts are silent with respect to many of the criteria. (A "text" might be a passage, a

chapter, or even an entire volume, although at that granularity, only the most predominant ideas are the focus of analysis.)

Stage Four: Implications

In Stage Four, (Task 8), the silences and dissonances with respect to Assimilation Theory, recorded as findings from Stage Three analyses, are probed to identify causal and other relations that bear upon the Basic Relationship.   The resulting implications are claims to the effect that, where findings are dissonant with Assimilation Theory, obstacles to becoming informed are explained. The Stage Four work product is a chapter describing these implications.

Stage Five: An improved LIS framework

In Stage Five, (Task 9), the implications presented in Stage Four are used to derive suggestions for an Assimilation Theory-compliant framework for LIS theory and practice.   The work product is a chapter describing this improved LIS framework, its potential impact upon obstacles to becoming informed through LIS intermediation and consequent benefits to inquirers, and suggestions for follow-on theoretical and engineering work.

Study methodology differs from current LIS convention

The methodology employed in this study differs from those common in contemporary LIS research as found in its mainstream literature (e.g., *JASIST*, *Information Processing and Management*, *Library Quarterly*, *Annual Review of Information Science and Technology*, and *DLIB*) in two ways: (1) the objects or phenomena studied encompass the inquirer's mental constructs and processes, rather than only those objects found in the observable world outside the inquirer (such as automated systems, digital artifacts, interfaces, algorithms for manipulation of records, and even data derived from observable "user" behavior); and (2) the type of instruments used for making mental phenomena visible for study are theories and techniques from educational psychology and adjacent disciplines, rather than those adapted from bibliometrics, computer science, behavioral studies, or other social science approaches.

The present study stands in contrast to earlier attempts to read cognitive theory into the LIS literature. These approaches have promoted the "cognitive viewpoint" theme during the last thirty years. The main distinction rests on the proposition that our field benefits from building upon theory developed by disciplines concerned with how people become informed generally, particularly educational psychology, linguistics, linguistic philosophy, cognitive science, and early rhetorical theory. The "cognitive viewpoint" literature is sparse in its use of, and even reference to, any of these, preferring to originate its own postulates in these areas.

Not all corners of the greater LIS enterprise neglect the importance of *ideas* as an object of study, nor their domain. As shown in the analysis of selected LIS thematic literature groups below, classification specialists, thesaurus designers and maintainers, preparers of

materials for abstracting and indexing services, and reference specialists, openly embrace mental phenomena as legitimate, even essential work material and media.

Factors contributing to the abandonment of conceptual phenomena as objects of investigation in information science, and thus their apparent novelty here, are accounted for in the historical literature of our field. In summary, the increasing influence of scientism, fascination with the efficiency of machines, the rise of digital computing and networking, and the consequent paradigms of minds-as-computers, are foremost among factors that have led LIS researchers to limit their interests to mathematical, "scientific," and algorithmic approaches to their subject matter. These perspectives have had the effect, *not* of complementing humanist methodologies and concern for that which is uniquely human, mind, but of displacing them. LIS researchers often perceive themselves to be bound by methods and conventions used in the physical sciences, and accordingly, as forbidden to study mental phenomena under the mistaken impression that measurement of *inventio* and *dispositio* cannot be instrumented for observation. Invisible phenomena in the physical world are instrumented for human inspection by microscopes, telescopes, and other devices for representation in sensory-susceptible form. The study undertaken here is made possible through the availability of various devices used by psychologists and others for accessing and observing people's knowledge. Of these, Assimilation Theory, Fauconnier's blend analysis, concept maps, Vee-diagrams, the divisions of rhetoric, linguistic theories as to metaphor and the neural basis for thought and language (Lakoff, *et al.*), reading theory, and others are utilized. All arise from acceptance of the notion that how people think is legitimate matter for scholarly discourse. Thus, the reader may find that the methods and instruments adopted here differ markedly from those found in conventional LIS research.

This investigation is approached from a humanities perspective because becoming informed is inherently interpretative.

> How a reader assimilates a text is an eminently personal matter, involving choice and a restructuring of what is written. . . . Although writing is necessarily presented as a succession of words, lines and pages designed to be scanned in linear fashion from beginning to end, readers are none the less free to discover that space as they wish. Better, they are not passive when confronted with a text, and they need not necessarily accept its values and ideas.
> [Gilmont 1999 232]

Mind is essentially human, personal, and individual. It is individuals who become informed or not, are held accountable for what they know and do, and have sensory experience from which their abstract knowledge structure arises. Interpretation and expression of thought are both acts that define humans and the study of them, the *humanities*.

I.7 Scope

The analyses performed, conclusions drawn, and claims made in this report are confined to LIS. While the writer is indebted to many other fields for ideas applied here, no presumption of masquerading as qualified psychologist, cognitive scientist, trained educator, rhetorical specialist, linguist, nor accomplished philosopher is claimed. In particular, the general question of "how people become informed *generally*" is not investigated here. Rather, principles constructed in these domains are applied to LIS concerns, in particular, "how inquirers become informed *through LIS intermediation*."

Some matters, widely regarded as "information" issues, lie wholly situated outside the inquiring mind, are minimally related to LIS *intermediation*, and are thus deemed beyond the scope of this study. Among these are intellectual property issues which are matters of law and public policy, technological problems related to network engineering or computer science, privacy issues which are the domain of institutional policy and ethics, and commercial and regulatory information policy, better understood from management, economic, and policy perspectives than through the Basic Relationship.

Other familiar LIS themes lie outside the scope of this study as well. Among these are preservation, conservation, and archival issues, library technical services , and implementing and maintaining LIS computer systems. Issues pertaining to specific intellectual communities, such as users or producers of scientific and technical information, government documents, or, art or music librarianship are declared to be beyond scope.

I.8   Summary of significant issues and limitations

<u>Selection of analytical instruments</u>. Assimilation Theory is taken as valid. To the extent evidence is found to the contrary, the reader may interpret the conclusions here accordingly. Assimilation Theory is acknowledged to be incomplete, as is any theory.

<u>Selection of methodology.</u> The use, in this report, of "first person data," an interpretative methodology, has been disclosed above. Positivists may view this as a limitation to the validity of the conclusions reached. However, the platform from which positivists argue their case is itself problematic. The study of concepts and mental phenomena is too important to ignore generally, and too essential to LIS to exclude from study.

Accordingly, it is expected that future investigators might obtain different results, that is, different interpretations, perhaps using different analysis criteria. No claim is made to satisfy the reproducibility criterion inherent in scientific method.

Selection of evidence examined. The data selection adopted for this study relied upon examination of texts from numerous LIS sub-literatures. An assumption made in this study is that these texts reflect what is known as to LIS subject matter. Both the collection examined and the analysis operation itself were, of course, susceptible to incompleteness. The LIS literature is large both in pages published and in the number of categories. The risk in challenging the very foundations of an entire field is that some important texts and ideas might be overlooked, either inadvertently or by the necessity to limit the sheer volume of evidence examined. However, the danger here was no more than in the research enterprise generally, and is answered by the anticipation of follow-on studies by this writer and others.

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Part II

Analysis Criteria

Overview of Part II

II.1   What is Assimilation Theory?

   Sources

   Disciplinary and epistemological contexts

   Themes and principles of Assimilation Theory

   Presupposition: Learner's primary goal is to acquire new *meaning*

   Interpretation of *acquire* and *acquisition*

   Assimilation Theory emphasizes cognitive knowledge

   Meaningful learning: a learner relating new ideas to their prior knowledge

   Prerequisite for a teacher relating new ideas to learner's prior knowledge:
      ascertain concepts and relations in their prior knowledge

   Mandate to teacher: "teach accordingly"

   Meaningful learning is distinct from rote learning

   Meaningful learning requires learner to expend *deliberate* cognitive effort;
      intent

   Meaningful learning and epistemological individualism

   Meaningful learning elements

      Cognitive objects in meaningful learning:

         Concepts

            Anchor concepts

            Granularity of concepts

         Relationships among concepts: *meaning*

         Cognitive structures

      Cognitive processes in meaningful learning:

         Transfer

         Subsumption

         Progressive differentiation

         Superordinate learning

         Integrative reconciliation

         Process characteristics

            Motivation and attention

            Endpoints

         Feedback

      Learning set

Cognitive variables in meaningful learning
Cognitive capacity.
Concepts missing (relative to a reference structure); Gaps
Preconceptions
Readiness to learn

Meaningful *reception* learning
What is meaningful *reception* learning?
Material presented to learner is only *potentially* meaningful
Meaningful reception learning is distinct from discovery learning
Reception learning is distinct from problem solving

Instruments associated with Assimilation Theory
Advance organizers
Vee-diagrams
Concept maps
K-W-L charts
Personal interviews
Role of instruments in assessment and evaluation

Validity; critical evaluation of Assimilation Theory

Overview of Part II

This Part reviews the characteristic elements of Ausubel's Assimilation Theory, particularly the elements directed to meaningful reception learning (Part II.1). These elements are developed in greater detail (Part II.2) resulting in analytic criteria (expressed as questions) to be used to ascertain whether any given LIS text includes this component. contradicts this component, or is silent with respect to it.

Stage Two criteria are derived from two general sources: (1) principles of Assimilation Theory (Section II.1) and (2) concepts from educational psychology's neighboring literatures (particularly, early rhetoric, linguistics, and philosophy of language) that amplify principles of Assimilation Theory (Section II.2). Stage Two criteria are itemized in (Appendix I).

Among the criteria for ascertaining whether a text expresses Assimilation Theory elements are, for example:

> [Crit.113] Is educational psychology embraced as relevant to LIS?

> [Crit.114] Is the epistemological position of constructivism, that is, that one constructs ones own knowledge, embraced?

> [Crit.115] Does the text disclaim that *ideas* can be *outside* of people, during transmission or otherwise?

Throughout Part II, as different aspects of Assimilation Theory are examined, comparable criteria are identified. These criteria are not explicitly listed in Part II, but are listed in Appendix I.

II.1   What is Assimilation Theory?

David P. Ausubel applied the name Assimilation Theory to his work in *meaningful learning*. Both the term *assimilation* and a fundamental tenet of Ausubel's theory are clearly traceable to psychologist Jean Piaget:

> *Assimilation . . .* by incorporating new elements into its earlier schemata the intelligence constantly modifies the latter in order to adjust them to new elements [Piaget 1963 6-7].

Ausubel developed his ideas during the later part of the Twentieth Century through teaching and research in educational psychology at the Graduate School, City University of New York, and private practice as a medically-qualified psychologist (MD). Ausubel's work on Assimilation Theory culminated in 2000 with publication of his book *The Acquisition and Retention of Knowledge: A Cognitive View*   [Ausubel 2000].   (see also:
[Novak 1998 51] and [Footnote II.1])

This section summarizes the disciplinary context, significant themes, major principles, and some of the nomenclature of Assimilation Theory which underlie Stage II criteria.

Sources

An early version of the ideas which Ausubel eventually termed "assimilation theory" were published in his 1963 book, "The psychology of meaningful verbal learning" [Ausubel 1963]. Nearly four decades later, a "full-scale revision" [Ausubel 2000. ix] appeared as "The Acquisition and Retention of Knowledge: A Cognitive View" [Ausubel 2000] (cited henceforth as "[ARK]"). This recent book is taken as the primary

source for Assimilation Theory claims utilized in this study. His earlier book, "Educational Psychology: A cognitive view" [Ausubel 1968], and its second edition [Ausubel Novak Hanesian 1978], are occasionally cited in this report.

Joseph D. Novak at Cornell has popularized Ausubel's ideas by, in part, operationalizing them in the form of concept maps and other instruments for graphically expressing relations among concepts. These tools are used by students for learning and by teachers for presentation of material and for assessment of student understanding. Of particular value to this project are Novak's clear expositions of Ausubel's ideas and his first-hand accounts in working with Ausubel. "Learning, Creating, and Using Knowledge" [Novak 1998] offers accessible explanations of many of Assimilation Theory's themes. Three other books complete the core Assimilation Theory texts, "Learning How to Learn," [Novak and Gowin 1984], "Teaching Science for Understanding, A Human Constructivist View," [Mintzes Wandersee Novak 1998], and "Assessing Science Understanding," [Mintzes Wandersee Novak 2000].

Disciplinary and epistemological contexts

Ausubel taught and published in the field of educational psychology, and, holding an MD, practiced psychiatry privately. His Assimilation Theory is grounded primarily in the epistemological position of cognitive constructivism (Figure II.1)

Although Ausubel's work is unlikely to be regarded as cutting edge in current educational psychology discourse, his ideas have become popular more broadly. An inquiry of two databases of educational documents performed in 2005 [Footnote II.2] searching for references to Ausubel and Assimilation Theory found more than 3,000 documents

distributed across disciplinary boundaries and levels of sophistication. Similarly, references to Novak's work are frequently found well beyond the education or psychology literatures, often in the context of applying concept mapping techniques to a given subject matter [Footnote II.3].

Writing on themes in psychology in the latter part of the Twentieth Century, Ausubel worked within the spheres of influence of Jean Piaget (1923 - 1952), known for his complementary notions of assimilation and accommodation and for his constructivist theories of cognitive development in children, educational theorist Lev Vygotsky (1896 - 1934) known, in part, for his notion of *scaffolding* as applied to children's learning, and Jerome Bruner who emphasized subject matter *structure*.

Following the Soviet Union's successful launch of Sputnik, broadly interpreted in the U.S. as leapfrogging both the U.S. space program and American technological prowess generally, the educational establishment began a period of reevaluation. The disciplinary context in which Assimilation Theory developed confronted controversies around the notion of *roteness* in education. Ausubel believed roteness, and the institutionalized doctrines and methods that foster it, to be the greatest nemesis to learning:

Assimilation
Theory

epistemological
foundation for

Constructivism

holds

Meaning **not** conveyed directly among people

holds

text, speech, or
other signals
conveyed

interpretation

Intellectual
labor of writing

Intellectual labor to **construct**
an understanding from reading

results in changes to

Author

Learner

Meaning must be constructed by learner, as from engagement with a text

Figure II.1

Much of the psychology of learning that teachers in training study today is based on findings from rote learning experiments that have been borrowed wholesale, and uncritically, without any attempt to test their applicability to the kind of learning situations that actually exist in classrooms. It would be a shocking situation, indeed, if a comparable procedure were followed in medicine, i.e., if physicians employed therapeutic techniques validated only *in vitro* or by animal experimentation.

. . . The willingness of educational psychologists to extrapolate the findings of rote studies naturally led them to neglect almost entirely the nature and conditions of meaningful verbal learning and retention. This naturally delayed the discovery of more effective methods of verbal exposition, as well as helped to perpetuate the use of traditional rote approaches to teaching. These methods continue to dominate much of contemporary educational practice, particularly in the secondary school and university. [ARK 27-8]

The paradigm of behaviorism was dominant in education and psychology during the middle of the Twentieth Century. Ausubel and Mayer summarize:

The Neobehavioristic Theoretical Orientation
Like the behavioristic position from which it was derived, the neobehavioristic view focuses presumably on "real" behavioral responses, both overt and implicit, and their environmental instigators and reinforcers as the proper objects of scientific investigation in psychology. Consciousness, on the other hand, is regarded as a "mentalistic" concept that is both highly resistive to scientific inquiry and not very pertinent to the real purposes of psychology as a science; it is largely regarded as an epiphenomenon that is important neither in its own right nor as a determinant of behavior. Furthermore, according to neobehaviorists, it cannot be reliably (objectively) observed; and it is allegedly so extremely idiosyncratic as to render virtually impossible the kinds of categorization necessary for making scientific generalizations. In neobehavioristic terms, for example, a concept is not regarded as a generic or categorical *idea* in consciousness but rather as a common *response* to a class or family of stimuli. [ARK 38]

The rise of behaviorism in the first half of this [twentieth] century
formally restricted psychology's task to providing precise descriptions of
the relations among observable variables (Bower & Hilgard, 1981;
Skinner, 1938) -- the epitome of the literal view of scientific language.
During the behaviorist period, the literal view reached its summit in 1943
with the publication of Principles of Behavior by Clark Hull, a book that
sought to mathematize the laws of learning. Based largely on animal-
learning research, Hull provided formulas specifying the relations among
variables such as response strength, habit strength, drive level, and
inhibitory strength. . . .Today, Hull's attempt to build mathematical laws
of learning is largely viewed as a failure . . .

During the second half of this [twentieth] century, as psychology moved
from behaviorism to cognitive psychology . . . [Mayer 1993 564]

As noted by Mayer, by the end of the century, and Ausubel's career, this paradigm had
entered into decline, overtaken by cognitive constructivism:

the virtual collapse of the neobehavioristic theoretical orientation to
learning during the previous forty years; [followed by] . . . the meteoric
rise in the seventies and beyond of constructivist approaches to learning
theory. [ARK ix (annotation added)]

More broadly, Ausubel's work is historically and ideologically situated in the midst of
several shifts in philosophical thought as well. In particular, the undermining of
positivism, with its focus on finding one best answer to questions, influenced Ausubel's
writing [Novak 1998 50]. Positivism and epistemological behaviorism, where
understanding is claimed to come from observing behavior, were intertwined. Their
unraveling coincided with acceptance of the notion that overt behavior demonstrates
neither cognitive processes nor cognitive structure.

In contrast, in the phenomenalist camp (which Assimilation Theory inhabits), mental
objects are accepted as legitimate object of study:

> *actual* (phenomenological or psychological) meaning, which is a product
> of a meaningful learning process . . . [ARK 73]

In this light, the term *object* is used frequently in the present essay in the grammatical

sense of "a thing to which an action, feeling, or thought is directed," including entities

that inhabit either the mental realm or the tangible world. That is, the domain of *object* is

not confined to the physical or material world. This is consistent with the position taken

here that concepts, thoughts, and ideas (i.e., mental entities) *are real to learners* (readers,

listeners, writers, speakers, thinkers). Being *real*, they may properly be called *objects*.

Assimilation Theory draws substantially upon the tenets of human (cognitive)

constructivism, which he characterizes as:

> the learner's generation of new meanings which he purportedly 'constructs'
> from the interaction between presented and related potential meanings in
> the latter's cognitive structure. [*sic*] [ARK xi].

although he recognizes involuntary influences on meaning-making as well.

Perhaps the most essential aspect of constructivist theory is the event that it holds *cannot*

occur:

> Human constructivists reject the view that knowledge is a product that can
> be faithfully *conveyed* by teachers.
> [Mintzes Wandersee Novak 1998 49 (emphasis added)]

Note that *constructivism* is differentiated from social *constructionism*, where knowledge

is understood as constituted through social interaction:

> Constructionism is both a theory of learning and a strategy for education.
> It builds on the "constructivist" theories of Jean Piaget, asserting that
> knowledge is not simply transmitted from teacher to student, but actively
> constructed by the mind of the learner. Children don't *get* ideas; they
> *make* ideas. Moreover, Constructionism suggests that learners are

particularly likely to make new ideas when they are actively engaged in
making some type of external artifact . . . [Kafai and Resnick 1996 1]

Indeed, cognitive constructivist metaphors predominate throughout Assimilation Theory

as revealed in terminology such as *structure*, *building*, *reinforcement*, *concrete*, and even:

. . . *scaffolding* for the meaningful learning and retention phenomena . . .
[ARK 38 (emphasis added)]

Concepts, cognitive structures, and cognitive processes are understood as existing in an

individual's mental realm:

Phenomenologically, meaningfulness is an individual matter. [ARK 55]

Ausubel's overarching theme is that, to be meaningfully learned, new ideas received *by*

the learner must be connected to *their* existing knowledge, and the labor of forming such

connections must be borne explicitly by the learner. [Ausubel Novak Hanesian 1978, iv

(flyleaf)]. Thus, Assimilation Theory reflects Ausubel's commitment to methodological

individualism, and is explored in more detail later in this section.

Ausubel acknowledges that knowledge is also, in part, socially constructed:

Cognitive variables, on the one hand, and motivational-personality-social
variables, on the other, affect meaningful learning and retention through
different mechanisms. [ARK 9]

But Ausubel's focus is upon the *cognitive* aspect of learning in the individual learner.

In situating Assimilation Theory epistemologically and historically, Ausubel

acknowledges the influence upon his work of several Twentieth Century themes:

Some readers might also be somewhat surprised by the preponderance
of older references cited in the text of this monograph. . . . reflects the
much greater influence on the development and content of Assimilation

Theory of such historical and current movements in psychology as
Structuralism, Functionalism, Gestalt Psychology, and certain aspects
of Schema Theory (Bartlett) and Cognitive Psychology, than of such
other opposing psychological movements as Neobehaviorism,
Information Processing, Cybernetics, Computer Models, and
Associative and Semantic Network formulations. [ARK xv]

Themes and principles of Assimilation Theory

Ausubel's Assimilation Theory may be recognized through its signature assumptions,

principles, recurring themes, and idiosyncratic terminology.

Presupposition: learner's primary goal is to acquire new *meaning*

Ausubel's Assimilation Theory is based on two assumptions: (1) that people are meaning-

makers; and (2) that a learner's primary goal is to gain *meaning*.   Hence Assimilation

Theory is a theory devoted to *meaningful learning* (Figure II.2):

The main focus of attention in this book [is] on the processes of
meaningful reception learning and retention, and on ways of enhancing
them, . . . [ARK 29 (annotation added)]
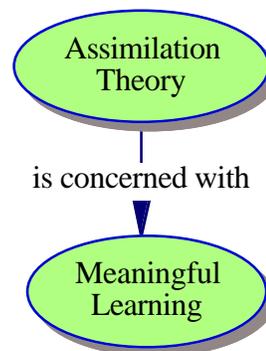
Figure II.2

Meaning is a defining characteristic of *knowledge* according to Ausubel:

Knowledge is meaningful by definition. [ARK vii]

Because meaning is an object of the mental realm and not the physical world, knowledge is thus an object of the learner's intellectual domain, not a physical object.

A learner's immediate goal might appear to be *other* than acquisition of new meaning for its own sake. Ausubel's focus however, is the motivated student in a classroom context, with teacher-prepared or administered materials used in formal learning environments. A goal of acquisition of *meaning*, i.e., *knowledge*, is imputed to learners as their immediate as well as long-term objective.

Interpretation of *acquire* and *acquisition*

Assimilation Theory centers upon deliberate cognitive effort by the learner. Yet, Ausubel expresses the learner-reader's goal with the terminology of physical transmission, as the "*acquisition* and retention of knowledge." Thus, the learner-reader might be mislead into interpreting Ausubel's work as discounting the constructive cognitive work that a learner must do beyond the physical *acquisition* of objects. Ausubel's position is quite the contrary, and embraces the essence of constructivist epistemology.

> One possible but unlikely misinterpretation of this book's terminology, first appearing in the title itself, *The Acquisition and Retention of Knowledge,* and later throughout the text is the possible suggestion that the conventional dictionary definition of "acquisition" in a learning context implies a passive, sponge-like mechanical, authoritarian, and uncritical ingestion of information, as an end in itself, rather than for the generation (production, construction) of viable (hierarchically-ordered and -organized subject matter) knowledge. However, in the context of this book,

41

> "acquisition" also has the more usual and *general* meaning (that also applies here) of "gaining possession" of new meanings (knowledge) that were not previously comprehended or were non-existent. . . . the term "acquisition" in the title as [*sic*] merely indicative of general concern with achieving and promoting the goal of enhancing meaningful learning in school and academic-like settings in assimilating subject matter. It will almost certainly not be justifiably related in any credible way to the dictionary definition of "acquisition" as a theory of meaningful learning.
> [ARK x-xi]

Ausubel's cornerstone theme emphasizes the indispensability of constructive cognitive labor inherent in learning and that meaningful learning requires willful, deliberate effort. The interpretation of *acquisition* as a passive cognitive notion lies at the heart of the conduit metaphor [Reddy 1979, 176-7, 181], of which English speakers are infected *en masse* despite conscious attempts to avoid it (see: Section II.2).

Assimilation Theory emphasizes cognitive knowledge

Human beings think, feel, and act:

> Throughout this book, I emphasize the interplay between thinking (cognition), feeling (affect), and acting (motor or psychomotor).
> [Novak 1998 51]

> Human beings do three things: they think, feel, and act. [Novak 1998 12]

Accordingly, personal knowledge is not exclusively factual, but of several types: cognitive knowledge, emotional knowledge, and psychomotor/physical sense knowledge.

Nevertheless, Assimilation Theory is directed primarily to understanding *cognitive* process and knowledge:

Ausubel's theory addresses primarily cognitive learning, or the acquisition and use of knowledge. [Novak 1998 51]

Meaningful Learning: a learner relating new ideas to their prior knowledge

Meaningful learning is synonymous with knowledge:

> Knowledge is meaningful by definition. It is the meaningful product of a cognitive ("knowing") psychological process involving the interaction between "logically" (culturally) meaningful ideas, relevant background ("anchoring") ideas in the particular learner's cognitive structure (or structure of his knowledge), and his mental "set" to learn meaningfully or to acquire and retain knowledge. [ARK vii]

Creation of new meaning is the presumed objective of meaningful learning:

> the learner's generation of *new meanings* which he purportedly 'constructs' from the interaction between presented and related potential meanings in the latter's cognitive structure. [ARK xi].
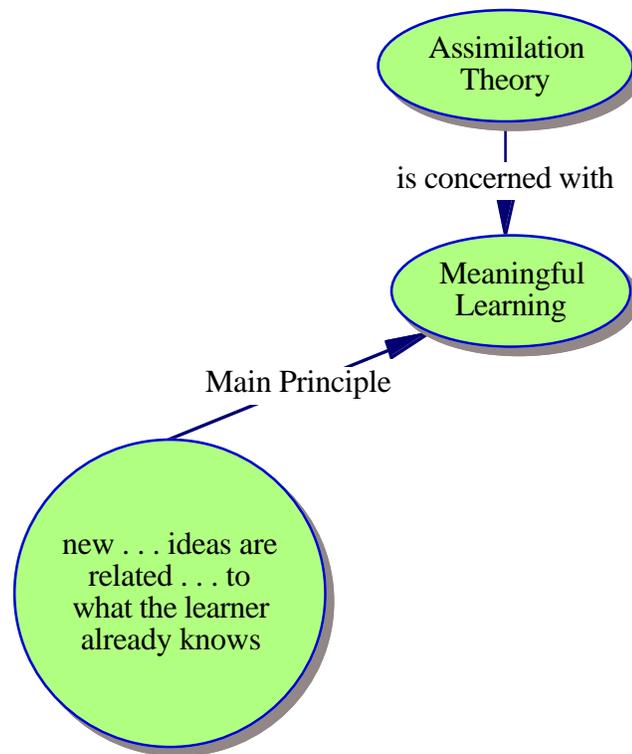
Figure II.3

Ausubel articulates the cornerstone of *meaningful learning* (Figure II.3):

> The essence of the meaningful learning process . . . is that new . . . ideas
> (the learning task) are related . . . to what the learner already knows (his
> cognitive structure in a particular subject-matter field) [ARK 67-68].

Meaningful learning is not synonymous with *learning meaningful material* because

material is only *potentially* meaningful.

Ausubel distinguishes three kinds of meaningful learning:

> *Representational* learning (such as naming) is closest to rote learning. It
> occurs when arbitrary symbols are equated in meaning with their referents
> (objects, events, concepts) and signify to the learner whatever meaning
> their referents do. . . .
>
> [*C*]*oncept* learning [two methods]: (1) concept formation, which takes
> place primarily in young children; and (2) concept assimilation, which is
> the dominant form of concept learning
>
> [V]erbal *propositions*: . . . a composite idea that is expressed verbally in a
> sentence [i.e., a *relation* between concepts]
> [ARK 1-2 (emphasis and annotation added)]

Prerequisite for a teacher relating new ideas to learner's prior knowledge: ascertain concepts and relations in their prior knowledge

To relate new ideas to concepts and relations in the learner's prior knowledge, Ausubel reasons that the learner's *a priori* knowledge must be ascertained (Figure II.4):

> The most important single factor influencing learning is what the learner already knows. *Ascertain this* . . .
> [Ausubel Novak Hanesian 1978, iv (flyleaf) (emphasis added)]
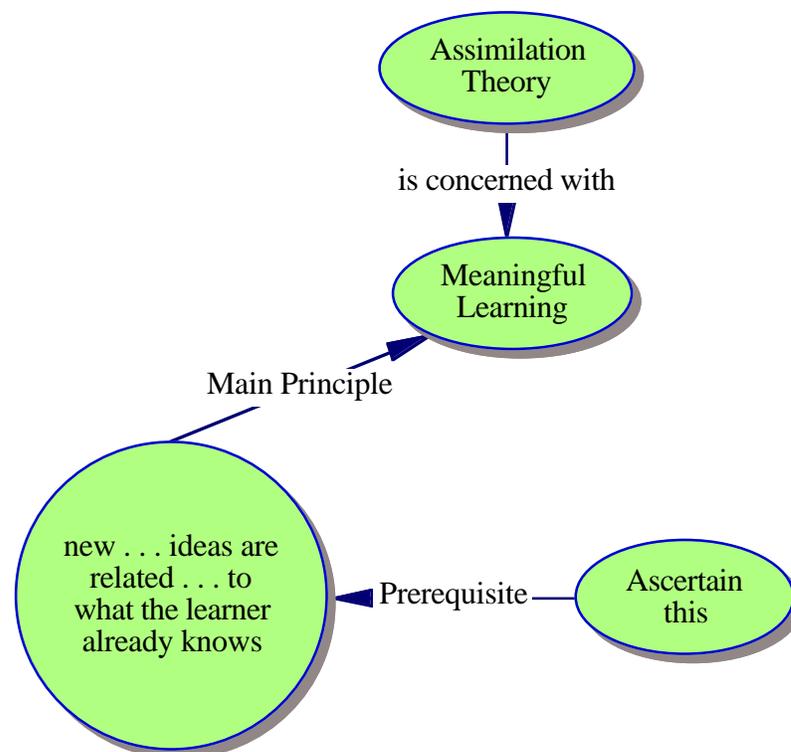
Figure II.4

How shall the teacher construct such an image of the learner's knowledge? Communication (in the sense of sharing for the construction of meaning), the distinction between public and private knowledge, and instruments (languages) directed to ascertaining another's knowledge (Instruments, this Section) all enable this prerequisite.

Mandate to teacher: "teach accordingly"

From the directive to "ascertain what the learner already knows," Ausubel reaches a succinct conclusion: *teach accordingly* (Figure II.5):

Assimilation Theory

is concerned with

Meaningful Learning

Main Principle

new . . . ideas are related . . . to what the learner already knows

Prerequisite

Ascertain this

procedure

and teach accordingly
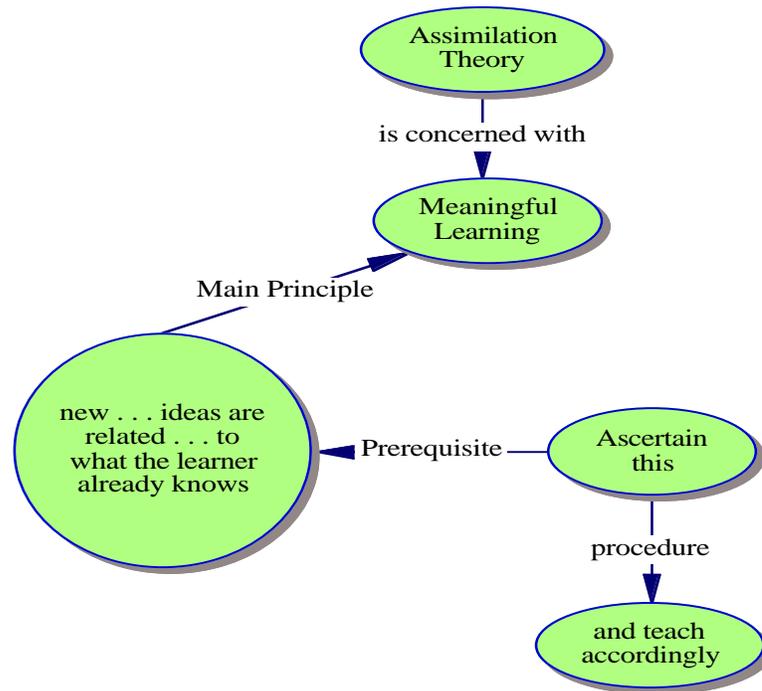
Figure II.5

What actions satisfy this mandate?

> Teachers must decide what is important for pupils to learn, ascertain what learnings they are ready for, pace instruction properly, and decide on the appropriate size and difficulty level of learning tasks. They are expected *to organize subject matter expeditiously, present materials clearly*, simplify learning tasks at initial stages of mastery, and integrate current and past learnings. . . . offering confirmation, clarification, and correction; asking critical questions; providing suitable rewards, evaluating learning and development; and where feasible, promoting discovery learning and problem-solving ability. Teachers must grapple with . . . individualization, *communication*, and discipline.
> [Ausubel Novak Hanesian 1978 10-11 (emphasis added)]

Teaching materials are expected to express concepts that form a continuous connection of concepts (clarity), between new ideas and the student's prior knowledge, that is, a path through the gap between prior knowledge and new ideas. This expectation implies that the teacher constructs an informal image (map) of concepts comprising the subject matter (reference concept map), an image of the learner's knowledge (learner's concept map), and then, by comparing and contrasting the two, constructs a third object, a conception of the differences between the two. This process is revisited in the next section as isomorphic mapping. That there are differences between the learner's knowledge structure and a new "conceptual reference structure" or subject matter is evidence of a gap in the learner's knowledge. Where either learner's map or reference map are unclear, the differences in the two may be more difficult to recognize. In these circumstances, Novak recommends rendering the learner's map and the reference map in explicit terms and symbols, such as those of a concept map or other instruments (below).

Having ascertained discrepancies between the learner's map and a desired state, the teacher selects or prepares teaching materials, then transmits them to the student. These are intended to invoke processes leading to concept formulation and assimilation.

How do objects in the physical world operate to effect change in the learner's mental realm? The concepts and relations expressed by the materials should be selected from the ideas in the reference map but missing in the learner's map, i.e., the differences between the two structures. Expression of these ideas by the teaching materials is expected to result in construction of corresponding ideas in the learner's mind.

Meaningful learning is distinct from rote learning

Ausubel conceptualizes *meaningful learning* as the antidote to rote learning (Figure II.6):

> Rote learnings . . . do not add to the substance or fabric of knowledge inasmuch as their relation to existing knowledge in cognitive structure is arbitrary, non-substantive, verbatim, peripheral, and generally of transient duration, utility, and significance. [ARK x]

> Rote learning occurs when the learner memorizes new information without relating it to prior knowledge, or when new material has *insubstantial* relationship to prior knowledge.
> [Novak 1998 19 (emphasis added)]
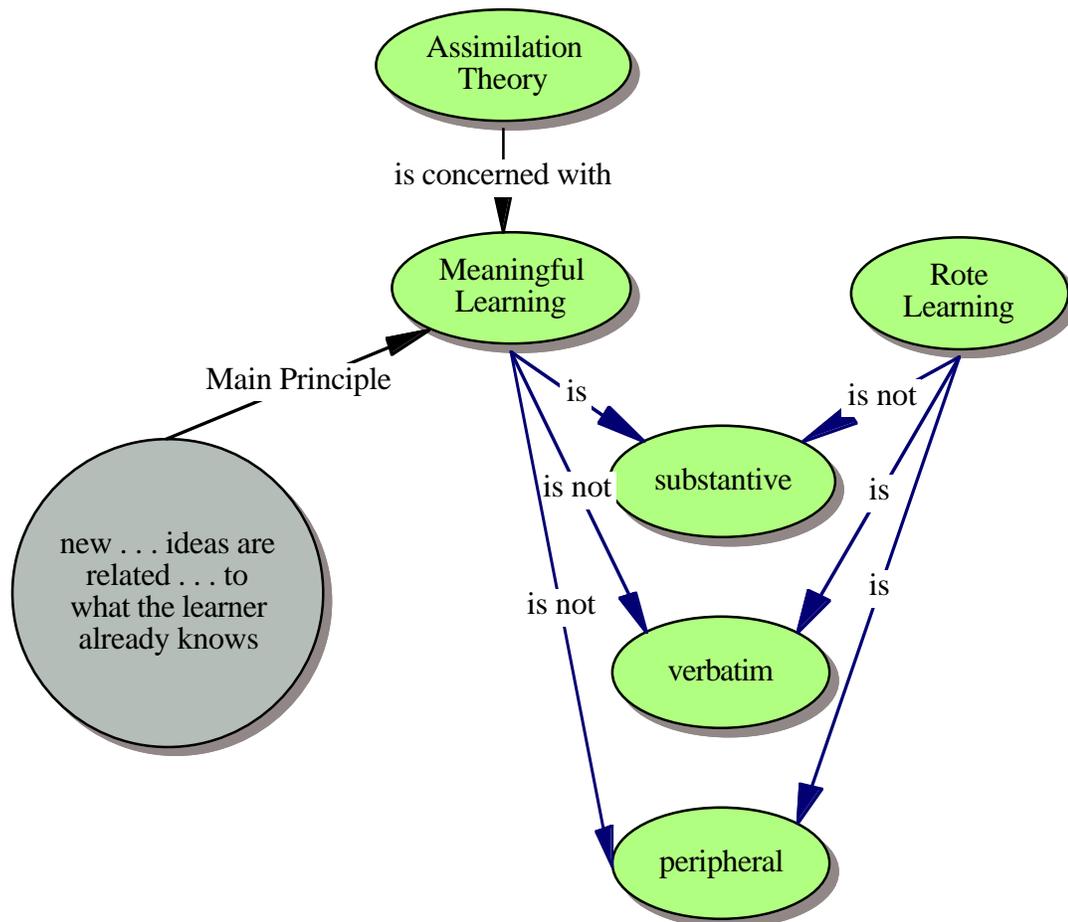
Figure II.6

The term *not substantive* is the pivotal criterion differentiating roteness from meaningfulness. A "substantive" relationship is comprised of multiple relations between a new idea and the learner's existing "specifically relevant" knowledge.

> It is important to recognize that meaningful learning does not imply that new information forms a kind of simple bond with preexisting elements of cognitive structure. On the contrary, only in rote learning does a simple arbitrary and nonsubstantive linkage occur with preexisting cognitive structure. In meaningful learning the very process of acquiring information results in a modification of both the *newly* acquired information and of the specifically relevant aspect of cognitive structure to which the new information is linked. [ARK 3]

(a)
Learner's existing concept (C) structure

(b)
New concept, N_1, arises from sensed experience

50
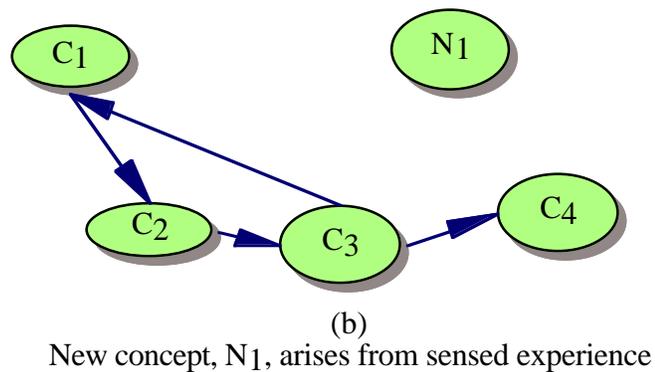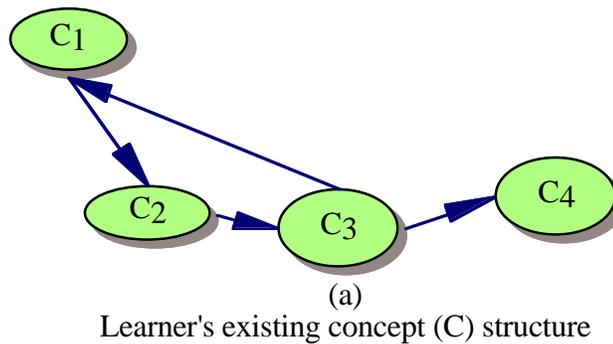
Meaningful learning also implies constant vigilance as to whether learning is well-integrated with the learner's prior knowledge, or is not (i.e., rote), and that both new concepts and existing knowledge undergo change as both become a part of new relations among ideas as shown in (Figure II.7 a-d).

(c)
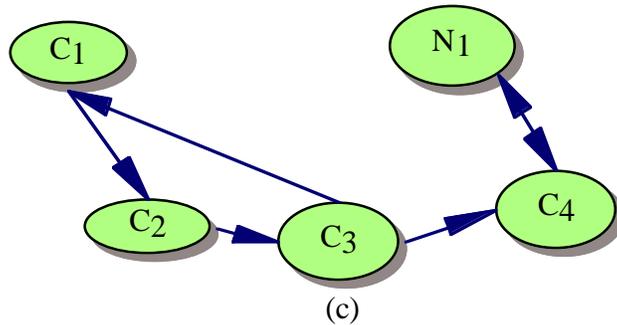
Rote Learning: New concept, N_1, has minimal (one shown here) relation to existing concept structure.
For example, a new person, N_1, may be encountered, and the name Smith, C_4, becomes associated with him.

(d)
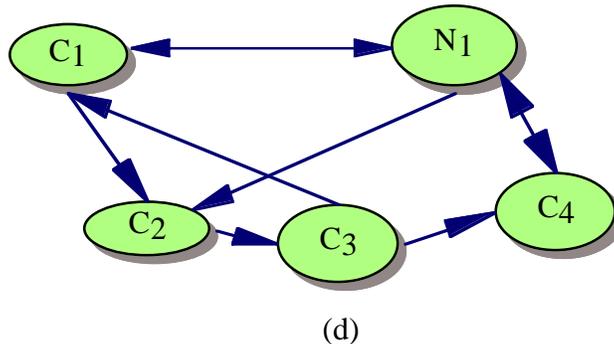
Meaningful Learning: More aspects of new concept, N_1, become related to existing concept structure, with different types (types not differentiated in diagram) of relations.

For example, a new person, N_1, may be encountered, his occupation become known as "4th grade teacher" C_1, the name Smith, C_4, associated with him, and the thought of the new person invokes a thought of the learner's own 4th grade teacher, Mrs. Johnson, C_2.

Figure II.7 a-d

Relating a new concept (N_1) to existing concept structure

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Meaningful learning requires learner to expend *deliberate* cognitive effort; intent

Learning is work. It is labor that the learner him- or herself must perform. Perhaps this is obvious, yet learning and thinking are often treated passively, or as automatic, effortless. The cognitive processes that enable learning and thinking (described below) cannot be passive, but require deliberate expenditure of cognitive energy (Figure II.8).

> . . . although it is possible for children to learn some things incidentally, *deliberate* effort is required for the efficient learning of most types of academic material [ARK 33 (emphasis added)].
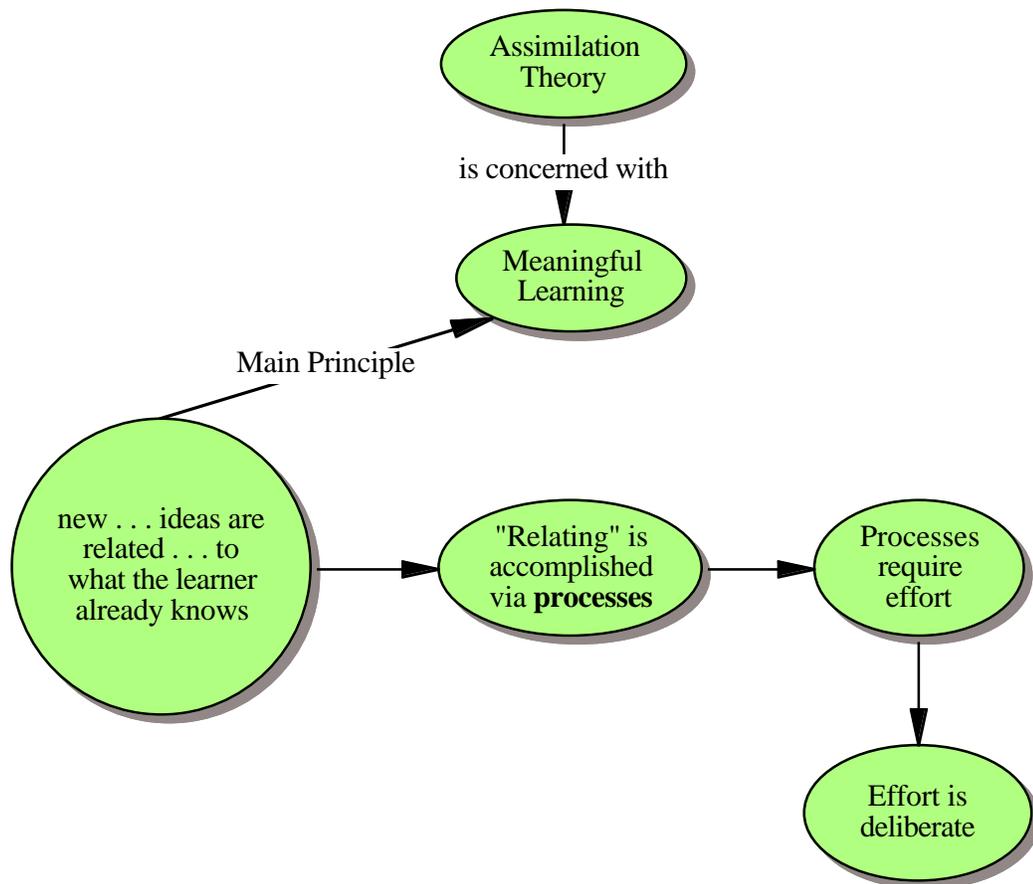
Figure II.8

Although individuals can acquire much miscellaneous information incidentally, *deliberate* effort is required for the efficient learning of most types of academic subject matter. [ARK 194]

. . . irrespective of how much potential meaning may inhere in a particular proposition, if the learner's intention is to memorize it arbitrarily and verbatimly (as a series of arbitrarily related words), both the learning process and the learning outcome must of necessity be rote or meaningless. [ARK 68]

What is the nature of this cognitive labor? What work actually is performed? Why is it difficult? Assimilation Theory stands on the epistemological platform of cognitive constructivism, the claim that knowledge must be constructed by the learner rather than passively received. Construction requires labor. It is not passive. One must recognize what is already in place to know the best method of affixing new materials to it. Existing structure must be sound before adding more to it, concrete must be dry. The second story must exist structurally before the third floor can be set in place, even if constructed elsewhere. Concepts too can be constructed elsewhere and presented in a completed state, relieving the learner of some of the constructive labor: this differentiates *reception* learning from *discovery* learning.

In Ausubel's terms, the psychological work is the constructive integration of new ideas with ideas previously held by the learner. Establishing new relations among concepts may require several specific sub-tasks, including searching for and recognizing which concepts are to be related or which attributes of which concepts are to be related, recognizing the relations to be established among them, and determining whether the new structure is to be associated with a linguistic expression label of its own. These are accomplished through the processes described by Assimilation Theory (transfer, subsumption, etc., below).

The intellectual effort a learner expends is a cognitive component of the price or cost of meaningful learning. It might be borne wholly by the learner, or subsidized through constructive labor performed by others, but the final construct left to be assimilated by the learner. Despite the discovery labor performed by others, this final assimilation still requires cognitive labor to establish relations between the new constructing and their existing knowledge, just as a home owner can avoid the labor of constructing a kitchen counter by *receiving* it from a vendor but the labor of connecting to the existing kitchen must still be performed.

Novak reinforces the indispensability of the learner's *intent* to perform cognitive labor:

> To Ausubel, *meaningful learning* is a process in which new information is
> related to an existing relevant aspect of an individual's knowledge
> structure. However, *the learner must choose to do this*.
> [Novak 1998 51 (emphasis added)]

Nor can the integrative aspect of this labor be performed by others on the learner's behalf, nor shared (see next section, Meaningful learning and epistemological individualism).

> . . . learning is an activity that cannot be shared . . . is rather the
> responsibility of the learner . . . [Novak 1998 113]

Meaningful learning and epistemological individualism

The Assimilation Theory principle requiring deliberate cognitive effort by the learner comports with the epistemological position of individualism (Figure II.9).
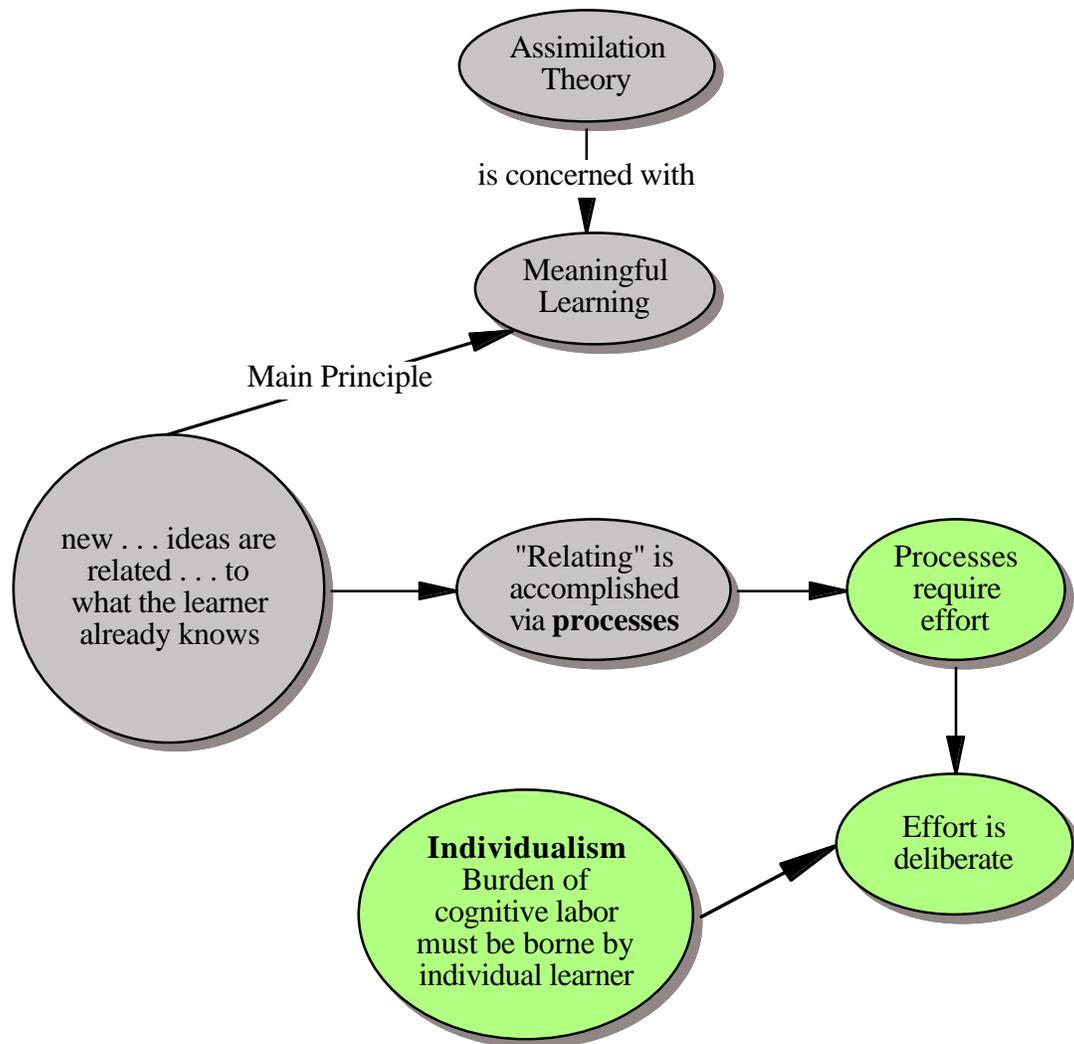
Figure II.9

Individualism holds, in part, that responsibility for one's knowing rests with oneself. It is directly opposed to the notions that knowledge can only be socially constructed and that study of the individual mind is unwarranted. Methodological individualism derives from the rationale that no two persons' concepts can be identical because knowledge arises, in part, from one's accrued sensory experience. And because each person has different experience, each constructs his or her own idiosyncratic meanings, personal knowledge.

Assimilation Theory recognizes that *individuals* engage in intellectual challenges that others do not, such as enduring a SAT test, earning a living, or qualifying for a driver's license. Similarly, it is the individual learner who must perform the cognitive labor of learning and who is held accountable for his or her knowledge and lack of knowledge.

> . . . the assumption that social interaction is *cognitively* mediated . . . that our interpersonal behaviors are determined by *what we know* (or believe) about ourselves, other people, the situations in which we encounter them, and the behavior that takes place in them.
> [UCBPsych250C 2006 (emphasis added)]

Ausubel's commitment to individualism is unwavering:

> . . . *learners* are able effectively to *exploit their own* existing knowledge.
> [ARK 77 (emphasis added)]

Novak affirms Assimilation Theory's epistemological position of individualism:

> To Ausubel, meaningful learning is a process in which new information is related to an existing relevant aspect of an *individual's* knowledge structure. [Novak 1998 51 (emphasis added)]

Meaningful learning elements

Ausubel specifies several cognitive resources that must be provided by the learner (Figure II.10):

> New meanings . . . are the product of an active, integrative interaction [processes (2)] between [4] new instructional materials and [1] relevant ideas in the learner's existing structure of knowledge. The conditions of learning presuppose additionally the existence of a [3] meaningful learning set in the learner . . . [ARK 40 (enumeration added)]

Potentially meaningful instructional materials are provided by a teacher.
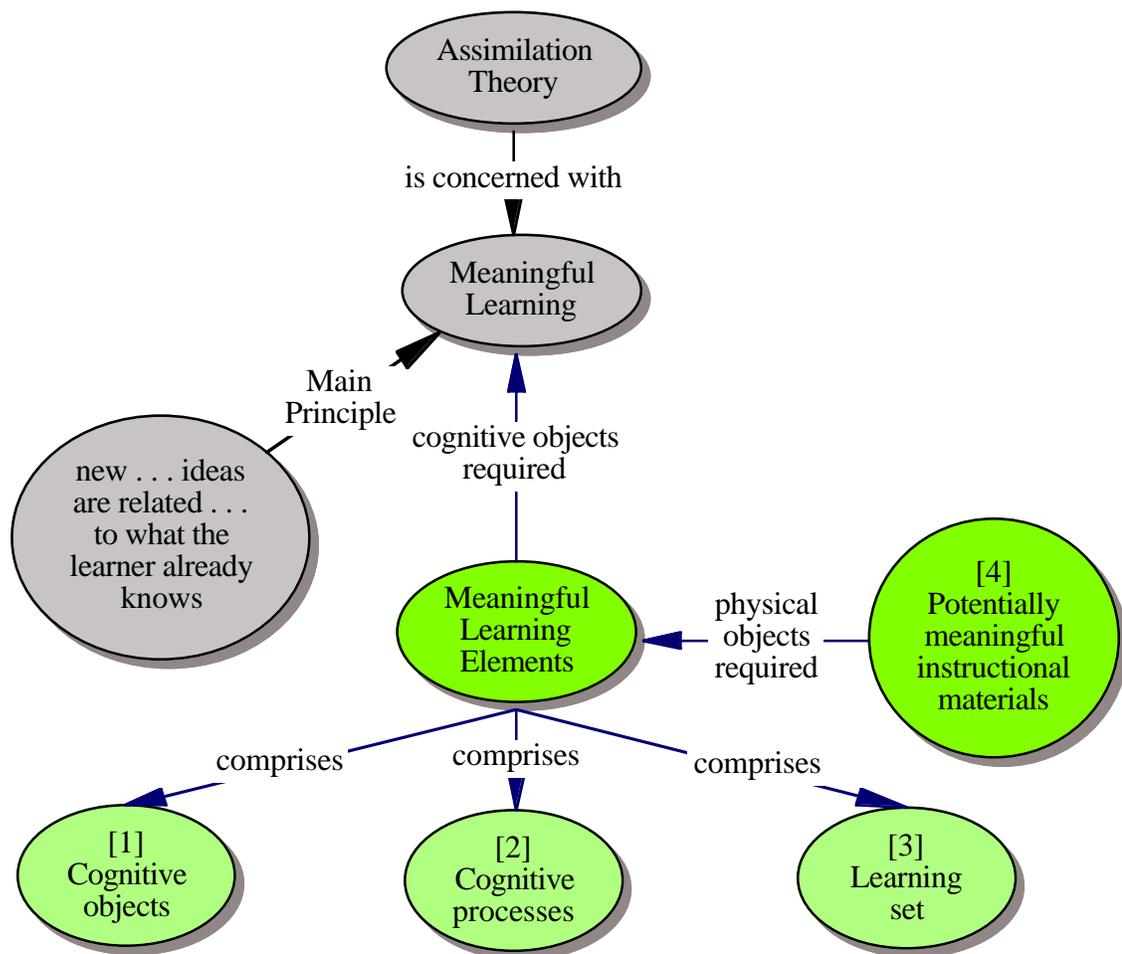
Figure II.10

Cognitive objects in meaningful learning:

The first of the three elements required of the learner is *cognitive objects*, i.e., an existing network of ideas. (Figure II.11).
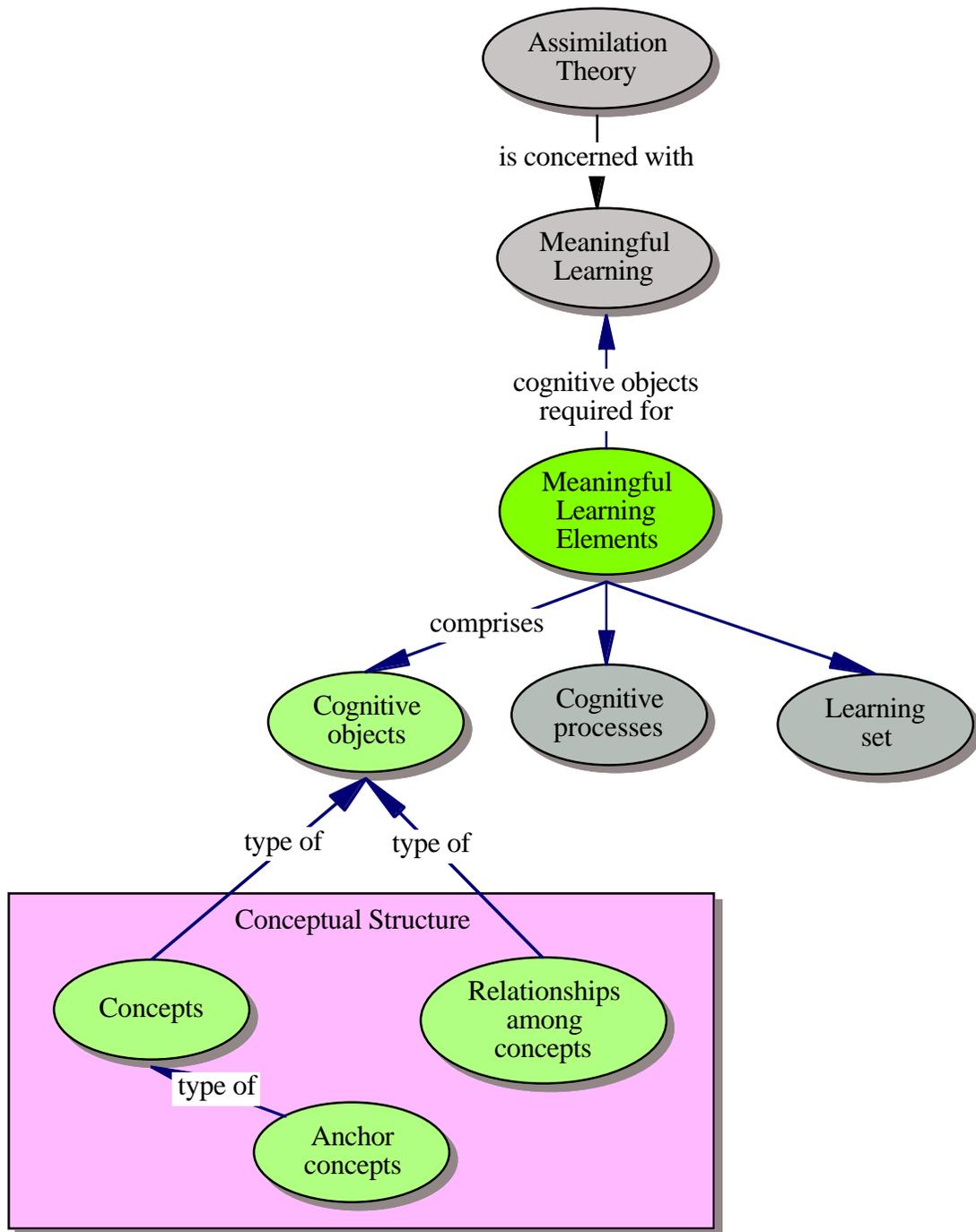
Figure II.11

Concepts

Ausubel defines *concepts* as:

> *Concepts Defined and Kinds of Concept Learning* Concepts may be
> defined as objects, events, situations, or properties that possess common
> criterial attributes and are designated by the same sign or symbol.
> . . . criterial attributes of new concepts can be defined by use in new
> combinations of existing referents available in the child's cognitive
> structure. . . .
> Concepts themselves consist of the abstracted criterial attributes that are
> common to a given category objects, events, or phenomena, despite
> diversity along dimensions other than those characterizing the criterial
> attributes shared by all members of the category [ARK 2]

The first statement in the passage is ambiguous as to whether concepts inhabit the

physical world. Then, "concepts are criterial attributes" and "criterial attributes defined

in the child's cognitive structure" locate concepts in the learner's mental realm.

Ausubel recognizes a bright line between concepts and linguistic expressions:

> Concepts . . . *are designated by* the same sign or symbol.
> [ARK 2 (emphasis added)]

reflects the notion that concepts are distinct from signs and symbols. Ausubel defined

concepts in terms of "criterial attributes":

> [I]t is very convenient to be able to represent the multiple *criterial*
> *attributes* of a newly learned concept by a single word that is equivalent to
> its meaning. But learning what the concept itself means, which, in effect,
> consists of learning what its criterial (distinguishing or identifying)
> attributes are, requires a very different type of meaningful learning that,
> like propositional learning, is substantive in nature and intent rather than
> nominalistic or representational.
>
> 'These two types of meaningful learning (concept and propositional) differ

in that in the former instance the *criterial attributes of a new concept are related to relevant ideas in cognitive structure*
[ARK 81 (emphasis added)]

Thus, concepts are internally structured, and comprised of concepts, relations, and optionally a linguistic term, label, or name (on occasion, one might have difficulty finding terms to express concepts one thinks or feels).

The terms *concept* and *conceptual structure* have substantially similar connotations. Ausubel also refers to concepts as *cognitive structure*s (see below).

Anchor concepts

Anchor concepts are those concepts with which relationships to new ideas may be established. They are often superordinate (inclusive, having many relations) concepts:

> Knowledge . . . is the product of . . . relevant background ("anchoring") ideas in the <u>particular</u> learner's cognitive structure . . .. [ARK vii]

> In order to indicate that meaningful learning involves a selective interaction between new learning material and preexisting ideas in cognitive structure, we will employ the term *anchorage* to suggest linkage over time to the preexisting ideas. [ARK 3]

Anchor concepts have a key role in the cognitive processes associated with meaningful learning (described below), for example:

> . . . in subsumption, preexisting superordinate ideas provide anchorage for the meaningful learning of new information. [ARK 3]

Ausubel uses *scaffolding* interchangeably with *anchor*:

In effect, they [relevant existing cognitive structures] provide ideational scaffolding (anchorage) at the appropriate level of conceptualization. [ARK 62 (annotation added)]

This is a different sense of the term *scaffolding* than that of "assistance to a learner provided by an outside source." Thus one may distinguish *ideational scaffolding* from *externally-provided support scaffolding* as in Angelo:

The weaker or smaller the student's foundation (preparation) in the subject, the stronger and larger the instructional scaffolding (structure and support) that is required. [Angelo 1993]

Granularity of concepts

Figure II.14 (see: Cognitive structures, below) depicts both a unitary form of a concept (polygon, relation, and label) and a version that details the structure of the concept. The notion of different levels of granularity or detail is important because these component concepts may function as the attributes to which the relations with other concepts are formed:

[T]he most general and inclusive ideas of the discipline are presented first and are then progressively differentiated in terms of *detail and specificity*. [ARK 163 (emphasis added)]

Relationships among concepts: *meaning*

Relationships *among* concepts are the second component of concept structures.

> Meaningful learning requires . . . that the material they learn be
> potentially meaningful to them, namely, *relatable* to their particular
> structures of knowledge . . . (Ausubel, 196la)
> [ARK 68 (emphasis added)]

Ausubel uses the terms *relation* and *relationship* interchangeably. In this essay,

relationships among concepts are comprised of one or more specific *relations*, e.g., *is*

greater than, *is name of*, *gave birth to*, *is a logically valid syllogism from . . . and . . .*

etc. Relation types are potentially unlimited in number as human imagination itself.

Relations are, themselves, concepts. Thus, relation concepts also have structure

comprised of concepts and relations (Figures II.12 (a-b)).

Mary ——— is a parent of ———▶ Caitlin
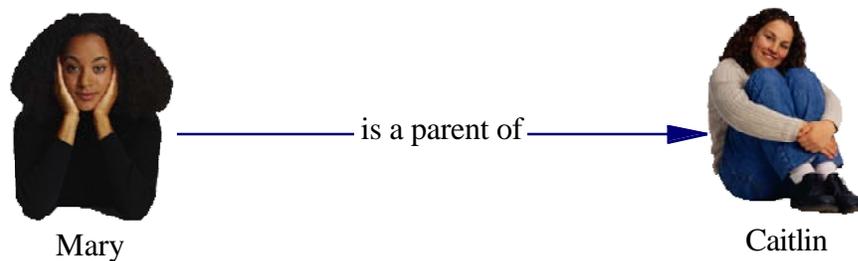
(a)
A simple concept map might depict a typical relation, *is parent of*
between the concept of *Mary* and the concept of *Caitlin*

Figure II.12(a)

The relation *is a parent of* is, itself, a concept comprised of concepts and relations:
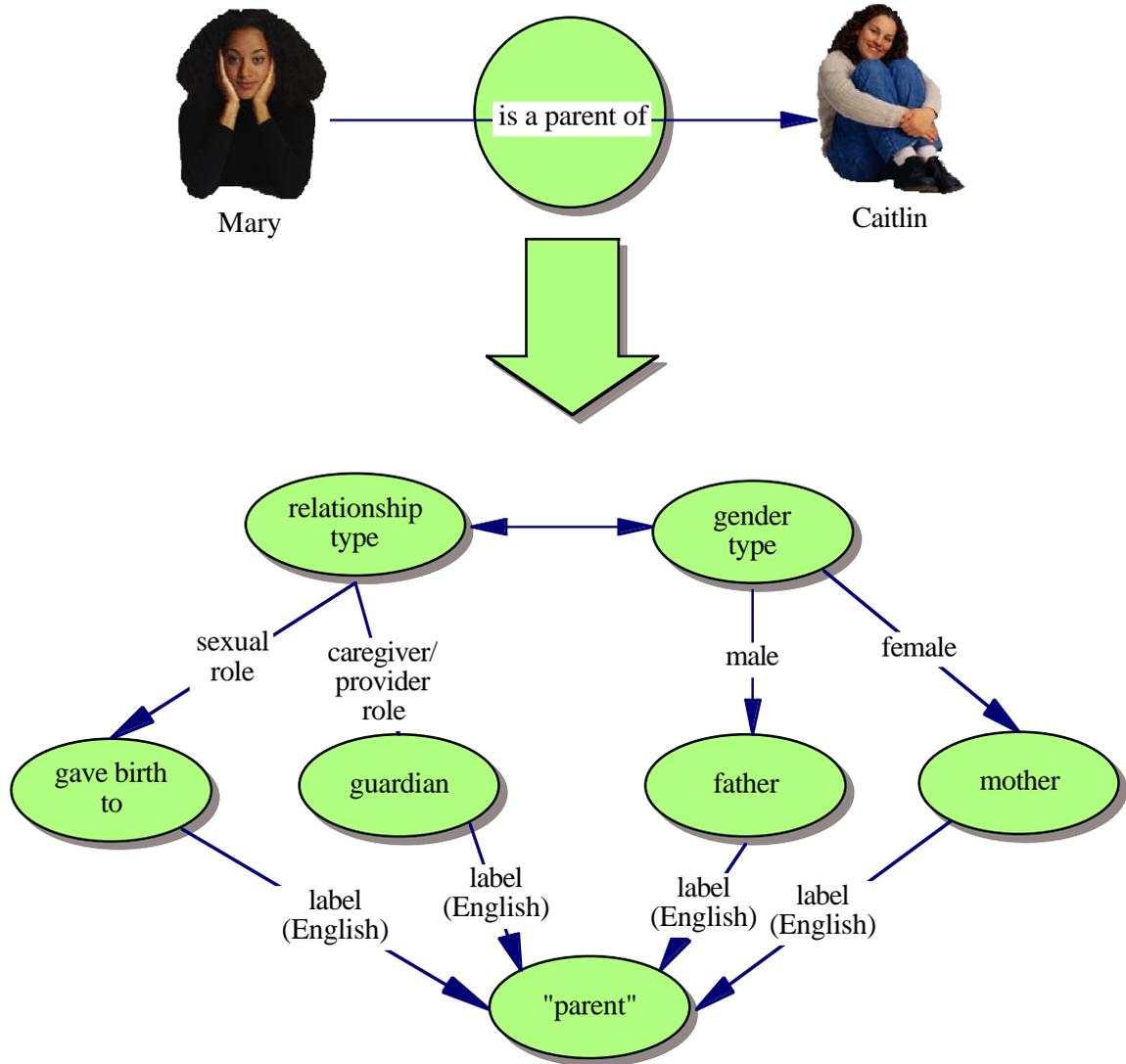
(b)
A typical relation concept, *is parent of*
analyzed for its constituent concepts and relations

Figure II.12(b)

Relations are formed through *learning*, that is, through the cognitive processes as described by Ausubel (see: Cognitive processes in meaningful learning).

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Why are relations among concepts important? Because relations among concepts are the source of meaning:

> . . . meaning is an interactional product of the *particular* way in which the content of the new proposition is *related* to the content of relevant established ideas in cognitive structure. . . . [ARK 3 (emphasis added)]

Meaning of an idea only occurs to the extent it has relations to other ideas.

Humans are meaning makers. *Meaning* is thus the human experience of an *existing* relation among concepts. *Learning* is the construction of a *new* relation, that is, new meaning. When a learner cognitively constructs a relation among concepts, one has *made meaning*, to a lesser or greater extent. Making meaning is often a terminal endpoint to an inquiry. That is, making meaning is sufficiently satisfactory that an inquirer might find no reason to continue the expenditure of cognitive effort required in thinking about a matter. Both the cognitive constructive learning effort and the concepts themselves are characterized by Ausubel as *meaningful*.

The degree of meaningfulness is a function of various factors including the type and relevance, strength, and number of relations. For example, where one's existing knowledge has few relations or weak relations to a new idea, the new concept is characterized by Ausubel as more rote than meaningful:

> Representational learning (e.g., learning concept *names*), for example, is much closer to the rote end of the continuum than either concept or propositional learning since its process embodies significant elements of arbitrary and verbatim relatedness to its referent in cognitive structure. [ARK 5 (emphasis added)]

As the relationship becomes comprised of more, stronger, or more important types of relations, the new concept is deemed more *meaningful* (Figure II.13).
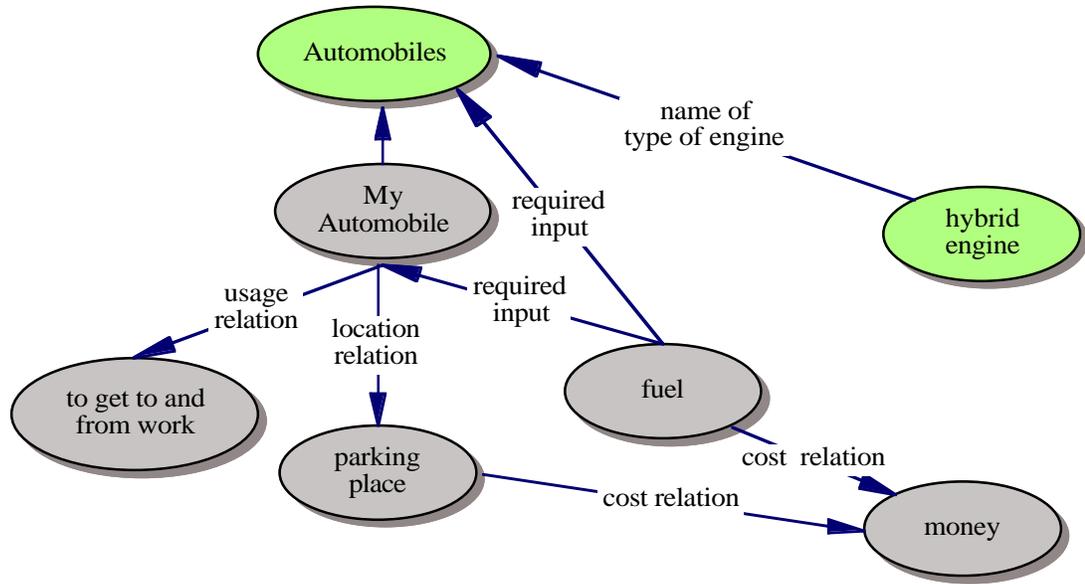
(a)
Existing knowledge structure and a new idea,
hybrid engine having only one relation, *name*, and thus not learned meaningfully.
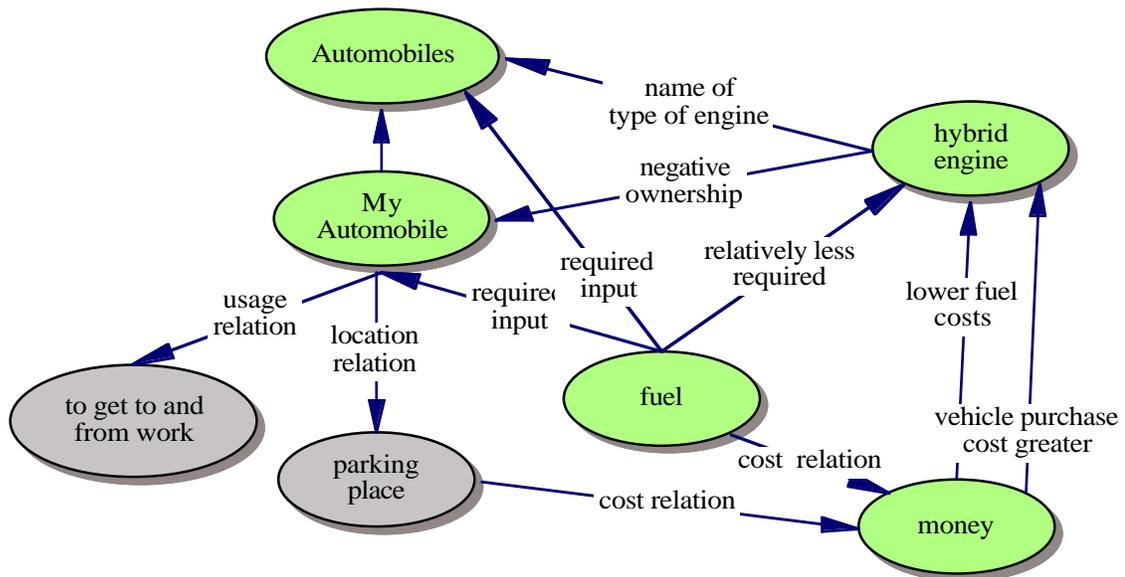
(b)
The concept of *hybrid engine*, learned somewhat more meaningfully
Note: the relationship between *hybrid engine* and *money* is comprise of **two** relations..

Figure II.13

Cognitive structures

Cognitive structures, or conceptual structures, are objects comprised of concepts and the relations among them (see: [ARK 81] quoted above).

Ausubel uses *concept*, *conceptual structure*, *knowledge structure*, and *cognitive structure*, interchangeably depending on whether emphasis is on the unit or upon its constituent elements. In some contexts, *knowledge structure* connotes a limitation to declarative knowledge, while *cognitive structure* encompasses declarative knowledge, process knowledge and ability, and even emotional, sensory, or motor knowledge.

Thus, cognitive structures have the same composition as concepts themselves,

concepts + relations among concepts + optional linguistic label.

Thus, they may be depicted in concept maps either with only a label, or with their internal structure revealed (Figure II.14).

Of what constructive use are cognitive structures? Structures bind or connect objects. Connections can facilitate a response by one element upon stimulus of another element connected to it.

For an oversimplified example, suppose a learner's mental structure binds concept A to concept B. Then, stimulated by A, the learner evokes, constructs, or draws conclusion B. One may say that the learner has "been reminded or informed of B by stimulus of A."

As with their brick-and-mortar counterparts, cognitive structures can be incomplete relative to a conceptual reference structure, contradictory, damaged, have internal inadequacies, or be defective in other ways. Connections among concepts can possess the same defects: obstructed, or of a type that does not serve the learner well (e.g.,

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unsupported by evidence, believed by others to be "alternative understandings," false, mistaken, or logically inconsistent, "wrong," "misinformation").
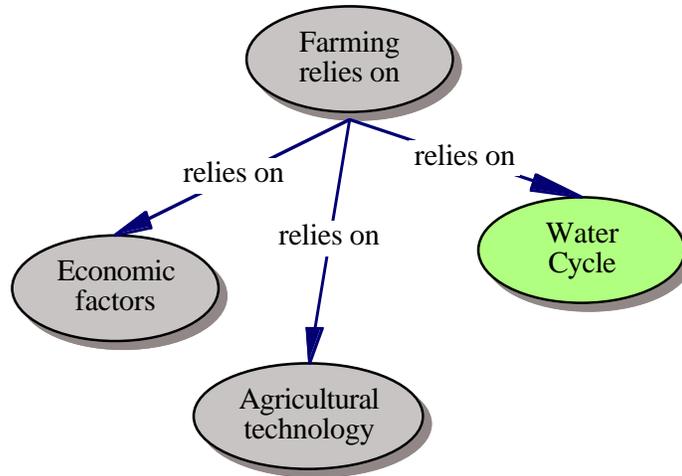
(a)
Water Cycle depicted as a unitary
concept in a simple concept map
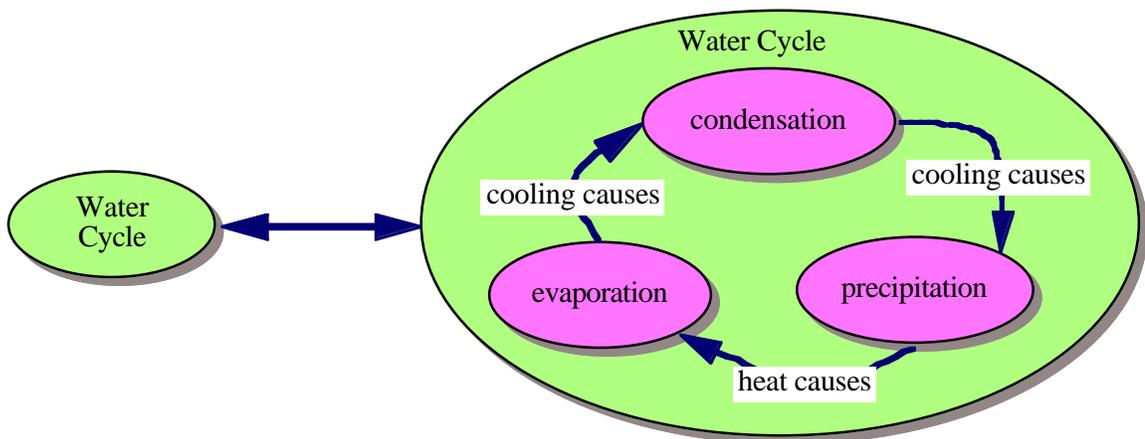
(b)
Water Cycle magnified to show its internal
conceptual structure, concepts and relations

Figure II.14

Generalization vs. Hierarchy. Ausubel's theory (unfortunately) appears to recognize *only* one particular type of structure: hierarchy.

> The most *general* ideas of a subject should be presented first and then
> progressively differentiated in terms of detail and specifics.
> [Bowen undated]

Although both *generalization* and *hierarchy* provide the benefit of *inheritance*, Ausubel interprets generalization *as* hierarchy, foreclosing the possibility that inheritance could apply to non-hierarchical structures. Thus, proclamations equating hierarchical structure with a continuum of general-to-specific, are found throughout Assimilation Theory:

> The first principle acknowledges that most learning, and all retention and
> organization, of subject matter is *hierarchical* in nature, proceeding from
> the top downwards in terms of level of abstraction, generality, and
> inclusiveness. [ARK 6 (emphasis added)]

Hierarchy is only one of many types of relations between conceptual objects. One may question whether Ausubel's assumption that inheritance, general-to-specific deduction must impose hierarchy to *all* concept structure, rather than other network- or web-like structures. Not every relation is comprised only of parent and child components. Further, hierarchical status of a concept structure can change depending on context: a concept may be a parent to another concept in one context but inherit characteristics from it, i.e., as a child, in another (Figure II.15(a)).

Though Ausubel's adherence to hierarchy is acknowledged, it reflects an internal inconsistency within his theory. The limitation of conceptual structure to hierarchy is not a <u>Stage Two</u> analytic criterion in this study. (Figure II.15(b))

Relationship between concepts not
always rigidly hierarchical

library

may
contain

may
contain

may
contain

(*book* as *child*
to *library*)

a map

a piece of
sheet music

a book

a book

may be
found at

may be
found at

may be
found at

(*library* as *child*
to *book*)

a bookstore

a friend's
house

a library
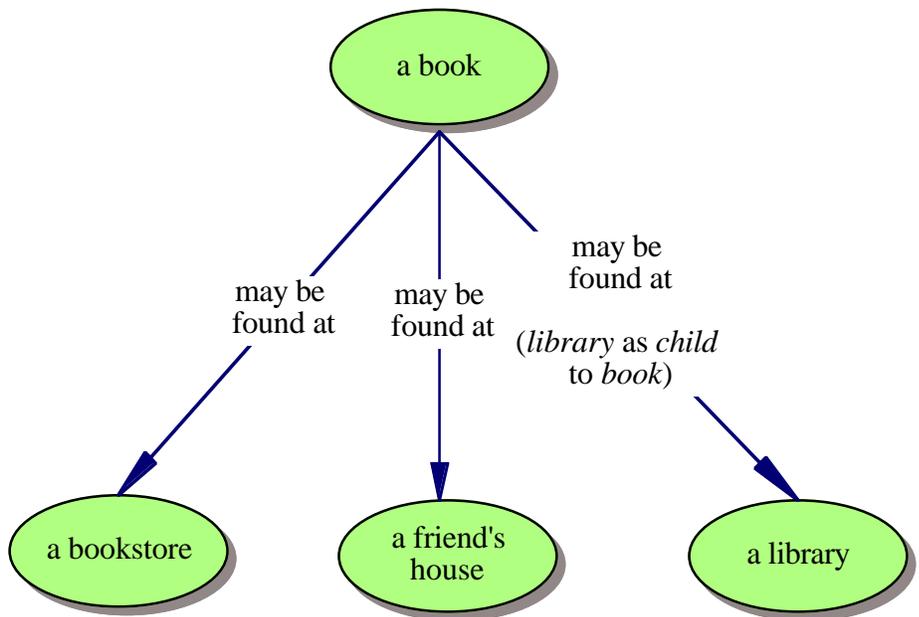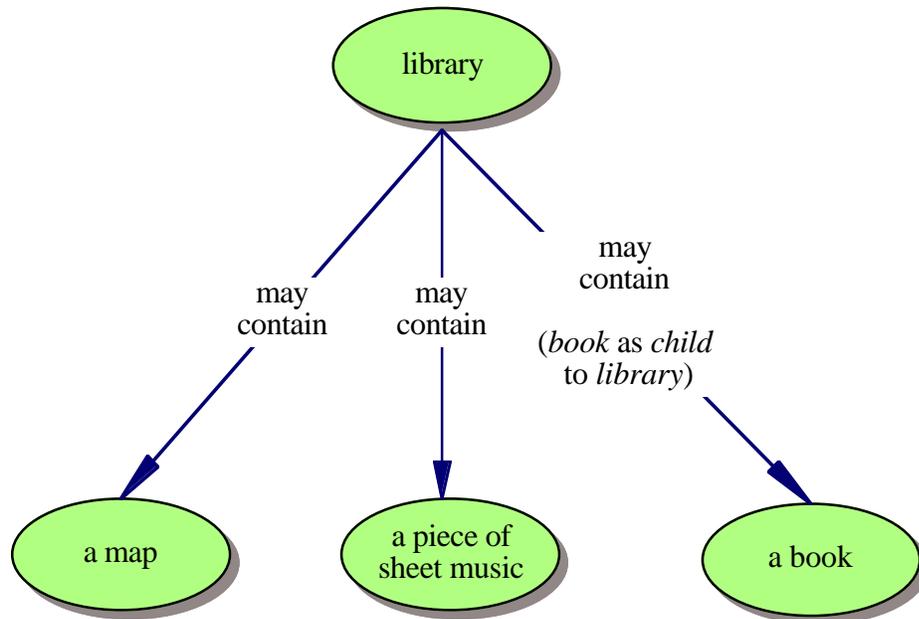
Figure II.15 (a)

Network-style relations
adopted for this study
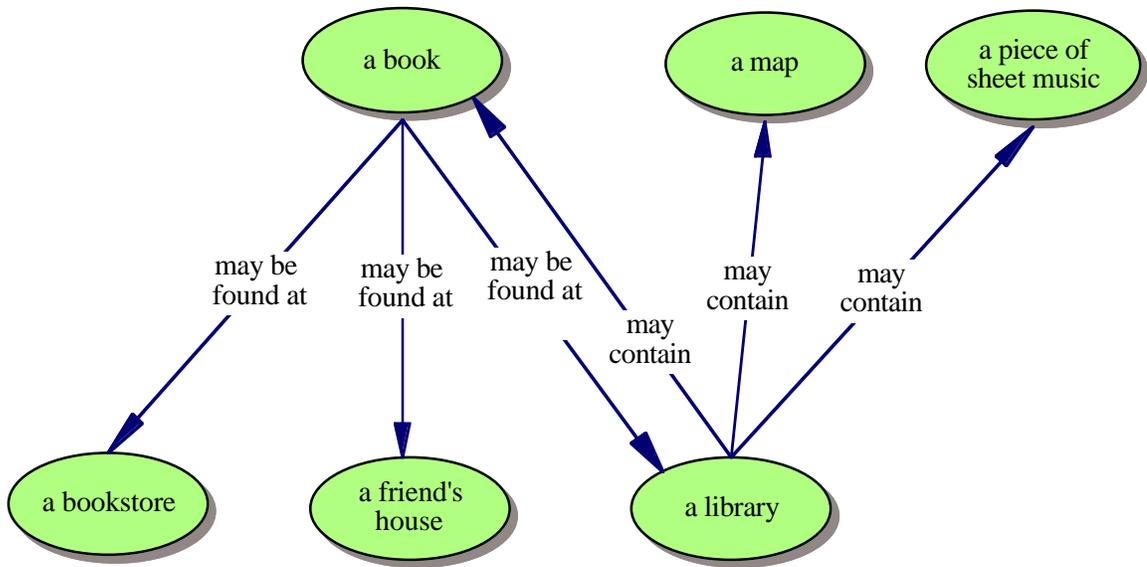
Figure II.15 (b)

Cognitive processes in meaningful learning

Cognitive processes are the second of three elements required of learners (Figure II.16).
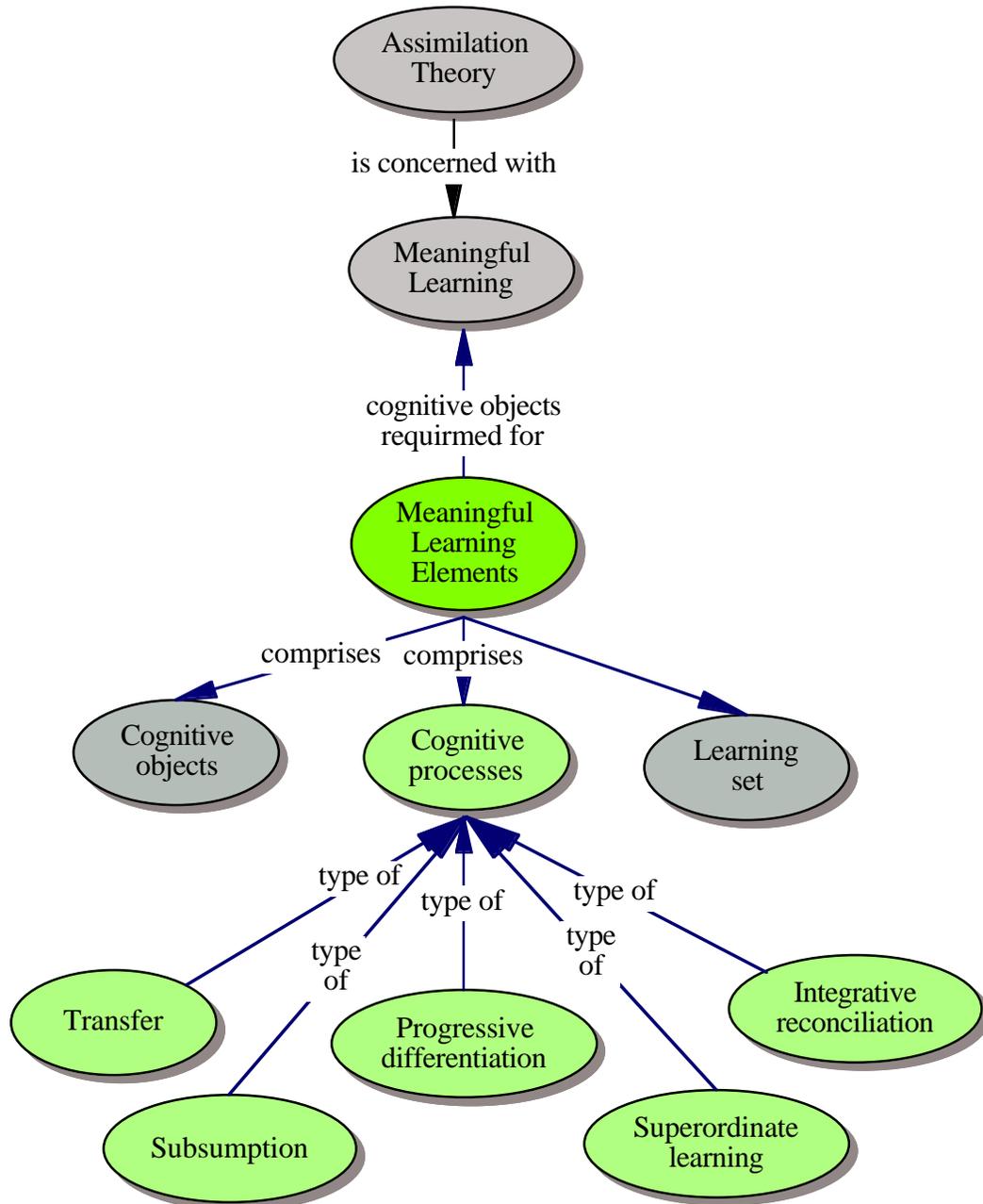
Figure II.16

"Relating new ideas to those already known" is the essence of meaningful learning, and provokes the question of *how* such relations are established. Ausubel responds with several hypothesized cognitive processes that result in the formation of new knowledge structure. These processes, originally described by Ausubel as integrative reconciliation, subsumption, superordinate learning, and progressive differentiation, are accompanied by *transfer*, also acknowledged by Ausubel as essential.

Transfer

Transfer is the name historically applied in education and educational psychology to the projection of knowledge held by a learner in one context or situation to a different context:

> . . . transfer still refers to the impact of prior learning experience upon
> current learning. [ARK 60]

> . . . the goal of transfer is considered accomplished if prior learning
> experience facilitates the learning of subsequent classroom learning tasks
> . . . [ARK 173]

> . . . all meaningful learning necessarily also involves transfer. [ARK 9]

Because Ausubel was a firm adherent of transfer [Ausubel Novak Hanesian 1978 165], it is treated here as equal in importance to processes for which Ausubel is the acknowledged originator (subsumption, progressive differentiation, superordinate learning, and integrative reconciliation):

Transfer operates by filling in structural gaps of one concept, from another concept, usually a richer concept. That is, one concept's relations or attributes are projected onto another concept either lacking those properties or possessing conflicting attributes.

A simple example of transfer is Newton's observations about an apple as it collided with his head, provoking him to wonder whether the same forces that might explain its flight path could explain relationships among objects in space. He projected or transferred the concept structure (the earth exerting a gravitational influence on an apple) to an interplanetary scale.

The benefit of transfer is that it conserves cognitive labor by using one element of a concept structure to evoke or trigger another concept. Constructing conceptual structure, learning, becoming informed [Buckland 1988 ch. 9], is expensive in terms of expenditure of cognitive energy. Mental work is required to find the relations, establish connections, and affix labels or terms. With transfer, energy is conserved. A new concept need *not* be constructed from raw materials, but instead, an existing concept structure is projected onto another that already exists.

Indeed, without transfer, every slightly varying object or experience encountered would seem wholly new and unique to the learner. She would be unable to use her prior knowledge about one object or experience to confront a similar object or event. In short, the learner could not categorize, theorize, or perform other cognitive tasks which people rely upon in daily life.

A worked example of transfer (Figure II.17(a - f)) illustrates the basic mechanisms in greater detail. Suppose a learner assimilates (i.e., abstracts from sensed experience) the concept that material accumulating results in a force upon adjacent material, then he or she demonstrates the notion of *transfer* if, upon encountering the same abstraction (pressure causes motion) in a non-material context, he or she can recognize regularities between the two contexts, and then project the idea of *pressure* onto the latter, a sparse

cluster of electrical concepts, to form the notions of *amperes*, which corresponds to *flow*, and *volts*, which corresponds to *pressure* (Figure II.17(a - f)):
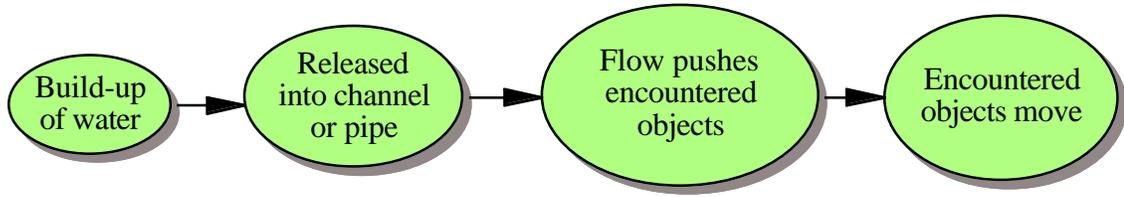
(a)
Observed in sensed
experience
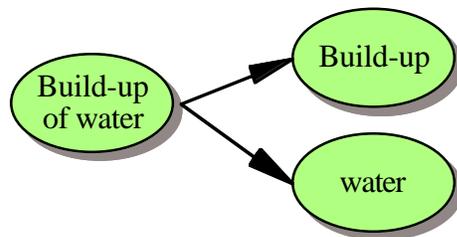
(b)
Initial concept
is deconstructed
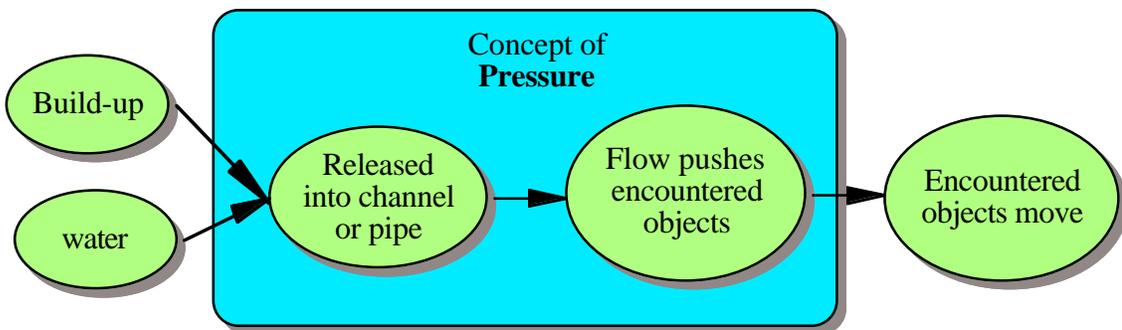
(c)
Concept or abstraction of
water **pressure** arises

75

(d)
Perimeter concepts ("build-up" and "encountered objects move")
arise, along with a new concept ("electrical charge")
that does not map isomorphically to water pressure
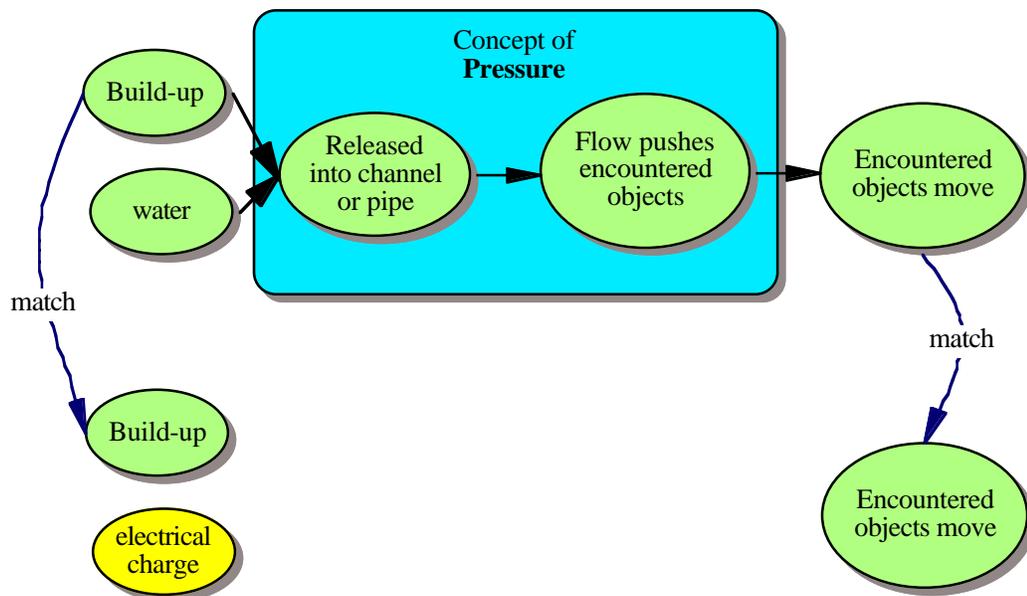
(e)
The process of **transfer**, i.e., isomorphic mapping, begins
with correlating those concepts that match, i.e.,
isomorphically map to one another, . . .
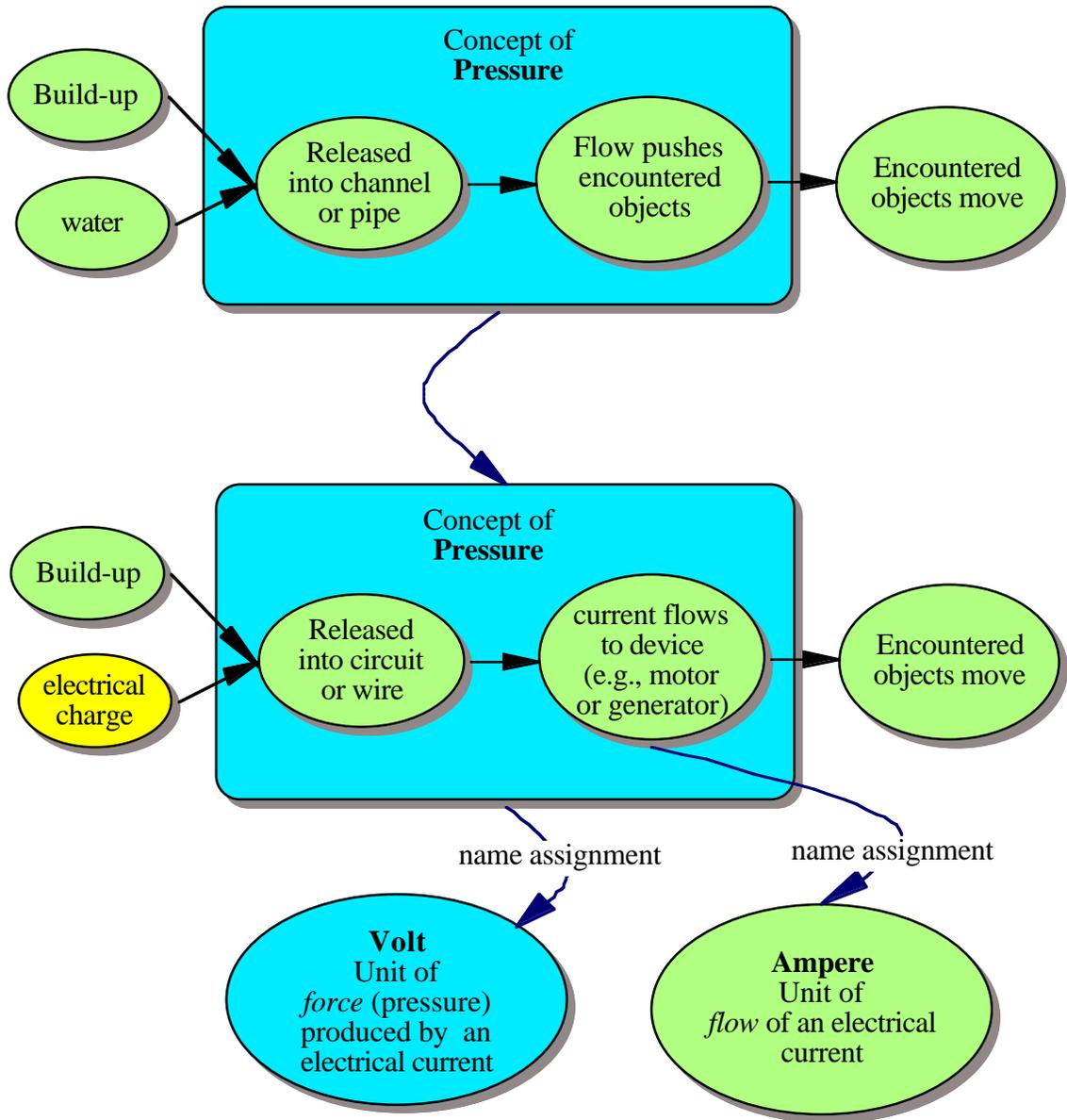
(f)
then, other elements of the source concept, for which there is no counterpart in the new concept, are projected to "fill in" the recipient structure.

Concept of **pressure** *transfers* to the concept of electrical phenomena,

to which a label, **volt**, is assigned. and

flow water transfers to flow of electricity and named **ampere**

Figure II.17(a - f)

Transfer is founded upon a pair of concepts described in this report as *isomorphic mapping* and *isomorphic projection* [Hofstadter 1979   49]. There are many variants of isomorphic projection beyond *transfer*. These are surveyed in Section II.2 as well.

Subsumption

Subsumption is a process whereby a new idea is subsumed into an existing established (superordinate or anchor) idea and thus benefits from the structure of the subsumer:

> [N]ew ideas and information can be meaningfully learned and retained most efficaciously when appropriately relevant and typically more inclusive concepts or propositions are already available to play a subsuming role or to provide ideational anchorage. [ARK 41]

> In both concept and propositional learning, new, potentially meaningful information is most frequently anchored to more general and inclusive relevant ideas in the learner's existing cognitive structure.   This process of relating new information to relevant preexisting superordinate segments of cognitive structure has been referred to above as subsumptive learning. [ARK 89]

The process of subsumption involves isomorphic mapping (see: II.2 Isomorphic mapping) between characteristics of a superordinate anchor concept and those of a new concept, followed by isomorphic projection of remaining aspects of the new concept onto the superordinate anchor.

> A subsuming concept is not a kind of mental fly paper to which information is stuck; the role of a subsuming concept in meaningful learning is an *interactive* one, facilitating movement of relevant information through the perceptual barriers and providing a base for linkage between newly perceived information and previously acquired knowledge. . . . in the course of this linkage, the subsuming concept becomes slightly modified, and the stored information is also altered

somewhat. It is this interactive process between newly learned material and existing concepts (subsumers) that is at the core of Ausubel's assimilation theory of learning. [Novak, 1998. 59 (emphasis added)].

Figure II.18 illustrates the important events in the subsumption process.

As an example, suppose a young learner establishes an anchor concept of "attending school" where that school is kindergarten. The concept structure might include (A) the idea of a teacher, (B) the abstraction of a location of activity such as a classroom or play area, (C) the notion of a lunch period, and (D) the idea of classmates. The following year, our learner encounters a new concept of having a desk in which, in part, pencils are stored (X). Gradually, the new concept of *pencils stored in desk* is subsumed into the concept of "attending school" and eventually, in the final phase of subsumption which "obliterates" the new concept, it (the subsumed concept, *storing pencils*) is no longer available (evocable) by the learner when the anchor concept "attending school" is activated.

One effect of subsumption is that attributes of the new concept, having become part of an existing anchor concept, become associated with the linguistic expressions of the anchor.

Ausubel associates the mental process of forgetting as one type of subsumption:

> Forgetting, in process terms, is conceptualized as the second, or "obliterative" phase of subsumption in which the distinctive import and substance of a meaningfully learned and subsumed idea is at first dissociable from the anchoring (subsuming) idea, then gradually loses this dissociability, and is finally assimilated completely by the more general meaning of its more stable and inclusive subsumer. . . . [ARK 41]

Specific types of subsumption, viz. obliterative subsumption, correlative subsumption, and derivative subsumption are described by McGriff [McGriff AT].

Existing Anchor (superordinate) concept
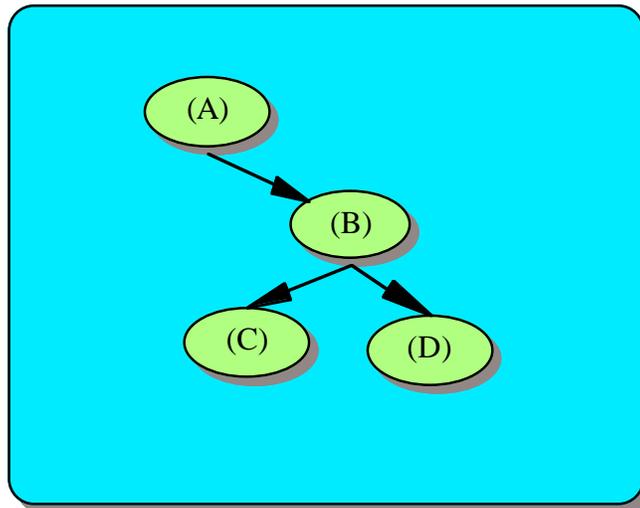
(a)
An established (existing) anchor concept resides in learner's mind.
It is a conceptual structure comprised, for example, of concepts (A), (B), (C), (D),
and having relations between (A) and (B) and between (B), (C), and (D).

New concept
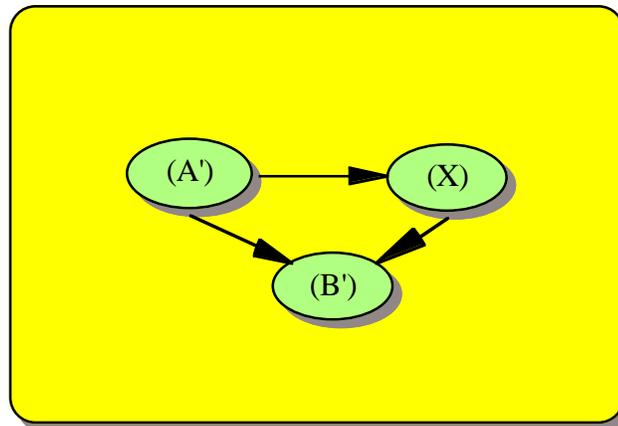
(b)
New concept arises either constructively or
from sensory experience.
It is comprised of concepts (A'), (B'), and (X),
with relations among them as shown,
and where (A') is substantially similar to (A) in the anchor,
and (B') is substantially similar to (B) in the anchor.

Figure II.18 (a-b)

Existing Anchor (superordinate) concept

New concept

matched

matched

(A)

(B)

(C)

(D)

(A')

(X)

(B')
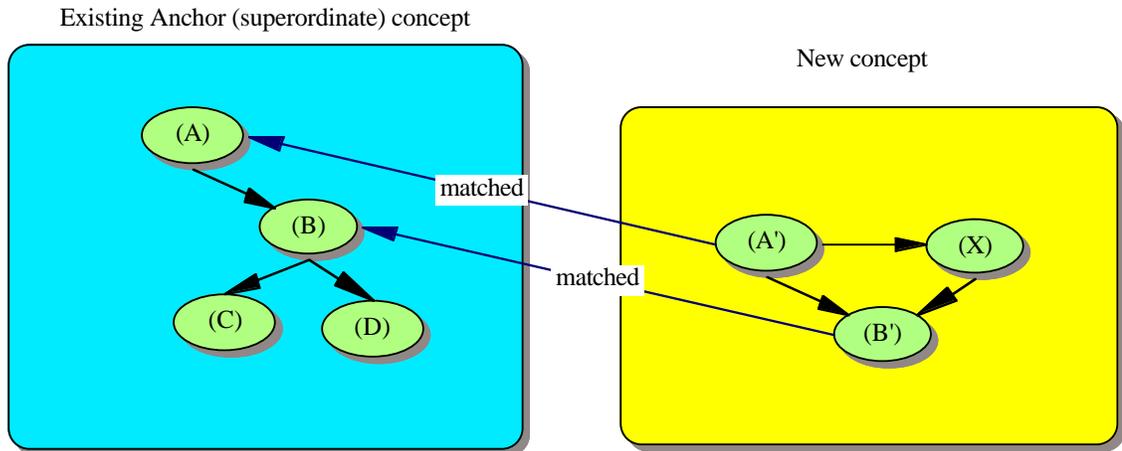
(c)
Through isomorphic mapping (matching)
(A') is mapped to (A),
(B') is mapped to (B), and
the relation between (A) and (B) is mapped (not illustrated) to the relation between (A') and (B')

Result: Because of the isomorphism, the new concept is
a candidate for subsumption into the existing anchor concept.

Existing Anchor (superordinate) concept

New concept

(X) projected to
anchor concept

(A)

(X)

(B)

(C)

(D)

(A')

(X)

(B')
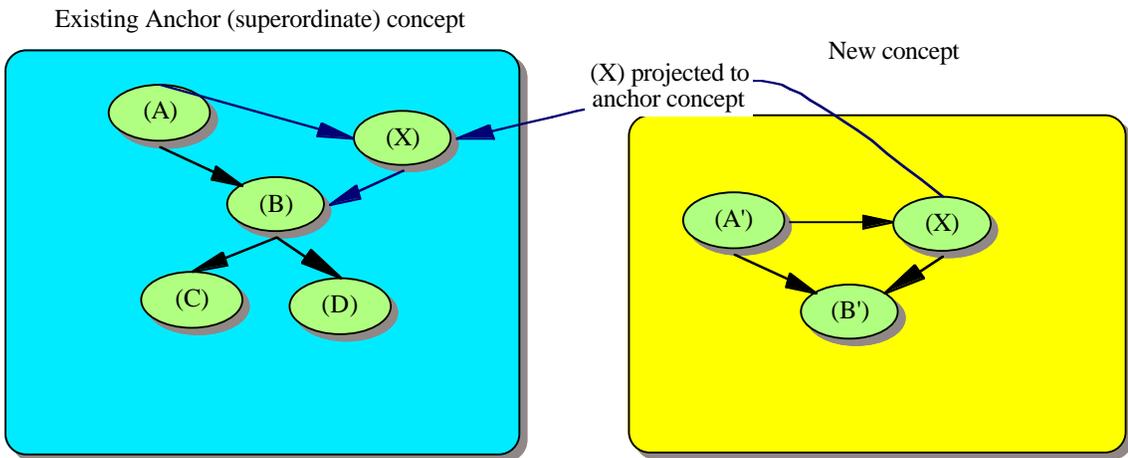
(d)
Through isomorphic projection,
(X) is projected from new concept onto anchor concept,
the relation between (A') and (X) is also projected onto anchor concept, and
the relation between (B') and (X) is projected onto the anchor concept.

Figure II.18 (c-d)

Subsumption of new concept complete.
Existing Anchor (superordinate)
concept (modified)
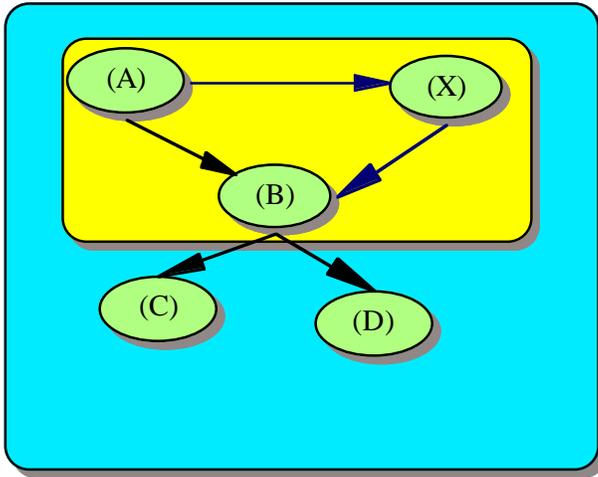
No longer available as
distinct concept
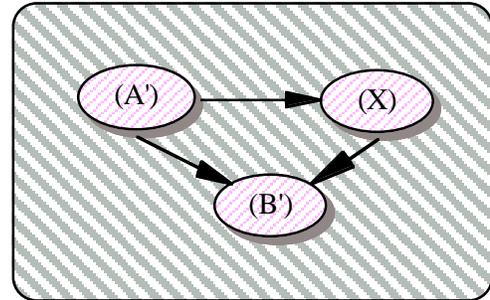
(e)
The subsumption process is completed with the unavailability of the new
concept as a separate entity, and with its attributes found only in the established,
but modified (now including (X) and its relations), anchor concept.

Figure II.18 (e)

Progressive differentiation

Progressive differentiation of concepts is the ongoing recognition of variants of concepts
that are differentiated from one another:

> The refinement of concept meaning in cognitive structure giving more
> precision and specificity to these concepts is called progressive
> differentiation of cognitive structure. [Novak, 1998.   63]

> The process of sequential assimilation of new meanings from successive
> exposures to new, potentially meaningful materials results in progressive
> differentiation of concepts or propositions, in the consequent refinement of

meanings, and in enhanced potentiality for providing anchorage for further meaningful learning. [ARK 102]

A diagramed example (Figure II.19 (a-c) illustrates the process. A learner might, through sensed experience, come to know a new term, Capital Corridor Train system. The term is associated with the real or imagined experience that large machines, which roll on rail pairs, carry passengers for a fee, and arrive at particular locations at posted times at regular intervals.   Of course, the main concept of the Capital Corridor Train system may inherit characteristics of similar systems known to the learner, such as: comprises locomotive and passenger train equipment, runs according to a schedule (or not), requires a ticket, sells food on board, etc.

The Capital Corridor Train system (concept A) may appear to have among its attributes a *route* (concept B) such that it provides passenger service between Oakland and Sacramento. Indeed, concept (concept A), the Capital Corridor Train system, is understood by many such that all its runs are associated with concept (concept B), Sacramento-Oakland service.

However, the learner may discover that, of its twenty-four daily runs, a small number, two, do not terminate at Sacramento, but either initiate or terminate from a station in the city of Auburn. Consequently, the concept *route* (concept B) is differentiated into (concept B) Sacramento-Oakland service, and (concept B') Auburn-Oakland service.

Existing Anchor superordinate concept with one subordinate concept (B)
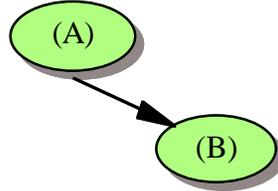
(a)
Capitol Corridor service (A) operates (relation designated by arrow)
a *route* (B) between Sacramento and Oakland

Existing Anchor superordinate concept with two subordinate concepts (B) and (B')
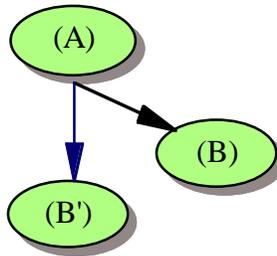
(b)
Through sensed experience (reading schedules or talking with passengers or crew),
the learner discovers that not all (A) operates (B), a route between Sacramento and
Oakland, but instead, some operate the route (B') Auburn - Oakland.

Existing Anchor superordinate concept
with three subordinate concepts (B), (B') and (B")
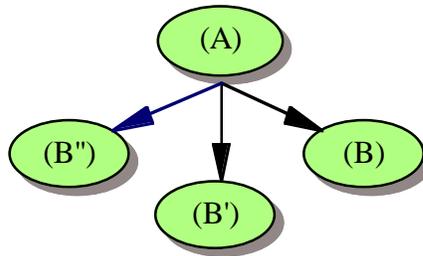
(c)
Some trains to not terminate in Oakland, but proceed to San Jose.
The concept route (B) has yet another variant, (B"), Sacramento-San Jose.
Thus, the concept (B) route undergoes progressive differentiation.

Figure II.19 (a-c)

The process of differentiation does not stop with this initial variant. Further experience leads to the discovery that some trains to not terminate in Oakland, but proceed to San Jose. Thus the concept route (concept B) has yet another variant, (concept B"), Sacramento-San Jose. The concept (concept B) *route* has undergone progressive differentiation, into (concept B), (concept B'), and (concept B").

Progressive differentiation is an *analytical* process whereby one concept at process initiation results in multiple concepts at the process endpoint.

Superordinate learning

Superordinate learning is the obverse of subsumption learning: In subsumption, a new idea is subsumed into one of the learner's existing anchor concepts. In superordinate learning, a new idea subsumes existing concepts by virtue of being more general:

> Superordinate propositional learning occurs when a new proposition is relatable either to specific subordinate ideas in existing cognitive structure or to a broad background of generally relevant ideas in cognitive structure that can be subsumed under it. [ARK 3]

Novak describes the process of superordinate learning as acquisition of a new concept that *explains*, or makes sense of, concepts already in the learner's knowledge structure:

> Occasionally . . . new concepts are constructed that pull together and integrate large domains of knowledge that were not previously recognized as intimately related. . . . a learner may experience the acquisition of a new broad, general concept that then subsumes in powerful new ways the meanings of previously learned concepts and adds new and rich meanings to these concepts. [Novak, 1998. 69]

In simple terms, superordinate learning is often expressed as "seeing the big picture" that "makes everything fall into place."

Superordinate learning is more difficult for two reasons: (1) more labor is required to project relations of the superordinate idea onto the many existing concepts that are organized by it, and (2) *recognition* that an idea *is* a superordinate idea is an imaginative act, relying on recognition of similarity of very little conceptual structure of the superordinate idea being relatable to other concepts.

An interesting effect of superordinate learning is that it *explains*, i.e., shows a path of concept relations between, previously conflicting ideas into a framework where constituent ideas relate to one another without conflict.

Novak provides several examples of superordinate learning, including the way in which:

> Newton's concept of universal gravitation brought together domains of
> knowledge that most people saw as totally unrelated. [Novak, 1998. 69]

Although this example illustrates both transfer and superordinate learning, they differ in that transfer is a more basic mechanism common to many process types.

Superordinate need not imply *hierarchical* (although Ausubel so teaches), but rather may be interpreted in the sense of *more comprehensive*, that is, *more encompassing*.

As a worked example (Figure II.20 (a)) (based on [McGriff AT]), consider a child who comes to be acquainted with trout, goldfish, eventually, salmon, and other slippery elongated aquatic animals that that swim around in lakes, rivers, and oceans. He comes to know that they are categorized as "fish." His categorization is reinforced upon continuously encountering new species, sharks, halibut, and perch, all which turn out to be understood by others as "fish." He might know that other animals, like crabs, octopi,

eels, and jellyfish, also inhabit the water, but those do not look like fish, and thus the young learner is comfortable with these entities cluttering his cognitive category of *fish*.

Existing Anchor (superordinate) concept
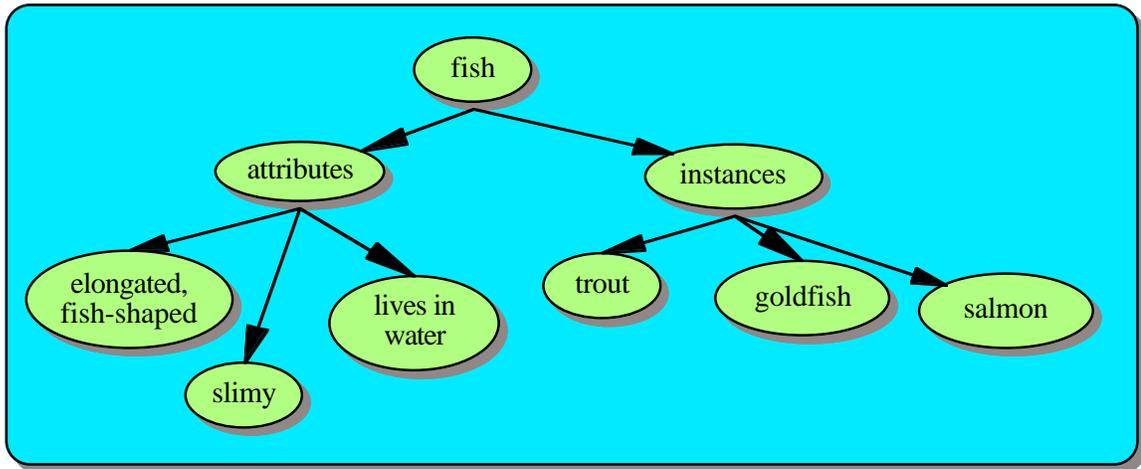
(a)
Fish resides in learner's mind as an an established (existing) anchor concept.

Figure II.20(a)

The domain of fish-like water creatures appears to make sense, that is, his concept structure *fish* is coherent, having no conflicting relations. But then, the student encounters (Figure II.20(b)) magazine photographs of whales and dolphins with a caption stating that these creatures are *not* fish. He is now confronted with seemingly conflicting concepts: creatures having all the characteristics of fish, but which are "not fish."

Cognitive dissonance ("distressing ignorance" [Buckland 1991a]), a motivating discomfort for which a remedy is sought, impels him to examine the magazine article for explanations which might help him construct and understanding of why whales and dolphins are not fish.

Three New Concepts
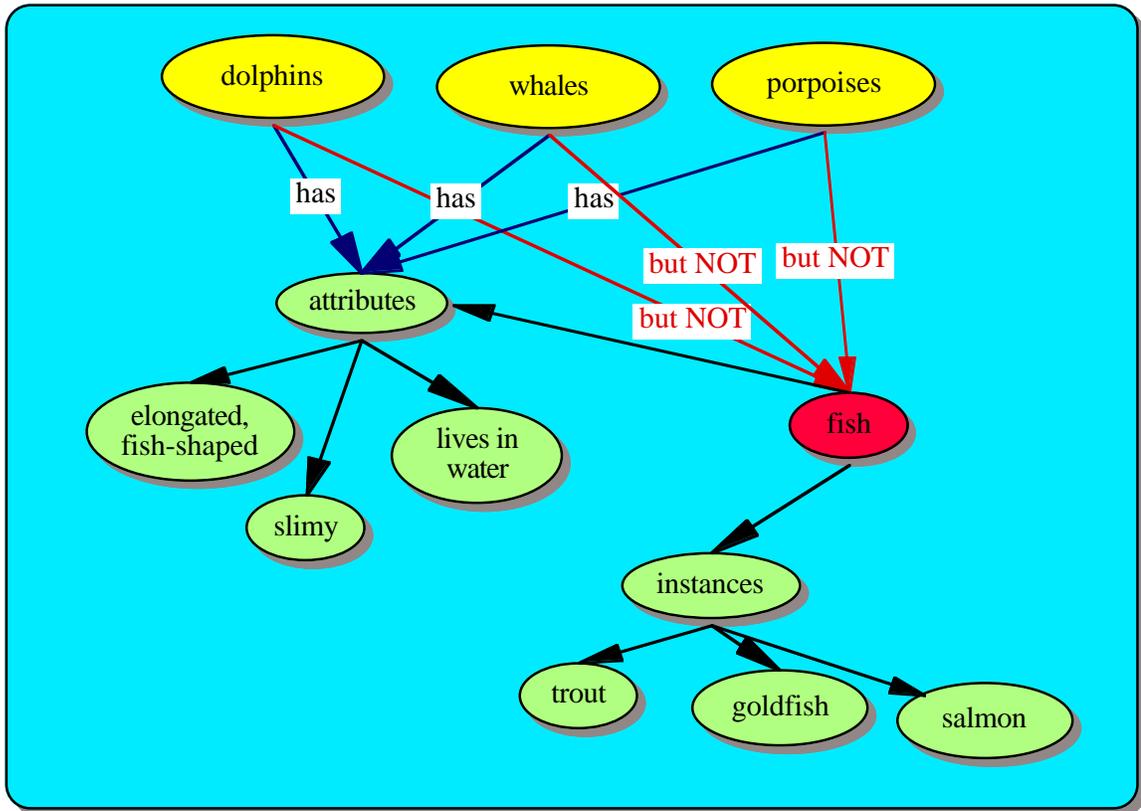
(b)
The learner now assimilates not just one, but three new concepts
that have the attributes of fish,
but are categorized by others as *not fish*.
These three new concepts are dissonant with the existing anchor concept of fish.

Figure II.20(b)

Our young learner then encounters an explanation (Figure II.20(c)) expressing the

concept of *breathing systems*, and two of its associated concepts, *gills*, whereby oxygen is

extracted from water, and *lungs*, which extract oxygen from air.

Similarly, he encounters the concept of *body temperature type*, whereby creatures may be

warm-blooded or cold-blooded.

Two New Concepts
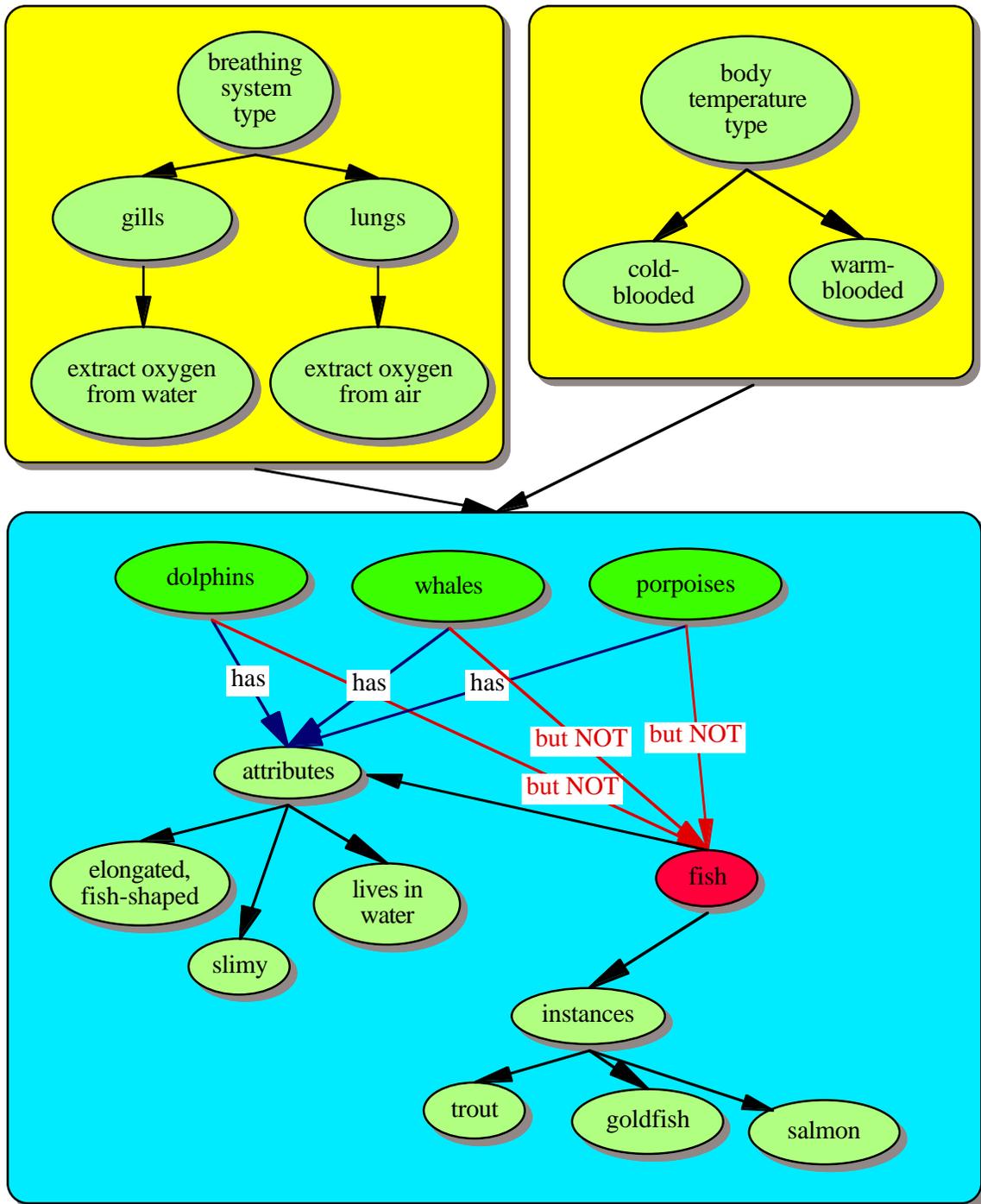
(c)
Two new concepts,
breathing system type, and body temperature type
are assimilated by the learner.

Figure II.20(c)
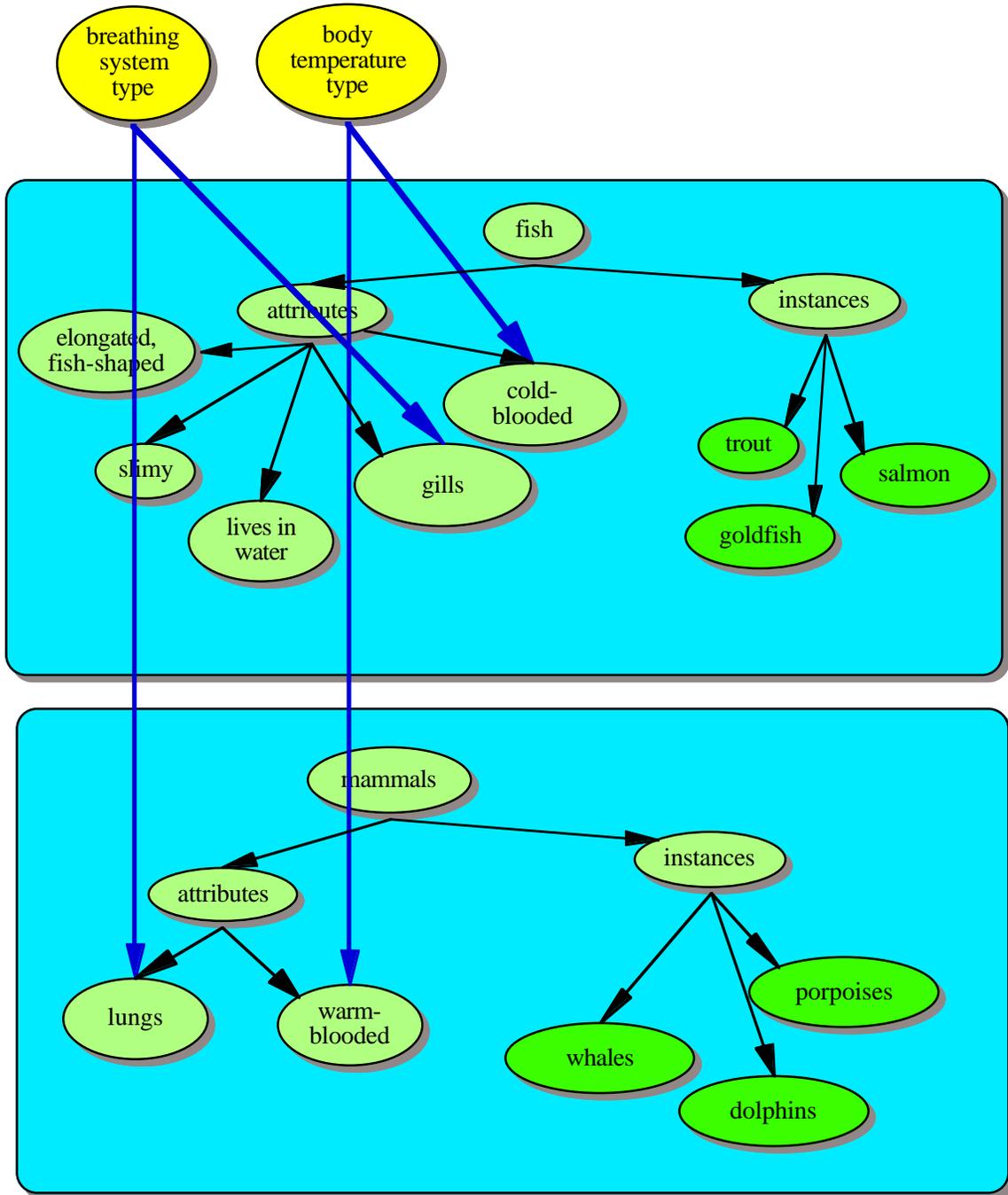
(d)
Overarching superordinate concepts applied to
sorting instances of creature concepts into categories
fish or *mammal*.

Figure II.20(d)

From the text of the explanation, he further understands that the concept of breathing systems can be a defining characteristic of categories of creatures: gills are an attribute of fish, and lungs are a characteristic of mammals.

That is, the concept expressed by the term "breathing systems" is a superordinate concept against which all the instances of the student's concepts of fish-like creatures can be evaluated. This enables him to sort gill-bearing creatures into his *fish* category, and assign lung-bearing animals to his *mammal* category, resulting in a reorganization of his concept instances that formerly fell under *fish* (Figure II.20(d)).

One instance of superordinate learning entails more cognitive labor than subsumption learning. The new superordinate concept must first be constructed, i.e., its component concepts and relations among those concepts formed, then, relationships between the new superordinate idea and existing concepts which it explains must be forged. However, the greater expenditure of cognitive energy derives a significant benefit: a powerful superordinate idea has the effect of leaving the impression that a great many pieces have fit together effortlessly.

Integrative reconciliation

Integrative reconciliation is a process through which dissonant relations between concepts lead to recognition of additional relations which neutralize the conflict, usually by differentiating attributes of the concepts such that one is not expected to map onto the other:

> Another form of cognitive differentiation arises when new
> interrelationships are seen between concepts in cognitive structure,

relationships we can represent as cross-linkages on a concept map. These cross-linkages represent . . . integrative reconciliations.
[Novak, 1989. 64]

[R]ecombination of existing elements of cognitive structure is referred to as integrative reconciliation.   [Ausubel Novak Hanesian 1978 124-125

The useful effect of integrative reconciliation is resolution of dissonance in the learner's cognitive structure, mind.

. . . conflicting meanings may possibly be resolved through a process of integrative reconciliation. [ARK 102]

The setting for the initiation of integrative reconciliation is similar to that of superordinate learning: the learner is confronted with concepts that appear to conflict or contradict one another, but rather than a new superordinate concept being received to resolve the conflicts, the relations among the conflicting concepts change (Figure II.21). Using the example from the discussion of superordinate learning, and beginning from the first two states described earlier (resulting in a cognitive dissonance):

Existing Anchor (superordinate) concept
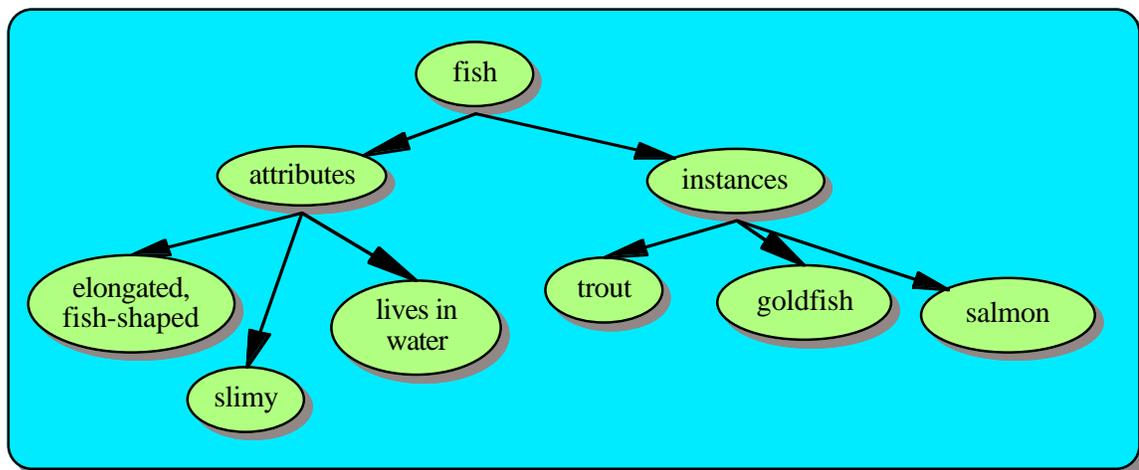
(a)
Fish resides in learner's mind as an an established (existing) anchor concept.

Figure II.21(a)

Three New Concepts
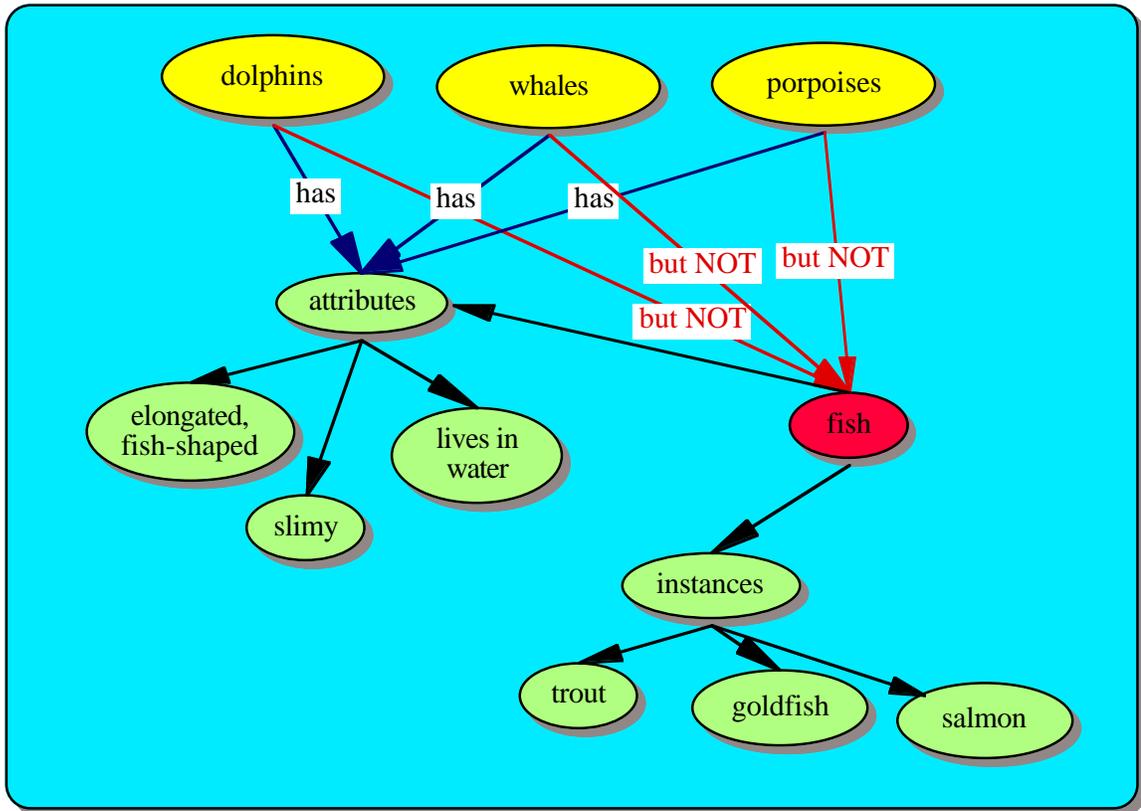
(b)
The learner now assimilates not just one, but three new concepts
that have the attributes of fish,
but are categorized by others as *not fish*.
These three new concepts are dissonant with the existing anchor concept of fish.

Figure II.21(b)

Here, the process path diverges from that of superordinate learning. Rather than

importing an overarching superordinate concept, the learner examines the relations

among the instances recognized by others to be categorized as fish, and those associated

with the new concepts of whale, dolphin, and porpoise. For example, the learner might

simply accept that these three creature concepts possess a negative cognitive authority

relation to other animal concepts considered to be fish, based on some unknown attribute.

(Figure II.21(c)).
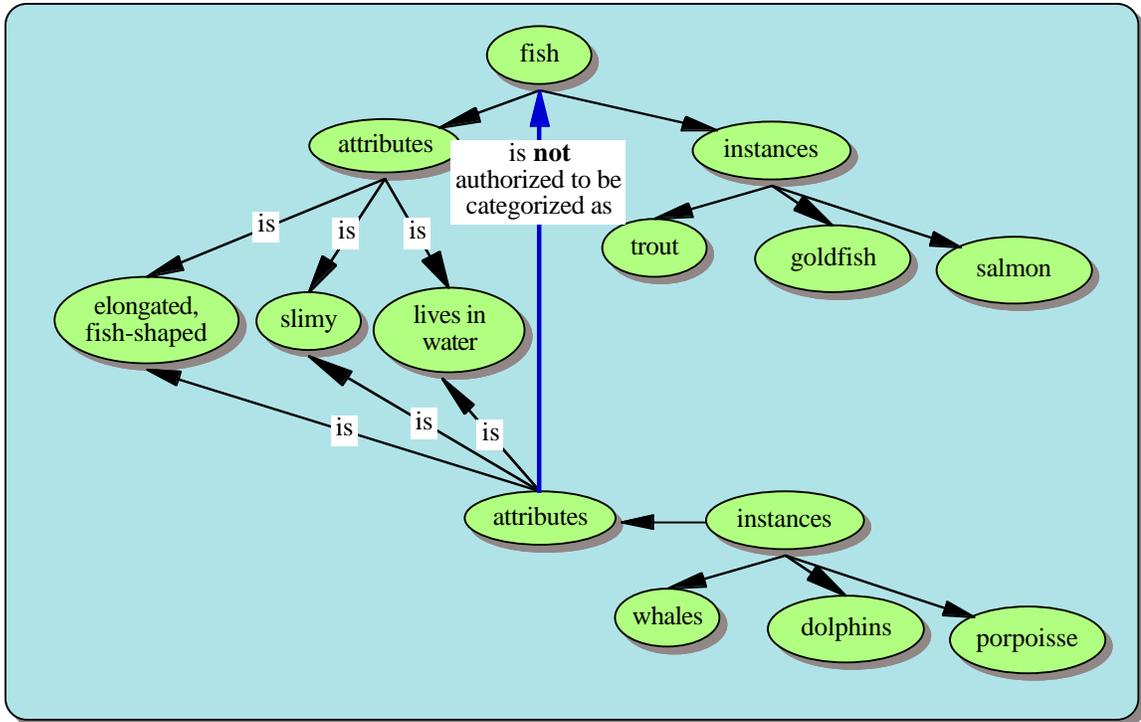
(c)
Integration of the *cognitive authority* relation reconciles the distressing anomaly.
Inquirer concludes that whales, dolphins, and porpoises are not fish, even if why is not known.

Figure II.21(c)

At the process terminal endpoints, the same concepts stand but with modified

relationships to one another.

Some amount of skepticism is usually healthy. The learner might construct the

understanding as depicted in (c), and yet experience some distress that may continue until

a relation to an additional attribute of whales *et al*. becomes available that is not an

attribute of fish. Nevertheless, existing knowledge such as cognitive authority ("parents

and teachers are generally correct about stuff like this") is often sufficient to enable an

inquirer to reach the conclusion that the conflict is reconciled. Integration of the

cognitive authority relation reconciles the distressing anomaly.

Paul Ammon has pointed out that Piaget recognized a comparable process that he

described as "equilibration of cognitive structure" [Piaget 1985] in which contradictory

conceptual structures are accommodated by learners such that a state of equilibrium (perhaps a minimal level of distressing ignorance or curiosity about the conflict) is achieved.

Process characteristics

What motivates learners? What stimulates learners to expend cognitive energy that fuels learning processes? What initiates these processes? Once underway, what causes them to conclude? Are endpoints to cognitive processes detectable? If so, how does detection facilitate assessment of changes in the learner's knowledge?

Ausubel's ideas about motivation and attention, process endpoints (initial and terminal), and assessment provide valuable Stage Two criteria.

Process characteristics: Motivation and attention

> Anyone who can draw as many people into situations related to learning as
> . . . Nintendo, knows something that educators who have trouble holding
> the attention of 30 children for 40 minutes should want to learn.
> [Papert 1996 13]

To learn an idea, the learner must *attend* to the idea. Ausubel repeatedly advises that meaningful learning requires learners to devote active and deliberate effort to *process*, that is, to relate new ideas to their prior knowledge. What motivates the learner to do so?

Ausubel devotes an entire chapter to the "Practice and Motivational Factors in Meaningful Learning and Retention." For the most part, his discussion of motivation is of its effect on meaningful learning rather than on how motivation may be manipulated:

Is Motivation Necessary for Learning ?
The weight of the evidence indicates that although motivation is a highly significant factor in and greatly facilitates meaningful learning, it is by no means an indispensable condition, especially for limited and short-term learning. However, it is absolutely essential for the sustained and long-term type of learning involved in mastering a given subject matter discipline or vocational curriculum. [ARK 196]

Typically, however, motivational variables are not directly involved in the cognitive interactional process. . . . We can conclude, therefore, that motivational factors affect meaningful learning and retention in ways that are qualitatively different from the comparable effects of relevant cognitive variables. [ARK 198]

Ausubel acknowledges a relationship between motivation and meaningful learning, primarily through *attention*:

Attention
Much of the facilitating effect of motivation is apparently mediated by an increase in attention. Merely directing students' attention to certain aspects of subject matter, irrespective of how this is done, promotes learning. . . . As a mediating variable in undoubted instances of motivation, attention is presumably the major general intervening variable through which motivational factors influence meaningful learning. A major cause of everyday forgetting perhaps in most instances of undue loss of ostensibly learned material (including subject matter) is failure to pay proper attention at the time of learning. Generally speaking, what is not attended to is neither learned nor remembered. [ARK 200]

Most readers have experienced reading a passage, then realizing that they were not *grasping* the concepts expressed, not paying *attention*. This is sometimes described as the difference between looking and seeing, or between hearing and listening. Looking and hearing do not connote cognitive engagement, but merely passive, lazy, *inattentive* visual or auditory function (not constructing meaning, "not engaged"). Seeing and listening both imply active deliberate sense-making, relationship recognition and identification, and questioning or testing concepts as they are assimilated. Students

confronting assignments they consider boring or "make-work" are susceptible to intellectual disengagement.

Process characteristics: Endpoints

Intellectual processes are generally finite, having temporal endpoints (at initiation and at termination)

> [I]t is important that the conditions of practice gradually begin to approximate the *desired* (unprompted) *endpoint* of the learning product. [ARK 192 (emphasis added)]

How can initial and terminal process endpoints be detected? Can the learner or teacher know when a process has reached an endpoint?   Conditions of initial endpoints may be expressed as questions. Terminal endpoints are often demarcated by the completion (and assimilation) of concept paths that result in *understanding*.

> "Meaningful learning," by definition, involves the acquisition of new meanings. *New meanings, conversely, are the end-products* of meaningful learning. [ARK 67]

Thus, a learner who wishes to be conscious of a learning process can use his or her recognition of *satisfaction*, new *meaning*, or both, as evidence that a terminal endpoint has been reached. Use of instruments (below) can facilitate such recognition.

For teachers, process endpoints can be detected by expressions of new meaning as instrumented by assessments such as making concept maps or traditional examinations.

For example, an automobile owner might have heard about vehicles powered by hybrid engines, but know little more than the term *hybrid engine*. A learning process is initiated. (Figure II.22(a)).
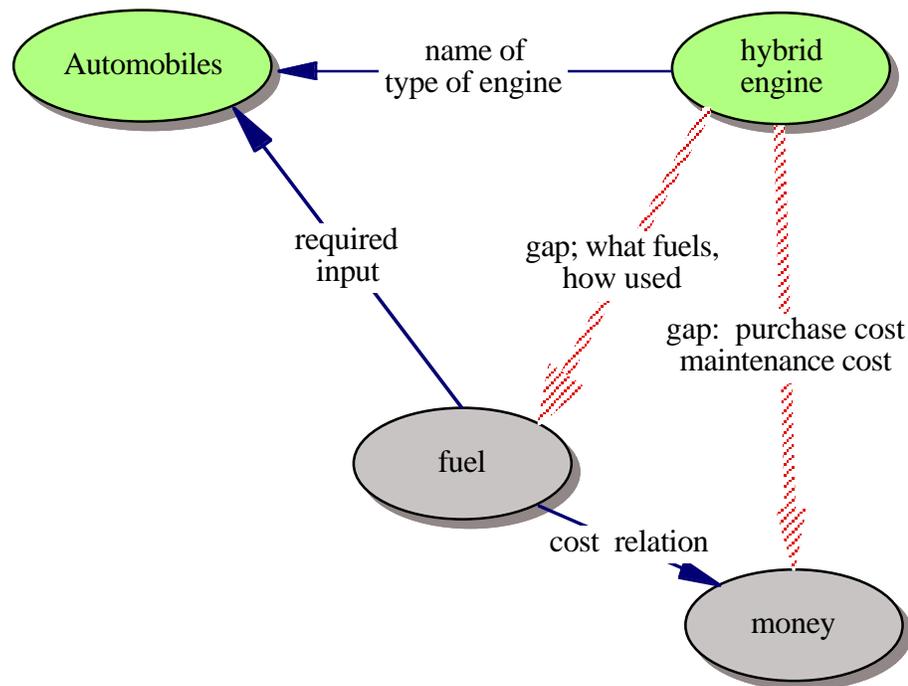
(a)
Existing knowledge structure, *Automobiles*, and a goal concept,
hybrid engine giving rise to a gap in understanding (1) between the new idea and *fuel,*
and (2) between the new idea and *money*.

Figure II.22(a)

Concept formulation and assimilation (integration of new ideas with existing knowledge) continues iteratively until a continuous conceptual path (not necessarily linear) is formed between them, and the learner concludes that she is *satisfied* that the new meaning relieves the conflict, cognitive dissonance, question, gap in understanding, or other intellectual discomfort (Figure II.22(b)). The terminal endpoint of a psychological process or event is often the recognition of construction or creation of a meaning. "Aha, now I understand that. I am satisfied."
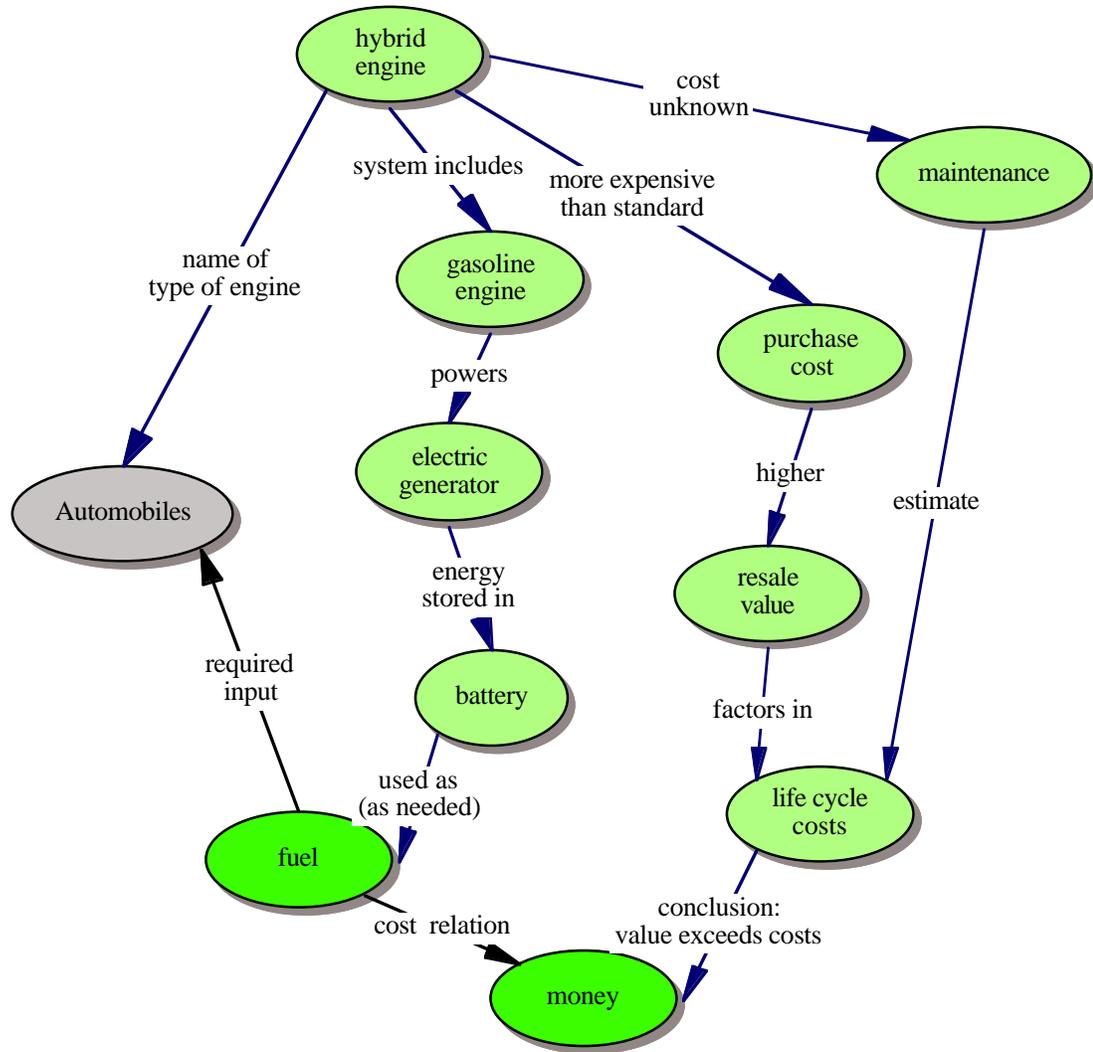
(b)
A continuous path between *fuel* and the goal concept, *hybrid engine*,
constitues the concepts of an *explanation*.

A continuous path between *money* and *hybrid engine* leads to a *conclusion* or *decision*.

Figure II.22(b)

Thus, the conceptual path between prior knowledge and (new or existing) ideas is formed
of connected relations, meaning. It is not the goal concepts, *fuel* nor *money*, that is the
terminal endpoint, but the *satisfaction* of meaning that the concept of *hybrid engine* is
better understood. This implies that *meaning is felt*.

Recognition of endpoints is helpful in understanding conditions that trigger processes, whether or not they initiate, how such processes are formulated, and what agent originates them. The learner's recognition of a conflict among concepts, a question, or other dissonance may lead to assimilation processes.

Subsequent work with Assimilation Theory recognizes several expressions of endpoints, e.g., *explanation*, *decision*, or *conclusion*, or formation of a *belief*.

> [T]he purpose of the investigation is often to get information on which to
> base personal or civic *decisions*.
> [Champagne Kouba 2000 228 (emphasis and annotation added)]
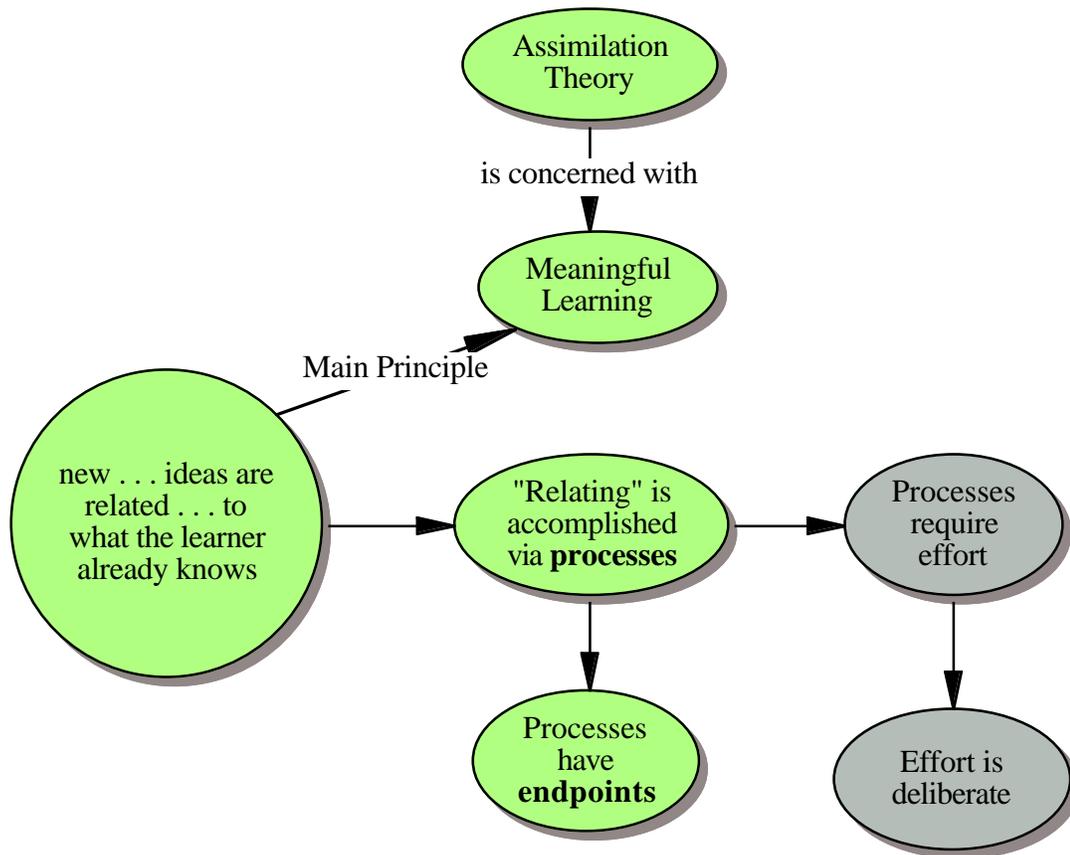
Figure II.23

Formation of conclusions, explanations, and beliefs are explored in the following section.

Feedback

Ausubel battled some of the learner-is-like-a-machine metaphors popular during his career, including cybernetics, behaviorism, and Shannon-Weaver-style "information theory." In confronting these broad paradigms, some specific but important notions associated with these, but also important in more humane approaches to educational philosophy, occasionally suffered collateral damage in Ausubel's polemics. Among these is *feedback*:

> Cybernetic and Computer Models of Cognitive Functioning. One of the most flourishing of the more eclectic theoretical positions in recent years has been a variant of the cybernetic or information theory approach based on a computer model of cognitive organization and functioning. The general flavor of this approach is behavioristic in the sense that it deals somewhat mechanistically with input-output relations; but in place of an associative or conditioning model of cognitive processes, it substitutes a more substantive view of the nature of information as well as the cybernetic principle of a control system that is both (1) sensitive to *feedback* indicative of behavioral error or discrepancy between existing and desired states of affairs, and (2) differentially responds to such feedback in ways that correct the existing error or discrepancy. [ARK 135]

Ausubel finds feedback to be minimally significant on technical grounds:

> On both motivational and cognitive grounds, *feedback* probably also has less facilitating effect on meaningful than on rote learning. Since the achievement of understanding is a reward in its own right and requires less brute effort than rote learning, it is less necessary in meaningful learning to invoke the energizing assistance of extrinsic motives and incentives. Selective reinforcement of successful responses through drive reduction (gratification) is similarly less necessary for learning, even if it were possible, when logical considerations are applicable to the content of the learning task than when a purely arbitrary and verbatim connection must be established. The internal logic of the learning material also makes possible some implicit confirmation, correction, clarification, and evaluation of the

learning product, even in the absence of any explicit provision of feedback.
[ARK 194].

Yet, away from theological battles, and instead writing in the context of his cognitive

variables, clarity and stability, Ausubel declares feedback to be important:

> STABILITY AND CLARITY OF ANCHORING IDEAS
> The stability of either general background knowledge or of more specific
> anchoring ideas may be ascertained by administering a series of equivalent
> forms of a pretest, over a specified time interval; and it may itself be
> manipulated . . . by the confirming and disconfirming of the effects of
> *feedback*.
>
> Clarity can be manipulated in the same way as stability and also by the
> corrective effects of feedback.
>
> . . . and by supplying immediate *feedback*, . . . ruled out and corrected
> alternative wrong meanings, misinterpretations, ambiguities, and
> misconceptions before they had an opportunity to impair the clarity of
> cognitive structure and thereby inhibit the learning of new material.
> [ARK 158-9 (emphasis added)].
>
> Frequent testing and provision of feedback, especially with test items
> demanding fine discrimination among alternatives varying in degree of
> correctness, also enhance consolidation by confirming, clarifying, and
> correcting previous learnings. [ARK 170].
>
> Another study trial also provides the learner with informational *feedback*, in
> the form of textual reference, for testing the correctness of the knowledge
> retained from the first trial. This testing confirms correct meanings, clarifies
> ambiguities, corrects misconceptions and indicates areas of weakness
> requiring differential concentrated study. The net effect is consolidation of
> learning. . . . [ARK 186 (emphasis added)]

Thus, for specific cognitive functions, especially *clarity*, the process element feedback is

embraced by Assimilation Theory.

Learning set

The third of the three elements of meaningful learning is the learner's mental *processing* abilities and cognitive variables, or *learning set*:

> New meanings . . . The conditions of learning presuppose additionally the existence of a meaningful *learning set* in the learner. [ARK 40]

> [B]ut it is primarily the superiority in meaningful learning *processes* (i.e., the learner's *meaningful learning set* and the nonarbitrary, nonverbatim relatability of the instructional materials to relevant anchoring ideas in cognitive structure) that basically accounts for the superior learning and retention outcomes. [ARK 15]

Ausubel further describes his notion of the *learning set*:

> *Meaningful Learning Set*
> In meaningful learning the learner has an obligatory set to relate nonverbatim . . . aspects of new concepts, propositions, information, or situations to relevant components of existing cognitive structure in various nonarbitrary ways . . .. Depending on the nature of the learning task (i.e., reception or discovery), the set may be either to discover or merely to apprehend (comprehend) and incorporate such relationships into his cognitive structure. . . . [ARK 53-54]

Cognitive variables in meaningful learning

People learn a concept at the moment it's important to them. What determines a learner's readiness to assimilate a *particular* new concept or proposition? Ausubel's notion of cognitive variables, in part, determine readiness:

> . . . the properties of the existing structure of knowledge at the time of learning (cognitive structure variables) are, perhaps, the most important consideration. [ARK 9-10]

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Cognitive variables include:

> . . . (the availability, specificity, clarity, stability, and discriminability of these relevant ideas), reflective of what learners already know, and of how well they know it ... Additionally, for the sake of completeness, such other cognitive variables as practice, review, instructional materials, motivational factors, and developmental changes in cognitive capacity to handle verbal abstractions were also considered. [ARK xi]

> The most important cognitive structure variables considered in this book are (1) the availability in the learner's cognitive structure of specifically relevant anchoring ideas at an optimal level of inclusiveness, generality, and abstraction; (2) the extent to which such ideas are discriminable from both similar and different (but potentially confusable) concepts and principles in the learning material; and (3) the stability and clarity of the anchoring ideas.
> Stability and clarity of the relevant anchoring ideas are . . . important for their significant effect on the discriminability of similarities and differences between the new and the anchoring ideas. [ARK 10-11]

> Cognitive structure variables, as indicated earlier (for example, the availability in cognitive structure of relevant anchoring ideas, their stability, clarity, and discriminability from related internalized ideas and from ideas in the instructional materials) were originally regarded as the most important proximate factors influencing the meaningful learnability and the degree of learning and retention of new, potentially meaningful instructional materials; hence, since they still are still largely so considered, they necessarily occupy a central place in the content of this book [ARK xi]

Cognitive variables operate differently than social, emotive, or motor variables:

> Cognitive variables, on the one hand, and motivational-personality-social variables, on the other, affect meaningful learning and retention through different mechanisms. [ARK 9]

Ausubel categorizes *clarity* with the terms *precision*, *explicit*, and *unambiguous*:

If cognitive structure is clear, stable, and suitably organized precise and unambiguous meanings emerge and tend to retain their dissociability strength or availability. If, on the other hand, cognitive structure is unstable, ambiguous, disorganized, or chaotically organized, it tends to inhibit meaningful learning and retention. [ARK 9]

. . . abstract understanding that is qualitatively superior to the intuitive level in terms of generality, clarity, precision, and explicitness. [ARK 50]

(but see: Can *elocutio* specify meaning *explicitly*?, II.2).

Ausubel establishes a close relation to *discriminability*:

The discriminability of a new learning task is also in large measure a function of the clarity and stability in cognitive structure of the existing ideas to which it is related. [ARK 157]

Thus *clarity* in Assimilation Theory is interpreted to imply that learners will not experience doubt as to the attributes or implications of a an intellectual object, i.e., a concept or cognitive structure, and will not suffer uncertainty as to the meanings of a linguistic term that is understood *clearly*. However, clarity is not *in* the term or in the world, but in the mind of the learner.

Cognitive capacity

Cognitive *capacity* refers to quantification of concepts, relations, and processes a learner can accommodate. Ausubel acknowledges such limits. Among them, he recognizes Miller's [Miller 1956] observation that humans have difficulty manipulating more than seven ideas (plus or minus two) in many contexts.

> Human beings, unlike computers, can apprehend and immediately
> remember only a few discrete items of information that are presented just
> a single time. [ARK 77-78] [Footnote II.4]

Concepts missing (relative to a reference structure); Gaps

Concept structures (a learner's reference structure and a conceptual reference structure i.e., another person's knowledge structure against which a learner's knowledge is assessed) can differ in at least two ways: (1) the learner's structure may express concepts different from, or structured differently from a given reference (misperceptions, obstructed relations, contradictory or illogical relations, "alternate understandings," or false or mistaken relations) (discussed in Preconceptions, below), or (2) exhibit *gaps* (missing concepts, missing relations), or unwarranted relations and relations unsupported by evidence). Ausubel directly acknowledges *gaps*:

> An advance organizer is a pedagogic device that helps implement these
> principles by bridging the *gap* between what the learner already knows,
> and what he needs to know if he is to learn new material most actively and
> expeditiously.
> [ARK 11 (emphasis added)]

Teachers are expected to express concepts that connect new ideas with the student's prior knowledge, and to take the learner's prior knowledge into account so as to construct a

conceptual bridge between the learner's knowledge and the new concepts. This expectation implies that the teacher constructs a third object, an understanding of the differences between the learner's knowledge and the conceptual reference structure, and a fourth object, a conceptual bridge (path) connecting prior knowledge with new concepts.

Observe that a teacher's conceptual reference structure is distinct from the linguistic terms the teacher might use to express it.

A learner's questions may attempt to express a conceptual gap. However, the learner is in a dilemma: having to express the very concepts they do not have. They may attempt such description by describing the conceptual structure *adjacent* to their conceptual gap, that is, their most relevant knowledge (metaphorically, the shoreline that abuts the void, the sea of missing concepts).

Preconceptions

> It is what we think we know already that often prevents us from learning. [attributed to Claude Bernard]

> The result is that most of our so-called reasoning consists in finding arguments for going on believing as we already do. [Robinson 1968 16]

> Copernicus broke the rule that the earth stands in the center of the universe. Napoleon broke the rules on the proper way to conduct a military campaign. Beethoven broke the rules on how a symphony should be written. Picasso broke the rule that a bicycle seat is for sitting on while pedaling a bicycle. Think about it: almost every advance in art, science, technology, . . . has occurred when someone challenged the rules and tried another approach. [von Oech 1982 48]

Ausubel's prime directive requires the teacher to take into account ideas the learner already knows. Suppose, however, that the learner's existing knowledge is not merely

missing concepts, but is internally inconsistent or comprises errors, i.e., ideas

contradictory to those intended in some reference set. Existing ideas can be resistant to

novelty. Ausubel recognizes the obstructive power of preconceptions:

> One such limiting factor is the existence of erroneous but tenacious
> *preconceptions . . .* the potent role of *preconceptions* in inhibiting the
> learning and retention of scientific facts, concepts, and principles. These
> *preconceptions* are amazingly tenacious and resistant to extinction because
> of the influence of such factors as primacy and frequency and because
> they are typically anchored to highly related, stable, and antecedent
> preconceptions of an inclusive nature . . . [ARK 153]

> Research on students' *misconceptions* of scientific principles shows, for
> example, that students often enter the physics classroom with a *well-
> established set of incorrect concepts* built up from their everyday
> experience (McCloskey, 1983; McCloskey, Caramazza, & Green, 1980).
> Students' intuition can include the idea that "motion implies force" -- that
> is, force is required to keep an object in motion. [Mayer 1993 566]

Ausubel acknowledges the *potency* of preconceptions, and their cousins, misconceptions:

> Very *potent*, seemingly plausible, and well-established, relevant
> *misconceptions* in cognitive structure . . . [ARK 116]

> . . . loss of dissociability strength due to the assimilative presence of
> *potent* misconceptions in cognitive structure [ARK 123]

A learner can reconcile their misperceptions. But first, the learner must *recognize* them.

Ausubel imputes high value to such conceptual remodeling:

> One such limiting factor is the existence of erroneous but tenacious
> *preconceptions. . . .* the fact that the unlearning of preconceptions in
> certain instances of meaningful learning and retention might very well
> prove to be the most determinative and manipulable single factor in the
> acquisition and retention of subject-matter knowledge.
> Moreover, resistance to the acceptance of new ideas contrary to prevailing
> beliefs seems to be characteristic of human learning. [ARK 153]

Despite the commonsense notion of the importance of overcoming preconceptions (see: What is critical thinking?, II.2), one encounters a logical inconsistency at this point in Assimilation Theory: Ausubel's fundamental tenet is that meaningful learning requires that new ideas be the assimilated through *establishment of relationships to the learner's existing knowledge*. But this may be the *very* prior conception that must be overcome!

That is, the learner's prior knowledge is privileged over new ideas. New ideas can *only* be assimilated according to knowledge previously constructed by the learner. Thus, there is an inherent bias in the process of learning: the privileging of those ideas for which relations to existing knowledge can be established, and against those ideas for which connections to prior knowledge cannot be found. The consequences of this bias are all too familiar: Learners evaluate new ideas against existing ideas more frequently than critically testing old ideas against new. One might prefer the first idea, the original version better than a new rendition. The "old math made sense but this new-fangled stuff they're teaching kids nowadays doesn't." The original movie is better than the remake. The symphony's rendition was "not as good as" the recording one enjoys at home.

Thus, overcoming prior misconceptions requires an explicit evaluation of prior ideas using the new concept as the baseline for evaluation, that is, the reverse of the ordinary.

Readiness to learn

> This aspect of learning set reflects . . . an appropriate performance attitude or momentary state of readiness for engaging in a particular kind of activity ("warm-up" effect) . . . warm-up aspects of learning set . . . consists of transitory readiness factors involved in the momentary focusing of attention . . .
> [ARK 189-190]

Learners learn an idea best at the moment that idea is important to them. This may partially explain why individual *browsing* can be or feel more effective than a prepared lecture. The learner is browsing because he is in a state of readiness-to-learn. When he leaves that condition, he likely discontinues browsing.

This principle aligns with Ausubel's fundamental dictum, *ascertain the learner's existing knowledge, then teach accordingly*.

This element must be taken into account in continuous derivation (see: Continuous derivations, II.2) and in planning (see: What is the role of planning in thinking?, II.2).

Meaningful reception learning

What is meaningful *reception* learning?

Meaningful reception learning is that portion of learning influenced by the learner's

receipt and use of expressions prepared by teachers and others:

> Meaningful reception learning primarily involves the acquisition of new meanings
> from presented learning material. [ARK 1].

> . . . meaningful reception learning through appropriate *expository* teaching and
> instructional materials . . . [ARK xiv (emphasis added)]

> Most meaningful learning is meaningful reception learning. [ARK 6]

Meaningful *reception* learning is distinct from the type of learning a student may do on

his or her own exclusively through thought, or reason, writing, or discovery.

The elements of meaningful reception learning comprise:

> New meanings, in other words, are the product of an active, integrative
> interaction between (1) new instructional materials and (2) relevant ideas
> in the learner's existing structure of knowledge. The conditions of learning
> presuppose additionally the existence of a (3) meaningful learning set in
> the learner and of potentially meaningful learning materials.
> [ARK 40 (numerals inserted)].

Expository instructional materials express a knowledge structure ("conceptual reference

structure"), of which the learner will assimilate part, then compare to their own.

Teaching materials should express concepts that form a continuous connection of

concepts, a path, *between* new ideas and the student's prior knowledge. That is, materials

should also build from, or take into account, the learner's existing cognitive structure.

(see: Figure II.24)

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Figure II.24

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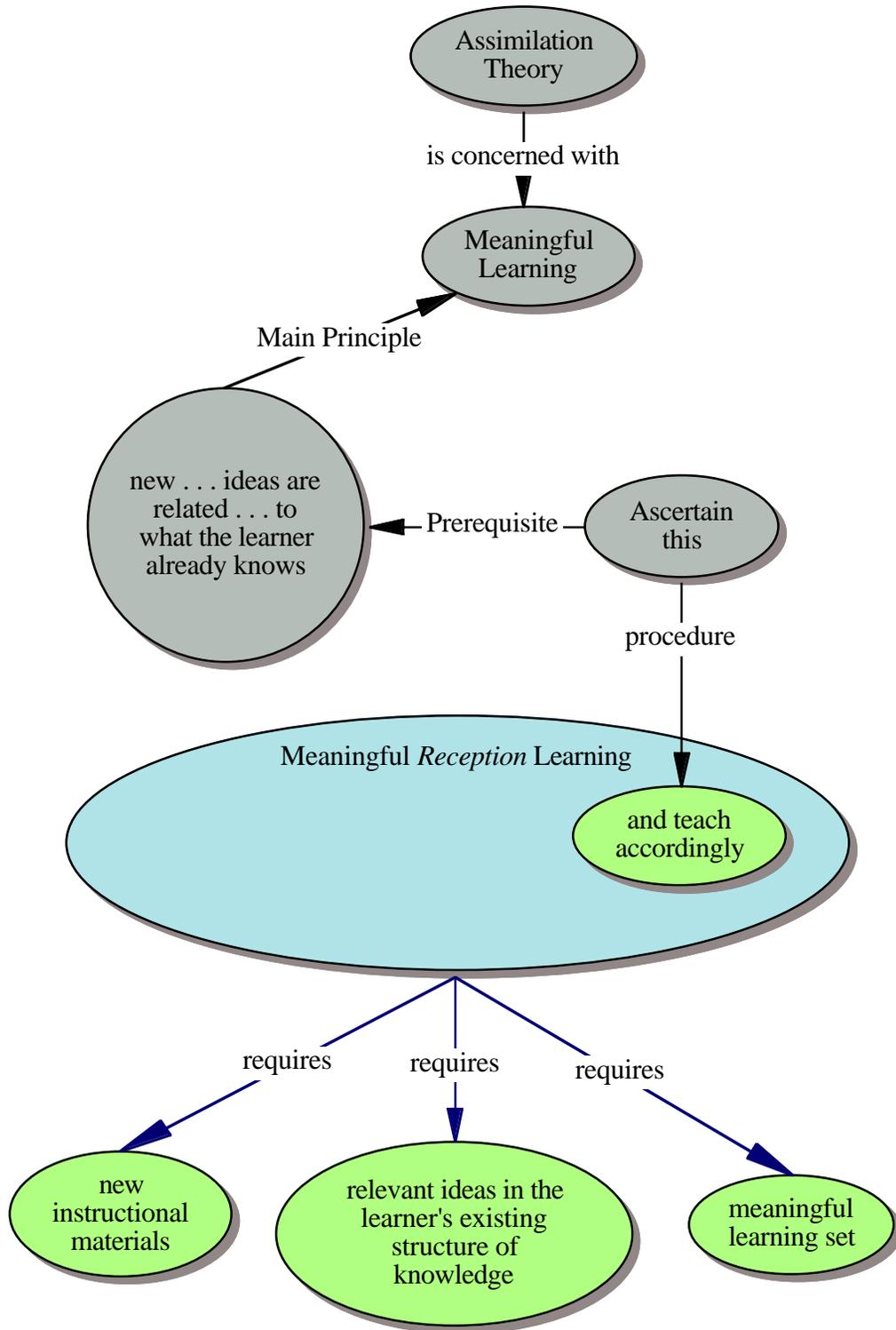
Ausubel characterized actions involved in meaningful reception learning:

> Meaningful reception learning is inherently an active process because it
> requires, at the very least (1) the kind of cognitive analysis necessary for
> *ascertaining* which aspects of existing cognitive structure are most
> relevant to the new potentially meaningful material; (2) some degree of
> reconciliation with existing ideas in cognitive structure— . . . ; and (3)
> reformulation of the learning material in terms of the idiosyncratic
> intellectual background and vocabulary of the particular learner.
> [ARK 5 (emphasis added)].

Meaningful *reception* learning may be understood as meaningful learning with the added
element of provision to the learner of materials constructed by others (teachers, authors),
transmitted as records (e.g., documents) or as real-time presentations (e.g., lectures,
tutoring), which are then interpreted by the learner. Thus, *reading* and *listening* are
examples of the communicative portions of meaningful reception learning.

Because reception learning encompasses persons beyond the learner himself, Ausubel's
prime directive applies to the provider of instructional materials, not just the learner:

> The most important single factor influencing learning is what the learner
> already knows. Ascertain this and teach accordingly.
> [Ausubel Novak Hanesian 1978, iv (flyleaf)]

Satisfying this requirement can be difficult where the teacher/author is not in direct
communication with individual learner/reader. The teacher's usual shortcut, relying upon
their experience, is to make *assumptions* about the would-be learner's existing
knowledge. These assumptions may be optimistic. Indeed, reception learning and other
forms of communication fail when the assumptions about prior knowledge are faulty.

Material presented to learner is only *potentially* meaningful

Learning materials are often assumed to *be* meaningful or *carry* meaning. They do not. Why?

Meaning is not *in* the document but constructed by the reader. The meaningfulness of the document depends upon the readiness of the learner, and thus, the document is only *potentially* meaningful. This is the central notion of cognitive constructivism.

The limitation of *potentially* meaningful emphasizes the indispensable role of cognitive labor in contrast to focus on external materials presented to the learner (Figure II.25):

> The rationale for referring only to the *potential* meaningfulness of instructional materials (rather than to their actual meaningfulness) is an important condition of meaningful learning and retention and was provided in the previous chapter: If we had merely considered this aspect of the learning material as simply meaningful, without adding the qualifier, *potential*, the goal of the meaningful learning process would then obviously have been accomplished in advance, thereby rendering the learning process per se superfluous. This is the case because meaning itself is an emergent product of the interaction between the ideas to be learned in the instructional material and relevant subsuming (anchoring) ideas in the learner's cognitive structure. [ARK 70 (emphasis added)]
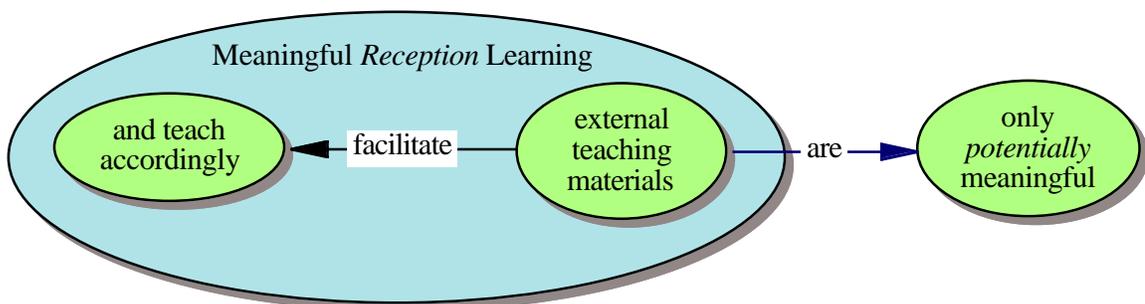
Figure II.25

Learning materials are objects in the physical realm which may be prepared by a teacher or other expert, expressed in terms from a linguistic system assumed to be understood by learners, then transmitted to learners. According to Novak:

> A key problem in learning . . . is that most instructional materials are *conceptually opaque*, that is, they do not present the concepts and concept relationships needed to understand the meaning of the . . . ideas involved. [Novak 1998   162]

One can find conduit metaphor (see: Section II.2) influence in the claim "material presented to learner is only *potentially* meaningful." Physical teaching materials themselves can *never* constitute, be full of, nor possess *meaning*, which resides only in the mental realm.   Indeed, Ausubel acknowledges that there is no perfect certainty that a learner will be successful in constructing meaning as a result of engagement with particular learning materials.

> A meaningful intentional set or approach to learning, as already indicated, only eventuates in a meaningful learning process and outcome provided that the learning material itself is *potentially* meaningful. Insistence on the qualifying adjective "potential" in this instance is more than mere academic hairsplitting. If the learning material (task) were simply considered *already* meaningful, the learning process (apprehending and generating its meaning and making it functionally available) would be completely superfluous; the object of learning would obviously be *already* accomplished, by definition, before any learning was ever attempted irrespective of the type of learning set employed or the existence of prior relevant knowledge in cognitive structure. . . . [ARK 54, footnote 3, 64]

Meaningful reception learning is distinct from discovery learning

Ausubel distances meaningful learning from discovery learning. Conversely, discovery learning is not necessarily meaningful. Meaningful reception learning requires "the entire content of what is to be learned is presented to the learner in final form." In discovery learning, the student must first discover which materials and ideas are relevant (see: Figure II.26 and Figure II.28):

> The main difference between propositional learning as found in reception learning situations, on the one hand, and in discovery learning situations, on the other, inheres in whether the principal content of what is to be learned is discovered by, or is presented to, the learner. ... In discovery learning ... the learner must first discover this content by generating propositions that represent either solutions to the problems that are set or successive steps in their solution [Ausubel Novak Hanesian 1978, pp. 4-5]

> In reception learning, the entire content of what is to be learned is presented to the learner *in final form*. The learning task does not involve any independent discovery on the student's part. The learner is required only to internalize or incorporate the material that is presented so that it is available or reproducible at some future date.
> [Ausubel Novak Hanesian 1978 24 (emphasis added)]

During the late 1950's, dissatisfaction with educational institutions, their conventions, and perceived responsibility for decline in world status gave rise to controversy about causes and cures. One theme that appeared to appease the dissatisfaction partially was that students would learn more, and better, if they worked harder. One form of their working harder was to require learners to *discover* for themselves the material and concepts they were to learn, *discovery learning*. Ausubel challenged the idea that requiring students to design their own curriculum, even at the level of an individual lesson, would lead to improved learning. [Footnote II.5]

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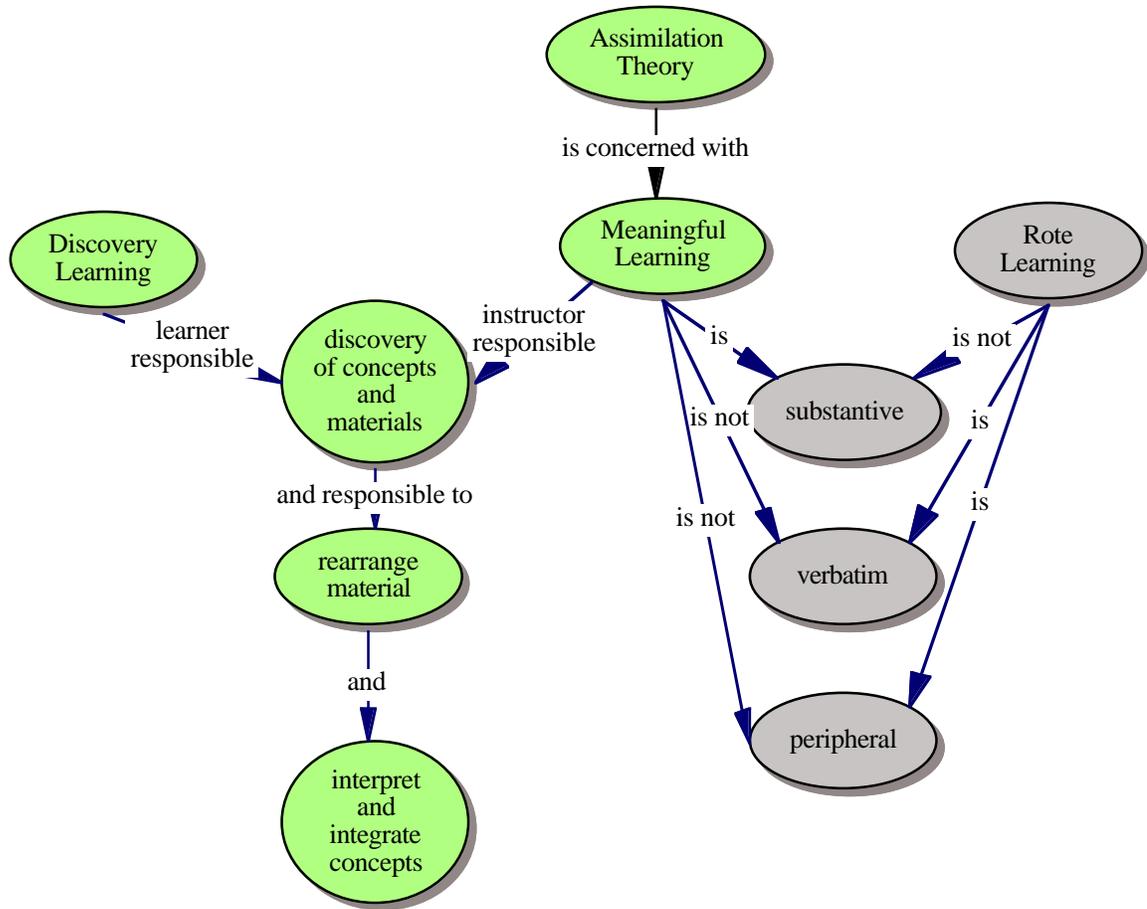
Figure II.26

For years, discovery learning was accepted to be the antidote to rote learning:

> (2) the prevailing tendency to confuse the reception-discovery dimension
> of the learning process with the rote-meaningful dimension [ARK 48]

Ausubel argues that one could not expect a school-age learner to perform the same

meaningful cognitive work that led Newton to his laws, Galileo to his discovery, nor

Einstein to his equations:

> [T]he entire content of what is to be learned is presented to the learner in
> final form. The learning text does not involve any independent discovery
> on the student's part. The learner is required only to internalize or
> incorporate the material that is presented so that it is available or
> reproducible at some future date. [Ausubel Novak Hanesian 1978. 24]

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The battle cry of the progressivists that the student must assume full responsibility for his own learning has been distorted into a doctrine of pedagogic irresponsibility. It has been interpreted to mean that it is the student's responsibility to self-discover everything he has to learn, that is, to locate and organize his own instructional materials from primary sources, to interpret them independently, to design his own experiments, and merely to use the teacher as a consultant and critic.

Education, however, is not, and has never been, a process of complete self-instruction. Its very essence inheres in the knowledgeable selection, organization, interpretation, and sequential arrangement of learning materials by pedagogically sophisticated persons. The school cannot in good conscience abdicate these responsibilities by turning them over to students in the name of democracy and progressivism. [ARK 34]

Ausubel showed that rote - meaningful learning and reception-discovery learning were two different continua, and that meaningful learning, not discovery learning, is the antidote for rote learning (Figure II.27 (from Figure 1.1, p. 25)):
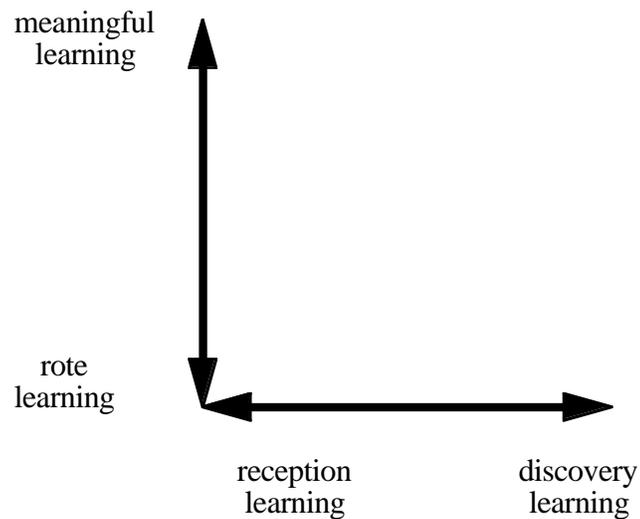
Figure II.27

Reception learning is distinct from problem solving

A student's ability to apply an algorithm to a problem and obtain an answer, without understanding the intellectual basis of the algorithm, indicates rote problem solving ability, not meaningful learning (Figure II.29).

Ausubel differentiates *reception learning* from mere *problem solving ability*:

> It has been commonly accepted for example (at least in the realm of educational theory) (1) that meaningful generalizations cannot be presented or "given" to the learner but can only be acquired as a product of problem-solving activity (Brownell & Hendrickson, 1950)   . . .
> It should be clear by now that verbal reception learning can be genuinely meaningful without prior discovery experience or problem-solving activity . . . [ARK 44]
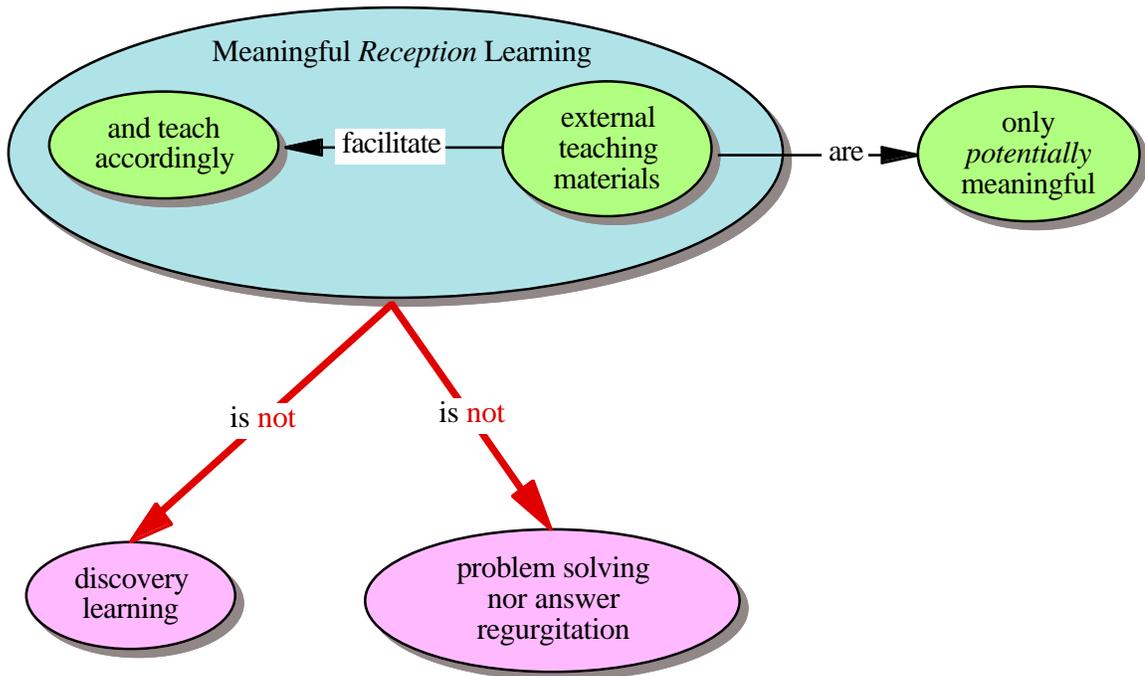
Figure II.29

Instruments associated with Assimilation Theory

What evidence is accepted that a learner has constructed meaning? How may a learner's cognitive objects (concepts, structures, and processes) be recognized and identified? Instruments are a tool (method) for recognizing and identifying structures and processes. Instruments express or produce representations of invisible phenomena in visible (physical) form and thus able to be transmitted to others. Concept maps and other tools described by Ausubel and Novak are instruments for expressing and viewing a partial image of a learner's knowledge, otherwise invisible to all but the learner (Figure II.30).
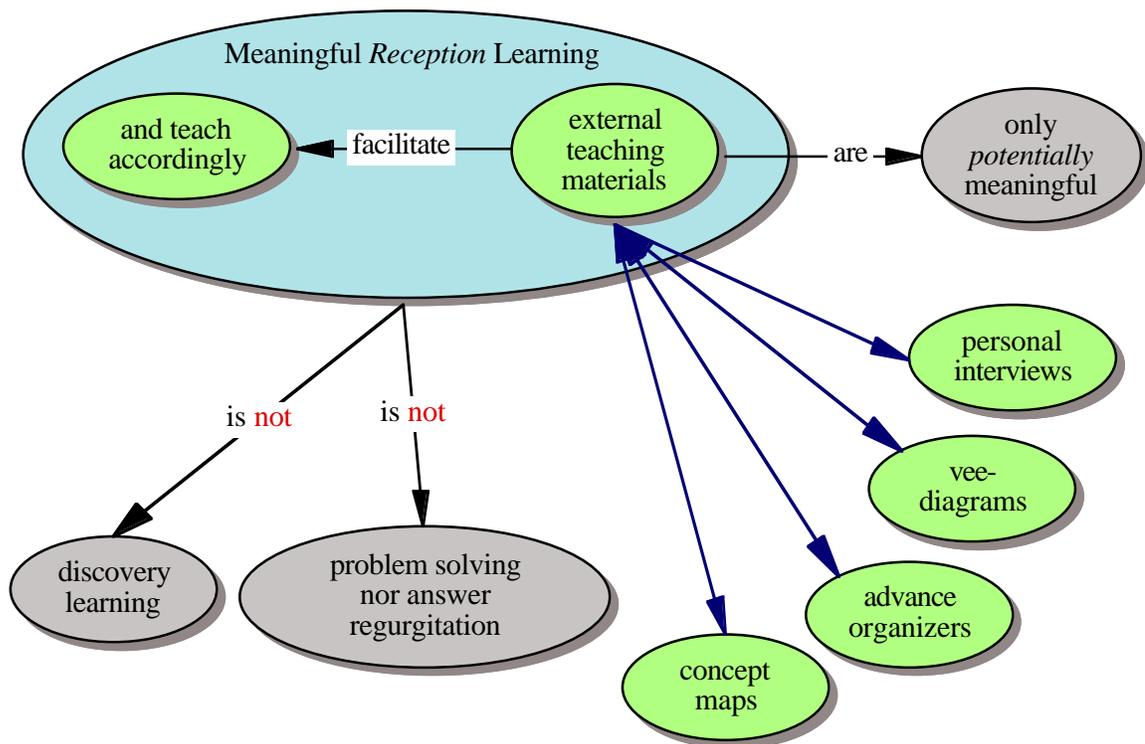
Figure II.30

Joseph Novak, one of Assimilation Theory's leading proponents, has published widely about the application of Ausubel's ideas in classroom settings. Perhaps Novak's most valuable contribution is in his descriptions of concept maps and other instruments.

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Advance organizers, vee-diagrams, scaffolding, K-W-L Charts, and personal interviews are briefly described but contribute importantly to Stage Two criteria. The attributes and value of concept maps are explored in greater detail as they play a more prominent role in Novak's explications of Assimilation Theory. Finally, various functions of these instruments are enumerated.

Advance organizers

Prior to study of a topic, advance organizers present anchoring concepts specific and relevant to the topic context (in the teacher-writer's knowledge structure) that the learner requires to make sense of the subject matter itself:

> The function of the organizer, after it interacts with relevant subsumers in cognition structure, is to provide ideational scaffolding . . . [ARK 149]

Advance organizers are not simply summaries or overviews, but express bridging concepts between general context and specific ideas that explain or satisfy the conceptual gaps reflected by a *focus question*. They are intended to be presented prior to learning a body of subject matter. They highlight the superordinate anchors and their relations of the new subject matter and indicate how these relate to the student's existing knowledge. This implies that the learner's existing knowledge has been identified.

Advance organizers have been the subject of frequent research since 1960 when Ausubel originally proposed the idea. As one of the few practice-oriented Assimilation Theory-based instruments acknowledged by Ausubel, his explications of the principles of advance organizers are used in developing Stage Two criteria for this project.

Advance organizers are an example of *scaffolding*.

An introduction to advance organizers using Ausubelian terminology:

> ADVANCE ORGANIZERS
> *Structure, Function, and Rationale for Use*
> An advance organizer is a pedagogic device that helps implement these
> principles by bridging the gap between what the learner already knows, and
> what he needs to know if he is to learn new material most actively and
> expeditiously. The proximate situation that makes an advance organizer
> both desirable and potentially effective in bridging this gap is the fact that in
> most meaningful learning contexts, the existing relevant ideas in cognitive
> structure are much too general and lack sufficient particularity of relevance
> and content to serve as efficient anchoring ideas for the new ideas
> introduced by the instructional material in question. The advance organizer
> remedies this difficulty by playing a mediating role͵ i.e., by being more
> relatable to, and relevant for, the *particular* content of the specific learning
> task, on the one hand, and by additionally being relatable to the more
> *general* content of the potential anchoring ideas, on the other. . . .
> [in contrast to advance organizers] [s]ummaries and overviews, on the other
> hand, are ordinarily presented at the same level of abstraction, generality,
> and inclusiveness as the learning material itself. They simply emphasize the
> salient points of the material by omitting less important information.   Thus,
> they largely achieve their effect by repetition and simplification.
>
> Thus, an advance organizer is introduced to the learner prior to confronting
> him with the learning material itself.
> [ARK 11-12 (emphasis and annotation added)]

Advance organizers may also be used as an assessment tool. For example, an advance

organizer for newly employed youth about personal income taxes, might outline different

types of taxes, describe taxpayers' obligations, show a pie-chart of how tax revenues are

distributed, and show a sample of a pay stub with deductions. This would prepare

students to learn the process of obtaining and using tax forms and instructions.

Vee-diagrams

Vee-diagrams employ a spatial device, a V-shape, to organize and present context around a focus question.

The vee-diagram is attributed to D. Bob Gowin, a colleague of Joseph Novak. Ausubel does not discuss Vee-Diagrams other than to acknowledge Gowin's contribution:

> Gowin's (1977) "Vee" is a heuristic device designed to help learners become explicitly aware of the methodological and procedural issues involved in discovering new knowledge. [ARK. 174]

Novak presents the notion of "epistemological vees" succinctly:

> To aid students in understanding research reports, Gowin (1970) devised five questions, the answers to which could provide the student with a better understanding of the research. These five questions were:
> 1. What are the telling or focus questions? These are questions that tell what the inquiry seeks to find out.
> 2. What are the key concepts? These are the dozen or so disciplinary concepts that are needed to understand the inquiry.
> 3. What methods of inquiry (procedural commitments) are used? These are the data gathering or data interpreting methods used.
> 4. What are the major knowledge claims? These are the answers claimed by the researcher as valid answers to the telling questions.
> 5. What are the value claims? These are claims, explicit or implied, about the worth or value of the inquiry and the answers found in the inquiry.
>
> [Novak, 1998. 80-81]

An example of a vee-diagram is presented in Figure II.31. [Novak and Gowin 1984] presents perhaps the most detailed description of vee diagrams, their construction, and their use.

conceptual   methodological

                          Focus Question

World View   How to evaluate   Value claim
Role of numbers   student understanding   Digital computers
in daily life   of number systems   can solve problems
                          other than base 10?   requiring numerical
                                                       calculation.
Philosophy
Numbers reflect
attributes of the
physical world, from
which valid conclusions
can be drawn about
what is.
                                                      Knowledge claim
                                                      9 (base 10) may be
   Theory   represented in a digital
   Number theory,   computer
   properties of integers

      Principles   Transformations
      Fixed number of possible   9 (base 10) = 1001 (base 2)
      integers in a "column";
      "carrying" to next column.

         Constructs
         Binary: 0 = decimal 0
         Binary: 1 = decimal 1
         Binary: 10 = decimal 2
         Binary: 11 = decimal 3

            Concepts   Records
            counting, zero, one,   9 (base 10)
            two, three, etc.

                          Events or objects
                          Translation of value in
                          base 10 to base 2

Figure II.31

The Vee diagram is structured such that the progression from top to bottom on both

wings of the vee is from the general to specific. The vee is traversed beginning at the

upper left, with presentation of concepts in increasing specificity, until the event or object

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to be studied is described at the nadir of the Vee. Proceeding up the right side, entries are dedicated to methodological elements that begin with records, then with increasing generality, interpretations, and then knowledge claims. At the top right of the Vee, the most abstract entry is given, e.g., value claims of the inquiry.

Vee diagrams are useful because they aid both author and reader in recognizing the concepts intervening between a specific focus question and its generalized context. Thus they may be constructed by instructors for use as presentation material or for organizing presentations, and by students. Use of vee-diagrams for assessment is described in the educational psychology literature adjacent to Assimilation Theory but their use in that role appears limited in practice.

Concept maps

Concept maps are simply diagrams depicting objects and relations among objects. The accumulated knowledge of concept maps by Novak and others contribute to Assimilation Theory's theoretical base.

Earlier, Ausubel's notion was presented that teaching materials should express concepts that form a continuous connection, a *path*, *between* new ideas and the student's prior knowledge. Maps express paths. Concept maps can express conceptual connections, paths, *between* new ideas and the student's prior knowledge.

As concepts inhabit the intellectual realm and not the physical world, the depictions on concept maps are only representations of concepts. Diagrams depicting real world objects can be indistinguishable from diagrams depicting *the ideas of* real world objects.

Concept maps are annotated with labels describing concept objects and the relations among them. Concept maps easily depict non-linear relations. The symbols of which concept maps are comprised form a limited linguistic system to express conceptual structures, comprised of concepts, relations among concepts (which are, themselves, concepts), and concept attributes (also concepts). In concept maps, lines are meaningful, space is not, and distance generally is not, although density of neighboring concept depictions may be meaningful.

Concept maps appear in varying degrees of formality from highly systematized and rule-laden to free-form sketches. Concept maps are among many diagrammatic forms for depicting relationships among objects (physical or intellectual), including cognitive maps (Edward Chance Tolman originated the term to explain aspects of rat behavior), process maps, mind maps, semantic networks, and conceptual graphs, to name a few. Some reflect concept objects, others reflect conceptual processes, including depictions of their endpoints. The software manufacturer whose product was used in producing the concept map examples in this section lists about sixty variant map types.

Though Ausubel himself made little use of concept maps, his foremost adherent, Joseph Novak, has written (and drawn) prolifically about their principles, their relationship to Assimilation Theory, and their use in practice.

> Despite this lengthy and precise elucidation of the theoretical issues,
> however [Ausubel] has not provided educators with simple, functional
> tools to help them ascertain "what the learner already knows." Concept
> mapping is such an educational tool. [Novak and Gowin 1984 40].

The primary function of a map is to enable a wayfinder to identify "where" he is, "where" he wants to go, and find a path for travel, while also providing context. Concept maps offer this same potential to reader-learners. Other important functions and benefits

accrue from use of concept maps. Their use in assessment of knowledge accrued by the learner is addressed below.

The labor of learning requires several kinds of tasks (described throughout this Section, e.g., establishing relations among concepts (i.e., *meaning*)). This work can be difficult. Tools are for making work easier. Concept maps are a writing-and-thinking tool that students and teachers can use to stimulate the various tasks inherent in learning, teaching, and assessment. Writers, including teachers, use concept map tools in stimulating the construction of an expression of their own knowledge structure for use in presenting subject matter to others. In the course of construction, the mapping processes force recognition, identification, construction, and labeling of concepts, attributes, and relations to other concepts, and provoke recognition of their "gaps" (missing concepts, and unsupported or missing relations among concepts), misconceptions, and, alternative and mistaken ideas, in their knowledge and in vocabulary to express concepts. As in brick-and-mortar construction, bricks cannot be installed into mid air. The construction worker is forced to assure each object is properly connected to the existing structure. In constructing concept maps, as in writing, the writer may discover new ideas, and re-discover ideas they had neglected because they are forced to be conscious of relations among concepts:

> Even very experienced teachers are often surprised at the fuzziness of their own ideas about a topic they may have taught for years when they make a concept map. [Novak 1998 116-117]

Concept maps, if limited to seven plus or minus two [Miller 1956] objects, provide readers a parsimonious visual view of a subject matter area.

Concept maps may be viewed and grasped in non-linear *chunks*. They partially overcome a cognitive processing burden that arises on account of deriving non-sequential

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webs of meaning from linearly structured writing in which each word must precede or follow other words (see below, Stage Two criteria derived from Foucault).

For example, consider the brief paragraph:

> The warm wind had swept in from the south and taken the children's newest and best friend, Frosty. Frosty had been built that morning, and was outfitted with a colorful scarf and a shiny top hat. The snowman was young Sally and Tom's first try at building a snowman, and sadly, their first experience with mourning.

Figure II.32a

To construct meaning from this paragraph, one must perform many cognitive tasks. One must build, among others, two constructs, one *past* (a snowman and the labor to gather the material and to shape it), and one *present*, his melting away. Beyond this, one then must recollect and project one's own recollections of (1) snowmen, (2) loss of a friend, and, perhaps memory of loss of a snowman. One might filter or de-prioritize non-essential ideas, e.g., the snowman's clothing. If performance of these tasks has any inherent sequential order, it does not appear rigid.

However, the source for these non-linear tasks is a sequence of 56 words, 313 characters that must be parsed and processed to evoke the ideas expressed in the paragraph. Of course, most are facile in performing this construction and thus understanding appears to happen virtually effortlessly. But, work is still performed, the work of recognizing which are the important concepts and what their relationships are to one another.

Now consider a concept map that expresses some of the same concepts (Figure II.32). In this map, only selected concepts are depicted, primarily, the snowman and a distinction between past and present status. The relations among concepts are also expressed. The map is not linear. The reader may assimilate it as a general whole, or study it in detail

from any starting point. Foremost, concepts and relations are expressed explicitly, thus inviting greater attention, greater focus, and resulting in greater clarity.
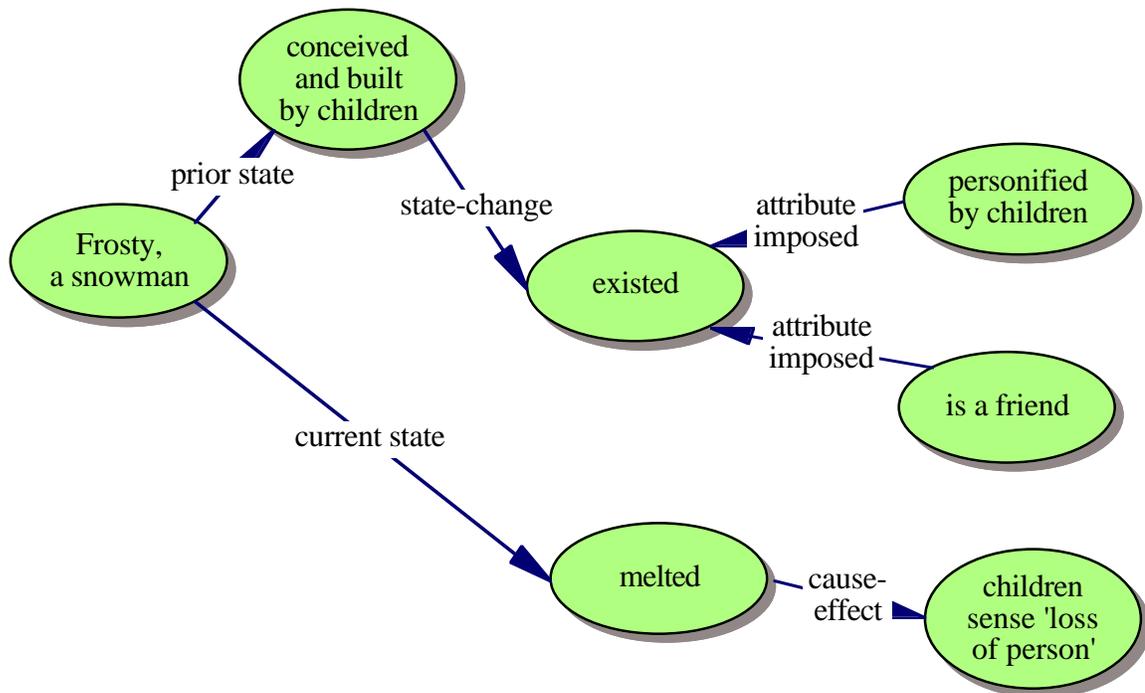
Figure II.32b
Differences (Figure II.32a and Figure II.32b) between an idea expressed
(1) as natural language (linear) and (2) as concept map (network)

Because concept maps generally restrict the number of concepts and relations, they can make possible the reader's detection of differences between the reader's understanding of the structure of a subject and the author's understanding that might not have been otherwise apparent. A learner might have been unaware that he held conflicting concepts. The conflict might become visible as the learner constructs a concept map:

> If seekers are asked to build the best concept map (for their inquiry), they
> will reveal both their valid and invalid ideas. The process of creating
> concept maps alerts the seeker to the fact that they do have some relevant
> knowledge [but also a gap]. [Novak 1998 72 (annotation added)]

Concept maps generally offer benefits of general maps. Reading maps, and especially constructing maps, can motivate questions and evoke ideas. Map theory, beyond that expressed by Novak, is an important aspect of the role of visual depictions in reading, writing, and thinking, and is considered further below (Section II.2).

Finally, benefit is often accompanied by detriment. Use of concept maps can be easy to resist because their construction requires an unfamiliar explicit kind of cognitive labor: searching for, recognizing, identifying, and explicitly expressing and labeling each concept and relation. For example, it is easy to draw an oval and label it *snowman*, but identifying and rendering its relevant attributes is work. Assimilation Theory teaches that this expenditure results in benefits with impact: increased meaningful knowledge.

K-W-L charts

K-W-L Charts [Carr Ogle 1987] represent the student's existing knowledge (K), the knowledge the student wants (W) to learn, and the knowledge the student has learned (L). These align with Ausubel's prime directive, to ascertain the learner's existing knowledge, and reflect a cognitive constructive bridging or pathway between concepts known by the learner and how to step toward endpoints (goal concepts). They take the form of a simple three column chart. [Mintzes Wandersee Novak 1998 98].

Personal interviews

Interviews are widely used for eliciting an understanding of a person's knowledge or beliefs. In terms of Assimilation Theory, they serve as an assessment instrument.

Novak devotes an entire section of his book to personal interviews as an effective instrument for ascertaining a learner's existing knowledge:

> [The] personal interview [is the] most powerful tool for capturing knowledge held by individual. . . .
> The design of good personal interviews involves several steps. First is the clear definition of . . . the focus questions. . . .
> A concept map should be prepared to organize the structure of knowledge the interviewer anticipates will be relevant . . . this map may represent the knowledge structure held by the experts . . . [Novak 1998 101-104]

The learner's knowledge structure likely changes during the course of the interview. Merely asking a question potentially imputes importance to its subject matter and contributes to the learner's understanding of the interviewer. Southerland itemizes several detriments to the use of structured interviews as used purely for assessment.

Personal interviews provide the benefit that they are perceived less as a test or examination, than as a conversation. Different psychological influences obtain in a conversation than an examination.

Interviews are a verbal device for negotiating an understanding of the learner's knowledge. The interview structure described by Novak is similar to isomorphic mapping and projection and is the primary technique used by reference specialists in assisting inquirers in libraries.

Exercises

1. Select an abstract from a journal article with which you are unfamiliar. Using no more than three to five concepts, depict the concepts and relations among concepts as expressed by the abstract.

2. Read the whole article from the exercise above and construct a concept map depicting the most important concepts and relations. Contrast the previous and current maps. What restructuring of the fuller concept map, or disregarding of concepts or relations, would have to be performed to arrive as the map derived from the abstract? Identify criteria that the render these concepts and relations less essential than those appearing in the concept map of the abstract.

Role of instruments in assessment and evaluation

The learner and the instructor share responsibility for detecting when the learner is off course, i.e., failing to recognize concepts, endpoints, relationships, overarching ideas, or failing to assimilate or synthesize ideas, and draw conclusions according to expectations.

Concept maps and the other devices described above can be used in several ways: (1) (by teachers) to ascertain (partially) a learner's initial knowledge state, (2) iteratively, to ascertain the knowledge the learner has assimilated at a point during a period of instruction, and (3) by the learner as a means of compelling him to expend cognitive energy to recognize concepts and relations among concepts on a given topic.

Novak specifies the defining characteristic for assessment of *individual* learners:

> [W]e must strive to measure what we believe are the most important relevant variables. Here is where a theory of education can be helpful in deciding on what to record.   . . .
> . . . our central concern in evaluation of cognitive learning should be with the ability of the test instrument to assess conceptual and propositional frameworks held by the subject, or the extent to which knowledge is learned substantively, which is the case in meaningful learning.
> [Novak 1998 181-183]

> The main assumption behind concept mapping is that expertise or understanding can be assessed by asking a person to construct a map by relating concepts in a hierarchical structure using propositional statements such as is regulated by and results in the links or connections. The resulting map reflects the person's mental structure related to the concept(s) in question. [Good 2000. 347]

Construction of "before and after" concept maps can show changes in the learner's cognitive structure. This detection of process endpoints, that is, expression of concepts

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and relations or their absence, can be useful to the instructor in planning teaching materials and can provide objective reinforcement to the learner as to their progress.

Concept maps can be particularly valuable in enabling instructors to detect students' misperceptions and preconceptions (see above).

Various schemes for using concept maps for assessment of a student's grasp of subject matter have been described in the educational psychology literature. Earlier assessment techniques were primarily quantitative, simply counting concepts and links.

> . . . the mental measurements crowd . . . the psychometric gang . . .
> unwarranted reverence for precise numbers. [Novak 1998 76]

This approach has been integrated with more meaningful qualitative methods to recognize where a student succeeds or fails to recognize specific concepts or specific relations in specific situations. Assessment requires the learner's knowledge structure to be compared to a conceptual reference structure. Concept maps may be used to assess whether specific concepts or concept relations occur, or whether they occur in a specific context. Merely counting concepts and connections might be useful, in quantifying information overload, but not in other lines of inquiry. Novak recommends:

> My approach is to provide students with a list of 20 to 30 concepts and ask
> them to map these, . . . construction of the map requires . . . organizing the
> structure of the map, selecting important, relevant concepts . . . searching
> out salient cross-links, indicating relationships between concepts in
> different sections . . . .
> We have developed a variety of scoring algorithms to give numerical
> scores to concept maps, permitting statistical tests and comparison with
> other tests. [Novak 1998 192-194]

Validity; critical evaluation of Assimilation Theory

Validity of research findings is limited by the validity of the instruments, assumptions, and other elements utilized by the investigator. The primary evaluative instrument in this essay is Ausubel's Assimilation Theory. Thus, the veracity of the findings expressed in this report depends upon the validity of Assimilation Theory.

Assimilation Theory is assumed valid in its role as the baseline evaluative instrument adopted for this essay. This assumption is supported both by the credible provenance of Ausubel's research record:

> Literally hundreds of research studies and dissertations on such related
> variables as advance organizers, integrative reconciliation, progressive
> differentiation, sequential organization of subject matter, review,
> overlearning, and the consolidation of learning, etc. have been conducted
> in a meaningful learning context.
> [ARK xiii]

and by the absence of claims of invalidity generally encountered in the literature when working with theories and ideas that have been discredited or fallen into disrepute.

Challenges to Assimilation Theory are few, although this may be in part because Ausubel's work is only modestly cited in the intra-disciplinary literatures, primarily educational psychology. Ausubel frequently anticipates and confronts ideas that conflict with Assimilation Theory throughout his texts. Beyond the borders of educational psychology, Ausubel's ideas are cited more widely. [Footnote II.6]

Within the confines of educational psychology, Ausubel recognized challenges to ideas with which Assimilation Theory aligns:

> Excellent reasons, of course, exist for the general disrepute into which expository teaching and verbal reception learning have fallen. The most obvious of these is that, notwithstanding repeated policy declarations of educational organizations to the contrary, potentially meaningful subject matter is still very often presented to pupils in preponderantly rote fashion. [ARK 44]

This is taken as an intramural debate that need not bear upon Assimilation Theory's value to this study.

Interestingly, though Ausubel heavily emphasizes the importance of ascertaining a learner's prior *knowledge*, there is no mention of ascertaining what *processes* or process capabilities the learner has or does not have as his disposal.

Within the scope of this essay, a handful of concerns arose.

Ascertainment of the learner's existing knowledge. Ausubel's theory is anchored to the axiom that facilitating meaningful learning requires the teacher to

> Ascertain this [the learner's existing knowledge] and teach accordingly. [Ausubel Novak Hanesian 1978, iv (flyleaf)]

There is little dispute that one's mind is, for the most part, a private world. Assimilation Theory does not admit telepathy as a possibility. How may an instructor ascertain a learner's existing knowledge?

Helpful here is Wilson's [WilsonP 1977] distinction between public and private knowledge. In public knowledge, the intersubjective, concepts are held by pluralities of

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people. These ideas are assumed to be substantially similar from person to person based on education, training, negotiation of meaning, and common experience.

Assimilation Theory relies on the intersubjective notions of (1) a distinction between private and public knowledge, and (2) of *communication*. Indeed, the basis of communication is the assumption that one's ideas may be expressed such that others may receive a physical manifestations of the expression and reconstruct some meaning, perhaps the speaker's or writer's meaning, but with only imperfect certainty. Language is the bridge that provides for transmission of expressions from one to another.

Thus, Ausubel's dictate to ascertain the identity objects (concepts) that can exist only within the learner is problematic but resolvable through the notion of communication: Others can construct their idea of what concepts the learner knows, and negotiate meaning to achieve some degree of certainty of consonant understandings among people.

Process ascertainment. Ausubel writes prolifically about both *concepts* and *processes*. His doctrine calls for ascertaining the *concepts* a learner has assimilated. Oddly, he does not make a complementary call for ascertaining the *processes* a learner is able to perform. One might read these to be part of his characterization of a learner's *meaningful learning set*, but Ausubel never prescribes *their* ascertainment in the clear and constant manner as for ascertainment of the learner's *knowledge*.

Methodological individualism. Methodological individualism (see: Meaningful learning and epistemological individualism, Part II.1) has been challenged and condemned in favor of approaches based on social clusters and communities. This debate rages on, unresolved, and inconclusive as to bearing on validity of Assimilation Theory.

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<u>"Acquisition" of knowledge and susceptibility to conduit metaphor effects</u>. Questions of terminological validity invariably arise when expressions become overused. The central term *information* is used in many specific senses, and often without conscious reference to any specific sense, but as a blanket term referring to mental objects such as ideas, physical objects such as documents, or both. Despite their conscious recognition of indispensability of the individual cognitive labor that must be part of any informative event, both Ausubel and Novak fall prey occasionally to the pervasive conduit metaphor. Reddy predicts as much -- that awareness of the conduit metaphor is, by itself, inadequate inoculation against its seductive lure and its adverse effects. This seduction is, as Reddy points out, embedded in the metaphorical structure of language. Ausubel's use of terms such as *content* and (mis-)use of the preposition *in* (as in "meaning *in* instructional material") are not interpreted here as evidence of the invalidity of Assimilation Theory.

A potential inconsistency in Ausubel's writings is the notion that a "new idea" (sometimes unhelpfully described as "new *material*") becomes integrated into one's knowledge structure. This raises the possibility that one can "have an idea" that is not in their knowledge structure. Yet the essence of a concept relies upon its composition of relations to other concepts and sensed experience. Thus, *integration* is interpreted here to mean merely that there is an increase in the number, kind, or degree of influence of a new idea upon the sum or one's existing knowledge.

Perhaps the most egregious conduit metaphor error in Ausubel is his selection of the very term *acquisition* in the title of his book [ARK] rather than *construction* or *derivation* of knowledge. Ausubel confronts the implications of this terminology directly (see: Interpretation of *acquire* and *acquisition*, above).

Limitation on cognitive structure to *hierarchy*. Ausubel's (mis-)interpretation of *generalization* as strict hierarchy is critically discussed earlier in this Part. As Lakoff and Rosch and others have pointed out, generalizations often are conflicted exceptions. In these debates, the exemplar *chair* is often cited as an example. According to Ausubel's doctrine, prior to teaching about the ergonomics of movie theater design, the general notion of *chair* should be understood. However, not all chairs have the same properties, for example, legs. Some "chairs" in sports stadiums and on busses and trains, have no legs, but are supported by horizontal girders. Thus, *legs* are not hierarchically inherited from *chair* in all cases. A better perspective is to understand chairs as a generalization in which most, but not all variants possess the attribute *legs*.

The method for overcoming prior misconceptions relies upon those very misconceptions. Ausubel's Theory's fundamental tenet is that meaningful learning requires that new ideas be the assimilated through *establishment of relationships to the learner's existing knowledge*. But this may be the *very* prior conception that must be overcome!

Differentiation between recall and recognition. This essay does not follow Ausubel on the distinction between recall and recognition. Ausubel sees recall as the more difficult, and the difference as a matter of "dissociability strength." The sense of *recall* adopted in this essay is simply as synonymous with memory, whereas *recognition* is regarded as comprising two operations: recall, and then either a mapping to ascertain recognition-as-identity or a projection to ascertain recognition that an idea is an explanation.

Summary. Though beyond the scope of this report, the reader may draw upon *intra*disciplinary accounts of how Ausubel's work may be differentiated from his contemporaries' and from current theoretical trends. No claims of epistemological inconsistencies in Assimilation Theory have surfaced. Ausubel's claims are founded on the provenance of a substantive record of case studies, his own private practice, and university-based research reported in peer-reviewed forums. His Assimilation Theory is accordingly concluded to be deemed credible.

II.2   Complements to Assimilation Theory

What is communication?

Communication requires not only physical *transmission*, but cognitive
sharing for use and constructing *meaning*

Negotiation of meaning

Private knowledge vs. public knowledge

Sensory-perceptual capacity limits communication

Loss of meaning is inherent in communication and reception learning

What are implications of the conduit metaphor to meaningful learning?

Manifestations and adverse consequences of conduit metaphor effects

Mitigation of conduit metaphor effect: communications reference models

The Five Divisions of Rhetoric: a communications reference model

Properties of objects of each Division of Rhetoric

Inventio

Basic *inventio* and abstract *inventio*

Basic *inventio* and epistemological individualism

Basic *inventio* and categories

Dispositio

Dispositio reveals the relations among component *inventio*

How *dispositio* explains contemporary category theory

Species of *dispositio*: Idealized cognitive models

Species of *dispositio*: Frames

Species of *dispositio*: Image schema

Intervention

Dispositio attributes: belief, trust, truth

Elocutio

Unique property of language, *elocutio*:
it reaches into both mental and physical realms

Fixity

Pronuntiatio

Differentiating *pronuntiatio* from *dispositio* explains the
giving anomaly

Memoria

Role of memory in Assimilation Theory

Differentiating *recall* and *recognition*

Historical role of memory

Impact of *memoria* on thought and language

Differentiating objects derived in any Division from those of the others

Mistaking objects of one Division of Rhetoric for objects of another

Derivation of objects of one Division from objects of another Division

        Objects of each Division are *derivations,* not *transformations*, not *representations*, not encapsulations, and not *codes*

        Loss, change, or addition of meaning may be a consequence of any derivation

        Notation

        Specific derivations

            Inventio ➔ *dispositio* and *dispositio* ➔ *inventio*

            Dispositio ➔ *elocutio* and *elocutio* ➔ *dispositio*

                Dispositio ➔ *elocutio* is selection of linguistic system and terms

                Elocutio ➔ *dispositio* is specification for evoking and selecting meaning

                    Dispositio ➔ *elocutio* compels speaker-writer to (re-)organize *dispositio*

                    Elocutio only indirectly correlates to meaning, *dispositio*

                    Elocutio always *under*specifies *dispositio*

                    Can *elocutio* specify meaning *explicitly*?

                    Dispositio is not linear, natural language *elocutio* usually is

            Elocutio (semantic) ➔ *elocutio* (percept) and vice versa

            Elocutio ➔ *pronuntiatio* and *pronuntiatio* ➔ *elocutio*

            Pronuntiatio ➔ *dispositio*

                Principles that bear upon *pronuntiatio* ➔ *dispositio*

                Interaction with paper

                Human-computer interaction (HCI)

            Evidence that a learner has constructed meaning

        Continuous derivations

What are reading and writing?

    Reading and writing are *personal*

    What is a *text*?

        What is the purpose of a *text*?

    What is reading?

        Why is reading difficult?

        Why is proofreading difficult?

        Innovations that mitigate obstacles to meaningful reading

        What is *paying attention*?

Function of isomorphic mapping and projection: labor-saving

Most isomorphic operation is subconscious

Why is thinking difficult?

Innovations that mitigate obstacles to thinking

What is *incubation*?

What is critical thinking?

> How can assumptions be recognized?
>
> How does warrant probing operate in critical thinking?
>
> *Reliability*, the quest for certainty: belief, trust, truth, knowledge, cognitive authority, etc.

Where do plans come from?

What is the role of imagination in thinking? What is creativity?

> Imagination *is* isomorphic projection of counterfactual concepts

Macro isomorphic operations: Idealized cognitive models

> *Recognizing* basic schema, *dispositio*, or idealized cognitive models (ICMs)
>
> *Anticipating* idealized cognitive models (ICMs)
>
> Subconscious influence of an ICM is *a perspective* or *preconception*
>
> Dichotomy: anticipating concepts is indispensable, but anticipation can also be misconception

The *Eureka!* event

> An example of imaginative comprehension events
>
> Relations among *inventio*, not *inventio* themselves, are best determiner of underlying structure

What is inquiry?

Elements of a model of inquiry

(0)   What is a *conceptual reference structure*?

(1)   What is *curiosity*?

(2a)   The *cognitive question*: inadequate *dispositio* (*gaps* and *blocks*)

(2b)   *Cognitive question*-as-expression (*expressed question*), *elocutio*
        How does the learner formulate an expressed question?

(2c)   Performing the *expressed* question to a teacher-subject specialist

(3a)   Reconstructing the inquirer's cognitive question

(3b)   Mapping the inquirer's cognitive question to a conceptual reference structure

(3c)   Projecting explanatory concepts from the conceptual reference structure to the inquirer's cognitive question

(3d)   Expressing the concepts projected

(3e)   Published texts identified

(3f)   Performing *pronuntiatio* for the inquirer

(4a)   Inquirer perceiving *pronuntiatio*

(4b)   Inquirer unpacks *pronuntiatio* into *dispositio*

(4c)   Inquirer replicates isomorphic projection

(4d)   Intellectual engagement with records
      Explanations mitigate inadequate *dispositio*
            An *explanation* is a conceptual *path* that displaces a
                 cognitive question

(5a)   Inquirer relates new concepts to their existing knowledge
            Recognizing *dispositio* as explanatory

(5b)   Inquirer imputes attributes of trust, belief, or truth to new
            knowledge

(6)   *Understanding* (meaningful learning or becoming informed)

(7)   Iteration and feedback

II.2   Complements to Assimilation Theory

Ausubel's Assimilation Theory provides important superordinate ideas from which the
Stage Two criteria are derived. However, some tenets of Assimilation Theory are
explained in greater dimension by writers in adjacent fields. For example, Ausubel
explicates *meaningful reception learning*, but provides little reference to ideas from
communications, linguistics, or cognitive theory. Cognitive linguists and philosophers
explain concepts that Ausubel does not, for example, the mechanisms *underlying* transfer,
i.e., isomorphic mapping and isomorphic projection. In this Part, complementary ideas
that amplify Assimilation Theory are drawn upon as sources for Stage Two criteria.

As LIS claims expertise in use of documentary sources to assist inquirers in becoming
informed [Buckland 1988 ch. 9], it is incumbent upon LIS to have an understanding of
how inquirers become informed through interaction with documents (records). If the
products of LIS labor, bibliographic instruments and systems, do not reflect such
understanding, their effectiveness and usefulness are unlikely to fulfill their potential.

Thus, to attain a better understanding of the Basic Relationship, one must attend to the
means by which inquirers become informed through use of documents, including
communication, its modes, how people use documents, how people read and listen); how
they write, author, organize, speak, and perform; how they *interpret*; and indeed, how
people *think* (Figure II.33).

Reception learning inherently relies upon *communication*. This section begins with an
exposition of *communication*, in particular, a historically-grounded sense of the concept
that is differentiated from the more common transmission-of-objects sense.
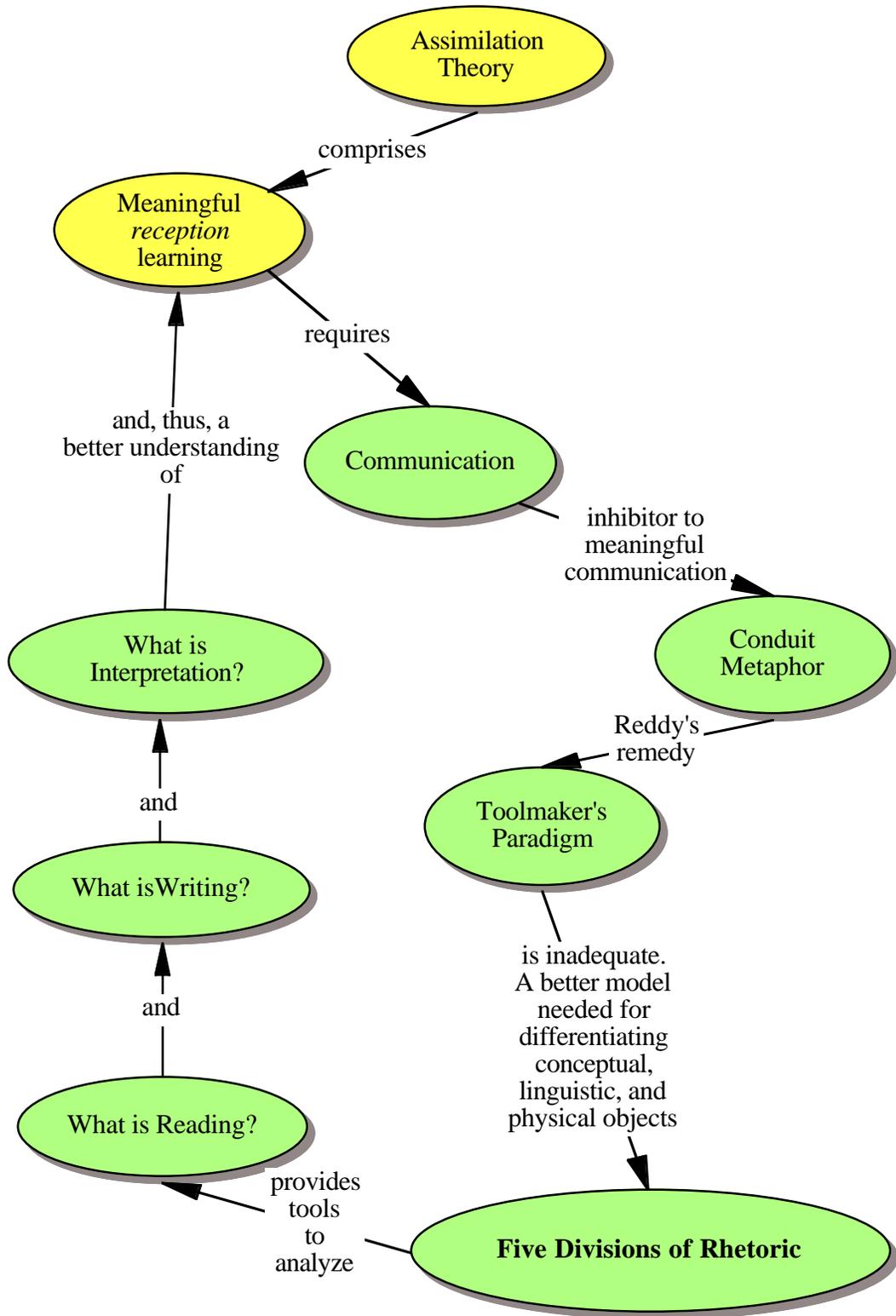
Figure II.33

What is communication?

Communication is an essential element of human activity, especially learning. Reception learning may be regarded as one mode of *communication* (Figure II.34).

Communication requires not only physical *transmission*, but cognitive *sharing for use* and constructing *meaning*

The popular connotation of *communication* is as a synonym for *transmission* of "information," that is, delivery of signals or objects via channels in the physical realm *constitutes* communication. Shannon and Weaver's well-known paper [Shannon Weaver 1949] uses *communication* in this non-cognitive sense.

The sense of *communication* used in cognitive constructivist theories, including Ausubel's, is distinct from the *transmission-only* sense, instead focusing on activity in the intellectual realm rather than the physical world. The notion of *transmission* of a message from one place to another was wholly absent in *communicare*, the parent term of *communication*, which emphasized *imparting* or *sharing* meaning. The ancients chose to coin and use the distinct term *communicare*, rather than use words derived from *transport* terms, surely available to them. Why? Perhaps because in oral communication, nothing moved from place to place. Thus:

Communication is *sharing for use*
namely, the use of constructing *meaning in people*

This distinction is important because the labor entailed in communication was not viewed as *physical transport*, but rather as *intellectual* work.

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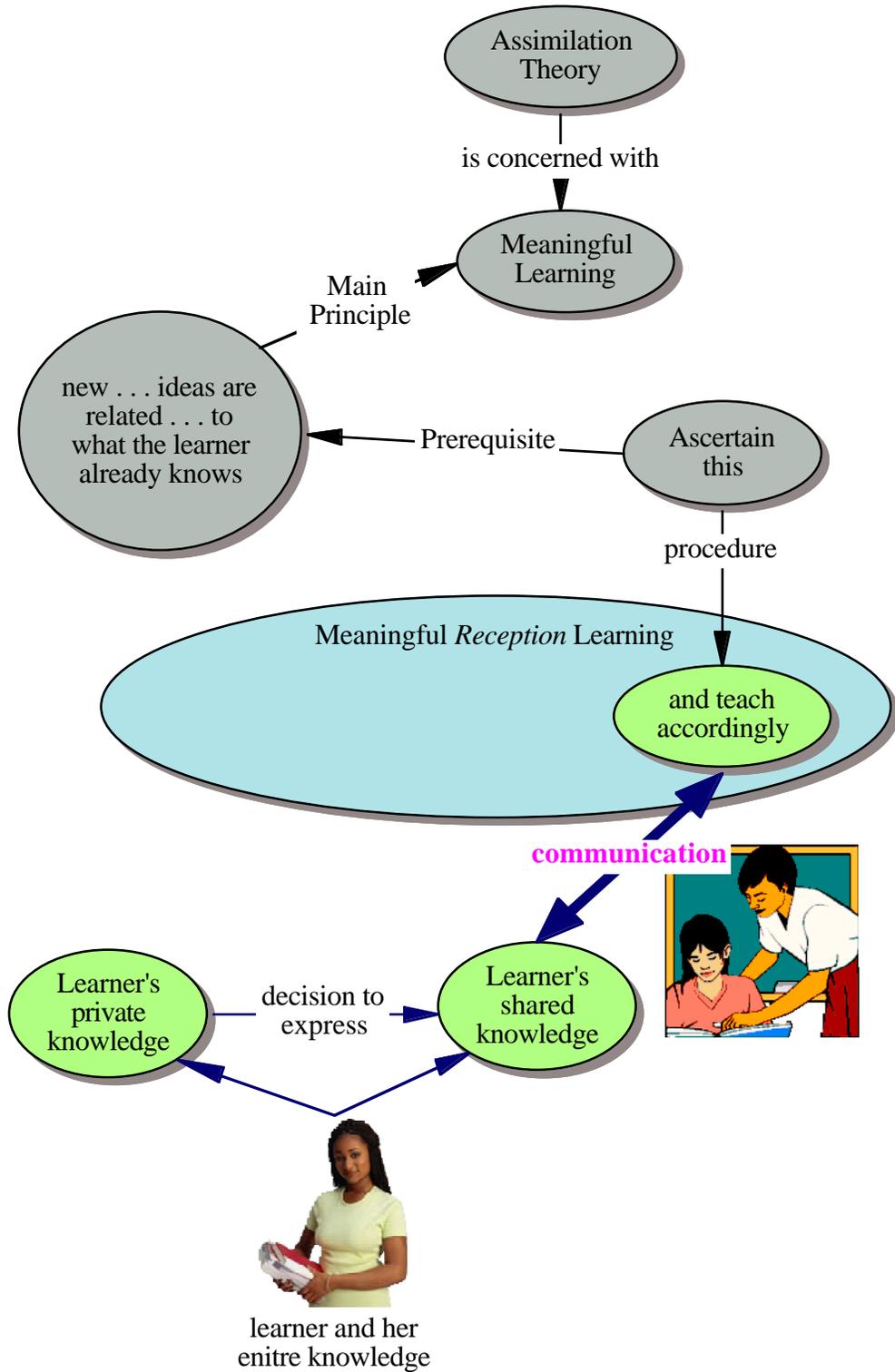
Figure II.34

Ausubel acknowledges this historical sense of *communication*:

> Psychological meaning is invariably an idiosyncratic phenomenon. Its
> idiosyncratic nature, however, does not rule out the possibility of social or
> *shared meanings*. The various individual meanings that different
> members of a given culture assign to the same concepts and propositions
> are ordinarily sufficiently similar to permit interpersonal *communication*
> and understanding. As we have had occasion to note earlier, this
> homogeneity of *sharing meanings* within a particular culture, and even
> between related cultures, reflects both the same logical meanings implicit
> in logically meaningful concepts and propositions as well as many
> common aspects of ideational background in different learners' cognitive
> structures. [ARK 74 (emphasis added)]

Through communication, learners construct their own idiosyncratic interpretations as to

the meanings writer-speakers express. Such meanings may be substantially similar to

their own. This does *not* imply that knowledge is *in* documents or transmissions, but

instead derives from them through cognitive labor.

Negotiation of meaning

The labor of *communication* is of two kinds: internal only, *constructing* one's own

idiosyncratic meaning, and, internal-external, *negotiating* meaning with interlocutors:

> There is constant need to negotiate meanings . . . [Novak 1998 38].

> The field of communication expands to include all aspects of the creation
> and negotiation of meaning in society. [Craig 2000]

Negotiation of meaning is an internal-and-external process whereby people ascertain

what mental models their interlocutors impute to particular linguistic expressions.

In *negotiation of meaning*, negotiation, i.e., conversation, continues until each party has concluded that the understanding they have constructed is comparable to the meaning that others have reached, or they are exhausted. If not, they may continue exchanging expressions with the intention of provoking their interlocutors to construct such a substantially similar understanding. The expressions are an imperfect and incomplete derivation of an author or speaker's state of mind, of which an idea is an inseparable part. However, with sufficient feedback, ideas formulated by one person can be reconstructed by others in the sense that they have ideas comprised of similar attributes (concepts and relations among them). Negotiation results in imputing meaning to terms, and disambiguating linguistic expressions, that is, creating or arriving at least one, but no more than a small number of alternative meanings or senses for an expression.

Below (see: What is Reading?), a complement to the *negotiation of meaning* view of communication is described that conceptualizes the task of the reader-listener as attempting to match and select cognitive models from among those already in mind, then select those that best fit the text read or heard. Wittgenstein frames the negotiation aspect of language as *games*, though not necessarily for the purpose of constructing meaning.

Private knowledge vs. public knowledge

The basis of communication, sharing ideas for use, relies on the notion that people can, with some certainty, know the thinking and meaning of others. *Can* one know the ideas in another's mind?

Minds are private. Yet, one *can* know ideas in other people's minds. How? Resolving this dilemma requires making a distinction between public and private knowledge:

> Understandings, including beliefs that rest on *shared meanings* [are] a trait
> that philosophers sometimes call *intersubjectivity*.
> [Mintzes 2000 43 (emphasis added)].

Aspects of one's private knowledge can be *expressed* to others, reconstructed by them, that is, *communicated*. In this process of communication or intersubjectivity, the writer-speaker's expressed thought loses its status as private. Such thoughts become their *public* or *intersubjective* knowledge.

One aspect of the distinction between private and public knowledge is that a speaker-writer can never express or communicate *all* aspects of their ideas. Some elements of an idea may remain subconscious, perhaps constructed from childhood experience (see: Basic *inventio* and abstract *inventio*, below). Communication is always imperfect in that it is incomplete.

Sensory-perceptual capacity limits communication

Much human communication is orally spoken or written. Quantitative limits to the sensory-perceptual tasks people can perform must be acknowledged: Humans can read or listen to a physical object faster than they can inscribe, copy, speak it, or perform it.

This bandwidth disparity in *transmission* can influence *communication*: people *assimilate* a text (for example) faster than they can *express* or produce it.

Some aspects of human perception and cognitive processing accommodate simultaneity. Humans can perceive aural/verbal, visual, tactile, olfactory, even gustatory experience *simultaneously*. Speakers and performers can use multiple linear expressive forms (*voices* or melodic lines in music) simultaneously, such as voice and hand or facial

gestures. When one inscribes and speaks, one employs not only systems of words and phrases, but also audible and visible gestures and inscribed stylistic forms (paper and image quality, etc.):

> . . . an interpretation using voice and gesture to give the best possible rendering in keeping with the literary genre and the author's intentions. [Cavallo Chartier 1999 11]

Body language (gesture), inflection, and print format and style, among others, are linguistic systems in their own right, from which reader-listeners derive meaning.

Nevertheless, all types of human expressing involve cognitive initiation, muscular action, and movement of mass, whereas assimilating requires only perception and cognition. Accomplishing movement of muscular and other physical mass consumes time. The human act of *expressing* (which includes physical component) is generally slower than the act of *assimilating* (cognitive only).

Loss of meaning inherent in communication and reception learning

Loss of meaning in communication can be attributed to several causes: (1) because *elocutio* is derived from *dispositio*, linguistic expressions are only indirectly correlated *to* meaning, not containers *of* it, (2) linguistic expressions always underspecify meaning, because expressions can never completely specify all the concepts from which it derived (see: Private knowledge vs. public knowledge, above), and (3) because experience is unique to each individual, so meaning grounded in experience is unique to each individual. These principles are explored further below (see: Implications of derivation).

What are implications of the conduit metaphor to meaningful learning?

> Human constructivists reject the view that knowledge is a product that can be faithfully *conveyed* by teachers. [Mintzes 1998 49 (emphasis added)]

Writers periodically rediscover an important notion that Michael Reddy calls the *conduit metaphor* [Reddy 1993 168] (anticipated by Patrick Wilson [WilsonP 1979]). This pervasive *logic*, as he characterizes the conduit metaphor, imposes adverse consequences upon virtually all users of language.

Conduit metaphor refers to use of *linguistic expressions* that treat *mental* objects as if they are *physical* objects and thus can be *transmitted* from person to person, as via a *pipe* (language) (Figure II.35). Conduit metaphor implies that meaning is *in* a text, *in* a word or phrase, or *in* a document. Thus all the reader-listener need do is *extract* it, further implying little or no constructive cognitive labor by the reader-listener.

For example, the expression, "That was a very good book, I got a lot out of it." implies that meaning was literally *in* the book rather than being constructed by the reader.

Conduit Metaphor

Meaning transmits from mind to mind
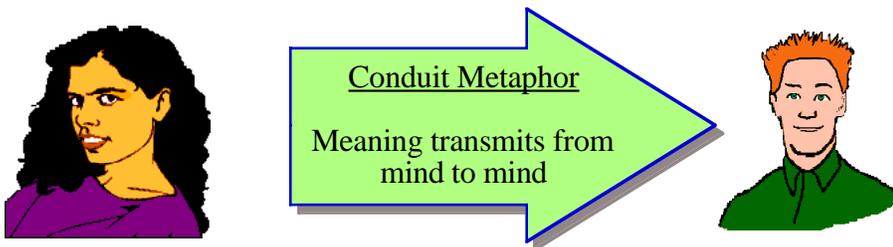
Figure II.35

In such an expression, the learner's intellectual labor in interpreting the text is treated as trivial and automatic. Communication is regarded as having occurred when the learner has merely *received* the expression, word, or term.

text, speech, or other signals conveyed

Intellectual labor of writing

Intellectual labor to **construct** an understanding from reading

Author
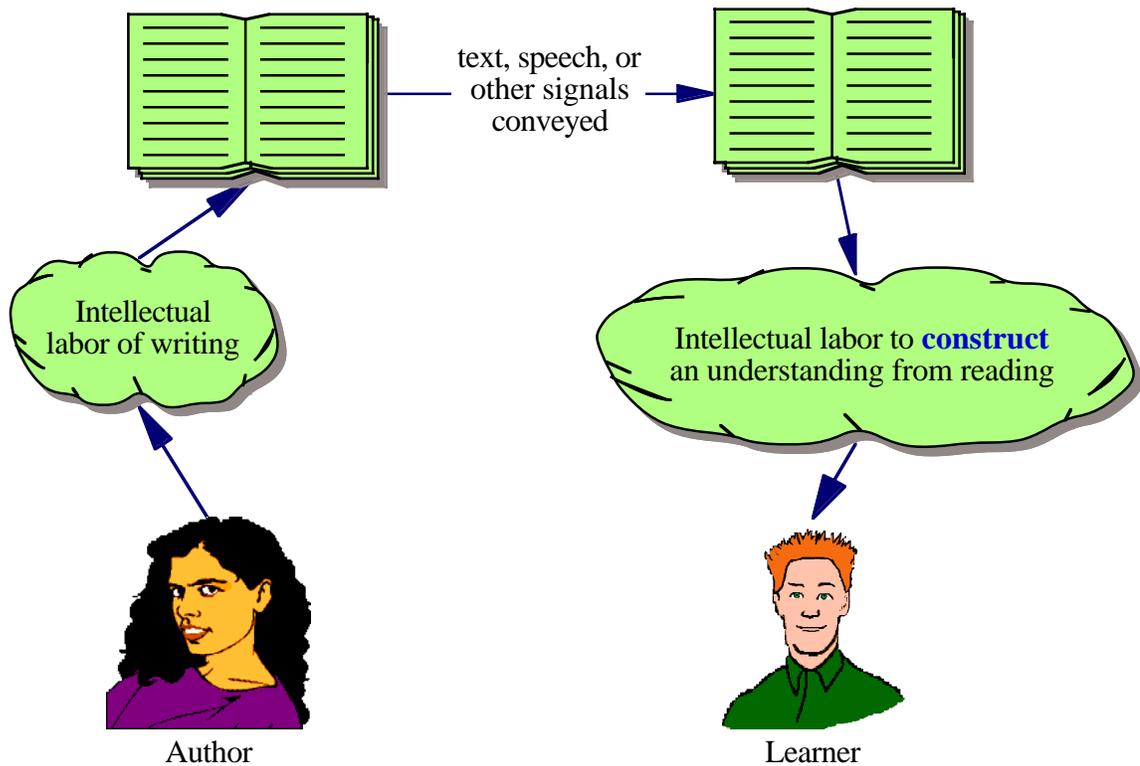
Learner

Constructivism
Meaning must be constructed by learner, as from engagement with a text

Figure II.36

In contrast, Ausubel's theory of meaningful reception learning recognizes the indispensable role of the learners' *mental* realm in communication (Figure II.37).

Novak regards meaningful learning, rooted in cognitive constructivism (Figure II.36), as standing in direct contrast to the conduit metaphor viewpoint:

> Most education, Freire asserted (1970), assumes the person is an empty vessel to be filled with information. This banking concept of education

proceeds by rote memorization of material that has little or no relevance nor meaning for the learner. [Novak 1998 33]

Mintzes, with whom Novak has authored two books based on Assimilation Theory, reinforces the inadequacy of regarding language as a vessel for carrying meaning:

MIT's educational visionary Seymour Papert (1993, [The children's machine: Rethinking school in the age of the computer] p. 104) observes: 'The metaphor of learning by constructing one's own knowledge has great rhetorical power against the image of knowledge transmitted through a pipeline." [Mintzes 1998 347]

Reddy's ideas are substantially similar to the concerns that compelled Ausubel to offer a defense of his expression *acquisition of knowledge*, i.e., it should be interpreted as a constructive effort of integrating new meanings with prior knowledge as opposed to a mechanical taking.

Manifestations and adverse consequences of conduit metaphor effects

Reddy explores the adverse effects of the conduit metaphor, of discounting the cognitive labor required to derive meaning from linguistic expressions. He suggests measures to mitigate its effects:

In writing and speaking, people believe that they *put* or *insert* their thoughts *into* words. [Reddy 1993 170]

Thus, ideas, meaning, are *inside* words. [Reddy 1993 168]

If meaning is *in* words, then words have insides and outsides, [Reddy 1993 168]

Words and expressions are therefore *containers* of ideas, of meaning. [Reddy 1993 170]
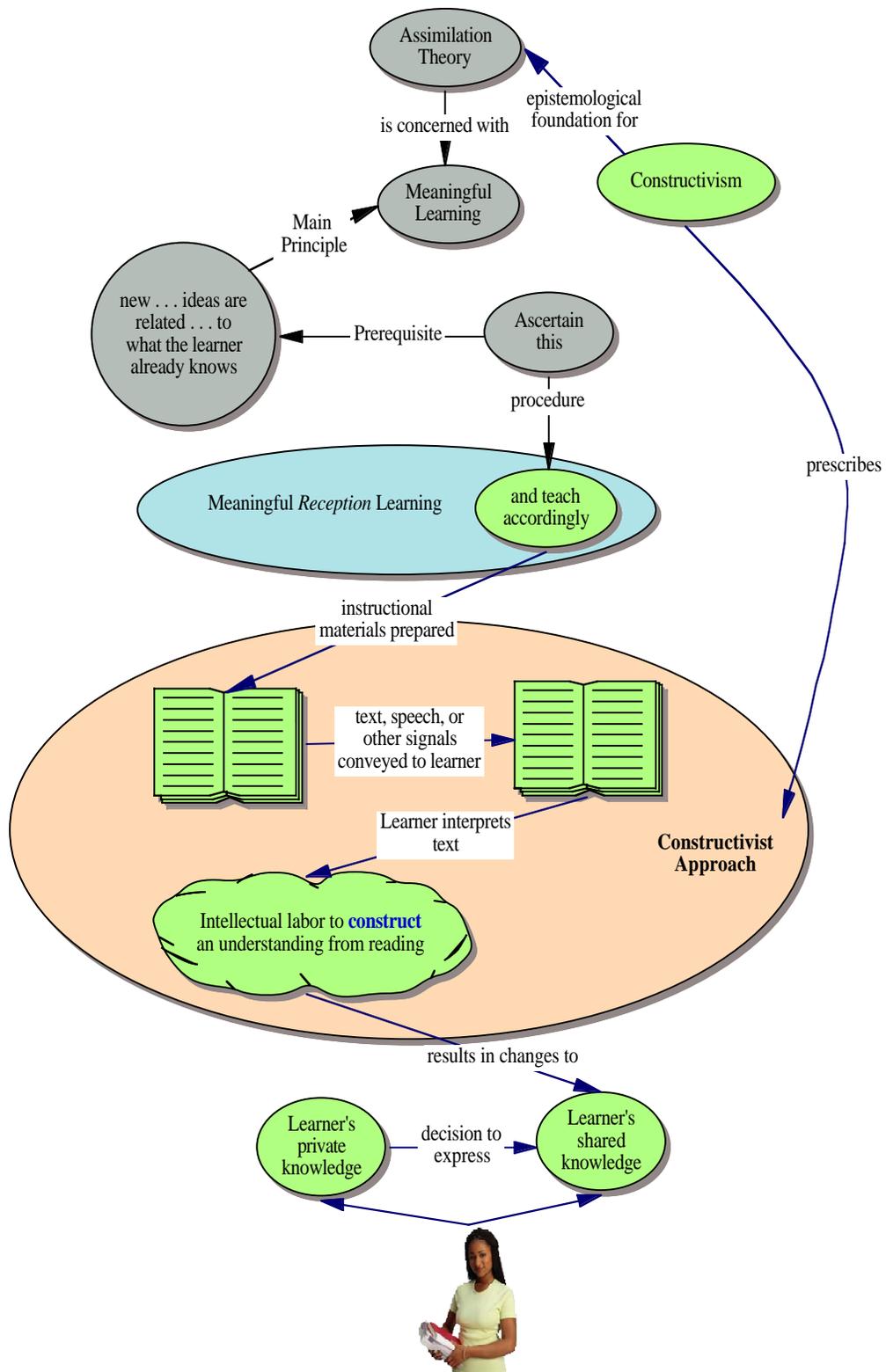
Figure II.37

As words (containers) are conveyed from person to person, they *carry* ideas, meaning. [Reddy 1993 170]

Words, as containers, *flow* through a conduit, known as *language*, from person to person. Language is a conduit. [Reddy 1993 170]

During transit between people, words, as containers of meaning, are *outside* of people, and therefor *ideas* can also be *outside* of people. [Reddy 1993 170]

Meanings can be acquired by acquiring objects outside people, rather than constructed intellectually

And since ideas are *in* words, and words exist in the physical world, and since ideas can exist *outside* of people, ideas are thus susceptible to operations in the physical world, e.g., storage, retrieval, processing, management.   Thus, *data processing* becomes *knowledge management*!

Communication is *transmission* of (a physical manifestation of a) text, rather than construction of an understanding. [Reddy 1993 170]

In listening or reading, people *extract* meaning from the words. [Reddy 1993 168, 170]

Meaning can be *received* from someone else, in contrast to having to be constructed by the listener-reader. [Reddy 1993 170]

Receiving meaning from someone requires transmission of texts, but is otherwise labor-free, automatic, passive [Reddy 1993 175]

Therefore, if anything goes wrong in becoming informed, it must be the reader/listener's fault or incompetence. [Reddy 1993 168]

Or, if the text was "impenetrable," and thus the meaning could not be extracted, it's the writer's fault. [Reddy 1993 168]

People extract meaning from words easily, "success without effort." Learning is passive, effortless. [Reddy 1993 174]

Therefore, receiving or possessing *words* is virtually equivalent to possessing their *meaning*. *Having* information is *knowing*.

Thus, if one *has* a book or document, one possesses the knowledge it contains. *Having documents* is *having knowledge*. [Reddy 1993 187]

Large "amounts" of knowledge reside in books, databases, and libraries. And if one has a large library of books, one has a correspondingly large storehouse of knowledge. [Reddy 1993 187]

If one is responsible for managing books, databases, or libraries, one is a *gatekeeper of knowledge.*

And, the most incorrigible detrimental attribute of conduit metaphor effect:

Conduit metaphor is difficult to overcome even if one is cognizant of it. It is embedded in our language and thus, in our minds.
[Reddy 1993 176, 181]

Lakoff and Johnson, echo Reddy's warnings:

Communication theories based on the conduit metaphor turn from the pathetic to the evil when they are applied indiscriminately on a large scale, say, in government surveillance or computerized files. . . . When a society lives by the conduit metaphor on a large scale, misunderstanding, persecution, and much worse are the likely products.
[Lakoff Johnson 1980 232]

Assimilation theory is grounded in cognitive constructivism, which holds that the intellectual labor of communication, of constructing meaning, is distinct from transmission of objects in the physical world. Juxtaposed to the primary principle of cognitive constructivism, the conflict with the conduit metaphor is bright and harsh: individual cognitive labor is ignored or taken for granted, resulting in emphasis on objects available in the physical world, technology, transmission, systems, all displacing attention to the cognitive functions of learning. What's more, even armed with deliberate conscious effort to avoid the conduit metaphor trap, one soon falls prey to its seductive ready-made expressions for describing intersubjective phenomena. What to do?

Mitigation of conduit metaphor effect: communications reference models

Recognizing the value in resisting the conduit metaphor's allure, Reddy suggests that a communications reference model is necessary to help theorists and everyday practitioners of language recognize conduit metaphor when it arises. He first offers suggestions for disambiguation of word senses for terms that evoke both physical and mental objects.

Reddy then provides [Reddy 1993 171] a model, his Toolmaker's Paradigm, actually, a story in which identical writings are passed to different recipients who construct different understandings. The intent of the Toolmaker's story is to remind us that, because different people construct different meanings from a text, meaning is constructed by the reader rather than embedded within linguistic expressions awaiting some type of mining operation.

While Toolmaker's Paradigm perhaps serves its purpose in providing the reader of Reddy's article with a prop for recalling the essential nature of the construction of meaning, it is awkward when used as a generalized theoretical tool. Specifically, it does not differentiate conceptual objects, linguistic objects, and physical objects, and operates merely through retelling the story.

Fortunately, a better communications reference model for cognitive analysis is available to us: the ancient Five Divisions of Rhetoric (Figure II.38).
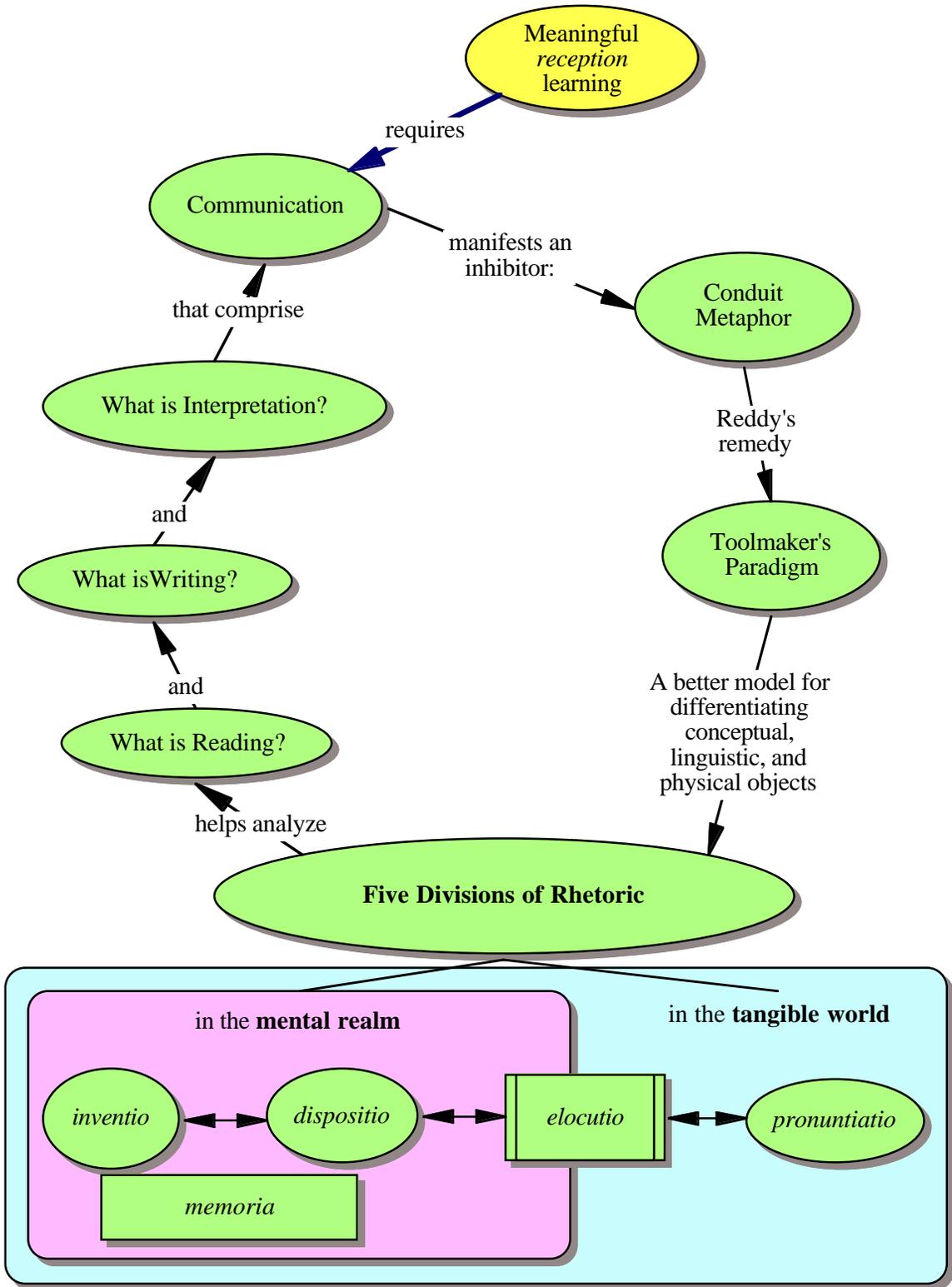
Figure II.38

Exercises

1. Identify in the excerpt, instance of conduit metaphor error:

    > In a system designed for providing information retrieval [as differentiated
    > from data retrieval], other metrics, besides time and space, are also of
    > interest. In fact, since the user query request is inherently vague, the
    > retrieved documents are not exact answers and have to be ranked
    > according to their relevance to the query. Such relevance ranking
    > introduces a component which is not present in the data retrieval systems
    > and which plays a central role in information retrieval. Thus, information
    > retrieval systems require the evaluation of how precise is the answer set.
    > This type of evaluation is referred to as *retrieval performance evaluation*.
    > [Baeza-Yates Ribeiro-Neto 1999 73]

2. Attempt to rewrite the passage avoiding conduit metaphor error.

The Five Divisions of Rhetoric: a communications reference model

Assimilation Theory is concerned, in part, with the teacher's intermediation of the learner's engagement with instructional materials. Thus, distinctions between instructional materials, which inhabit the physical world, and objects within the learner's mental realm, must be clear. While some differences are immediately obvious, there is little doubt, as Reddy shows, that objects of one realm are too frequently mistaken for objects of the others. How may these distinctions be reinforced in our theory and practice to avoid continued confusion?

Three hundred and fifty years before Christ was born, Plato's student, Aristotle, articulated distinctions between concepts, structures of concepts, linguistic expressions, and physical performances of expressions in his *Rhetoric* [Aristotle *Rhetoric*], whose purpose was giving force to truth. In the first century B.C., Cicero's *De Oratore* [Cicero *De Oratore*] applied these distinctions to lending persuasive force to the speaker. Two hundred years later, this communications reference model was expressed in its classic form as the Five Divisions of Rhetoric (divisions of labor) by the teacher Quintilian, in *De Institutione Oratoria* [Quintilian *Institutiones oratoriae*] [Clark 1957] (Table II.1).

Rhetoric is popularly regarded as the art of persuasion or communication. However, the ancient rhetoric is drawn upon here as an instrument for cognitive analysis.

The Five Divisions of Rhetoric serve as a communications reference model applied to cognitive analysis that (1) provides distinctions between ideas, structured clusters of ideas, linguistic terms expressing those clusters, and physically transmittable forms of linguistic expressions, and (2) bridges the intellectual and physical domains:

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Five Divisions of Rhetoric

inventio   Invention of <u>concepts</u> ("arguments" or ideas)

dispositio   <u>Arrangement of concepts</u> and relations among them; concept structures, sequence of ideas (as for presentation);

elocutio   <u>Linguistic expression</u>, (term selection). To express; to clothe the arranged concepts with language; to *render* ideas using a linguistic system. Language is a *specification* for associating meaning with physical objects, e.g., printed characters or audible sounds.

memoria   Recall and mastery of subject matter for oratory and private thinking.

pronuntiatio   <u>Delivery</u> or transmission of physical productions or performances derived from the specifications of the linguistic expression.

Table II.1

The Divisions of Rhetoric terminology will be used with the aims of distinguishing concepts, words, and physical objects, and of committing fewer conduit metaphor violations -- mistaking linguistic expressions for ideas. Most of all, by forcing distinctions among intellectual and physical objects, adoption of this model takes first steps toward counteracting the frequent blurring of these distinct objects (processes) into the familiar, amorphous *information*.

As originally conceived, the Divisions of Rhetoric were processes used by orators to prepare for and perform public speech. In this essay, the Divisions, when referred to in the process sense, are tagged as *division-as-process*. Without the *as-process* suffix, Division names refer to the *objects produced* by the specified Division process, whether of the physical realm or the mental.

Properties of objects of each Division of Rhetoric

Inventio

> In our schools and colleges today we need more of the tradition of *inventio*
> in our own teaching of oral and written composition. Practice in the use of
> status and of the places of argument can be as fruitful now as in the past.
> Our students deserve more training in the preparation of their themes.
> [Clark 1957 79]

Inventio-as-process refers to the invention of concepts, that is, intellectual objects often

called ideas, claims, themes, facts, beliefs, conclusions, and propositions, or arguments.

The ancients characterized *inventio* (as object) as "the arguments themselves" (see:

[Cicero *De Inventione*]) and are thus objects of the intellectual or mental realm.

Clark [Clark 1957], describes the process of marshalling *inventio* as marshalling

arguments and facts, determining main characters and issues (in a judicial context),

answering the where, what, when, how, and why questions. These also encompass

emotional concepts.

Concepts, *inventio*, are intellectual objects comprised of attributes and relations among

them (see: *Dispositio*).

Basic *inventio* and abstract *inventio*

Lakoff partitions *inventio* into *basic* concepts, which arise from sensory experience, and

abstract concepts, constructed from mental processes that project basic concepts onto

abstract ideas to form new abstractions [Lakoff 1993 239].

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How does that work? Early on, infants experience situations where, for example, a desired object is beyond reach or is too heavy to lift. From these motor and sensory experiences, the infant develops the *basic* concepts of *distance* and *weight*, among many others. Later in life, these basic concepts and the linguistic terms used to express them are also used to describe abstract ideas for which the learner has no other mental models, no other linguistic terms. In this example, the ideas of *distance* and *weight* and the terms expressing them are projected (i.e., metaphorically) onto *abstract* concepts, e.g., "That advanced calculus class is *way over* my head," or "Refinancing the house lifted a great *burden* from my shoulders."

> Philosophy . . . turns out to be very different from what we thought before.
> Instead of being the activity of pure reason, it is the activity of an
> *embodied reason*. It operates through the cognitive unconscious and thus
> makes use of all the *imaginative* resources of the cognitive unconscious.
> It is grounded in and constrained by *structures* that depend on the nature
> of our bodies and the environments we live in.
> [Lakoff Johnson 1999 540]

> Our conceptual system is grounded in, neurally makes use of, and is
> crucially shaped by, our perceptual and motor systems.

> Conceptualization Only Through the Body: We can only form concepts
> through the body. Therefore, every understanding that we can have of the
> world, ourselves, and others can only be framed in terms of concepts
> shaped by our bodies.

> Basic-level concepts: These concepts use our perceptual, imaging, and
> motor systems to characterize our optimal functioning in everyday life.

> [Abstract reason:] Primary metaphor is the activation of those neural
> connections, allowing sensorimotor inference to structure the
> conceptualization of subjective experience and judgments.

> Abstract reason: By allowing us to *project* beyond our basic-level
> experience, conceptual metaphor makes possible science, philosophy, and

all other forms of abstract theoretical reasoning.
[Lakoff Johnson 1999 556-557]

Consider the abstract idea,

the *higher* or more senior an employee is in an organization,

the *more* power they have

This abstract concept is built upon the metaphor:

more is up

which arises from a *basic* concept formulated early childhood experiences such as observing that when *more* water is put into a glass, the water level goes *up*.

Because all our cognitive structure is influenced by our sensory experience, avoiding abstract concepts derived from basic concepts, e.g., metaphor, is virtually impossible.

Convention has regarded metaphor as a figure of *speech*. Contemporary metaphor theory regards metaphor as the relating or projecting of one *inventio* upon another, as distinct from the use of one *elocutio* for another. The projection is a *cognitive* event (see: Metaphor is a figure of thought, not a figure of language, below). A *metaphoric expression* is the linguistic expression describing the cognitive event of metaphor.

Assimilation Theory acknowledges that human thinking derives, in part, from human sensory capacity:

[H]umans beings think, *feel*, and act. [Novak 1998 12]

Novak draws upon Lakoff's ideas about metaphor [Novak 1998 164], acknowledging the experiential bases of abstract concepts:

> [P]rimary abstractions derive directly from experience with concrete objects or events. [Novak 1998 127]

Although Ausubel does not explicate the distinction between basic and abstract *inventio*, Novak's description of the process of abstraction as deriving from concrete events is sufficiently similar to conclude that the production of abstract concepts from basic concepts is consonant with the process operations described by Assimilation Theory.

Basic *inventio* and epistemological individualism

The notion that abstract thought arises from sensory experience also reinforces the epistemological position of individualism. Sensory experience, weight, heat, distance, etc., are *personal* experiences, and thus are *personal* concepts.

Basic *inventio* and categories

Each single instance of *inventio* may be regarded as a criterion for a *category*. (Please see How *dispositio* explains contemporary category theory, below.)

Dispositio

Dispositio and *inventio* are two names for the idea of *concept*. The difference is that *dispositio* is a fine-grain resolution, or zoom-in of *inventio* Figure II.39(b). *Dispositio* reveals the internal structure of *inventio*, i.e., component concepts and relations among them, much as an x-ray might reveal the inner structure of an egg as if it had no shell.
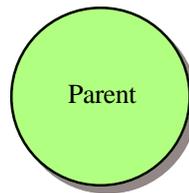
(a)
Concept *parent* as *inventio*
manifested as linguistic term, but little else
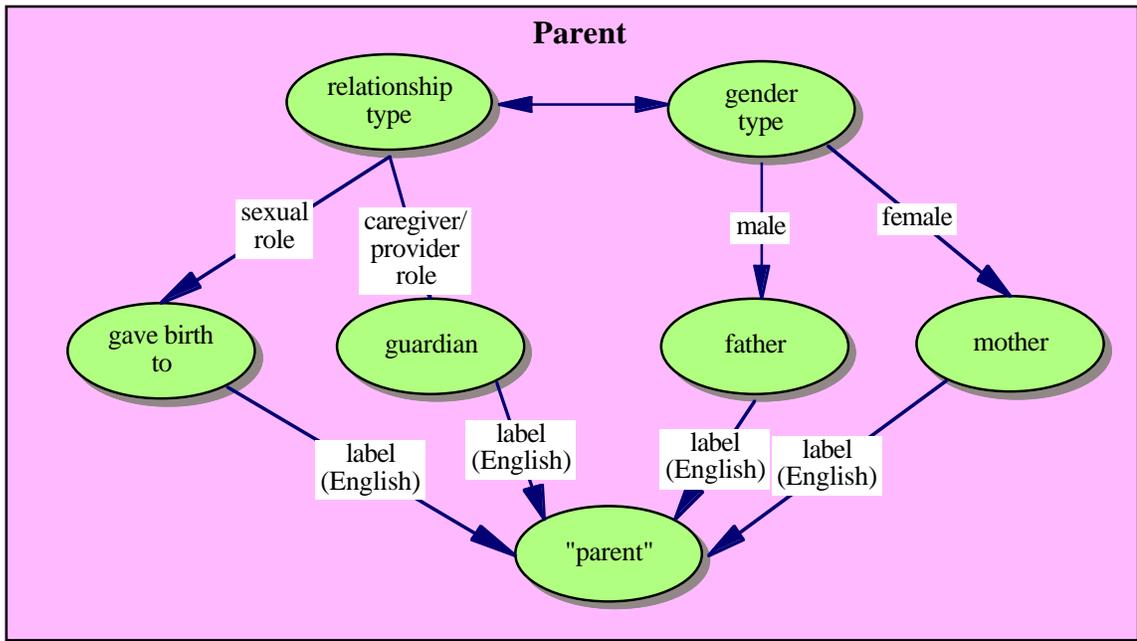
(b)
Concept *parent* as *dispositio*
manifested as related concepts, relations among concepts,
and linguistic term p-a-r-e-n-t

Figure II.39 (a) and (b)

A mental space [*dispositio*] consists of *elements and relations* activated simultaneously as a single integrated unit.
[Fauconnier Turner 2002 104 (emphasis added)]

Inventio, in contrast, is a unitary view of a concept, usually having a label or linguistic term as one of its properties (Figure II.39(a)).

Dispositio reveals the relations among component *inventio*

The way to understand anything is to understand how it is related to other things [Lamb 1999 53]

Clark summarizes the ancients' intentions of *dispositio*:

When Cicero in *De Oratore* stated that after finding out what he should say, the speaker should next "dispose and arrange what we have found, not only in an orderly way, but with a certain weight and judgment." . . . There remain many problems of sequence: problems . . . growing out of the strategy involved in marshaling arguments . . . [Clark 1957 79]

Dispositio-as-process is the arranging or coordinating of concepts, and thus requires *recognizing relationships* among concepts. The resulting composite is *dispositio*, that is, the arrangement of instances of *inventio* and the structure among them:

Dispositio-as-object is

(attribute concepts) + relations among them + reference to *elocutio* (label or name)

Properties of relationships, according to Assimilation Theory, can be comprised of one or more relations. Further, Assimilation Theory holds that:

relations among concepts *are* meaning:

> Meaningful learning requires . . . that the material they learn be
> potentially meaningful to them, namely, *relatable* to their particular
> structures of knowledge . . .   (Ausubel, 1961a)
> [ARK 68 (emphasis added)]

Inventio, i.e., concepts that are not yet related to other concepts, are only *potentially* meaningful and do not become meaningful until related to the learner's prior knowledge, *dispositio* (see: Material presented to learner is only *potentially* meaningful, II.1).

What relations may obtain among arguments?   Nearly any *inventio* can act as a relation among other *inventio*. The domain of *inventio* that may act as a relation type is nearly as large as language itself. Examples of frequently encountered relations include:

identity (is)	purpose (A used for B)
simile (is like)	step-goal
question - explanation	member-class, type of,
evokes	has attribute in common with
comparison with, contrasts to	hierarchic, includes,
cause and effect	included by
1-to-1, 1-many, many-to-many,	reason
part-to-whole, part-part	etc.

These, of course, barely scratch the surface of the domain of possible relation types.

Dispositio is comprised of component *inventio* and of *structure*. The constructive purpose of any structure is to bind (even separation is a type of binding to a relative position). Structures are susceptible to intellectual processes as described in Assimilation Theory. Among these is *transfer*, and its underlying mechanisms, isomorphic mapping and isomorphic projection (below). The results of these processes are new relations, new structure, that is, *construction of new meaning*. Thus, the Divisions of Rhetoric reference model is helpful in amplifying concepts of Assimilation Theory.

How *dispositio* explains contemporary category theory

Instances of *inventio are* categories. In *inventio* form, the concept is a unified object. The idea *chair* is the idea of a chair. The idea *mother* is the idea of a mother. In *dispositio* form, however, one can see that these concepts are composites, composed of other component *inventio* and structure among those component concepts.

> Each component *inventio* of a *dispositio* may define a category
>
> of which that *dispositio* is a member

For example, a *dispositio*, *volcano*, may have, as one of its constituent *inventio*, the idea of *spewing forth hot material*. Thus, *spewing forth hot material* may define a category of which *volcano* is the prototypical instance. However, some volcanoes might not spew lava. Thus, *spewing* hot stuff is not a necessary and sufficient attribute to define volcanoes. Conversely, a person who has a reputation for becoming angry might achieve membership in the category of *spewing forth hot material* and thus be referred to as someone with a volcanic personality.

Any particular instance of the *inventio*, e.g., a *specific* chair, a *specific* mother, is unlikely to possess *all* the component properties, *all* the component concepts, *all* the structure of the *inventio* form. A specific chair might not have the component concept of *legs* but be built into a wall. A specific mother might not possess the component concept of *having given birth*, but be an adoptive mother. Though the *dispositio* forms of a specific instance of chair or mother are not identical matches to the generic *dispositio* form, both general and specific utilize the same *inventio* form. Thus adoptive mothers are understood to be members of the category *mother*, and seats on a bus are regarded as instances of *chair*.

Categorization works because a person's mental process of categorization may be based upon as little as a single component *inventio* (Figure II.40). For example, an individual may be regarded as *mother* even though she does not possess all the attributes of the *dispositio*., but only one, e.g., nurturing. A woman might have a care-giving relation to a child, but not be the wife of the father or the birth mother. That is, she might be a stepmother, and thus, a *mother* (*inventio*).

Mother, as *inventio*

Mother, as *dispositio*
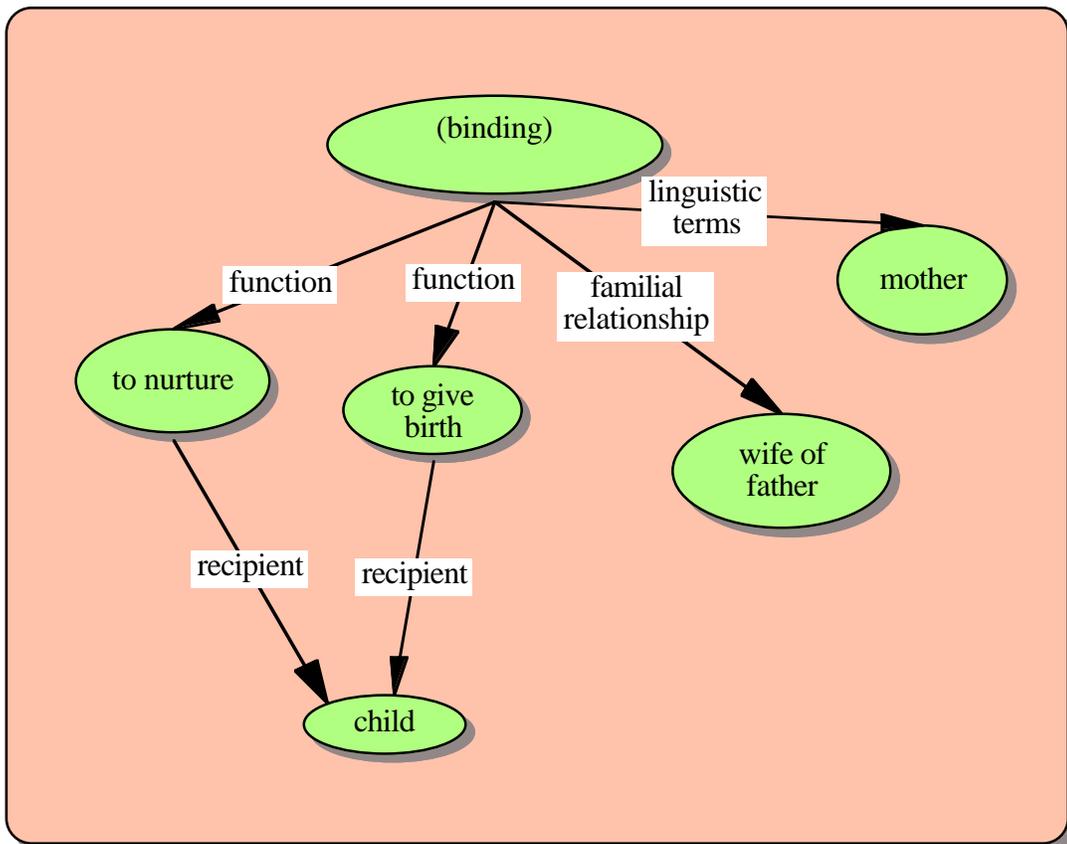
Figure II.40

The two views of concepts, *inventio* as a unitary view and *dispositio* as revealing the structure within a concept, align with research on categories and prototype theory [Rosch 1981], and family resemblances [Wittgenstein 1958], [Rosch 1975].

Species of *Dispositio*: Idealized cognitive models

Dispositio is described by various names in various contexts. These views of *dispositio* are of interest because the contexts often are associated with particular mental processes.

Idealized cognitive models (ICMs) [Lakoff 1987 68 ff.] are forms of *dispositio* often found in the role Assimilation Theory describes as *superordinate learning* because they provide structure needed to organize other concepts through isomorphic mapping and isomorphic projection (see: Isomorphic mapping and isomorphic projection, below):

> [C]onceptual structure is indicated by Idealized Cognitive Models (ICMs) and frames, which structure the mental spaces. [Fauconnier 1994 x]

> Probably the best way to provide an idea of what ICMs [idealized cognitive models] are and how they work in categorization is to go through examples. Let us begin with Fillmore's concept of a *frame*. Take the English word *Tuesday*. Tuesday can be defined only relative to an idealized model that includes the natural cycle defined by the movement of the sun, the standard means of characterizing the end of one day and the beginning of the next, and a larger seven-day calendric cycle -- the week. In the idealized model, the week is a whole with seven parts organized in a linear sequence; each part is called a day, and the third is Tuesday. . . . Our model of a week is idealized. Seven-day weeks do not exist objectively in nature. They are created by human beings. [Lakoff 1987 68-69]

As an example of a *dispositio* applied as an ICM, consider a *race*, that is a contest that has winner(s) and losers, requires labor, can result in rewards, etc. This ICM of a *race*, as a model of a *contest*, may be projected onto another daily experience such as completing a job assignment. Where a person applies the *race* ICM, consciously or subconsciously,

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they may be found to be competing with or racing the clock, competing or racing with a competitor, or competing with or racing with themselves, that is, with a hypothesized alter ego. Recognition of the *race* ICM might be important where one is attempting to understand the individual's behavior, e.g., why they work long hours or skips lunches.

In similar cases however, the *race* ICM, alone, might not be explanatory of such behavior. A *different* ICM, that of head-of-household-as-provider contributes to an explanation such behavior. These two ICMs have different goals, one is *winning*, the other is *providing* for household purposes. Possibly, the individual is under the influence of both ICMs simultaneously.

Members of a community likely hold many of the same ICMs in common. Indeed, the ideas members of a community hold are a defining property of a community. For example those in Western developed nations generally have an ICM of the human body as a machine, of physicians as mechanics, and thus, that physicians can fix bodies that are ill or injured, and restore them to health. This ICM is referred to as "western medicine."

An exposition of idealized cognitive models is found below (Macro isomorphic operations: Idealized cognitive models).

Species of *Dispositio*: Frames

> [I]maginative structures have been called *frames* or *schemas*. . . .
> Frames are special cases of *idealized cognitive models*.
> [Lakoff 1988 135-136 (emphasis added)]

Frames, another expression of *dispositio*, bind together properties into a structure.

Marvin Minsky, originator of the idea of frames, defines a frame:

> A frame is a data structure for representing a stereotyped situation, like
> being in a certain kind of living room, or going to a child's birthday party.
> Attached to each frame are several kinds of information. Some of this
> information is about how to use the frame. Some is about what one can
> expect to happen next. Some is about what to do if these expectations are
> not confirmed. . . . We can think of a frame as a network of nodes and
> relations. [Minsky 1974]

Frames are often a sequential or tabular form of *dispositio* where one-to-one relations are conceived as lists or columns of attributes. For example, for a *dispositio* describing a process, such as *addition*, frames may comprise begin states, operation, and end states:

```
Frame: addition
 Objects: (positive or negative) number
 Beginning condition:  begin at 0
 Operation:
        apply positive values in positive direction on number line
        apply negative value in negative direction on number line
 Ending condition:  Sum is location on number line following last
                          operation.
 End of Frame
```

For example, a frame for the addition of 2 + 3 = 5:

Frame: addition of 2 and 3:
  Objects: +2, +3
  Beginning condition: begin at 0
  Operation:
          Move positive direction from 0, 2 units, arrive at 2.
          Move positive direction from 2, 3 units, arrive at 5.
  Ending condition: 5
  End of Frame

This frame can be interpreted as relying upon another *dispositio*, numerical accumulation as *traversal along a path*, an image-schema in the form of a *number line*.

The *inventio, addition*, and its *dispositio* form may, of course, be expressed also as concept maps (Figure II.41 (a) and (b)), as can the particular instance,

[2 + 3 = 5] (Figure II.41(c)).

The same frame *addition*, as a cognitive structure, *dispositio*, may be evoked by various linguistic expressions, *elocutio*:

   (a) 2 + 3 = 5

   (b) 3 + 2 = 5

   (c) Add 2 and 3

   (d) Jane had two lollipops. Her mother bought her three more. If Jane
          did not eat any of her lollipops, how many did she have?

(a)
The *inventio* Addition
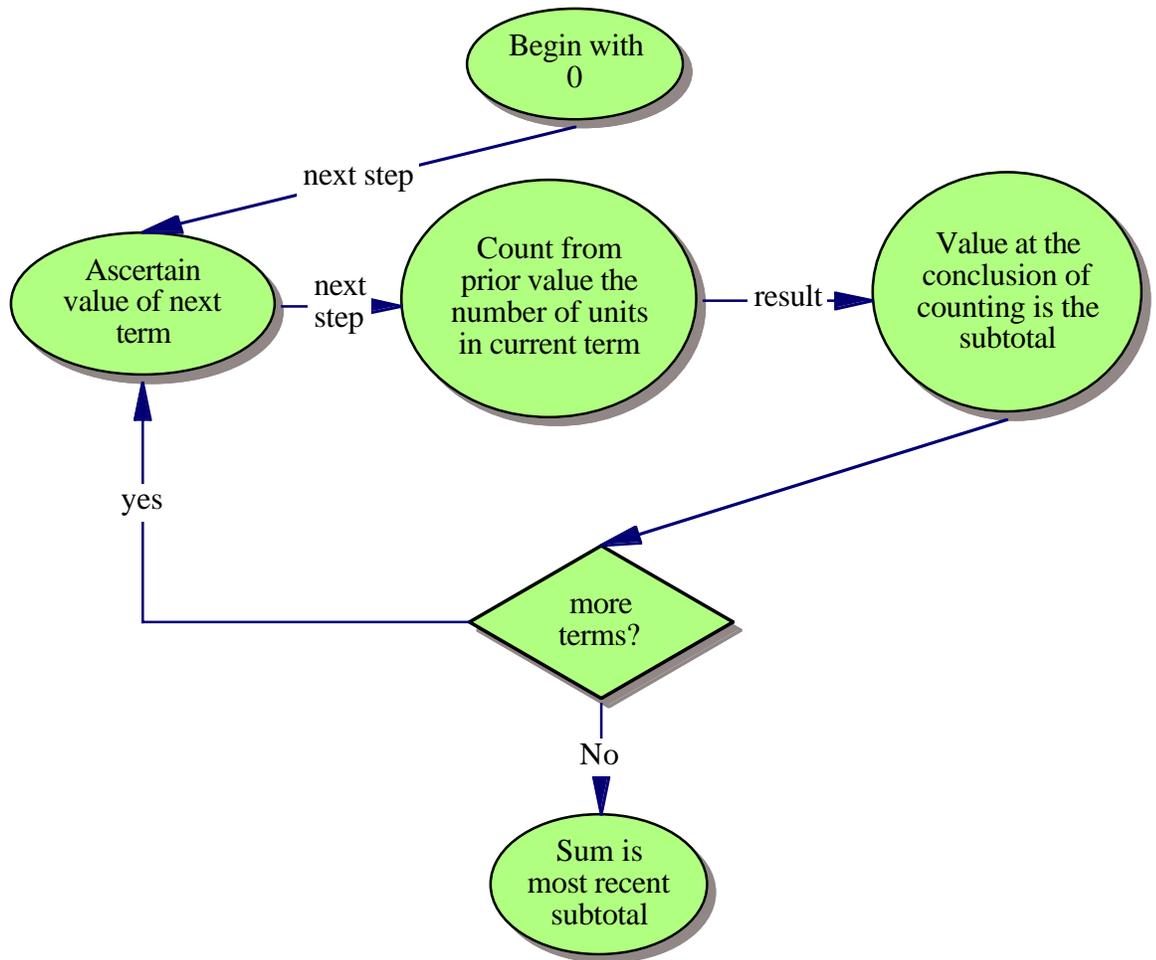
(b)
Dispositio (concepts and relations) for the
inventio Addition

Figure II.41 (a) and (b)
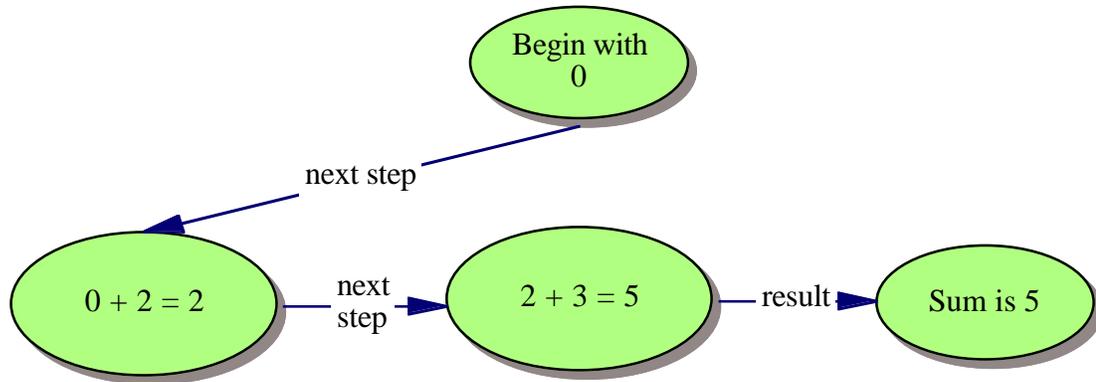
(c)
An instance of Addition
2 + 3 = 5

Figure II.7(c)

Species of *Dispositio*: Image schema

Image schemas are basic concepts, *dispositio*, derived from sensory visual experience.
They are often applied as superordinate organizing ideas and are *dispositio*.

For example the image schema *travel along a path*, arises from a human's sensory
experience of walking toward a destination, and comprises properties of sequential step-
taking (step-taking is cumulative, is linear) toward a destination (the sum) onto the
structure of addition. *Travel along a path*, as image schema *dispositio*, underlies
surprisingly many of our abstract thoughts, e.g., working toward a goal, a step in the right
direction, looking forward to the end of the task, getting side-tracked are all ideas
organized by, or projects of, the *travel along a path* image scheme.

Recognition of image schema *dispositio* can be useful to a learner where they do not
understand a particular fact pattern. For example, a young learner confused about the
arithmetic concept of addition, say 2 + 3, could be shown a number line, which is a

projection of the image schema of a path, then beginning from zero, counting two units to the right, arriving at "2," then counting three more units to the right, arriving at "5."

> The image-schema structure of the source domain is *projected* onto the target domain in a way that is consistent with inherent target domain structure. [Lakoff 1993 245]

Similarly, *that travel along a path* image schema can be used to show a learner tasked with adding 2 + 3 does not need to ascertain the color of the objects being added because that task is *not on the path* to adding 2 and 3, and thus, to ascertain the color of those objects is to become *side-tracked*.

Some schema *dispositio* describe processes and thus include an *endpoint*. (Part II.1).

Other species of *dispositio*. Aside from ICMs, image schema, and frames, there are many other names and forms of *dispositio*, such as semantic networks, webs, nodes-and-links, plots, memes, superordinate ideas, maps, etc. Piaget described cognitive structures, such as for *percentage*, as *schema* or *schemata*:

> Assimilation . . . by incorporating new elements into its earlier *schemata* the intelligence constantly modifies the latter in order to adjust them to new elements [Piaget 1963   6-7 (emphasis added)].

Intervention

Idealized cognitive models and other superordinate forms of *dispositio* are important in the intervention performed by a teacher for a learner having difficulty comprehending a particular idea. Provision of an appropriate model that the learner can project onto the subject matter with which the learner is struggling, can facilitate the student's construction of intended meanings. For example,

> [T]o help students understand Ohm's law, an instructor might invite the student to envision a water-flow system in which the water pipes correspond to metal wires, water pumps correspond to batteries, and narrow pipes correspond to resistors; within the water-flow system, the rate of water flow corresponds to electrical current, the narrowness of the pipe corresponds to resistance, and water pressure corresponds to voltage. [Mayer 1993 568]

Misapplication of *dispositio* or use of the wrong *dispositio* can result in the learner's misunderstanding:

> Students hold a model of mixing light that is quite similar to the mixing of paint. [Mintzes 2000 270]

> Research on mental models demonstrates that the metaphor students use for understanding a scientific formula influences how they go about solving problems. . . .
> It follows that if we want students to understand quantitative descriptions such as formulas they must first construct qualitative models of the underlying explanatory mechanisms. [Mayer 1993 567-568]

Therefore, as superordinate ICM *dispositio* objects project onto a learner's prior knowledge, the learner, teacher, or both must evaluate whether the concepts learned meet criteria based on their alignment with other fundamental ideas within the subject area.

Dispositio attributes: belief, trust, truth

> [R]esearch done by others determines most of what any of us *believes*.
> [Booth Colomb Williams 1995 6]

A concept (viewed as *dispositio*) may be associated with various component *inventio*, such as a linguistic term, label, or name. Figure II.40 shows that ideas, viewed as *dispositio*, are comprised of other concepts, including basic concepts connected to memory, relations among them, and labels or terms associated with the *dispositio* cluster (e.g., the term *mother* for the cluster of ideas and relations that comprise the concept of a *mother*).

Another frequently encountered attribute of concepts is an imputed attribute of *belief*, *trust*, or even the concept-as-*true* (Figure II.42).

A later section, What is critical thinking?, describes processes by which these attributes are imputed to *dispositio*.

Mother, as *dispositio*
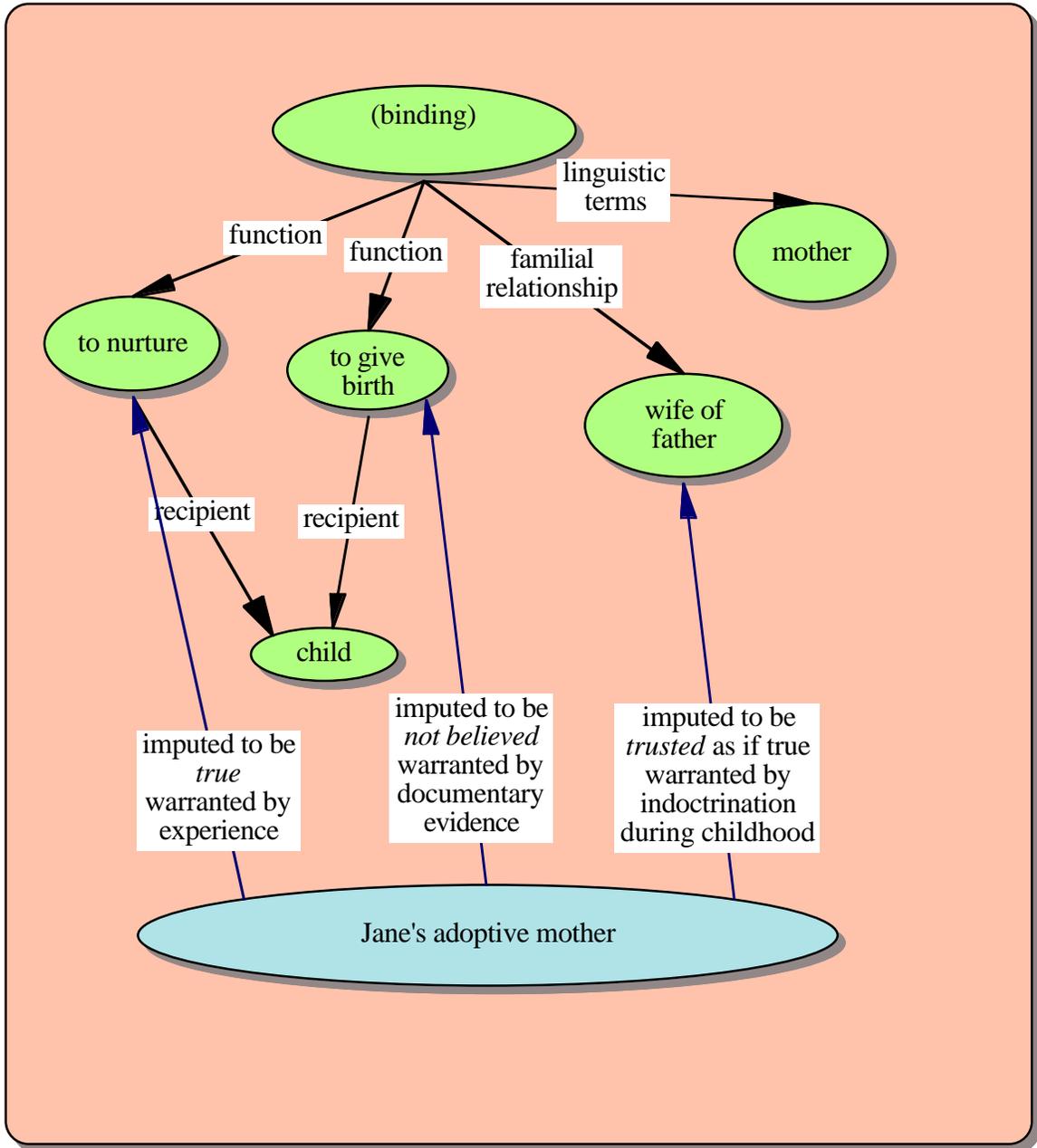
Figure II.42

Exercises

1. An exercise from Learning and Cognition in Education at Indiana:

> **Learning activity 5.1: Scrambled schemata** Identify at least three instructional problems or "failures" you have encountered that you think could be, at least in part, schema or mental model problems. By that I mean that the problem can be framed as learners lacking (or failing to use) appropriate schemata or mental models. For each problem you identify, suggest strategies in accordance with schema/mental models theory that might have resulted in a more successful outcome.
> [Perry P540]

2. Occasionally, people act irrationally. In some cases, however, their behavior, presumed irrational by the observer is, in fact rational, but relative to a different superordinate idea than held by the observer. The familiar story of the derelict on the street corner provides a simple illustration. Late one night, he was confronted by a police office an interrogated as to what he was doing. "I dropped a quarter about halfway down the block." he explained. The police officer, imputing irrational behavior to the derelict, inquired, "If you dropped the coin halfway down the block, why are you searching for it here?" The derelict responded that the light was better under the street lamp. He was operating under a valid ICM, "to search for an object, one needs adequate light or visual instruments." The office imputed irrational behavior because he assumed a different ICM was operative, "search for a item where it was most likely lost."

Select one of the three expressions that have been interpreted as irrational behavior and construct a *dispositio*, no matter how fantastic or counterfactual, where the concept cluster would seem rational:

A student committed suicide.

Research into fusion energy production over the last 25 years has cost over a billion dollars, yet design of a practical machine still has not been achieved. Investment in fusion energy continues.

The United States invaded Iraq following the events of 9/11 even though Iraq was not involved in the attack.

3. Construct a concept map expressive of the arguments presented in the judgment of the

Court of Appeals for the Federal Circuit in *Pfizer* v. *Ranbaxy*

(http://www.fedcir.gov/opinions/06-1179.pdf). Depict the concepts or others as you

deem appropriate and indicate (examples below) the relations among them:

> The United States Patent and Trademark Office ("PTO") agreed that this compound was within the scope of the '893 patent and extended the patent term to September 24, 2009
>
> The District Court found both patents were infringed, not invalid and not unenforceable.
>
> Ranbaxy contends that structural formula is limited to racemates, because: (1) one skilled in the art would represent a racemate by depicting one of its . . .

Pfizer's and Ranbaxy's arguments conflict. The task of the appeals court is to project superordinate concepts onto a fact pattern to organize them into a conceptual structure that is consonant with law and precedent. The Court did so in the case of the '893 patent.

Task: Identify the fact patterns (cases) and depict their conceptual structure, as source *dispositio*, that the Federal Circuit use to affirm. The concept map constructed from the fact pattern above, i.e., Pfizer v. Ranbaxy is the target *dispositio*.

Depict the isomorphic projection of the superordinate concept(s) from the source onto the target to show how the Court arrived at its determination.

Elocutio

> Crassus, in *De oratore*, states that the third task of a speaker is "to clothe
> and adorn his matter with language." [Clark 1957 83]

Elocutio, that is, language, pertains to any system for (1) *specification* of meanings
(semantic) and (2) *specification* of perceptible physical objects (e.g., graphic and phonic)
for provoking given meanings. Each may be used to derive the other.

Elocutio-<u>as-process</u> refers to the task of selecting linguistic terms that express *dispositio*.

Elocutio-<u>as-object</u> is a two-part *specification* for correlating intellectual objects
(meaning) with perceptible physical objects, e.g., graphic or audible objects:

> *Elocutio* (semantic) is a *specification* for *evoking meaning* (*inventio*,
> *dispositio*).

> *Elocutio* (percept, e.g., graphic or phonic) is a specification for *producing*
> sensory-susceptible objects, e.g. marks on paper, audible sounds. *Elocutio*
> is the *specification*, not the physical object itself.

In this essay, *elocutio* refers to *elocutio*-as-object unless *elocutio-as-process is explicitly
indicated.*

Crassus' description of *elocutio* (above) also includes *style* (adornment). Although style
contributes to the evocation or specification of meaning and thus deserves consideration,
inclusion of style is beyond the scope of this report. Future research may take this aspect
of *elocutio* into better account.

What are the properties of *elocutio*?

Elocutio (semantic) is comprised of several kinds of *specification*:

definition and senses, how it interacts with other words, part of speech,

usage, synonyms and antonyms, and etymology and root.

Elocutio (percept, i.e., graphic or phonic) is similarly comprised of several

kinds of specification: for spelling, syllabification, pronunciation, etc.

For example, the *elocutio* (linguistic term) *elephant*, may be comprised of:

---

elocutio **(semantic):**
>   a definition, such as "a large four-legged mammal with a trunk."
>   a part of speech: noun, denoting an object rather than an action or
>   modifier
>   interaction with other *elocutio*:
>   adjectives: big, gray, heavy
>   nouns: trunk, zoo, jungle
>   etc.

And,

elocutio **(percept, e.g., graphic or phonic):**
>   a spelling, E L E P H A N T
>   a syllabification: el - e - phant
>   a pronunciation: el' ∂ f∂nt
>   an illustration of an elephant
>   etc.

Elocutio (specification) for *elephant*
Figure II.43

Language is therefore *distinct from* meaning. Language is only a *specification* for

invoking meaning. Meaning is *confined* to the intellectual realm, whereas language

reaches into both the physical realm and the mental realm, and is thus, distinct.

Language and meaning, that is, *elocutio* and *dispositio-inventio*, each may be used in

derivation of the other. *Elocutio* specifies *dispositio* that a reader-listener is to evoke.

From *dispositio*, a writer-speaker derives *elocutio*, that is, selects terms to express meaning.

Elocutio (percept, e.g., graphic or phonic) *alone*, such as a spelling (a specification of a character string) or a specification for pronunciation, *absent* the semantic component of *elocutio*, is *not* a word. Treatment of a character string as if it were a *word*, as if it possesses all the properties of a specified word, but absent semantic specifications, is a common error.

Elocutio is not confined to so-called natural languages, but applies to any system of signifying meaning. Other linguistic systems, in this sense, may include various dialects of music (notated or not), mathematics, and nearly any cultural activity. Indeed, visual gestures (body language) comprise specifications for both meaning and physical performance:

> . . . the raised eyebrow of the actor that may illustrate the whole situation
> in the state of Denmark . . . [Turbayne 1970 13]

Elocutio is an imperfect and indirect mechanism for provoking others to construct particular understandings. Facets of the relationship between *elocutio* and *dispositio-inventio* are considered below (see: *Elocutio* ➔ *dispositio*, below).

Elocutio, that is *terms*, encompass words, phrases, sentences, and entire texts. Issues relating to how meaning derived from words leads to meaning derived from phrases, sentences, or entire texts are in the domains of linguistics and literary criticism:

> As we have seen, words and the patterns into which words fit are triggers
> to the imagination. They are prompts we use to try to get one another to
> call up some of what we know and to work on it creatively to arrive at a
> meaning.

> Words by themselves give very little information about the meaning they prompt us to construct. [Fauconnier Turner 2002 146]

Elocutio provides for expressing conceptual objects in tangible forms for transmission.

For example, a teacher may wish to instruct students about the idea of the distributive property of multiplication. She may express the concept as an equation, that is an expression in a mathematical language (algebra), *elocutio*. *Elocutio* provides a specification for how the mathematical expressions may be performed in tangible form, resulting in the character string:

$$ab + ac = a(b+c)$$

The *elocutio* characters "a," "b," "c," "+," and "=" are specifications from which are derived *pronuntiatio*, i.e., the shapes of "a," "b," "c," "+," and "=" that appear on the page.

The linguistic concept of the letter "a" is an idea, a specification for how the graphical expression of an "a" should appear and a specification for a mathematical variable. The semantic (*inventio*) value of the expression ab + ac = a(b+c) suggests the cognitive relation that "ab + ac" may be interchangeable with and substitutable for "a(b+c)."

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Unique property of language, *elocutio*: it reaches into both mental and physical realms

Of all the Divisions of Rhetoric, *elocutio* is unique:

> *elocutio* reaches into both intellectual and tangible realms.

It specifies both derivation of sensory-susceptible objects (printed inscriptions, oral performances) from meaning, and for derivation (evocation) of meaning (semantic) from perceptible, e.g., graphic or phonic specification. Thus, the function of language is twofold:

The conceptual function of language

to bridge the gap between one's *mental* realm and

the world of *physical* transmission of objects among people

Elocutio accomplishes this function by manifesting pairings between the *specifications* for inscribed or phonic objects and semantic objects (*inventio*, *dispositio*).

> *Elocutio* (semantic) can specify *elocutio* (percept, e.g., graphic or phonic)

and

> *Elocutio* (percept, e.g., graphic or phonic) can specify *elocutio* (semantic)

Assimilation Theory follows this perspective with acknowledgement that

symbols . . . represent . . . concepts:

> Single words in any language, after all, are conventional or socially shared
> *symbols*, each *representing* a unitary object, situation, *concept*, or other

symbol in the *physical*, social, and *ideational* worlds.
[ARK 80 (emphasis added)]

although the terms *express* and *derived from* better align with constructivist perspective
than *representing*.

Other Divisions of Rhetoric may be categorized as inhabiting either the physical or
intellectual (mental) realms *exclusively*. Figure II.44 shows, foremost, that the
conceptual function of *elocutio*, language, is to reach into *both* worlds, mental and
physical, to provoke a receiving reader-listener to evoke a specified thought.

Intellectual Realm	Physical Realm
inventio	
dispositio	
elocutio (semantic), e.g., definition and senses, part of speech, usage, synonyms and antonyms, etymology, root, term's relation to other words such as polysemy, synonymy, meronymy)	*elocutio* (graphic or phonic) specifications, e.g., spelling, syllabification, pronunciation, are used to derive *pronuntiatio*
	pronuntiatio

Figure II.44

Concepts, *inventio-dispositio*, exist only within the embodied mind. To communicate,
that is, *to provoke another* person, a different embodied mind, *to evoke a specified
concept*, that concept must be expressed in transmittable form (*pronuntiatio*), received,
assimilated, and finally, interpreted through provocation of the recipient's perceptual and
conceptual apparatuses.

Fixity

> The word I forgot
> Which once I wished to say
> And voiceless thought
> Returns to the shadow's chamber.
> [Vygotsky 1934 final chapter]

One of the commonly-accepted differentiating characteristics of the tangible world over the learner's mental realm is that objects in the so-called "real" world have stability that derives from physical *material*, whereas thoughts, beliefs, or knowledge are fleeting, mercurial, and ethereal.

Elocutio often performs a function that corresponds to the durability imputed to or inherent in *pronuntiatio*: fixity in memory. That is,

the act of associating a term, *elocutio*, with an idea, projects some *fixity* to the idea.

By recognizing a relation between an idea and a term, e.g., word or phrase, the idea may become fixed, more recallable, than if the learner is unable to establish an association between the thought and the word. Greater fixity may lead to greater interaction with other concepts in the learner's thinking. That is, the concept flourishes by having an identity that includes a name or label, *elocutio*.

For example, a learner may have a beginner's-level understanding of the effect of bank deposits on the money supply. She may have a vague understanding that there is a correspondence between increased deposits and increased money supply, and accordingly, between decreased deposits and decreased money supply. She might even know that deposits to banks are lent out to borrowers, and thus, both the whole amount of the deposit and the portion lent out constitute *money supply*. Intuitively she might be

aware that some portion of deposits must be retained by a bank, but with little if any idea why those funds are retained. However, having the ability to recall the *elocutio* "reserve requirement" may enable the learner to evoke the *dispositio* corresponding to the portion of funds that cannot be lent, that their retention is mandatory not optional, and that the agent administering this influence is a governmental one operating through regulations.

Thus, the learner's recollection of the term *reserve requirement* potentially results in her intellectually specifying (evoking) the concept (*inventio*) of *reserve requirement*, and subsequently its relations to her other knowledge about banking, money supply, and economics.

Interaction between *elocutio* and *memoria* might account for fixity. *Memoria* capacity is amplified when more relations to an adjoining concept are established. A relation to a linguistic term increases the quantity of relations in the relationship and also the potential for subsequent links that might aid the learner in re-evoking a concept upon encountering an instance of *elocutio*.

Other *elocutio*-based procedural devices, such as rhyming, yield fixity and thus also aid memory. *Pronuntiatio* counterparts of fixity are considered below.

Pronuntiatio

Pronuntiatio is the performance in physical media, of *elocutio*. To the ancients, *pronuntiatio* (*pronuntiatio*-as-process) was the task of delivering one's speech in a sensory-susceptible form, usually orally for aural reception or in written form for reading.

Pronuntiatio-as-object exists *only* in the physical realm. Because *pronuntiatio* exists *only* in the physical realm, and *dispositio*, meaning, exists only in the mental world, *pronuntiatio* and ideas inhabit mutually exclusive domains. *Elocutio* is the bridge between them.

Cognitive constructivism does not acknowledge telepathy, and thus concepts can only be communicated via *elocutio* and *pronuntiatio*. But *pronuntiatio* does not *carry* meaning: it can only provoke a listener-reader's recognition of *elocutio*, from which one might evoke a concept having structure that is substantially similar to the concept the speaker-writer expressed. Because *pronuntiatio* does not *carry* meaning, a listener-reader-learner's receipt of *pronuntiatio* does not constitute their having acquired, constructed, or evoked meaning. Receipt of *pronuntiatio* is strictly a perceptual event to the listener-reader, like grasping a frying pan, tasting an ice cream cone, or feeling a cool breeze. Whether the listener-reader constructs meaning as a result of the provocation, receipt of *pronuntiatio*, may vary from learner to learner. Nor should the listener-reader-learner's subsequent evocation of meaning be considered trivial. Ability to "see the writing on the wall" does not refer to one's ability to recognize the letters, recognize words comprised of letters, or recognize grammatical patterns, but to evoke meaning from them.

Pronuntiatio thus refers to any (physical) object, including electromagnetic waves, specified by, i.e., *derived* from, *elocutio*, that may be conveyed, displayed, or otherwise delivered in the physical realm, and, if necessary processed into a form (e.g., TV, radio, digital data streams) for provoking a reader-listener's perceptual resources such that they evoke *inventio-dispositio*. Some *pronuntiatio* are physical objects (e.g., sound from a radio or light from pixels in a CRT device) derived from other *pronuntiatio*, e.g.. *digital* encodings (requiring machine processing rather than directly human sensory-susceptible) as from waves transmitted as electrical signals via airwaves or cable media.

Pronuntiatio occasionally assumes a role in a learner's construction of meaning. Readers impute credibility to ideas expressed in a book or journal partly because its physical appearance, for whatever reasons, implies credibility, a form of meaning. However, *pronuntiatio* does not perform the *implying*, the learner-listener-reader performs this task.

Another important function of *pronuntiatio* accrues on account of its durability, even if briefly as with a radio signal. The physical durability of *pronuntiatio*, in conjunction with *elocutio* (graphic-phonic) inscriptions, accrues on account of its materiality, and enables the production of *records*. To achieve production of a record, a *pronuntiatio* manifestation is indispensable. This fixity is the tangible counterpart to the learner's *elocutio*-based *memoria*. For example, actors and musicians often use the repetition of *pronuntiatio* (speaking, playing, acting) of a text to establish the muscular and other sensory (e.g., auditory) elements of memory.

In summary, primary functions ascribed to *pronuntiatio* include material fixity, recordation, and transmission.

An example of *pronuntiatio*, differentiated from *dispositio* and *elocutio*

The analysis of the *elocutio* (term) *elephant* specified above:

> *elocutio* (graphic or phonic):
>   a spelling, E L E P H A N T
>   a syllabification: el - e - phant
>   a pronunciation: el' ∂ f∂nt

From these specifications, a physical performance, *pronuntiatio*, of the term may be produced, e.g., a spoken or printed word, or even a pictorial image may be produced.

Pronuntiatio encompasses terms of all lengths and types, including paper-base objects, images, sound and audible objects, and even tactile, gustatory, or olfactory objects.

Pronuntiatio operates to provoke a reader-listener to evoke an idea. It is, of course, *not* the *pronuntiatio* object itself that is the subject matter of the listener-reader's idea. That is, a writer-speaker may express the *elocutio* "elephant" by physically writing or speaking "elephant." *Elocutio* specifies a word, "elephant," to the listener-reader. From this, the listener-reader evokes his own specific *inventio*, that is, an *idea* of an elephant. He does not, of course, evoke a real elephant.

Differentiating *pronuntiatio* from *dispositio* explains the *giving* anomaly

Differentiating between *pronuntiatio* and *dispositio* explains a phenomenon that bewilders researchers when conflating the Divisions of Rhetoric into "information": The non-standard sense of the verb "to give" applies to *pronuntiatio* and *dispositio* differently in the act of communication: a sender conveys *pronuntiatio*, but *retains* their *dispositio*. When bundled into "information," there appears to be an anomaly of "giving information but still having it."

Summary of *pronuntiatio*

Thus, the speaker's concept of elephant, their *elocutio* (term) elephant, the written or spoken object transmitted, the listener-reader's recognition of the term elephant, and the listener-reader's constructed or evoked concept of elephant are all distinct different

objects. Thus to say that the *pronuntiatio* object *carries* meaning is metaphoric at best, simply incorrect at worst.

Memoria

Memoria, memory, inhabits the mental realm as does *inventio*, *dispositio*, and *elocutio*. *Memoria*-as-process is the *re*-evocation of basic and abstract concepts into consciousness.

Memoria-as-object refers to the cognitive capacity to re-evoke concepts already assimilated, learned.

Throughout this report, the terms prior knowledge and existing knowledge are used (interchangeably) to refer to *inventio* and *dispositio*. However, both *inventio* and *dispositio*, to be useful, must remain available cognitively, in the human body such that they can be recalled. Without *memoria*-as-process, knowledge might evaporate immediately. All knowledge created would be "new" and immediately evaporate.

Occasionally one may "remember" that some idea or event or fact exists, but be unable to recall it from memory. One "remembers it" but cannot "remember it." Obviously, multiple linguistic senses of *memory* obtain. In this scenario, the object to be remembered is *dispositio*, comprised of multiple attributes, some of which can be recalled, and some of which the learner is unable to recall, accounting for the dichotomy.

Role of memory in Assimilation Theory

Memory is the feedstock upon which the engines of isomorphic mapping and isomorphic projection (below) operate. Both rely upon memory as source (or target) *dispositio* to fill in elements of a target (or source or new) *dispositio*. Because human thought relies upon isomorphic projection and because isomorphic projection relies upon memory, no abstract thought is possible without memory

To appreciate isomorphic projection's fill-in function and the role memory plays in providing the "fill material," imagine human thought where each component of each thought could not be recalled from memory but had to be constructed anew! Cognitive overload would surely be immediate, and abstract thought would be impossible.

The frequently-encountered modern analogies of memory-as-computer-disk-storage and memory-as-an-online-database disserve our understanding of human memory for several reasons. First they imply that minds are computers or central processing units that operate sequentially and algorithmically, and always give the same result to the same input. The mind-as-a-computer metaphor also views other aspects of cognition as peripheral devices connected to a CPU or some application program. Memory is thus conceived as a peripheral device to a CPU or a database. Lakoff and others have refuted the mind-is-a-computer metaphor by showing that minds are not symbolic processors, are not step-by-step Von Neumann (one-step-at-a-time sequential processing) machines, and do not always yield the same result to the same question. Indeed, minds are embodied not just in the brain but the entire corpus: people do not just think, they think, feel, and act, [Novak 1998 51] and thus memory of concepts is grounded in cognitive, emotional, and motor activity.

Differentiating *recall* and *recognition*

Ausubel differentiates *recall* from *recognition*:

> Recall versus Recognition
> A more typical everyday manifestation of the unretrievability of certain **memories**, because of the selective operation of the threshold of availability, is the familiar experience of being unable to **recall** on demand either an episodic memory or a proper noun that was learned as part of instructional material, but at the same time being quite able to **recognize** it when it is presented among a number of possible and plausible alternatives (as in a multiple-choice examination). A credible explanatory hypothesis here that was also considered above is that the threshold of availability for the recall of a memory of given dissociability strength is generally sufficiently higher for recall than for recognition as to make a functional difference in ability to retrieve it. [ARK 120 (emphasis added)]

Recall is thus the learner's sheer ability to *evoke inventio* or *dispositio*. Recall is often used as a synonym for memory.

Recall is never complete. One's conscious recognition or evocation of *all* of a *dispositio's* conceptual components and relations is virtually impossible. One will always overlook some attributes of any given concept. Thus, there is always the potential for learning.

Though characterized in the passage above as easier, *recognition* comprises both recall (memory) and a second step, some form of matching with another intellectual object, an expectation, such as through isomorphic mapping (below) or isomorphic projection (below). That is, recognition entails a second step of ascertaining whether one idea satisfies criteria for identification as some other idea. The second step of *recognition* is of particular importance in Assimilation Theory: that is, *recognition* of an idea *as* an explanation (see: An *explanation* is a conceptual *path*, below).

Though *recognition* comprises both recall (memory) and isomorphic operations, Ausubel describes recognition as less difficult than recall because established memories can *enable* recognition, whereas recall *is* memory:

> Recognition and recall . . .: In recognition, the originally learned material is presented along with other plausible alternative variants and the subject need only selectively identify it; in the case of recall, on the other hand, the subject must spontaneously or on demand reproduce the substance of the original material. Obviously, therefore, recognition can lead to successful reproduction at a much lower level of dissociability strength than can recall. Items "on the tip of one's tongue" that cannot be recalled spontaneously can be both recalled with the aid of a hint (e.g., providing the first letter of the correct answer) and recognized correctly on a multiple-choice test. . . . In addition to this differential . . . between recognition and recall, . . . the threshold of availability is higher for recall than for recognition when dissociability strength is held constant.
> [ARK 113-114]

Benyon et al. also confront distinctions between recall and recognition, seeing recognition has having the second step of "matching":

> Recall is the process whereby individuals actively search their memories to retrieve a particular piece of information.
> Recognition involves searching our memory and then deciding whether the piece of information matches what we have in our memory stores
> [Benyon Turner Turner 2005 358]

This type of recognition, to ascertain identity, requires simply a mapping and a matching. A more complex recognition, the recognition that *an idea is an explanation*, is the situation where a complex or composite *dispositio*, one with many component *inventio* and relations among them, must be mapped to a problem (see: Cognitive question: inadequate *dispositio* (*gaps* and *blocks*)), then, not only do elements of the source project to the target, but upon completion of projection, evaluation is performed that results in satisfaction that the *dispositio* (problem) has had projected upon it additional structure

and is thus no longer inadequate (see: An explanation is a conceptual *path* that displaces a cognitive question).

> [C]hance favors only the prepared mind.
> Louis Pasteur [Vallery-Radot 1924 76]

Occasionally, one encounters an idea that is potentially a solution to a problem or inadequate *dispositio*, but does not realize it. Recognition of an idea as a solution to a problem, as in the paragraph above, is facilitated when the learner "knows what to look for" in an explanation, that is, has criteria by which he can recognize an explanation. Such criteria will map to the inadequate *dispositio*, and structurally be only skeletal relative to the explanation.

Historical role of memory

Memoria was prominent in ancient oral cultures for its techniques of using image schema (concepts derived from objects observed visually - see below) as a means of evoking abstract ideas, that is, using the visual metaphor

```
            a place is an idea.
```

It is combined with the metaphor of

```
  a path through a place is a sequence of thoughts.
```

This technique, frequently described as a *memory palace*, enabled the speaker to recall ideas by associating them with objects in the imagined place, then further imagining his own walking through it. Each object encountered in the imaginary place evokes a particular abstract idea such as a portion of a poem. Variant paths were possible from

one retelling to another.   Such feats seem extraordinary to those of us accustomed to

relying on written records, but were widely practiced in oral culture:

> [20th century scholars] heard such men creating their works as they
> performed, not merely with words but using *formulas* to *embroider* on
> such traditional *themes* as anger, vengeance, and combat. They found that
> thanks to this *method* the poets of oral cultures could still improvise on a
> subject, develop it, memorize thousands of lines of verse, and recreate
> them in recitation, although no two versions were an exact replica of one
> another. [Martin 1994 83 (emphasis added)]

The place image may be of any place, such as a garden or a great cathedral that offers a

rich variety of sensory experience. An image schema, e.g., of *walking from an entry hall*

to another room, underlies the association of proceeding from the prologue of the poem

to an adjacent verse:

> In the rules for images themselves, he [Matteo Ricci] explains that they
> must be lively and not too static, and that they must arouse strong
> emotions . . .
> As for the location where a given image is to be stored, Ricci gives the
> Chinese a number of further rules. The place should be spacious but not
> so crowded with images that a single one gets lost: a magistrate's yamen,
> a busy market, or a school jammed with students would all be unsuitable.
> The light must be clear and even, though not bright enough to dazzle. The
> spaces must be clean and dry, and kept covered lest the images be streaked
> with rain or dew. They should be at floor level or just above, not balanced
> on a beam or perched on the roof, which would make them inaccessible.
> The mental eye should be able to roam completely from one image to the
> next, so they should never be closer to their neighbor than three feet nor
> farther than six feet.   . . .
> So Ricci constructs the reception hall of his memory palace . . .
> [Spence 1985 25-26]

Memory palaces attest to the influence of image schema and to the notion that abstract

concepts are grounded in sensory experience. (see also: [Yates 1969] and [Carruthers

1990].)

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Impact of *memoria* on thought and language

> On the morning before this week's heartbreaking anniversary, I waded into the crowds at Ground Zero to ask about their memories of Sept. 11.
>
> Harold, a retiree from Lancaster, Calif., told me that he was awake early that day last year, watching "Today in L.A." in bed "just as it happened." He said he spent hours watching television that morning, riveted by images of the two planes striking the towers.
> . . .
> These recollections are typical, but not in the way you may think.   . . . their memory of what they saw is false. There was no video that day of the first plane hitting the World Trade Center," notes psychologist Kathy Podzdek of Claremont Graduate University in Claremont, Calif., one of many researchers studying Sept. 11 memories. "Yet 76% of the New Yorkers we surveyed say they saw it then, as do 73% of people nationwide."
> . . . memories are human constructs: They are amalgams of what we experienced, read and pieced together afterward, and what we should like to be true -- not documentary records.
> [Begley 2002 B1]

Ausubel devotes substantial attention to the phenomenon of *forgetting*. Indeed, for Ausubel, forgetting is not merely an annoying defect in one's thought processes nor a source of dysfunction arising from the learner's physical resources. Forgetting plays a *complementary* role in constructing new meanings -- there cannot be new learning without some forgetting:

> Forgetting, in process terms, is conceptualized as the second, or "obliterative" phase of subsumption in which the distinctive import and substance of a meaningfully learned and subsumed idea is at first dissociable from the anchoring (subsuming) idea, then gradually loses this dissociability, and is finally assimilated completely by the more general meaning of its more stable and inclusive subsumer. . . . [ARK 41]

That is, in constructing and using new ideas, one must forget some ideas or relations among ideas that have been displaced or overturned, for example, relations that no longer have a *trust* or *belief* attribute associated with them. For example, as one learns how banks use deposits to increase the money supply, one must unlearn or forget ones childhood model of the piggy bank where deposited funds simply sit unused.

While physiological and even obliterative subsumption aspects of memory receive only modest attention in this report, acknowledgement of these phenomena is appropriate because they contribute to difficulties in thinking and language use.

Apart from the necessary forgetting inherent in learning are the undesirable forms of forgetting: sheer inability to recall, and faulty recall.

We often treat memory as if it had the same properties as computer memory: it goes bad quite infrequently, but when it does, there is a noticeable if not total process collapse. On the other hand, if memory does not fail or appear to fail, then memories, that is the concepts that can be recalled, are accurate. Of course, there is counter-evidence for both of these myths, mostly of interest to researchers in psychology, neural physiology, education, and cognitive linguistics. However, such memory dysfunction is a contributing factor to meaningful learning and becoming informed, and thus must be taken into account.

Differentiating objects derived in any Division from those of the others

> How might our conceptions of things differ from our perceptions of them?
> [Tversky 1999]

> Now what is "music" -- a sequence of vibrations in the air, or a succession of emotional responses in a brain? But before there can be emotional responses, there have to be vibrations.
> [Hofstadter 1979 83]

> When we see a picture of the newborn baby, we cannot suppress our feeling that we are seeing a baby. In fact, the two-dimensional arrangement of colors in the photograph has almost nothing in common with a baby, and it takes a brain evolved over three billion years and trained through several months of early life to construct the identity between the picture and the baby. Because the brain does this instantly and unconsciously, we take the construction of meaning for granted. Or rather, we tend to take the meaning as emanating from its formal representation, the picture, when in fact it is being actively constructed by staggeringly complex mental operations in the brain of the viewer.
> [Fauconnier Turner 2002 5]

The motivation for outlining the Divisions of Rhetoric, as Reddy has called for, is to serve as a reference model for cognitive analysis: to retain distinctions between concepts, words, and papers or screens displaying print, and thus, to avoid blurring them all into *information*.

Objects of each Division of Rhetoric are distinct from one another based upon their properties. For example, *inventio* and *dispositio*, both conceptual objects, differ in their resolution and function: *inventio* is a simplified image of *dispositio*, usually comprising a linguistic term and a few essential component *inventio*, whereas *dispositio* reveals more component *inventio*, *and* the relations among them. These distinctions are important because the objects of each Division have different purposes, are derived differently, and are susceptible to different uses and processes.

Four of the Divisions of Rhetoric inhabit a different realm from the fifth: *pronuntiatio*, which is wholly situated in the tangible world while the others are wholly objects of the intellectual realm or, in the case of *elocutio*, bridge the two realms. Treatment of intellectual objects as if they were objects in the physical world leads to numerous misunderstandings (see: Implication of the conduit metaphor, above). Similarly treatment of words or terms (*elocutio*) as if they *are* concepts rather than derived from them is an error that confuses both theoretical discourse and practice in scholarly fields.

Inventio, *dispositio*, and *memoria* are susceptible only to imaginative, intellectual, mental processes. Objects of these Divisions cannot be transmitted directly among people, but must be the sources of derivations that ultimately result in the production of tangible transmittable *pronuntiatio*.

Pronuntiatio encompasses all earthly objects including those derived of other physical objects, e.g., vibrating particles by which radio and television and data signals travel, whether through the air, space, or copper or optical fiber, upon which derivations of linguistic expressions are inscribed or encoded. Merely because physical objects are transmitted does not mean that *dispositio* or *inventio*, expressed by *elocutio*, are communicated or received. The learner-reader-listener must derive concepts, through reconstruction and interpretation, then draw conclusions as to whether they are substantially similar to those intended by author-speaker, or as to whether they are credible, useful, or *true*. *Pronuntiatio*-as-object is susceptible only to operations in the physical world, including storage, retrieval, and processing and human perceptive functions (visual, aural, gustatory, tactile, and olfactory).

Analysis of Ausubel's theories reinforces recognition of these distinctions, for example:

established relevant existing *ideas* already present *in* learners' cognitive structures. [ARK 6 (emphasis added)]

Here, objects of *inventio*, "ideas," are differentiated from objects of *dispositio*, "cognitive structures."

We have acknowledged earlier that a learner may associate a linguistic term with a concept, but it is *not* a required characteristic of a concept. That is, a learner may evoke an idea but be unable to express it in linguistic terms. Thus, concepts and linguistic terms are also different from one another. Ausubel differentiates *elocutio* from *dispositio*:

I am making a distinction, in other words, between the formal organization of the subject-matter content of a given discipline, *as set forth in authoritative statements* in generally accepted textbooks and monographs, on the one hand, and the organized, internalized representation of this knowledge *in the memory structures of particular individuals*, especially students, on the other (Ausubel, 1964a). [ARK 76 (emphasis added)]

To mistake *pronuntiatio* for *elocutio*, *inventio*, or even *dispositio*, i.e., to mistake mere strings of displayed or performed pictographs or audiographs (*pronuntiatio*) for *meanings* leads to the profound misunderstandings described by Reddy. Marks are not letters, nor are the letters of a *word* (a spelling) a meaning. The implications of disregarding the distinctions of attributes of the Divisions of Rhetoric is explored next (see: Mistaking objects of one Division of Rhetoric for objects of another, below). Then how objects of each Division are derived from objects in an adjacent Division is considered, and thus the importance of differentiating among them.

Mistaking objects of one Division of Rhetoric for objects of another

Layered communications reference models are designed such that objects produced by an agent at any specific layer are intended to be processed by other agents in that same layer. Grave malfunction occurs where objects of one layer are confused with, or processed by, a different layer.

In communication, both writer-teacher and learner-reader perform *pronuntiatio*-as-process (including transmission), *elocutio*-as-process, and *inventio*- and *dispositio*-as-process. For *successful* communication, objects of each Division are processed similarly by each party: one's *pronuntiatio* is handled similarly to the other party's *pronuntiatio*. Each person's *elocutio must* be *coordinated* with the other party's *elocutio*. For successful communication, each party's *dispositio* must be coordinated with the other party's *dispositio*. Thus, this model has similarities to layered data transmission reference models (Figure II.45).

For example, if an employee holds up a company memorandum and declares to his colleagues, "You see, this memo cuts our medical benefits!" he is confusing the physical document (and the *elocutio*) with the *dispositio*. If the memo had been lost or mis-routed to the North Pole where it could do no harm, their medical benefits would still be changed. It was *not* the *memo* that changed their health benefits. It was, instead, an idea in the minds of decision-makers, *dispositio*, where the benefit cut was made. More to the point, if one intends to assimilate knowledge about one's employment benefits, one needs the *dispositio* potentially evoked by the document, regardless of whether they ever have possession of the linguistic statements or even the physical memo.

Author or
Teacher

Learner

inventio

relation

inventio

relation

relation

inventio

Dispositio

inventio

relation

inventio

relation

relation

inventio

Dispositio

derivation

derivation

Elocutio

Elocutio

derivation

derivation

Pronuntiatio

trans-
mission

Pronuntiatio
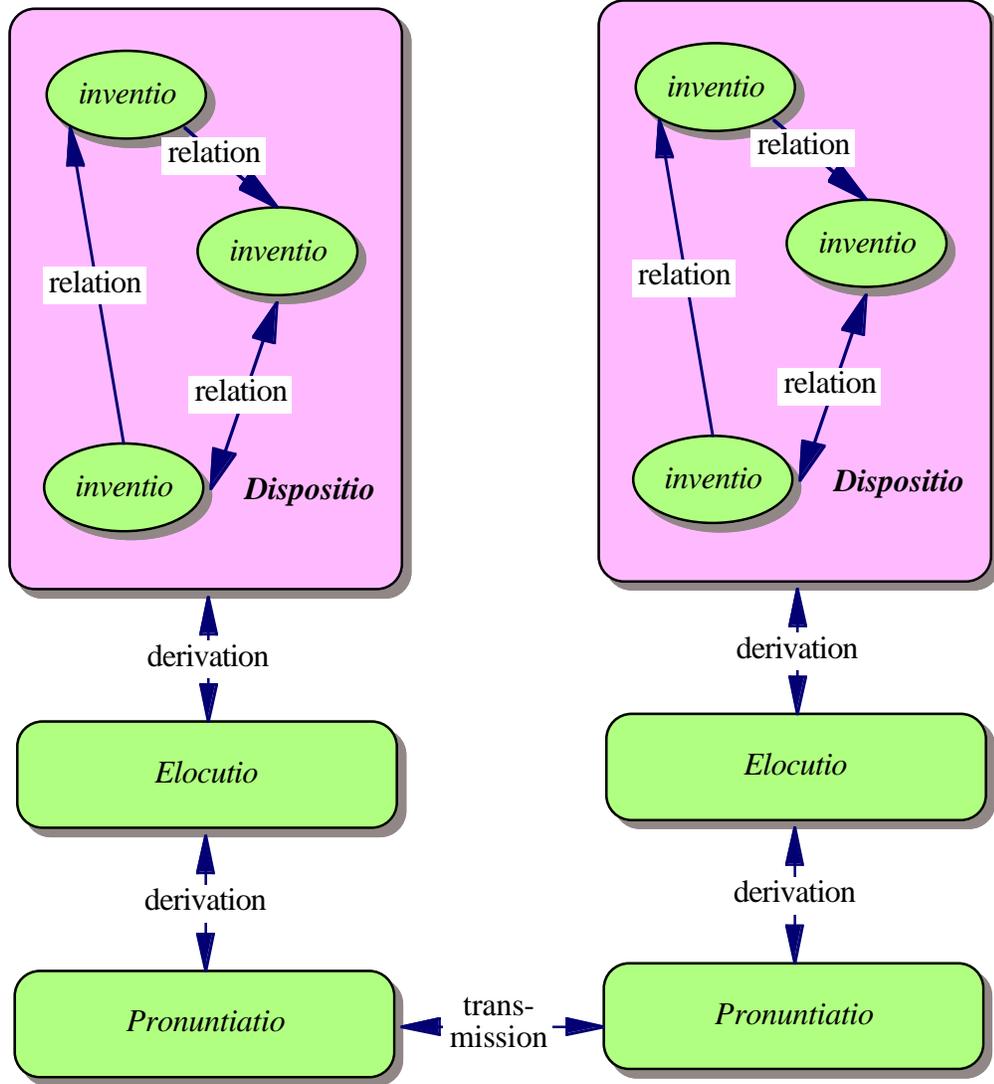
Divisions of Rhetoric
as a layered reference model

Figure II.45

To illustrate further, consider *ice cream*. Ice cream is produced from, that is *derived from*, specific objects, particularly cow's milk.   Milk is produced by, i.e., *derived from*, cows. Cows are derived from nutrients, e.g., water and grass, and of course, other cows:

	ice cream
derived from	milk
derived from	cows
derived from	grass, other cows

Each layer has its own use, system of terms, and modes of processing.

Ice cream is an object whose purpose is to be consumed by children on a hot summer afternoon. It is comprised of several materials including sugar, flavoring, and especially, milk. It has a system of naming of which *chocolate*, *vanilla*, *strawberry*, *sundaes*, and *bars* are members.

Milk. Several purposes are imputed to cow's milk. Some is used to feed calves, some is processed and used as a human beverage, and some is processed into *ice cream*. Milk has its own system of terms: whole, skim, homogenized, pasteurized, etc. Clearly, *milk* is distinct from *ice cream*.

Cows are bred and raised for the purposes of producing milk or meat. They have their own identifying systems such as Brown, Swiss, Guernsey, Holstein, Jersey, etc. Cows are produced from water and grass, and of course, other cows. Cows are clearly distinct from milk.

Grass has many purposes, among them food for bovine creatures. Grasses are organized by botanical nomenclature such as rye, Bermuda, etc. Grass is produced from seeds. Grass is easily distinguishable from cows.

Vendor
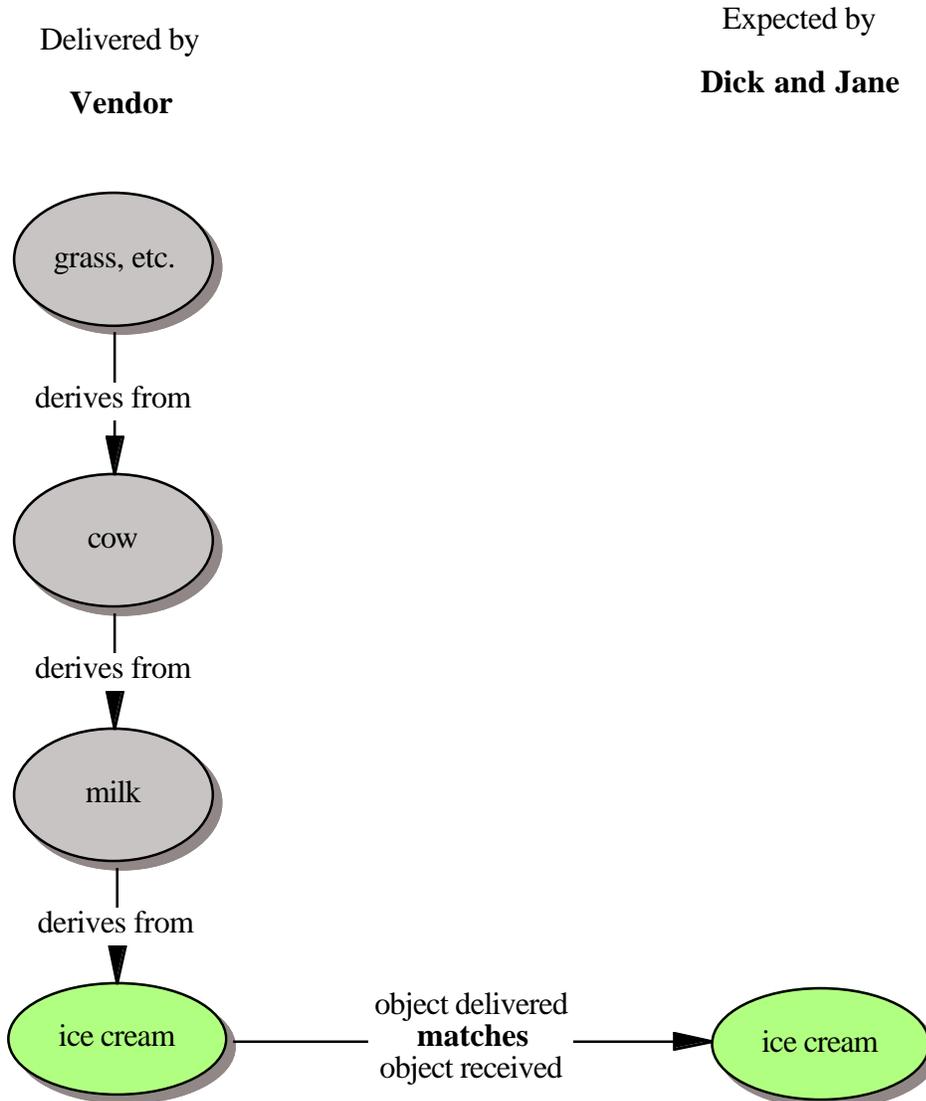
Dick and Jane

Figure II.46(a)

Now consider a beautiful summer's day, Dick and Jane accompany their parents to a baseball game. Sooner or later, Dick and Jane, perhaps observing others, politely express their desire for cold snacks. Let us suppose that Dick and Jane indicate that they would welcome ice cream sandwiches from the vendor hawking his wares through the stands. This state of affairs may be illustrated as in Figure II.46(a).

Delivered by

Vendor

Expected by

Dick and Jane

grass, etc.

derives from

cow

derives from

milk

derives from

ice cream

object delivered
mis-matches
object received

ice cream
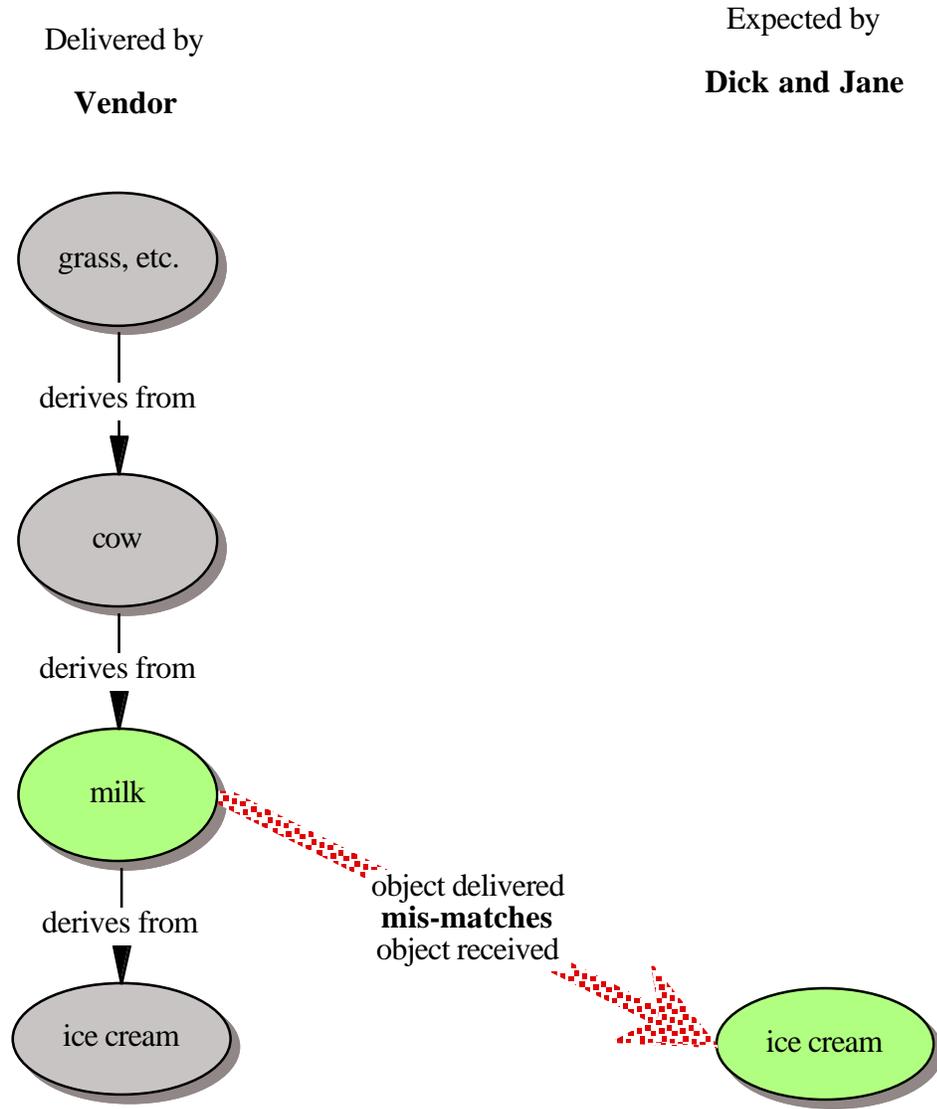
Figure II.46(b)

To this point, the scenario is commonplace. Now suppose further that Dick and Jane's

father, agreeing to provide the frosty confections requested, hails the vendor and

completes a commercial event transaction, receiving two objects in return for cash.

However, the two objects are not ice cream sandwiches, but two pint cartons of milk.   As

the illustration shows (Figure II.46(b)), a layer violation has now occurred:

Needless to say, the expectations of both Dick and Jane are dashed. They did not want milk, they wanted ice cream. Their characteristics are sufficiently dissimilar that not only is their desire for a frozen treat left unsatisfied, their intellectual resources have rapidly conjured grave doubts about the credibility of the vendor and the sanity of their father.

Imagine now a variant of this scenario: Dick's father hails the vendor, completes a simple financial transaction and is then handed, not two ice cream sandwiches, not two pints of milk, but two cows (Figure II.46(c)):

Delivered by

Vendor

Expected by

Dick and Jane

grass, etc.

derives from

cow

derives from

milk

object delivered
mis-matches
object expected

derives from

ice cream

ice cream

Figure II.46(c)

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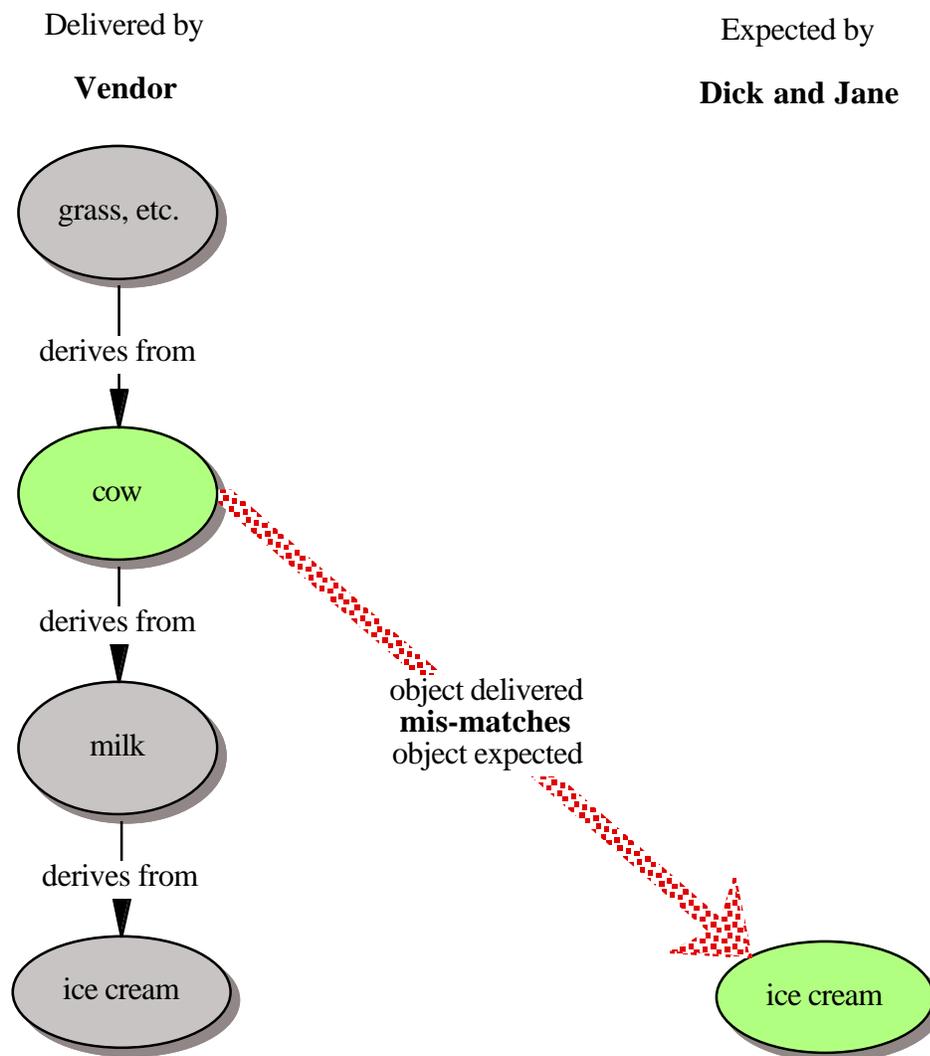
The discord in the youngster's minds in the previous example likely pales to their astonishment here, not to mention leaving the other spectators aghast. So many principles of our physical world and culture that are held as true or useful are undermined in this scenario, that they need not be itemized, but merely acknowledged *en toto*.

Of course, a third scenario can be easily imagined: Jane's dad hails the vendor, hands him a twenty, and receives in return two containers of cut grass. It matters little to a child expecting ice cream whether they receive a pint of milk, a cow, or a wad of grass. In virtually no case would an ice cream-seeking youngster of any age willingly accept a pint of milk, a cow, or a clump of grass in lieu of ice cream. Except for the pint of milk, the children do not even have the tactile, gustatory, or digestive systems to process these in the same way they process ice cream. If they attempted to do so, they would either become ill from the grass or injured by the angry cow who resents being treated as an ice cream sandwich. In short, these three scenarios would *not work*.

Imagine, now, the anecdote above with the following substitutions: reader-learner for child, writer-speaker for ice cream vendor, *dispositio* for ice cream, *inventio*, for milk, *elocutio*, for cow, and *pronuntiatio* for grass. That is, a reader-learner assimilates ideas, *inventio* and *dispositio* produced by a writer speaker (Figure II.47):

Delivered by

Speaker-writer

Expected by

**Reader-
listener-learner**

dispositio
and
inventio

used to derive

elocutio

used to derive

pronuntiatio

dispositio
and
inventio

used to derive

elocutio

used to derive

pronuntiatio

pronuntiatio — transmitted → pronuntiatio
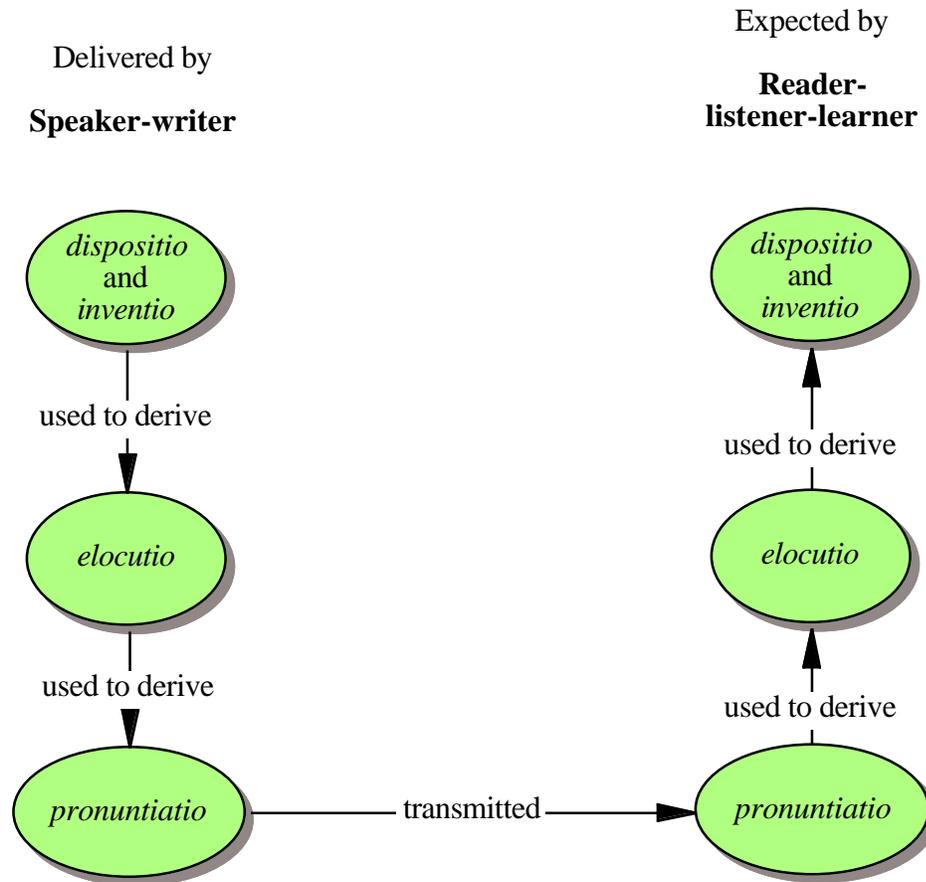
Communications Layered Reference Model
based on the
Divisions of Rhetoric

Figure II.47

Now consider the situations corresponding to the three alternative scenarios where milk,

a cow, or a bundle of grass were confused for ice cream: the results will be the same --

communication will *not work*. However, there is one important difference:

People are rarely surprised at such substitutions!

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Nobody is aghast that *ideas* have been interchanged with *text*. Nobody is shocked that a computer screen is confused with the text presented by it. Nobody questions the sanity of mistaking a piece of paper or book for the ideas that the reader might evoke from them.

Indeed, this is this is a daily commonplace and the essence of Reddy's complaint in the conduit metaphor (above), framed in Divisions of Rhetoric terms. These correlations may be similarly depicted (Figure II.48):
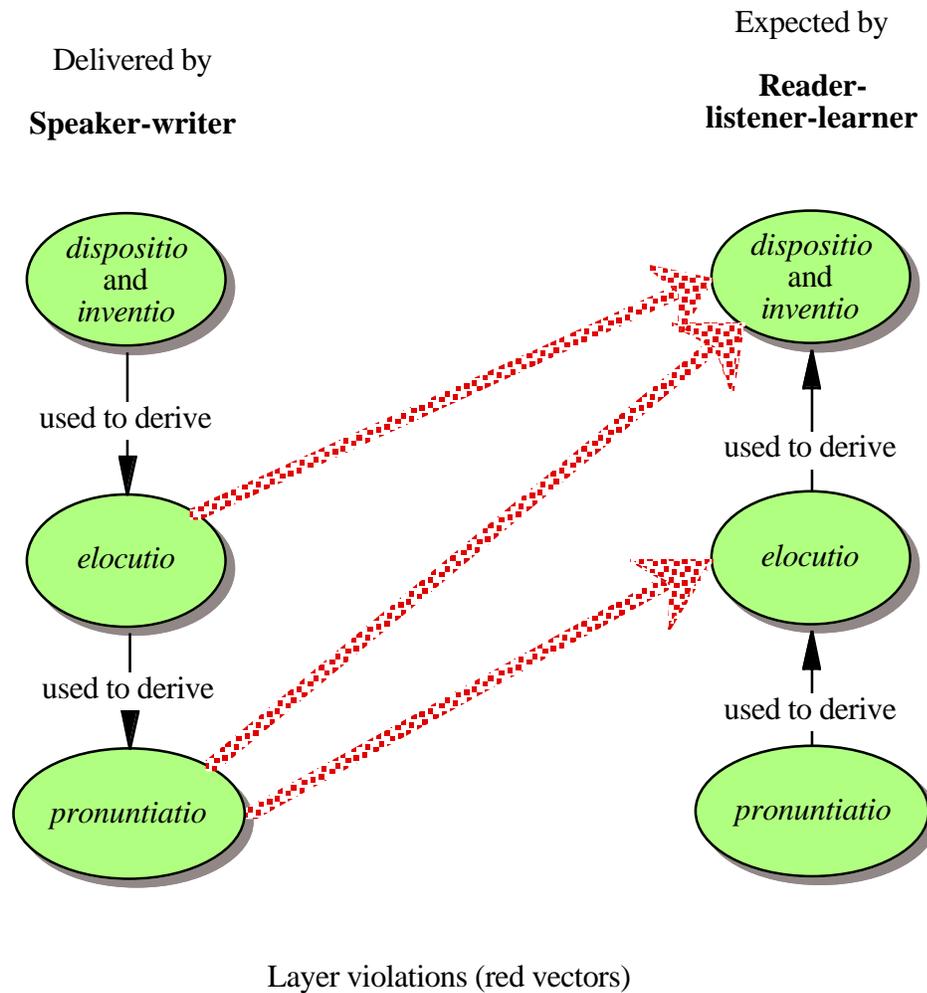
Figure II.48

The Divisions of Rhetoric communications reference model imposes a constraint: objects produced at a particular layer must be treated as objects *of that layer* by the recipient (see: Figure II.45). If not, constructive malfunction occurs (as depicted in Figure II.48):

If the speaker-writer's *dispositio* and the learner-reader's *dispositio* are not coordinated;

If the speaker-writer's *elocutio* and the learner-reader's *elocutio* are not coordinated;

If the speaker-writer's *pronuntiatio* and the learner-reader's *pronuntiatio* are not coordinated, that is, if the *pronuntiatio* sent is not substantially the same as the *pronuntiatio* received.

A pedagogical example of such constructive malfunction, and a pervasive one:

Provision of physical teaching materials, *pronuntiatio*, to a learner doesn't guarantee that he can read its *elocutio*, nor derive its *dispositio* (meaning).

Yet students are often assumed to be sufficiently familiar with terminology that they can reconstruct an intended meaning.

Lastly, not only does the Divisions of Rhetoric model illustrate that objects of any given layer transmitted by a teacher-speaker-writer must be treated as objects *of that layer* by the learner-reader-listener, but also that the learner-reader-listener's task is not complete until *dispositio*, *meaning*, is constructed. Receiving a physical object does not constitute construction of meaning.

Derivation of objects of one Division from objects of another Division

This section considers how conceptual objects, linguistic objects, and physical performance objects are derived or produced from objects of adjacent Divisions. Thus, this section identifies specific elements of the larger, conscious-level processes of how people read, listen, write, interpret, and indeed, think.

Objects of each Division are *derivations,* not *transformations*, not *representations*, not *encapsulations*, and not *codes*

Within the domain of an individual learner, objects of one Division are constructed according to, or *derived* from, objects of an adjacent Division (see: Figure II.45). *Derivation* is differentiated from *transformation from*, *representation of*, *encapsulation in*, *containment in*, and *encoding of*.

> *Meaning* ensues when such operations are performed, but is not itself
> directly assignable to sentences.
> [Fauconnier 1994 xx-xxi (emphasis added)]
>
> Language does not carry meaning, it guides it. As Mark Turner
> felicitously put it:
>
> > Expressions do not *mean*; they are prompts for us to construct
> > meanings by working with processes we already know. In no
> > sense is the meaning of [an] . . . utterance "right there in the
> > words." . . .
>
> [Fauconnier 1994 xx-xxi (emphasis added)]

Not transformation. *Inventio-dispositio*, *elocutio*, and *pronuntiatio* objects are not *transformed from*, or *contained within* objects of adjacent Divisions. The evidence is

that, following each derivation, the source remains unchanged, and thus was not transformed.

For example, *pronuntiatio* objects are produced by *deriving* them *from elocutio* specifications. *Pronuntiatio* is not a transformation of *elocutio* because upon production of *pronuntiatio*, i.e., the spoken sound of, or printed characters the *elocutio* (specifications for the audible or graphic object) still exists, unchanged in form. *Pronuntiatio* cannot be an encapsulation of *elocutio* because the *elocutio* is an object of the mental realm and *pronuntiatio* is an object of the physical.

Consider the *elocutio* `elephant`, that is, the linguistic specification for an elephant (please see Figure II.43). One reader may receive a particular *pronuntiatio* and be provoked to *derive* (in this case, through recognition) the term *elephant* and, in turn, evoke the ideas of an elephant. However, another reader may receive identical *pronuntiatio* and for any of several reasons, *not* be provoked to derive the linguistic term *elephant*, and thus not evoke the idea of an elephant. *Pronuntiatio* objects are *not* thought, *not* ideas, but only physical triggers that potentially provoke a reader-listener to evoke ideas.

Not representation. Similarly, *elocutio* does not *represent* meaning, *dispositio*, but rather derives or prompts the construction of it:

> [L]anguage *does not represent* meaning directly; instead it systematically prompts the construction of meaning.
> [Fauconnier Turner 2002 142 (emphasis added)]

> Human beings face a fundamental problem: Conceptual systems are vast and rich and open-ended, but linguistic systems, however impressive, are relatively quite thin. How can a linguistic system be used to convey the products of conceptual systems, and how can these products find expression in language, given the stark mismatch in their respective

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infinities?

> Because linguistic expressions prompt for meanings rather than represent
> meanings, linguistic systems do not have to be, and in fact cannot be,
> analogues of conceptual systems. Prompting for meaning construction is a
> job they *can* do; *representing* meanings is not.
> [Fauconnier Turner 2002 277 (emphasis added)]

> The folk-theoretical illusion that each expression of language has a
> meaning that we all retrieve in basically the same way allows interlocutors
> to interact under the impression of mutual comprehension, when in fact
> they may be engaged in quite different mental-space constructions.
> [Fauconnier 1997 160]

The verb *represent* is defined as "to bring *clearly* before the mind" or "to serve as a sign

or symbol of" [Webster's New College Dictionary]. If an object does not evoke a referent

clearly (reasonably unambiguously), it does not represent. There is ample evidence that

terms do *not* evoke ideas with certainty or clarity. If an object does not evoke a referent

relatively unambiguously, then the object is inadequate as a sign or symbol of it.

Similarly, *elocutio* does not represent concepts because there is no mapping from concept

to term that operates "clearly or serves as a symbol for concepts" from learner to learner.

Learners must provide and apply substantial prior knowledge to every term to construct

meaning. The term is only a trigger to evoke the learner's application of their prior

knowledge to deriving a meaning for the term. One learner might associate one term

with a concept, another learner might synonymously associate different terms with that

concept, and polysemously associate a different concept with the term used by the first

learner. Thus there is no universal representation of concept by term, but only clues that

potentially enable a learner-reader to evoke a concept from the term.

Not encapsulation. The specification for `elephant`, as *elocutio*, as shown in Figure

II.43, comprises several elements including definition, etymology, interaction with other

terms, syllabification, etc. The *pronuntiatio* `elephant` shows *none* of these, but only

visible shapes: and `e` followed by and `l` followed by an `e`, etc. Thus, the specifications,

elocutio, are not encapsulated within *pronuntiatio*.

Not encoding. Objects are not encodings of objects of adjacent Divisions because coding

implies a controlled set of meanings for corresponding codes. *Elocutio* is *not* a *coding* of

meaning (*dispositio*) because there is no finite or controlled set of meanings that may be

evoked by people for given words. People can use existing terms in imaginative ways to

conjure meanings that had never been conceived before:

> The rich meaning that will ensue is not inherently contained in the
> grammatical structures. What the grammar does is specify a range of
> constructions of blends from which to choose and on which to elaborate.
> This is why language functions so differently from *codes*, logical truth-
> conditional systems, and the like. It never does more than set a very
> schematic stage for the meaning that is going to be built and negotiated
> locally in usage. [Fauconnier 1997 160]

> In our folk theory, it is the words that carry the meaning: We "say what
> we mean," we "put meaning into words," and so on. The difference
> between the folk-theoretic conception and the actual (backstage) reality
> goes unnoticed . . .

> Expressions of language do not in themselves represent or code such
> constructions -- the complexity of the constructions is such that the
> *coding*, even if it were at all possible, would take very large amounts of
> time and be extremely inefficient. Instead, languages are designed . . . to
> prompt us into making the constructions appropriate for a given context
> with a minimum of grammatical structure. Language does not itself do the
> cognitive building . . . it "just" gives us minimal, but sufficient, clues for
> finding the domains and principles appropriate for building in a given
> situation. Once these clues are combined with already existing
> configurations, available cognitive principles, and background framing,
> the appropriate construction can take place.
> [Fauconnier 1994 xviii (emphasis added)]

Finally, loss, change, or addition of meaning may be a consequence of any derivation.

Notation

In this section, derivations are notated:

$$(\text{source object}) \rightarrow (\text{object constructed})$$

where "➜" indicates *derives*. This notation may be less awkwardly read from right to left, "object constructed is derived from source object." For example,

$$elocutio \rightarrow pronuntiatio$$

translates

pronuntiatio object derived from *elocutio* object

Unless the suffix *as-process* is appended, *inventio*, *dispositio*, *elocutio*, and *pronuntiatio*, refer to the Divisions-as-objects rather than to Divisions-as-process (actions of inventing, arranging, expressing, or delivering).

Specific derivations

Characteristics of each of the six derivations are described and illustrated (Figure II.49).
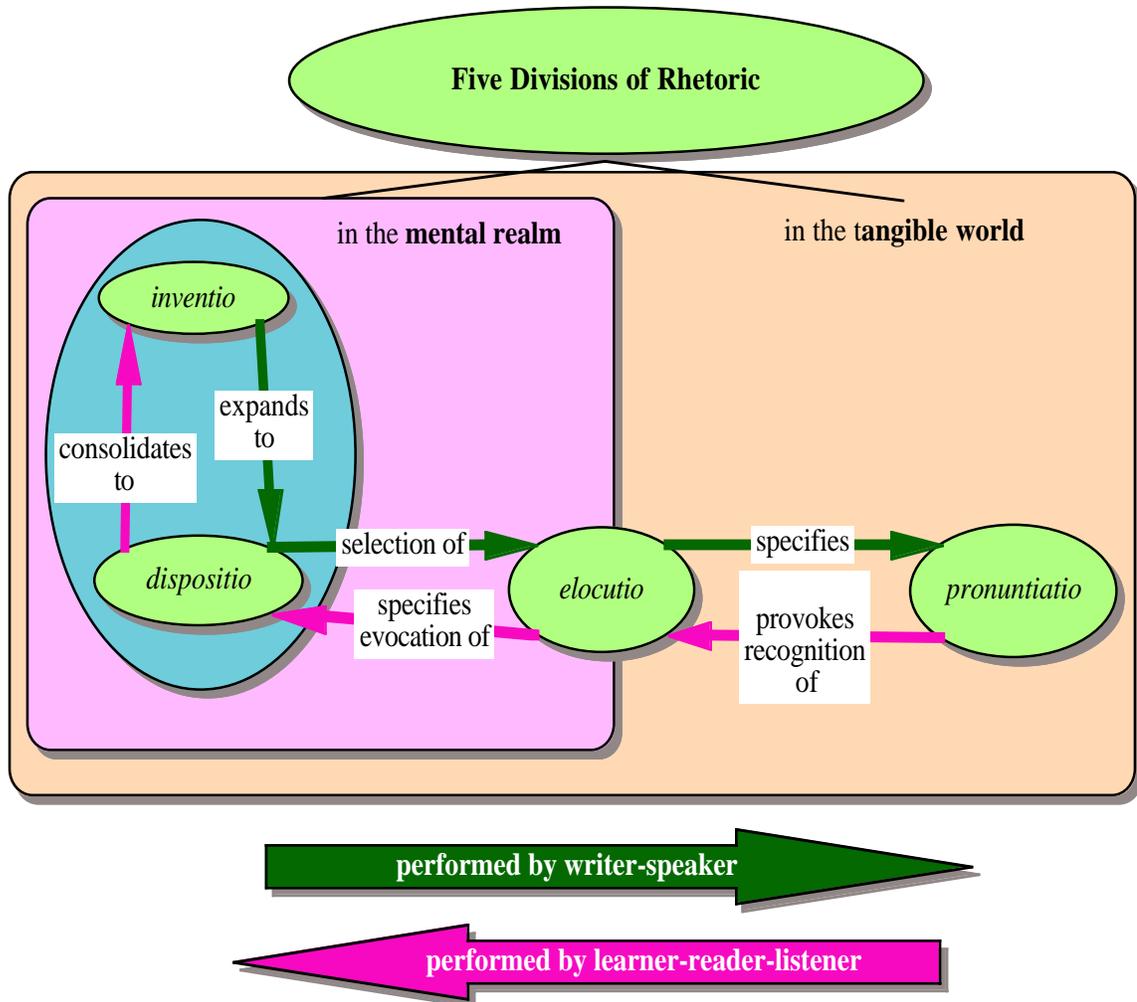
Figure II.49

Inventio ➤ *dispositio* and *dispositio* ➤ *inventio*

The relationship between *inventio* and *dispositio* is essentially one of granularity.   Both are forms of the same concept, but whereas *inventio* comprises the essential component concepts (which are also *inventio*) and perhaps an association with a linguistic term (*elocutio*), *dispositio* is comprised of the fine-grained detail of all the component concepts and the relations among them. Figures II.39(a), (b), and II.40 illustrate the differentiation of *dispositio* from *inventio*.

For example, consider the *dispositio* of "getting a college education."   This *dispositio* comprises massive detail related to applications, admissions, living arrangements, each specific course, the instructors, the friendships developed, the skills and ideas learned, etc. The *inventio* form however is often comprised as just (1) the endpoint *inventio*, go-to-college, get-a-degree, and (2) a label, "a college education," absent all the detail and structure. One might argue that such detail is implicit, implied, or even used when the *elocutio* "get an education" is expressed. Generally, however, when a learner encounters this *inventio*, specific ideas of registration, acquiring textbooks, final exams, getting admitted, etc. are not evoked as they are when unpacked into *dispositio*.

Often, a learner might have forgotten or never assimilated the detail structure of an *inventio*. Thus, for that learner, the derivation of *inventio* ➤ *dispositio* may be characterized as unpacking the concept to reveal its structure. Where the existing concept is not well understood, but instead is being developed or extended, *inventio* ➤ *dispositio* may be regarded as learning in greater detail, analyzing, or excogitating, that is, *thinking*. When such tasks are combined with *elocutio*-as-process, these are regarded as explaining, explicating, or exegesis.

The derivation of *dispositio* ➤ *inventio* is a reductionist one of selectively consolidating or discounting attributes of *dispositio* so as to use the concept in a general way.

For example, for years health costs and related issues exerted pressure on the health-care provider paradigm under which a patient was simply covered by his insurance, usually obtained through employment. To address cost control and other issues, policies had to be implemented, business methods changed, and new types of labor invented (e.g., matching coding on medical invoices with policy coverage), etc. As the enormity of these changes exceeded patients' grasp, a consolidated derivation of the *dispositio* was needed for the lay public, a reductionist image, a simplified concept with a theme and label, that is, an object of *inventio*. This object became known as the health maintenance organization (HMO) and developed an identity of its own.

Dispositio ➤ *elocutio* and *elocutio* ➤ *dispositio*

Dispositio ➤ *elocutio* derivations are performed by writer-speakers.

Elocutio ➤ *dispositio* derivations are performed by learner-reader-listeners.

The most complex of the six derivations are the interactions between thought and language (Figure II.49). These are the central concerns of linguistics, and portions of ancient rhetoric, cognitive science, and philosophy. Researchers in these fields inquire as to processes that result in thoughts and expressions, circumstances under which an expression evokes a particular meaning to a reader-listener, and circumstances under which a writer-speaker employs specific terms and grammatical forms. Their findings are drawn upon for their capacity to amplify the notion of *reception* (of expressions via *pronuntiatio*) in meaningful reception learning in Assimilation Theory.

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Linguistic terms are separate from, *optional* in, and have different properties than, concepts. A learner may evoke a concept with no linguistic term, or evoke a term for which he has no concept. Where a learner does not have relevant vocabulary, he might be less likely or even unable to evoke subsequent concepts associated with the concept [Lakoff Feldman NTL] [Adams 1974 63].

Conversely, on occasion, the only attribute of an *inventio* of which a learner may be conscious is its linguistic label. This can be the case upon hearing a new term, having some sense of its context, but being unable to disambiguate it from virtually all other concepts. Astute learners assimilate the vocabulary in a subject domain during and even prior to assimilating meaningful relations among concepts. Imagine a student at the first meeting of her Biochemistry 101 class, hearing the instructor proclaim:

> The study of proteins is a primary focus of biochemistry. Peptide bonds
> link amino acids into proteins. Peptide bonds (secondary amide bonds)
> link the alpha-amino of one amino acid to the alpha-carboxyl of the next.

Even if the student recalls general ideas about proteins, peptides, and amino acids from high school biology, she might know nothing more of an *amide bond* or *alpha-carboxyl*, upon hearing such a statement, than their pronunciation. As instruction proceeds, the student (hopefully) constructs relations between these new concepts (comprised, thus far, only of a name) and those more familiar. As the relations among new concepts and prior knowledge grows, the new ideas become more meaningful, and more than just labels.

As mentioned, a learner may evoke an *inventio* for which he has no linguistic expression, that is, an idea that he cannot describe. A lengthy description may be used in lieu of a term, expression, or name. There are many concepts (e.g., those of some emotions,

physical sensations) for which one might have difficulty selecting a satisfactory term, *elocutio*:

> GONERIL:
> Sir, I love you more than words can wield the matter;
> [Shakespeare King Lear. Act I, scene I]
>
> MACDUFF:
> I have no words:
> My voice is in my sword: thou bloodier villain
> Than terms can give thee out!
> [Shakespeare Macbeth. Act V, scene VIII]

Ausubel recognizes this predicament:

> First, it happens quite frequently, particularly in concept formation, that pupils acquire particular concepts meaningfully without learning for some time what their names are. Thus, simply because they do not know what particular concept words mean, it cannot be assumed that they necessarily do not know the corresponding concept meanings (criterial attributes).
> [ARK 86-87]

The derivation *dispositio* ➔ *elocutio* is selection of linguistic system and terms

From *dispositio*, a writer-speaker derives *elocutio* by *selecting terms* to express his ideas, "to clothe his thoughts with meaning." In confronting this derivation, the writer-speaker is confronted with two questions: (1) which linguistic system expresses the concepts in a manner most likely to be grasped by the learner-reader, and (2) which terms within that system are best suited to the learner?

Apart from selection of *elocutio* (semantic), the writer-speaker might decide to render the

expressions in tangible form, as *pronuntiatio*. If so, the *elocutio* (graphic-phonic)

associated with the *elocutio* (semantic) provides the specifications for producing

pronuntiatio for transmission to reader-listeners.

The derivation *elocutio* ➜ *dispositio* is specification for evoking and selecting meaning

> [A] fundamental distinction between a written mark - something fixed,
> lasting, preserving -- and its readings, which are always of the order of the
> ephemeral, plurality and invention. . . . [R]eading is *not* already inscribed
> in the text; that it is not true that there is no imaginable gap between the
> meaning assigned to it (by the author of the text or its editor, by criticism,
> by tradition, etc.) and the use or interpretation that readers may make of it.
> [A] text exists only because a reader [who could also be the author] gives
> it meaning.
> [T]he text has a meaning only through its readers; it changes along with
> them; it is ordered in accord with codes of perception that it does not
> control.
> [Cavallo Chartier 1999 1 (annotation added)]

Elocutio specifies meanings to be evoked and selected by the learner-listener-reader.

How does a learner-listener-reader ascribe meaning to expressions recognized?

According to the conventional reading model, the derivation of *dispositio* from *elocutio*

comprises several steps:

> [Comprehension through reading] takes place at four levels: lexical,
> syntactic, semantic and pragmatic [Rettig, 1992], [Rada, 1991].
> At the *lexical* level, the user determines the definition for each word
> encountered.
> At the *syntactic* level, the subject, action and object of a sentence are

determined.
The meaning of a sentence is determined at the *semantic* level.
The *pragmatic* interpretation of text depends on the integration of
semantic meaning of text with the reader's knowledge of self and of the
world. [Balasubramanian undated]

Miller describes, instead, a "top-down" model where the reader's primary objective is to

select ideas (idealized cognitive models) from within their prior knowledge, *dispositio*,

that best match the concepts provoked by the text. That is, if the reader can "get the main

idea" of a text, they do not devote time or cognitive resource to narrower distractions

such as specific word meanings, spelling, or punctuation. In *elocutio* ➤ *dispositio*, the

listener is attempting to ascertain conditions under which the expression would likely be

used, perhaps even be true.

> . . . in which case the model selected by his image contained more than
> one representation compatible with what he remembered, but he could still
> use his model to insure that every sentence he wrote was true in the model.
> . . .   Now consider models from the reader's point of view. Initially, the
> reader has a very general model if he has any at all. The reader is given,
> not a model, but a text, a string of descriptive sentences. He must discover
> a model that is compatible with those sentences -- a model that includes
> the author's model [or not] . . .   Then his task becomes just the reverse of
> the author's: a reader uses the true descriptive sentence to select a model
> (Cushing, 1977) [Miller 1993 362]

> . . . [L]et us say that you understand a sentence if you know the conditions
> under which a person would use it. [Miller 1993 364]

> Meaning is not encoded in sentences. That is what has led the mechanical
> translation of language and machine understanding of language astray.
> Sentences . . . are big pointers into shared metaphors. I think of language
> as being a technology of gesture. The first thing you try to find out when
> you are talking to someone is whether you share the same metaphors. If
> you don't then you are in a learning situation.
> [Kay 1983   55]

Miller's analysis coheres with one of the prominent claims from Wittgenstein's later work, an instrumental theory of meaning, to the effect that one knows a word when one knows how to use it. This is one of very few intersections between the present essay and Wittgenstein's work, early or late.

From Miller, a better understanding of *elocutio* ➔ *dispositio* may be synthesized:

(1) *recognition* of the terms, (2) *activation* of existing ideas by tracing relations from term to ideas associated with that term, then (3) *selecting* from among those meanings the most relevant, then (4) *construction* of first order grammatical (taking into account syntax) meaning, as integrated with the learner's existing subject matter knowledge. These may further include evaluation as to belief, i.e., as truth or its status as a counterfactual (a temporary construct where belief is suspended for the purpose of hypothesizing).

In sum, this derivation is a constructive one, not merely selecting from already held meanings.

Dispositio ➔ *elocutio* compels speaker-writer to (re-)organize *dispositio*

> [T]he use of writing to assess what students understand may pay an
> important bonus, because it is a common observation that engagement in
> the activity of writing can itself have a progressive effect on the writer's
> understanding, through a kind of re-thinking process.
> [Ammon and Ammon 1990 5]

Dispositio ➔ *elocutio* has a clarifying effect on selection and organization of ideas, and often consequently on the selection of expressions. Writing can be an iterative activity. In writing a report or producing concept maps, for example, the author or mapmaker

might recognize disconnected or unidentified concepts, or conflicting relations among ideas, adjust his *dispositio* accordingly, and then express those structures (*elocutio*) more clearly.

Further, the speaker-writer's effort to reorganize thoughts may be cyclic (*dispositio* ➔ *elocutio* ➔ *dispositio* ➔ *elocutio*, etc.) as in the cycle of markup/edit, print, read, markup/edit.

Elocutio only indirectly correlates to meaning, *dispositio*

Elocutio's function is to provoke learner-reader-listeners to evoke *dispositio*. The correlation between expression and meaning is imperfect and uncertain.   This is, in part, because *elocutio* is an intermediary between writer-speaker and learner-listener-reader. *Elocutio's* status as a device between people, an intervening object, even if its function is to serve as a bridge, nevertheless evinces the fact that communication between people is *not direct*, not telepathic. As a device that intervenes between people, *elocutio*-as-process adds error, uncertainty, and entropy to communication.

As an analogy, the objective of golf (directing a ball to fall into a cup) might be easier if the players could pick up the ball and *directly* place it in the hole. Instead, players are required to use an *indirect* and *intervening device* to manipulate the ball: a golf club. Results vary, but almost always, use of a club to direct the ball accurately leads to imperfect outcomes. *Elocutio* is like the golfer's stick: a somewhat clumsy device, but with skill, a linguistic expression can provoke the learner-reader to evoke the expected thought. When expressions are interpreted successfully (depending on the criteria for success), they sink the putt. If synonymy, polysemy, or a substantially different set of

personal experiences by the reader-listener interfere, the ball misses the hole. Sometimes there is no hole, leaving conversations to wander inconclusively. Other times, the "club" is so specialized, the novice is unable to use it at all.

An often overpowering idea in our culture is the notion of "the meaning of a word." That is, words and texts have objective, or at least negotiated meanings and it is the learner's simple job to evoke that meaning when receiving the term (see: Manifestations and adverse consequences of conduit metaphor effects, above). This powerful idea, like a belief that a witness who swears on a copy of the Bible to tell the *truth* to a court is able to do so, is a fiction. In practice, the witness' truth can only be as he understands it. And, the learner's meanings are only as he constructs and selects them.

The meaning imputed to a term or text by a learner may be influenced from several sources. A term or text used in the community polysemously requires the learner to choose from among alternative meanings and thus certainty in *elocutio* ➜ *dispositio* falls below a perfect 1.0.

Meaning is further influenced by the learner's private experience, existing knowledge (including beliefs and biases), memory, cognitive skills, and other private factors.

Another source of flex in the relation between *elocutio* and *dispositio* is the effect of cognitive authority people grant to others to determine meaning *for* them. Despite the attempts of teachers, dictionary compilers, advertising executives, and political advisors to correlate printed or spoken terms with specific meanings, meaning is, in the final stage, constructed by the learner herself. The meaning might have, embedded in it, hidden sequences based on various kinds of logic, conclusions, assumptions, or other artifacts of other people's attempts to install particular meanings into the learner-reader-listener. Indeed these attempts are often effective. Most of the concepts accepted as true

knowledge are constructed based on the cognitive authority of trusted other persons. However, construction of meaning is also based upon the learner's own experience and prior knowledge. To the extent she relates these to new ideas, she may detect hidden assumptions (implicit superordinate ICMs) and vet them accordingly.

For all these reasons, meaning is *derived from* terms by the reader-listener rather than inherent *in* the terms, and, terms are *derived from* meaning by the speaker-writer rather than being objective pre-ordained representations of meaning. Cognitive constructivism does not acknowledge telepathy. Thus, communication is required. Communication, as structured by the Divisions of Rhetoric communications reference model, is the art of transmitting expressions that *provoke* the receiver's *evocation* of meaning.

Thus, meaning expected to be expressed by an author-writer might not be the meaning evoked by the learner-listener-reader. This loss of *expected* meaning due to the *indirect correlation with meaning* is a property of so-called natural language.

Elocutio always *under*specifies *dispositio*

Elocutio specifies meanings to be evoked and selected by the learner-listener-reader. However, learner-listener-readers do not treat such specifications uniformly. Consequently, understandings of identical texts among learner-listener-readers varies.

As alluded to earlier, *dispositio*-as-object is the detailed structure of an idea with all of its component concepts and relations among component concepts and among other *inventio*. The composition of most concepts is complex beyond human comprehension. As learners lack the capacity to bring all component concepts and relations to conscious attention at any moment (or at all), similarly *elocutio* expressions of concept cannot be

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expected to evoke all such complex detail. Terms can never wholly express thoughts. Reductionism in any derivation, including linguistic specification is unavoidable, and thus, so is loss of meaning attributable to it. *Elocutio* always *under*specifies *dispositio*:

> 3. Language expressions underspecify cognitive construction.

> When a sentence is looked at in isolation, we come up with the typical interpretations . . . But when a sentence is correctly understood to be making an overall contribution to cognitive discourse construction, we find that the same "meaning" conceived of as building instructions, can give rise to different "interpretations," depending on . . . how they are applied; the "how" comes into play because the building instructions typically *underspecify* the construction: There can be more than one way to elaborate an existing configuration . . . [Fauconnier 1997 65]

Thus, people compensate for the underspecification of meaning expressed by linguistic terms, in part, by a mental process of "filling in," i.e., isomorphic projection (see: What is isomorphic projection? below). In this respect, isomorphic projection offers the benefits of a labor-saving device: one need not memorize every separate thought, but only a smaller number of key thoughts from which the others can be re-called, re-evoked.

Buckland points out [private communication] that several sources of indeterminacy are at work in *elocutio* ➔ *dispositio*: (1) any particular object of *elocutio*, as understood by the majority of speakers, only imperfectly specifies a particular concept; (2) a particular *elocutio* object might not evoke a particular *dispositio* in the mind of a particular person; not to mention that regardless of the looseness of the relation between *elocutio* and *dispositio*, *dispositio* objects are inherently imperfectly specifiable, (3) on account of their complexity and (4) because any specific person's *dispositio* arises from their own experience, which differs from person to person.

Can *elocutio* specify meaning *explicitly*?

A text (more accurately, the meaning <u>of</u> a text) is regarded as *explicit* if the learner-reader-listener consciously and unambiguously evokes the expected meaning, either by the writer-speaker or by a community whose vocabulary includes the expression. When she cannot construct an expected meaning from the text, or several meanings, even conflicting meanings, are possible, or when meaning is evoked only sub-consciously, the meaning has the status of being *implicit* "in," that is, as derived from, the text.

The concept of *explicit*, thus comprises two elements (1) conscious evocation of salient *dispositio* objects by the learner-listener-reader, and (2) *unambiguous* selection by the reader of the *dispositio* from all possible conflicting meanings.

Meaning that is explicit relative to (i.e., derived from) a text for one learner-listener might not be considered *explicit* by a different learner-listener. A community of writer-speakers may deem that a particular meaning is explicit in a term, e.g., "Pick up that trash you dropped." is likely considered explicit to most English speakers. Nevertheless, for an individual learner-listener-reader, the exhortation might not be explicit: (1) she might be preoccupied with eating her lunch and thus not be attending ("paying attention") to the expressions directed to her by the police officer, or (2) she might be uncertain about which trash is referred to by the text (if she did not believe she had herself committed a littering act).

Assimilation Theory, paralleling Reddy's observations (above), holds that meaning is not *in* texts, but constructed *from* them by the reader. Because a meaning cannot be *in* a text, it cannot be *explicit in* the text, nor can it be *implicit in* a text.

Dispositio is not linear, natural language *elocutio* usually is

> If there were such a thing as polyphony in prose, it would obviously be a
> godsend to the writer of history, whatever it might be to the reader. The
> historian would be spared his persisting struggle to reconcile the
> chronological thrust with the regional spread -- the development, over the
> years, of one kind of growth with the diffusion, over vast areas, of many
> kinds of growth simultaneously. However, language being less adaptable
> to contrapuntal treatment than music, the solution that is most suitable to
> the historian's problems has to be discovered from case to case.
> [Reese 1954 Preface]

The Twentieth Century philosopher Michael Foucault observed that *dispositio* is web-like

or may be conceptualized as having a network form of structure. However, most (though

not all) forms of *elocutio*, primarily the so-called natural languages, presented as

pronuntiatio, are linear:

> What distinguishes language from all other signs and enables it to play a
> decisive role in representation is, therefore, not so much that it is
> individual or collective, natural or arbitrary, but that it analyses
> representation according to a necessarily successive order: the sounds, in
> fact, can be articulated only one by one; language cannot represent
> thought, instantly, in its totality; it is bound to arrange it, part by part, in a
> *linear* order. Now, such an order is foreign to representation. . . .
> It is these representations, pressed in on one another in this way, that must
> be sorted out into linear propositions . . .
> If the mind had the power to express ideas as it perceives them, then there
> can be no doubt that it would express them all at the same time. But this is
> precisely what is not possible, for though 'thought is a simple operation',
> 'it's expression is successive operation.'
> [Foucault 1970 82 (internal references omitted)]

The observation that language is linear and *dispositio* is network-like (or hierarchical

according to Ausubel) is an immediate clue that substantial transformation work is

performed, and thus the labor of constructing meaning is not *in* the *elocutio* but

performed by the learner-reader.

> Relatively simple [linear] grammatical structures give instructions for
> space [cognitive] construction in context. But this construction process is
> often underdetermined by the grammatical instruction . . . may yield
> [ambiguous meaning constructed by the learner-reader]
> [Fauconnier 1994 2 (annotation added)]

> [T]he writing and reading blending network . . . includes complex
> projections and social conventions that we take for granted. For example,
> to read a book in English, we must map speech in time onto linearly
> ordered locations from left to right horizontally on the page, and
> understand that at the end of the line, the speech jumps back to the
> beginning of the next line, and that turning the page (the commonest
> action we take with a book) has no counterpart in the speech space.
> [Fauconnier Turner 2002 210 (annotation added)]

> Although writing is necessarily presented as a succession of words, lines
> and pages designed to be scanned in linear fashion from beginning to end,
> readers are none the less free to discover that space as they wish.
> [Gilmont 1999 232]

This structural dichotomy between *elocutio* and *dispositio* differentiates engagement with

newer forms of media and their native forms of *elocutio*:

> Reading a book requires a degree of active attention and engagement.
> Indeed, reading itself is a progressive skill that depends on years of
> education and practice. By contrast, most electronic media such as
> television, recordings, and radio make fewer demands on their audiences,
> and indeed often require no more than passive participation. Even
> interactive electronic media, such as video games and the Internet, foster
> shorter attention spans and accelerated gratification.

> While oral culture has a rich immediacy that is not to be dismissed, and
> electronic media offer the considerable advantages of diversity and access,
> print culture affords irreplaceable *forms of focused attention and*

contemplation that make complex communications and insights possible.
  [NEA 46 (emphasis added)]

Textual *elocutio* expressed in natural language terms is, in some ways, not linear: a poem may be understood as text, as rhythm, and in some cases as rhyme or alliteration. Musical expressions are interpreted both according to their definitional meaning, their inflectional meaning, and their musical meanings. Musical expression comprises dimensions of sound (dynamics, texture, pitch, tone color), form, harmony, rhythm, and melody all occurring simultaneously [LaRue 1970]. Visual languages are not exclusively sequential. Nevertheless, natural language expressions in *pronuntiatio are* linear. Thus non-linearity begins to appear with *pronuntiatio* ➤ *elocutio* in objects derived from natural language systems. A passage of text is referred to as a *line* of text. Booth joins the chorus of those protesting that reading is not strictly a linear process:

> Thinking like a reader
> Readers do not read sentence-by-sentence, accumulating information as
> they go . . . They need a sense of structure . . . an idea of why they should
> read [a document] in the first place . . .
> [R]eaders read each sentence in light of how they see it contributing to the
> whole. [Booth Colomb Williams 1995 201]

Perhaps future investigation will uncover aspects of *elocutio* that are overlooked and raise questions as to whether attributes of sentences and paragraphs interfere with their purpose of communication. For example, under what conditions might written materials provoke improved meaning if presented as frames, maps, graphs, concept maps, or sound objects?

As acknowledged earlier, this notion of multi-dimensional structure does not comport with Ausubel's exposition of Assimilation Theory, which conceptualizes knowledge structure strictly as hierarchical -- a conceptualization not adopted in this essay.

Exercises

1. Attempt to solve the following using English, then evaluate your results

> Consider a large piece of paper the thickness of this page. . . In your
> imagination, fold it in half fifty times. How thick is the folded paper?
> [Adams 1974 63]

Then, attempt to solve the same problem thinking visually. Evaluate your results.

Then, attempt to solve the same problem using mathematical expressions. Evaluate.

Ans.

> If the learner selected mathematics as the language for thinking about the
> problem, s(he) might have determined that the end result is t x 2^{50} where t
> is the thickness of the paper. If the paper were ordinary typing paper, the
> arithmetic calculation would return an answer of approximately
> 50,000,000 miles or over half the distance from the earth to the sun. . . .
> The correct language [for solving] this problem was clearly mathematics.
> [Adams 1974 63]

Elocutio (semantic) ➞ *elocutio* (percept) and vice versa

The correlations between semantic and perceptible properties (Figure II.43) are the associations one learns in the study of vocabulary. These correlations associate the specification of a meaning with *the idea of* a physical rendering, not the physical rendering itself.

Familiarity with one form of *elocutio* does not always indicate mastery of the other. For example, once having recognized the *elocutio* (graphic) specification `elephant` (for example, from a newspaper (*pronuntiatio*)), one might be successful in evoking, consciously or subconsciously, the idea of an elephant. However, if the specification is not `elephant`, but `differential calculus`, some readers might have no difficulty spelling, pronouncing, or syllabifying it, but be unable to associate it with attributes of *elocutio* (semantic), e.g., specific definitions or interactions with other terms, and thus also have difficulty in evoking *dispositio*, or even general *inventio*.

Correlating *elocutio* (semantic) with *elocutio* (percept, e.g., graphic-phonic), that is, organizing, and presenting evidence of new words, their spellings, describing their intersubjective meanings and other attributes is the work of dictionary compilers and encyclopedists. English teachers and subject matter teachers (as in biology), piano teachers, symphony conductors, landscape designers, and choreographers attend to vocabulary of the language system, e.g., how the marks on the page of music specify a musical idea before rendered in sound, how the choreographer specifies the idea of a sequence of positions in Labanotation, how the concept of grade of a garden is specified on blueprints.

Elocutio ➤ *pronuntiatio* **and** *pronuntiatio* ➤ *elocutio*

How artists, writers, and speakers produce (derive) *pronuntiatio* from *elocutio* (percept) is a process of rendering tangible (including digital) objects according to specifications. Learning rendering techniques according to natural language specifications (printing, cursive) is generally learned during childhood, and is complemented throughout life by training in diction, typing, graphic arts and layout, and elements of style, whether plain writing or speaking, or more recondite specifications as found in the fine arts and performing arts.

In the reverse derivation, *pronuntiatio* ➤ *elocutio*(percept), a reader-listener is provoked, through their physical senses, to perceive and recognizes expressions from tangible objects according to graphic-phonic specifications. Perceptions are then mapped to corresponding *elocutio* (semantic) from which *dispositio* are evoked or constructed.

As described earlier, *pronuntiatio*-as-object are sensory-susceptible tangible objects. Tangible objects may undergo transformations prior to rendering in sensory susceptible form, e.g., digital-to-sound or digital-to-visible. These include not only solid objects, but tangible vibrations such as sound waves.

> Speech may seem immaterial, hardly like . . . an inscription on a tombstone. But in fact it is a material anchor. Consider the scene in which the woman is actually listening to the speech of her fiancé. . . . From one perspective, what is happening is that longitudinal waves in the air are striking her eardrums, and she is aware of this. But from that same perspective, a lab rat or a pigeon would be doing the same thing, and again, *she is clearly doing something they are not.* . . . She knows a complex mapping that connects particular equivalence classes of sounds to particular linguistic structures like words and clauses that are publicly shared and mentally represented. [Fauconnier Turner 2002 211-212]

Texts comprised of various character sets, such as written languages and music, of course, require the reader's familiarity with the character set. However, the importance of recognition of individual characters is generally superseded by recognition of sets of characters as single objects: terms, words, or idioms. Recognition is facilitated where spellings of words became conventionalized:

> Typography arrested linguistic drift . . . [Eisenstein 1979 117]

Further, recognition of a character pattern may be achieved even with omissions, errors, or imperfections in some of the characters in the pattern.

> . . . people's enormous capacity for recognizing many different patterns . . .
> The way that elements are arranged in space -- in groups, orders, or
> distances -- can be meaningful either iconically or metaphorically.
> [Tversky 1999]

Thus, readers can recognize words even though they contain misspellings and musicians can recognize clusters of notes, figurations, as if they were spelled words. Cryptographers solve simple cryptograms using, among other techniques, recognition of pattern, e.g., one translation of **ab**cd**ab** is 'george' and **ab**c**a**d**b** is usually 'people.'

The *elocutio* provoked need not, of course, be confined to so-called natural languages:

> . . . the raised eyebrow of the actor that may illustrate the whole situation
> in the state of Denmark . . . [Turbayne 1970 13]

The sensory perceptions of vision and hearing are the most prominent mode for *pronuntiatio* recognition. Tactile, olfactory, and even gustatory senses receive expressions from which meaning is derived, e.g., the handshake, the aroma of morning coffee, or the taste of an appropriately selected wine are all potentially meaningful.

Pronuntiatio ➜ *dispositio*

Do learners derive the same understanding from the digital form of document as from a paper version of the same document? Or, does *pronuntiatio* have a meaningful bearing upon *dispositio*?

A great deal has been written over the last twenty years about the so-called digital revolution, the future of the book, the information society and their impact on people. As well, much has been published about internet technology and human-computer interaction-interfaces (HCI). With these, one might ask, "Is there any meaningful cognitive influence of digital *pronuntiatio* on how learners learn?" Or, do digital documents, networks, and processors simply mean that more documents are available faster, and with fewer trips to brick-and mortar buildings? What principles of educational and cognitive psychology might aid understanding of these two modes of *pronuntiatio* use (paper and digital)? How do they differ in regard to construction of meaning?

Theory from neurophysiology and perception, both relevant to understanding *pronuntiatio* ➜ *dispositio*, are nevertheless beyond scope of this report. Here, one is concerned with a narrower interest: explication of Assimilation Theory though accessible complementary psychological, educational, rhetorical, and cognitive-linguistic literatures.

pronuntiatio ➤ ***dispositi*o in the Divisions of Rhetoric communications reference model**

The first step in amplifying Assimilation Theory with complementary ideas was to recognize *communication* as sharing for use. Indeed, the derivations encompassed in *pronuntiatio* ➤ *dispositio* <u>are</u> communication.

The Divisions of Rhetoric communications reference model compels recognition of the functions and properties of the processes and objects of each Division. As mentioned, one of those, *elocutio*, has a unique function: to reach into both realms, intellectual and physical, by associating *elocutio* (semantic) with *elocutio* (percept). Perception of physical objects, *pronuntiatio*, is insufficient for communication, and thus human *elocutio* systems have become sophisticated.

Having acknowledged the indispensability of *elocutio*, one might not expect to find here reference to *dispositio* ➤ *pronuntiatio*, that is, as if skipping derivation to and from *elocutio*. Indeed, such is not intended here, but merely to emphasize the endpoints of the communicative model, *pronuntiatio* and *dispositio*. However, one category of concepts does arise without *elocutio*: Lakoff has differentiated between *basic* concepts and *abstract* concepts (see: Basic *inventio* and abstract *inventio*, below). Basic concepts arise from sensory experience, such as engagement with a physical object that is, for example, heavy, hot, or out of reach. From these experiences, basic concepts arise, such as a weighty responsibility, a hot idea, or an idea that is beyond one's grasp. In this sense, *dispositio* ➤ *pronuntiatio*.

Moreover, systems of expression are not confined to (so-called) natural languages. For example, if a learner, say a fourth grader, hands his teacher a book report that is crumpled, tinged with peanut butter from his lunch, and written in poor handwriting, the

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teacher constructs meaning apart from the natural language expressions inscribed on the paper. Conversely, if the book report with precisely identical text, *sans* peanut butter, is presented neatly, on clean sheets, freshly off a laser printer, different meaning is likely constructed by the instructor. A glossy periodical recognized as "popular" might be deemed as lacking credibility to a student seeking scholarly materials for a thesis. This does not mean that *pronuntiatio* itself "carries meaning" but that the tangible material performs expressions (*elocutio*) of many kinds. Thus in looking to texts describing meaning imputed to "interfaces" apparently lacking linguistic expressions, one must look carefully at the meaning constructed and the *pronuntiatio* that provoked such meaning.

In this section, our focus is upon the reverse derivation of *dispositio* ➤ *pronuntiatio*, i.e., *pronuntiatio* ➤ *dispositio*,. Two such examples are considered:

> *Pronuntiatio* (paper) ➤ *dispositio*

and   *Pronuntiatio* (digital media) ➤ *dispositio*, that is, human-computer interaction
(HCI)

Both paper interface and HCI literatures may be partitioned according to their disciplinary perspective, and then the psychological, educational, rhetorical, and cognitive-linguistic aspects of such theory considered as a source for Assimilation Theory-oriented <u>Stage II</u> analytic criteria.

Principles that bear upon *pronuntiatio* ➤ *dispositio*

Ausubel acknowledges differing properties of human learners and digital systems:

> The acquisition and retention of large bodies of subject matter is really a
> very impressive phenomenon, considering first, that human beings, unlike
> computers, can apprehend, and immediately remember, only a few
> discrete items of information that are presented a single time,
> [ARK 15]

He views the learner's interaction with material objects as partitioned into two stages:

> Thus, the understanding of a sentence is a two-stage process involving
> perception and cognition successively. The first stage involves the
> perception of the potentially meaningful material, and the second stage
> involves relating perceived potential meanings to relevant existing
> propositions in cognitive structure. In the first stage the learner perceives
> what the message is, or what he has to learn; in the second stage he
> understands what he perceives, that is, he acquires its meaning. Thus,
> perception precedes cognition in the meaningful learning of new
> propositions. [ARK 82-83]

This correlates to Miller's notion (see: The derivation *elocutio* ➤ *dispositio* is

specification for evoking and selecting meaning, above) of recognizing an expression,

then matching it to some meaning available in his existing knowledge:

> . . . Now consider models from the reader's point of view. Initially, the
> reader has a very general model if he has any at all. The reader is given,
> not a model, but a text, a string of descriptive sentences. He must discover
> a model that is compatible with those sentences -- a model that includes
> the author's model [or not] . . . Then his task becomes just the reverse of
> the author's: a reader uses the true descriptive sentence to select a model.
> (Cushing, 1977) [Miller 1993 362]

This perception-selection process is not confined to so-called natural languages. When

an online user perceives a scroll bar, a print icon or other image, or a colored area of an

interactive map, they rapidly, subconsciously, attempt to construct meaning for the recognized object. For example, a glossy looking periodical may be regarded with less credibility than an academic-looking journal to a scholar seeking sources for research. A *pronuntiatio's* appearance can influence how potential readers impute credibility to the ideas it was intended to express [see Written materials manifest cognitive authority in Innovations that mitigate obstacles to meaningful reading).

Thus, for *pronuntiatio* ➔ *dispositio*, whether paper or digital, the question becomes, what principles pertain to presenting material provocations that result in evocation of relevant meaning to the learner? Theories of paper-based provocations are summarized, followed by digital HCI theory.

Recalling the above discussion of conduit metaphor, meaning is not *in pronuntiatio*, but constructed *from* it by a reader-listener, differently by each person depending upon their prior knowledge, context, and their criteria for associating meanings with expressions provoked by *pronuntiatio*. Thus, interface design of both modes is challenged with providing *elocutio* with which the *specific* learner is familiar and cues that provoke the learner to select particular meanings, and not others, from those evoked by expressions.

Learners can have different criteria for associating meanings to documents based on different forms of *pronuntiatio*. Both digital and paper forms are laden with different functionality. For example, paper can be easily read and inscribed upon nearly anywhere. Inscribing on a digital document, even with a laptop, is ergonomically somewhat more awkward. However, digital documents can hyperlink to, and fetch, other documents. Paper documents cannot. Thus, the cognitive models the learner-reader applies to each might differ, even if each is presenting the same text. These two modes of *pronuntiatio* are examined in greater detail momentarily.

Beyond *what* provocations are presented to the reader-learner, digital or paper, are the concerns of *how* they should be organized and what cognitive models the learner might employ to navigate "where he is" (in his existing knowledge structure) to "where he wants to go" (ideas he might wish to acquire). Ausubel relates organization of material objects to his principle of progressive differentiation, that is, detail should be presented only *after* superordinate ideas are expressed as conceptual scaffolding:

> Most textbooks are organized topically (logically) at a uniform level of conceptualization despite the commonly observed fact that, psychologically, the order in which different segments of knowledge in a given discipline are acquired is generally congruent with the principle of progressive differentiation (that is, hierarchically speaking, from the top downwards) as demonstrated by various advance organizer studies . . . . As a result, in the absence of available explanatory concepts and principles, much factual information and symbolic manipulation are learned rotely. [ARK 76]

This parallels a corollary to Assimilation Theory's prime directive, meaningful learning is best facilitated where known concepts are expressed in a form that can be used to connect to new ideas, and thus, be meaningful.

Following issues of what concepts to express and present, and how to organize those presentations to foster construction of new meaning, comes the question of which linguistic system expresses the concepts in a manner most likely to be grasped by the learner-reader. One category of linguistic systems is visual systems. An entire sub-discipline of visualization, the unveiling of the underlying structure of large or abstract data sets using visual representations, provides its own theory and literature. Some of these are drawn upon (see: Human-computer interaction (HCI) below).

Interaction with paper

The technical and historical development of the cognitive influence of paper-based innovations upon learners, as readers and writers, is sketched below (see also: Innovations that mitigate obstacles to meaningful reading, and Innovations that mitigate obstacles to writing). Important concepts related to paper-based texts include, for example, the transition from rolls to codex format, which facilitated reorganization of pages, which in turn, paved the way for the notion of fragmentation generally (see: Fragmentation facilitates arranging, below), whereby documents became conceived as *part* of a larger work.

The notion of *incremental text* made the writer's task easier because other knowledge could be incorporated by reference rather than by origination of lengthy and duplicative writings. Similarly, the reader's task was easier because written documents, being less lengthy, became more tractable, less intimidating, less expensive, and thus more likely to result in assimilation of the ideas expressed.

Pronuntiatio partitioning also gave rise to intra-document (or intra-object) organization, such as the delimitation of acts and scenes in plays, and separation of verses and chapters in the Bible.

Paper also provides the benefit that it facilitates annotation. That is, a reader can perform inscriptions that modify the record and thus enter into "conversations" with the writer or oneself (see also: *Pronuntiatio* innovations to facilitate *elocutio* (graphic) perception and subsequent recognition for discussion of a variety of other paper-based innovations related to the reader's recognition of organizational elements of a text).

With paper (and paper-like materials) came a substantial increase in *reading* that complemented, if not displaced, the spoken word and memory schemes as the primary *pronuntiatio* of communication. The difference in these two modes was profound because, unlike a spoken source, the paper (-like) source constituted a *record* that could be revisited by the learner-reader at will:

> . . . preservative powers of print . . . Typographical fixity is a basic prerequisite for the rapid advancement of learning.
> [Eisenstein 1979 113]

> [B]ecause of the complexity of the subject matter, visual reading was essential for its comprehension. While the professor read aloud from his autograph commentary, the students followed the text silently from their own books. This was a change from the *lectio divina* of late antiquity and the early Middle Ages, where one monk had read aloud to others, who listened without the aid of a written text. In 1259, the Dominican house of the University of Paris required that students, if possible, bring to class a copy of the text expounded upon in the public lectures.
> . . .
> In 1309, Pierre Dubois . . . observed that students who did not have a copy of the text before them could profit little from university lectures. Students too poor to purchase their own copies could borrow them from libraries . . . The statutes of the Sorbonne provided for lending books against security deposits. In the final years of the fifteenth century, the printing press provided the copies needed for classroom use.
> [Saenger 1999 133]

Of course, as readers interact with records, they may be distracted from the other modes of communication:

> At Paris in 1355, the university recognized that the artificially slow pace of lecturing in order to facilitate extensive class notes of copies interfered with the student's need to focus his attention on the text in order to comprehend the subtleties of the master's lecture.
> [Saenger 1999 135]

It was in the chained libraries of the late thirteenth century that the reader's need for silence was first made explicit. In the late antique library and early medieval monastery, where readers had read aloud, each reader's own voice had acted as a physiological screen blocking out the sounds of the adjacent readers. When readers began to read visually [silently] noise became a source of potential distraction. . . . At Oxford, the regulations of 1412 recognized the library as a place of quiet. The statutes of the library of the University of Angers of 1431 forbade conversation and even murmuring. [Saenger 1999 136 (annotation added)]

Although the practice of, and benefits and detriments of, personal silent reading arose with the first tangible medium that could also be personal, paper, the same benefits and detriments accrue to modern media (digital or non-digital):

About five years ago, I co-taught the [an] engineering course with another faculty member. That professor used transparencies extensively, about 15 per class. He also handed out copies of the transparencies before class so that the students could use them to take notes. . . .
. . .
After a few weeks, I noticed . . . attendance at my class sessions was down to . . . as low as 50% of the class. . . . I also noticed that my interaction with the class was down. I still posed questions to the class and used them to start discussions . . . .
. . .
After a few more weeks of this approach, two students approached me after class and said, in effect, 'Dr. Roberts, this class is boring. All we do is go over the transparencies, which you have already handed out. It's really *easy to just tune out*.' After my ego recovered, I asked whether they thought they would get more out of the class and be *more engaged* if I scrapped the transparencies and used the chalkboard instead. Both said 'yes.' For the rest of the semester, . . . no transparencies in or before class, attendance went back up to traditional levels, the class became more interactive . . . [Reis 2006 #689 (emphasis added)]

Availability of the record, in the form of paper, also freed readers from ideological shackles inherent in oral (and therefore, non-private) cultures:

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Reading with the eyes alone [that is, silently rather than aloud, but *inclusive* of the reader's intellectual resources] and written composition removed the individual's thoughts from the sanctions of the group, fostered the milieu in which the new university and lay heresies of the thirteenth and fourteenth centuries developed.
[Saenger 1999 137 (annotation added)]

In the second half of the fifteenth century, the privately read aristocratic manuscript book became the principal medium for disseminating ideas justifying resistance to royal authority, much as the Latin *tractati* of the fourteenth century had provided a medium for those advocating resistance to papal authority.
[Saenger 1999 146]

The benefits of the record form (paper) of *pronuntiatio* also placed new burdens on the learner, as does any new technology:

Basic changes in book format might well lead to changes in thought-patterns. To handle printed reference works, for example, readers had to master certain skills that are now considered rudimentary but were previously esoteric . . . 'the reader must learn the alphabet, to wit: the order of the letters as they stand.' . . . memorizing a fixed sequence of discrete letters represented by meaningless symbols and sounds had been the gateway to book learning for all children in the West.
[Eisenstein 1979 89]

Not surprisingly, as new personal skills had to be learned to engage the new media, traditional skills grounded in oral culture were lost:

As learning by reading took on new importance, the role played by mnemonic aids was diminished. Rhyme and cadence were no longer required to preserve certain formulas and recipes.
. . .
To the familiar romantic theme of the Gothic cathedrals as an 'encyclopedia in stone,' Frances Yates as added a fascinating sequel. Not only did printing eliminate many functions previously performed by stone figures over portals and stained glass in windows . . . also affected . . . objects in imaginary niches located in memory theatres.

. . .
Printing made it possible to dispense with the use of images for mnemonic
purposes and thus reinforced iconoclastic tendencies already present
among many Christians.
[Eisenstein 1979 66-67]

Even the imaginary figures in memory theatres described by Frances
Yates did not vanish when their mnemonic functions were outmoded, but
received a 'strange new lease on life.' They provided the content for
magnificent emblem books and for elaborate Baroque illustrations . . .
 [Eisenstein 1979 68]

Reading a written record reduces reliance on memory, and thus can lead to deterioration

of memory skills. Just as many are skeptical of displacing paper money and checks by

electronic banking and financial transactions, one can similarly imagine, in an oral

culture where memory was of pre-eminent importance, the fear engendered by reading

practices which neutralized function and benefit of memory:

Theuth presents his discovery [writing] to the pharaoh Thamus:

To him came Theuth, and revealed his arts, saying that they ought
to be passed on to the Egyptians in general . . .   When it came to
writing Theuth said, "Here, O king, is a branch of learning that will
make the people of Egypt wiser and improve their memories; my
discovery provides a recipe for memory and wisdom."

But the king answered and said, "O man full of arts, to one is it
given to create the things of art, and to another to judge what
measure of harm or profit they have for those that shall employ
them. And so it is that you, by reason of your tender regard for the
writing that is your offspring, have declared the very opposite of its
true effect. If men learn this, it will implant forgetfulness in their
souls: they will cease to exercise memory because they rely on that
which is written, calling things to remembrance no longer from
within themselves, but by means of external marks; what you have
discovered is a recipe not for memory, but for reminder. And it is
no true wisdom that you offer your disciples, but only its

semblance; for by telling them of many things without teaching
them you will make them seem to know much, while for the most
part they know nothing; and as men filled, not with wisdom, but
with the conceit of wisdom, they will be a burden to their fellows.

Thus learning is equivalent to remembering, and the mission of the
memory is to permit access to the world of ideas . . .
[Martin 1994 91]

Consideration of the cognitive effects of the transition to the new media of written inscription on paper from the traditional "recording media" of memory (oral culture) might shed light on corresponding changes in meaningful learning through reading and writing inherent in the transition from paper to digital media.

Human-computer interaction (HCI)

HCI textbook chapters may be categorized according to disciplinary sources:

> (1) Theory grounded in education, educational psychology, and cognitive
> psychology
>
> (2) Theory grounded in neurophysiological, perceptual, and medical knowledge
>
> (3) Theory grounded in computer science (including "visualization")
>
> (4) Empirical principles, applied engineering observations, lore, tips, techniques,
> and reports of experimental work
>
> (5) "Human Factors" literature (including "ergonomics")
>
> (6) Reports of behavioral research, user studies, and needs assessment

Recognition of these partitions is important because (3), (4), and (6) have gradually crept
into the domain of information studies and thus are among the writings examined in the
next Part, whereas (1), (2), and (5) are appropriate as *sources* of <u>Stage II</u> analytic criteria.
As intimated, (2), the technical literature of physiological and medical knowledge that
bears upon the interface between perceived objects and human understanding is beyond
the reach of this project. Thus, this chapter draws primarily on (1) education and
psychology literatures, (3) visualization (although only superficially) and (5) human
factors literature.

Proceeding as before, Ausubel is taken as the point of departure, then complementary
amplifying concepts are sought from education, educational psychology, and adjacent
literatures, setting aside category (4), evidence comprised of *how to* claims, techniques,

reports of applications and experimental work not grounded in psychology, linguistics, or cognitive theories, category (2) medical literature, and category (6) because behaviorist approaches are often dissonant with Assimilation Theory.

With this, exploration of the HCI literature may begin for <u>Stage II</u> analytic criteria.

Perhaps the most prominent textbook in HCI studies is Designing the User Interface, currently in its fourth edition [Shneiderman Plaisant 2005]. Shneiderman, of the University of Maryland, introduced himself in 1993 as a constructivist educator interested in meaningfulness in learning

> While I appreciated the wisdom of and was influenced by many great educators such as Dewey, Bruner, Piaget, and Papert . . . I have made my own synthesis . . .
> I have tried to describe this philosophy of education with the two-level phrase 'engagement and construction.' At the classroom level, students are engaged with each other in an active way to construct something *meaningful* and substantial. [Shneiderman 1993 (emphasis added)]

Despite these promising statements, the book offers little more than scattered references to theoretical claims grounded in psychology, education, or cognitive science. Those articulated are isolated and strangely inconspicuous in the remainder of the text, comprised mostly of descriptions of observations, lore, tips, techniques, and reports of experimental work.

We turn, instead, to an alternate text, Designing Interactive Systems by Benyon *et al*. [Benyon Turner Turner 2005]. In Benyon*,* one finds teachings consonant with Assimilation Theory, in particular, Novak:

> Psychology is the study of how people think, feel, and act.
> [Benyon Turner Turner 2005 21]

> Human beings do three things: they think, feel, and act. [Novak 1998 12]

Specifically, Benyon's instructional objectives align with Assimilation Theory's interest in the learner and their meaningful learning:

> Being human centered is about putting people first; . . .
> it is about what people want to do rather than what the technology can do.
> [Benyon Turner Turner 2005 14]

Benyon begins where Assimilation Theory expects, with cognitive psychology as foundational theory for human-computer interface (HCI) research:

> If we are to design and build usable interactive systems, we must understand something about the capabilities of people -- us -- and psychology is the discipline which has been primarily concerned with understanding people. Consequently psychology, specifically cognitive psychology, has been a very important part of the theoretical foundations of HCI.
> [Benyon Turner Turner 2005 99]

From this baseline, Benyon provides an accessible framework specific to HCI theory:

> As cognitive psychology is an enormously large subject area, we have selected four of the most relevant aspects for discussion. These main elements of cognitive psychology are:
> (a) memory; (b) attention; (c) visual perception; and (d) mental models.
> [Benyon Turner Turner 2005 97]

(a) *Memory*, as one of the five Divisions of Rhetoric, has already been acknowledged as an element of an extended Assimilation Theory. Benyon underscores the notion that constructing knowledge, as memory, is not a passive event but rather one requiring cognitive labor:

> Secondly, memory is not a passive repository; indeed it is quite the reverse: memory comprises a number of active processes. When we remember something we do not simply file it away to be retrieved whenever we wish. For example, we will see that memory is enhanced by deeper or richer processing of the material to be remembered.

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. . .
Fourthly, memory can also be seen as a *constructive* process. Bransford, Barclay and Franks (1971) were able to show that we construct and integrate information . . .
[Benyon Turner Turner 2005 353 (emphasis added)]

(b) *Attention* Benyon recognizes an important characteristic of attention:

Attention can be *directed at* [focused on one] *a* particular task and/or *divided* between a number of different tasks
[Benyon Turner Turner 2005 108 (annotation added)]

Benyon provides an exposition of conventional wisdom as to how attention works:

How attention works
Historically there have been three different kinds of models (that is accounts of how attention works) . . . which do not agree with each other
[1] single-channel [whereby] there is a mental switch or filter which selects material either to be ignored or to which we pay attention . . . not widely accepted today
[2] limited amount of processing power at our disposal . . . referred to as allocation models
[3] controlled and automated processing . . . controlled processing . . . involves consciously directing attention . . . automated processing . . . is not subject to conscious awareness
[Benyon Turner Turner 2005 108 (annotation added)]

Later in the book, Benyon describes the "most important" factors that affect attention:

stressors (stimuli which cause stress) . . .
mental workload
[Benyon Turner Turner 2005 375, 378]

Stress appears to be comparable to distressing ignorance [Buckland 1991a], constructive discontent [Adams 1974 77], and similar intellectual conditions that give rise to physical sensations and percepts that are triggered by the condition of inadequate *dispositio* (see: What is curiosity? See also What is paying attention?, below).

Measurement of mental workload is comprised of evaluation of several contributing

factors, mental demand, physical demand, temporal demand (time pressure), performance

(degree success achieved), effort (how "hard did you have to work mentally"), and

frustration level [Benyon Turner Turner 2005 379]. Although Ausubel does not use

precisely these terms, these factors are acknowledged throughout Assimilation Theory.

Benyon recognizes a principle overlooked by many:

people are *a part of* systems

This principle obtains in all intermediation, not only to human-computer interaction. Yet

Benyon acknowledges the need to emphasize it because automation of engagement with

texts has focused on technology, displacing concern for the cognitive capacities and

limitations of the human learner.

Benyon not only states the principle, but integrates it into his view of applied work, e.g.,

exploration of measurement of mental workload and cognitive work analysis (CWA) (see

also: Why is thinking difficult? Mental workload):

> Cognitive work analysis (CWA) has evolved from the work of Jens
> Rasmussen and his colleagues (Rasmussen, 1986, 1987; Vicente and
> Rasmussen, 1992) originally working at the Risø National Laboratory in
> Denmark. .. . .
> One principle underlying CWA is that when designing computer systems
> or any other 'cognitive artifact' we are developing a complete work
> system, which means that the *system includes people* and artificial
> artifacts. Seeing the whole as a work system enables designers to
> recognize that this system is more than the sum of its parts; it has
> emergent properties.
> [Benyon Turner Turner 2005 383 (emphasis added)]

Benyon's third element, visual perception (c), is one of the most evident aspects of

human-computer interfaces. However, the psychological and cognitive issues of visual

perception and processing are beyond both Ausubel's scope and beyond the reach of this report. Nevertheless, an in-depth treatment of psychological theory underlying visualization is critically relevant and thus must be among topics of future research.

Benyon describes (d) *mental models* in terms comparable to the definition of *dispositio*:

> A mental model is a cognitive representation of our understanding . . .
> may have a structure; it is larger and more complex than knowing a fact.
> [Benyon Turner Turner 2005 127]

This conceptualization, except for the term *representation*, coheres with the Assimilation Theory notion of mental models elsewhere in this Part (see: Species of *dispositio*: Idealized cognitive models). From Norman (1983), Benyon finds:

> 1. The user's mental model is developed through interaction with the system
>
> 2. The designer expects the user's model to be identical to the design model;
>
> 3. But the designer does not communicate directly with the user . . . the user will end up with the wrong mental model
> [Benyon Turner Turner 2005 127]

Norman further observes that mental models:

> Are incomplete;
> People's abilities to 'run' (or try out) their models are severely limited.
> Are unstable -- people forget details.
> Do not have firm boundaries: similar [models become] confused.
> Are unscientific, exhibiting 'superstitious' behavior
> Are parsimonious . . .
> [Benyon Turner Turner 2005 127]

The position has been taken early in this report that the study of concepts, while not susceptible to conventional scientific measurement, is nevertheless instrumentable and

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sufficiently real to learners and inquirers that scholarly study is justified. Each of the elements cited by Benyon may be seen as consonant with Assimilation Theory, including the 'superstition' element, which is meaning that people construct, although perhaps without the benefit of contemporary scientific knowledge.

Benyon surveys other theorists' principles of mental models and then undertakes an empirical investigation of them.

Benyon provides an "introduction to cognitive psychology" (chapter 5) in which the so-called "human information processing" paradigm is presented that likens human thinking to computational machinery:

> Most importantly, cognitive psychology has given us the information
> processing paradigm which draws very strong parallels between the
> functioning of the brain (or mind) and computers.
> [Benyon Turner Turner 2005 100]

Benyon immediately and forcefully disclaims it:

> Human information processing [HIP]. A *once*-popular means of
> characterizing human cognition which *drew* heavily on a simplified model
> of the major constituents of a computer. . . .
> . . .
> While the human information processing account of cognition proved to
> be popular both within psychology and in the early years of human -
> computer interaction, this popularity has diminished dramatically in recent
> years, for the following reasons:
> . . .
> It is too simple -- we are much more complex and cannot be represented
> meaningfully as a series of boxes, clouds and arrows. Human memory is
> not a passive receptacle; it is not analogous [to] an SQL database. It is
> active, goal-directed and multi-modal.
> . . .
> HIP arose from laboratory studies. The physical and social contexts of
> people are many and varied and conspicuous by their absence from these

diagrams.

. . .

These models are very clearly incomplete as they omit important aspects
of human psychology. . they also fail to notice that we have bodies.
[Benyon Turner Turner 2005 130 (annotation added)]

(see also: Role of memory in extended Assimilation Theory, above.)

Benyon presents alternative perspectives that have gained credibility over the last decade,

one of which is the embodiment theory of thought and language as propounded by Lakoff

and others (see: Basic *inventio* and abstract *inventio*, above).

Embodied interaction, which is the design of technology that recognizes
that we are embodied, i.e., we are not merely cognitive systems from our
senses, processing that input and creating motor actions as output. To be
embodied is to recognize that we have physical bodies which have
evolved and are adapted to a range of activities. Two perspectives on
embodied interaction . . . are ergonomics and collaborative virtual
environments

. . .

Murrell (1965) defined ergonomics as the scientific study of the
relationship between man and his environment. . . . Ergonomics is multi-
disciplinary, drawing on anatomy and physiology, various aspects of
psychology . . . physics, engineering [etc.]
[Benyon Turner Turner 2005 163-164]

Benyon *et al*. does not, unfortunately, lay out psychological principles from which

ergonomics derives, but pays homage to two themes that have gained traction in recent

years, situated action and distributed cognition.

Benyon *et al*. venture into another topic important in Ausubel's Assimilation Theory, the

notion of *forgetting*:

How and why do we forget
. . . key distinction, namely the difference between accessibility and
availability. Accessibility refers to whether or not we are able to retrieve

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information which has been stored in memory, while the availability of memory depends on whether or not it was stored in memory [i.e., whether the concept was ever *known*, i.e. stored, in the first place]
. . . perhaps the oldest theory is decay theory which argues that memory simply fades with time . . . Another account is displacement theory which [holds that] . . . working memory is limited in capacity . . .
[Benyon Turner Turner 2005 358-359 (annotation added)]

Benyon's book complements Assimilation Theory's approach to other topics, including cognitive load (see below), distinctions between recall and recognition, and Fauconnier and Turner's ideas of metaphor and blending, and is thus more useful as an HCI source of Stage Two criteria than Shneiderman.

Returning, for a moment, to taxonomy of mental models, Khella contributes a classification:

> Mental Models in HCI:
> Several theories exist relating different models of users, designers, and systems. They proposed four basic models of models that affect the way users interact with a system which are *User's model of the system* which is the model constructed at the users' side through their interaction with the target system, the *system's model of the user* which is the model constructed inside the system as it runs through different sources of information such as profiles, user settings, logs, and even errors. The third model is the *conceptual model* which is an accurate and consistent representation of the target system held by the designer or an expert user, and the last model is *the designer's model of the user's model* which is basically constructed before the system exists by looking at similar systems or prototypes or by cognitive models or task analysis.
> [Khella 2002]

from which one might derive an Assimilation Theory-consonant taxonomy:

> (1) the inquirer's mental model of the subject matter

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(1(a)) the inquirer's mental model of the intermediation system

(2) a system's model of the inquirer's mental model of the subject matter

(although this can only be a mental model if "the intermediation system" is human, e.g., a reference librarian)

(3) an external-to-the-learner conceptual reference structure (mental model) (and distinct from a linguistic expression of the mental model) sufficiently rich to perform as a source model to project isomorphically concepts and relations to inquirer's target mental model (this reference set model can only be within the inquirer

(see: II.1 Concepts missing (relative to a reference structure); Gaps).

(3(a)) an external representation of (3)

(4) a system *designer's* model of the user's model

Evidence that a learner has constructed meaning

In Part II.1, (see: Instruments associated with Assimilation Theory), the question, "What evidence is accepted in Assimilation theory that a learner has successfully constructed meaning?" was posed. In the context of a classroom setting, Ausubel's primary focus, various devices (concept maps, examinations, etc.) are used to instrument a determination (by teacher or learners themselves) as to whether the learner has constructed particular concepts.

The notion of evidence of new meaning can be unpacked further. *Comprehension*, i.e., the construction of *meaning* (relations) among *inventio* that form *dispositio*, the presumed goal of meaningful learning, may be regarded as an event with two elements:

> (1) a *cognitive* change occurs (a relation established, a gap filled, a path completed) (see: An explanation is a conceptual *path* that displaces a cognitive question, and Recognizing *dispositio* as explanatory),

and

> (2) a felt *sensation* that displaces the distress of inadequate *dispositio*, e.g., feelings that are associated with various expressions such as , "Aha, I get it." or "*Eureka*, I understand it." (see: The *Eureka!* event).

Taken together, these indicate the *moment of conception*.

Detection of each (cognitive change and felt sensation) can be accomplished through the instrumentation described in Part II.1, e.g., using concept mapping techniques.

Continuous derivations

Thus far, derivations have been considered primarily serially:

$$pronuntiatio \rightarrow elocutio \rightarrow inventio \rightarrow dispositio$$

and

$$inventio \rightarrow dispositio \rightarrow elocutio \rightarrow pronuntiatio$$

Indeed, these forms are particularly relevant to meaningful *reception* learning, which is concerned with a learner's receiving and assimilating concepts expressed by others. However, one should not be left with the impression that assimilation is wholly linear. *Ideas stimulate other ideas*. Compare the derivations

$$elocutio \rightarrow inventio \rightarrow dispositio$$

and

$$inventio \rightarrow dispositio$$

with the iterative structure of continuous derivations (Figure II.50).

Continuous derivation of meaning encompasses subsumption, progressive differentiation, superordinate learning, integrative reconciliation, and transfer with its underlying processes of selection of source *dispositio* and subsequent isomorphic mapping and isomorphic projection to target *dispositio*.

The ongoing construction of new relations, i.e., new meaning, occurs largely subconsciously and thus absent the deliberate control of the learner. Because these

Ideas stimulate other ideas (meanings)
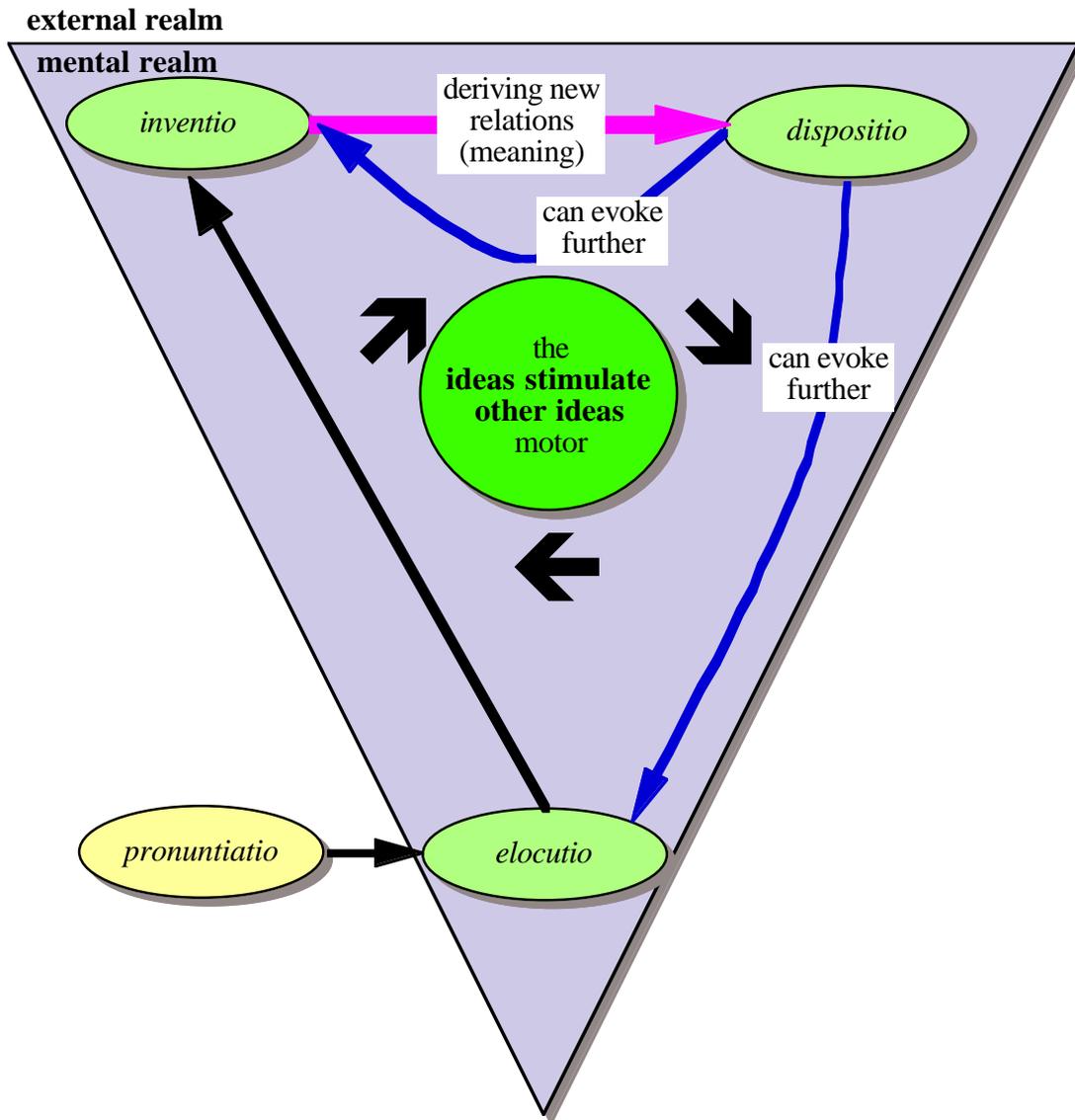
Origination from two sources:
Internal (existing ideas, blue)
External (*pronuntiatio,* black)
Creation of new meaning (red)

Figure II.50

derivations operate wholly within the intellectual realm, they often operate rapidly, below

the 100-millisecond threshold (see: Cognitive velocity).

Meanings (*dispositio*) in this continuous construction of new meanings originate from two sources: from external *pronuntiatio* (shown in black in Figure II.50) and from prior *dispositio* (ideas stimulate more ideas) (shown in blue). Continuous derivation of new meaning can operate *without* external *pronuntiatio*.

We consider further, two variants of the *internal* form of continuous derivation:

Establishing a relation between two *inventio* results in structure, *dispositio*. That new or modified *dispositio*, being comprised of other relations to other concepts (*inventio*) can evoke those *inventio*, hence the

$$inventio \rightarrow dispositio \rightarrow inventio \rightarrow dispositio \text{ etc.}$$

depicted by the red and blue arcs between *inventio* and *dispositio* in Figure II.50.

Similarly, *dispositio*, being comprised of other relations to other concepts that can be, in turn, associated with linguistic terms, such *dispositio* can evoke those *elocutio*:

$$dispositio \rightarrow elocutio \rightarrow inventio \rightarrow dispositio$$

depicted as blue arcs from *dispositio* to *elocutio* and *dispositio* to *inventio* (Figure II.50).

Thus, new meanings, relations among *inventio*, can be stimulated (1) directly by a *dispositio* (ideas beget other ideas), (2) by a term (*elocutio*), or (3) by perceptual stimuli from receipt of *pronuntiatio.*

Important to take into account is the readiness-to-learn principle whereby learners learn an idea best at the moment that idea is important to them (see: Readiness to learn, II.1).

The final result of continuous derivation, a sequence of *inventio* related to one another, and demarcated by an initial endpoint and a terminal endpoint may, where it projects

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continuously upon a cognitive question, be regarded as an *explanatory path* (see: An explanation is a conceptual *path* that displaces a cognitive question, below).

An example of continuous derivation

Let us attempt to observe a small number of iterations of continuous derivation and attempt to trace each *inventio* and each *relation* to the next *inventio* to the terminal point in the path. Here is a story taken from [von Oech 1982]:

> A few years ago, a city in the Netherlands had a refuse problem. A once-clean section of town had become an eyesore because people had stopped using the trash cans. There were cigarette butts, beer bottles, chocolate wrappers, newspapers, and other trash littering the streets.
>
> Obviously, the sanitation department was concerned, so they sought ways to clean up the city. One idea was to double the littering fine from 25 guilders to 50 guilders for each offense. They tried this, but it had little effect. Another approach was to increase the number of litter-agents who patrolled the area. This was more of the same, that is, another "punish the litterer" solution, and it, too, had little impact on the problem.
>
> Then, somebody asked the following question:
>
> What-if our trash cans paid people money when they put their trash in? We could put an electronic sensing device on each can as well as a coin-return mechanism. Whenever a person put trash in the can, it would pay him 10 guilders.
>
> This idea, to say the least, whacked everyone's thinking. The what-iffer had changed the situation from a "punish the litterer" problem to a "reward the law-abider" problem. The idea had one glaring fault, however; if the city implemented the idea, it would go bankrupt.
>
> Fortunately, the people who were listening to this idea didn't evaluate it based on its practical merits. Instead, they used it as a stepping stone and

asked themselves, "What other ways are there in which we can reward people for putting their trash in the trash cans?" This question led to the following solution. The sanitation department developed electronic trash cans which had a sensing unit on the top which would detect when a piece of refuse had been deposited. This would activate a tape-recorder that would play a recording of a joke. In other words, joke-telling trash cans! Different trash cans told different kinds of jokes . . . The jokes were changed every two weeks. As a result, people went out of their way to put their trash in the trash cans, and the town became clean once again.

There are some creative ideas that can only be reached through a stepping stone or two. [von Oech 1982 59-60]

Tracing an instance of continuous derivation

Analysis of the derivations may begin with an initial *inventio*,

We (a city in the Netherlands) have too much trash

A common relation of the "too much" *inventio* is the *solution is prevention of the litter* concept.

Too much ➡ [relation: reduction by prevention] ➡ Mitigated state

This was applied to *Too much trash*:

Too much trash ➡ [relation: reduction by prevention]

➡ Mitigated state: little or no trash

This did not work. So the *prevention* concept was amplified with a concept commonly evoked by city officials, *enforcement*:

Too much trash ➡ [relation: reduction by prevention ➡ *enforcement*]

➡ Mitigated state: little or no trash

This also did not work. Then someone challenged the *reduction by prevention* concept, offering an alternative:

Too much trash ➡ [relation: reduction by collection]

We do not know how he evoked the idea of replacing prevention with collection, but it is a common concept by city administrators to dealing with waste.

But obviously,

collection ➡ [relation: paid for by city budget] ➡ by city staff

would be too expensive at the rates proposed. A creative suggestion was to substitute *paying city employees* to collect litter with *paying citizens* to do it:

collection ➡ [relation: paid for by city budget ➡ via coin device to ➡ citizens]
➡ by citizens

Although original in this context, we may speculate that an isomorphic projection was performed from the commercial world source ICM of *motivating labor through monetary compensation* onto the target concept, *motivating citizens to perform labor*, with the result of the isomorphic projection being *motivating citizens to perform labor through monetary compensation*. The mechanical dispensing device is merely a clever projection of the *automatic teller machine* ICM onto the target concept of *monetary compensation*.

But that overall *dispositio* had the same inadequacy as paying city staff to pick up the litter, the *amount* was too expensive.

The terminal endpoint of the path comes with a simple algebraic substitution of *entertainment* in lieu of *money*, a much less expensive-per-item-of-litter cost burden to the city:

collection ➡ [relation: paid for by city budget ➡ compensation by entertainment
➡ citizens] ➡ by citizens

Thus, the final *dispositio* appears:

> Too much trash ➜ [relation: reduction by collection ➜
>
> [relation: paid for by city budget ➜
>
> compensation by entertainment ➜ citizens] ➜
>
> by citizens] ➜ Mitigated state: little or no trash

This "final *dispositio*" is *not* the trace of continuous derivation, but only an expression of the terminal endpoint concept. The trace of the entire continuous derivation, i.e., the explanatory path, is the whole of the narration in the box (beginning endpoint concept, intermediate relations and concepts, and terminal endpoint concept).

Finally, the new meanings from this iterative process, which seem to emerge as if out of nowhere, give rise to a felt sensation: A learner may suddenly experience a *Eureka*! feeling, for example, in the shower or during sleep, realizing that a problem has been solved or a connection made (also see What is incubation?).

Exercises

1. Recollect a recent thought. Then attempt to remember the subsequent thought. Attempt to identify the relation between the two such that the first idea begot the second.

2. Trace the explanatory path of your most recent conversation with another person. Write, or depict in a concept map, the initial and terminal ideas discussed, then intervening concepts.   Attempt to identify the relations between concepts, that is, the relation to the subsequent thought that caused the former idea to evoke the latter.

What are reading and writing?

With the preceding description of each of the Divisions of Rhetoric objects, and the processes through which they are derived, the 'big picture' of how these comprise conscious-level activities of assimilating (reading and listening) and expressing (speaking and writing), as well as thinking and interpreting, may now be approached:

Communication is comprised of

pronuntiatio ➜ *elocutio* ➜ *inventio* ➜ *dispositio*

(i.e., assimilating, as in reading and listening)

and

inventio ➜ *dispositio* ➜ *elocutio* ➜ *pronuntiatio*

(i.e., expressing, as in writing, speaking, and performing)
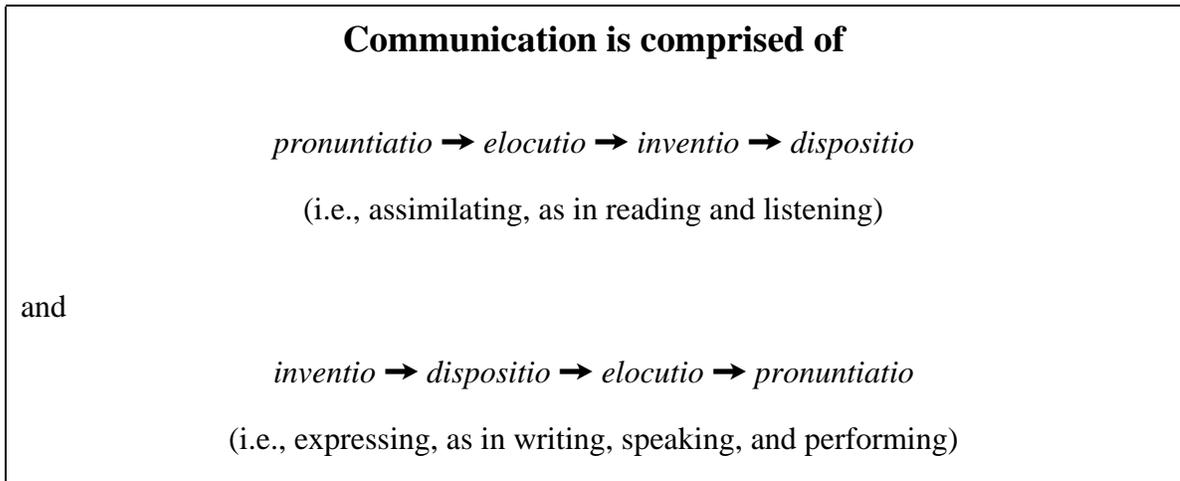
Figure II.51

Not notated in this Figure is the occurrence of *iteration*. Figure II.50 illustrates iterative derivations. In the remaining discussion and figures, iteration of processes is generally not described nor illustrated, but its possibility is assumed.

Figure II.52 illustrates how the Divisions of Rhetoric communications reference model applied to cognitive analysis facilitates a constructivist examination of the intellectual labor inherent in reading and writing (compare Figure II.37). Figure II.45 illustrates the layer separations: mental, linguistic, and physical. Figure II.49 depicts the specific types of derivations among Divisions of Rhetoric objects produced as the learner-reader reads and as the writer writes.

Assimilation Theory

is concerned with

Meaningful Learning

Main Principle

new . . . ideas are related . . . to what the learner already knows

Prerequisite

Ascertain this

procedure

Constructivism

epistemological foundation for

prescribes

Meaningful *Reception* Learning

and teach accordingly

instructional materials prepared

Constructivist Approach

text, speech, or other signals conveyed to learner
pronuntiatio

Learner **interprets** text:
pronuntiatio ➔ *elocutio* (inscribed)➔ *elocutio* (semantic)➔ *inventio* ➔

Learner's private knowledge

decision to express

Learner's shared knowledge

Figure II.52

Reading and writing are *personal*

In consonance with epistemological individualism, which underlies the constructivist basis of Assimilation Theory, reading and writing involve the learner's unique experience and thought, and thus are *personal* to the learner:

> How a reader assimilates a text is an eminently personal matter, involving choice and a restructuring of what is written. . . . Although writing is necessarily presented as a succession of words, lines and pages designed to be scanned in linear fashion from beginning to end, readers are none the less free to discover that space as they wish. Better, they are not passive when confronted with a text, and they need not necessarily accept its values and ideas. [Gilmont 1999 232]

What is a *text*?

What is a *text*? Are the printed characters (*pronuntiatio*) inscribed on a white paper page or a CRT screen *the text*? Is the ink itself, or screen pixels, the *text*?

Or, is the particular sequence of *elocutio* (terms), independent of physical presentation, *the text*? For example, is the particular set of terms (actor's words, narration, speaker designation, stage direction, act and scene delimiters and labeling, etc.) that comprise Romeo and Juliet *a text*, independent of whether printed on paper, acted aloud, or presented on a computer screen?

Or, is *the text* a reference to concepts evoked by a sequence of terms, i.e., *dispositio*, independent of the actual terms used? Is the Bible the same *text* written in German as in English? The terms are different, but the ideas expressed are intended to be the same.

Ah, but concepts are personal. One cannot be certain that a reader will evoke particular concepts from reading. So, if one cannot say "*a text* is a reference to concepts evoked by a sequence of terms" because different readers will evoke different meanings from the same inscription, can one say "*a text* is the concepts *intended* to be evoked by the author"?

Or, is *a text* a blend of all these?

Here one must recognize that the physical, conceptual, and purpose elements of a *text* are distinct. The term *text* is polysemous, referring at various times to any of these senses. Indeed, this ambiguity is at the heart of the need for the Divisions of Rhetoric communications reference model: One must be able to distinguish which sense(s) of *text* is (are) intended.

In this essay, *text* is considered a synonym for *document*, that is, *elocutio*, both having substantially similar properties, senses, and purposes. Thus, the Bible (a structure of concepts) rendered in German is a different text than the Bible expressed in English. Beethoven's Ninth Symphony (a structure of concepts) notated for full Nineteenth Century orchestra and choir is a different text than transcribed for piano.

Neither document nor text need be confined to alphanumeric characters of a so-called "natural language," but are understood to encompass images and graphical objects, sound objects, or tactile variants (e.g., [Tufte 1997 80]). Olfactory and even gustatory elements of texts are conceivable.

An important property that differentiates reading and writing from other forms of expression and assimilation is that they both involve the element of *recordation*, that is, *records* that provide for durability in tangible form over time. To achieve production of a

record, a *pronuntiatio* manifestation is indispensable. A *document* is a *recorded* text [Footnote II.7].

A text may exist in *elocutio* form only, absent *pronuntiatio* manifestation, that is, never inscribed, never articulated aloud, never recorded. In some respects, production of such a text is the subject matter portion of the overall task of writing. Mozart is renowned for having "written" his compositions *in toto*, prior to inscribing them on paper. Authors often organize their ideas prior to producing a first rendering, and continuously reorganize their ideas as they edit or re-inscribe.

What is the purpose of a text?

What does the text *do*? What does a book do? A document? A speech performance?

Ausubel holds that texts (should) organize presentation of ideas in a sequence in which the learner is ready to assimilate those ideas (see: Readiness to learn, II.1). The responsibility of the text, or its producer, is to assure that, for presentation of any particular concept, other concepts that are necessary for understanding the concept are presented prior to presenting that concept. Often, understanding one concept is necessary for understanding a second, and understanding the second is necessary for understanding the first. The human method mitigating this predicament is partial learning of each, that is, of their attributes, then to continue to learn attributes of each as they relate to the other.

Saussure presumes that writing is for no other purpose than *representing spoken expressions*:

> Language and writing are two distinct systems of signs; the second exists
>
> for the sole purpose of representing the first. (Ferdinand de Saussure)
>
> [Martin 1994 87]

One of the senses of *text*, above, alluded to an author's *intent* of their inscriptions.. As alluded to elsewhere, the matter of semantic *intention* of a text (*dispositio*), author's or reader's, remains problematic in philosophy.   An author may have expectations of the ideas readers might evoke from a given text, and the author's ideas might or might not be comparable to ideas any particular reader evokes.

Simon, theorizing about literary criticism, summarizes the issue of authorial intent, but does not provide philosophical exposition:

> A taxonomy of theories of literary criticism might derive from answers to the questions: How is meaning attributed to the text? Does criticism require us to ask what the author meant, what the text means, or what meaning derives from a reading of the text?
> . . .
> For, assuming that we have a theory of "meaning" -- of the meaning of "meaning" -- there is no reason why we should not explore what an author intended when in the process of writing down certain words, *and* explore what interpretations of that sequence of words are consistent with the syntax and semantics of the language (i.e., of the community that uses it), *and* ask what meanings various readers, with their various histories and experiences, are likely to extract from it. All of these seem to be wholly legitimate, if perhaps difficult, questions.
> [Simon 1994]

The reader interested in foundations of authorial intentionality will not find them described here, but might look, instead, to literary theory and, perhaps, philosophical texts.

What is reading?

The sequence of derivations:

$$pronuntiatio \rightarrow elocutio \rightarrow inventio \rightarrow dispositio$$

may be described as **assimilating**, i.e., constructing or deriving meaning from a tangible object, (*pronuntiatio*), whether visual text or image, audible image, or other form. Common forms of assimilation paths are *reading* and *listening* (Figure II.53(a))

Provocation by written *pronuntiatio*, through perception of external visual manifestation of natural language expressions (*elocutio* graphic), of internal evocation of meaning, is *reading*. The term *reading* polysemously evokes ideas of different types of activity. In some contexts, *reading* refers to the phenomenon of a learner constructing meaning from iteratively recognizing graphic *elocutio* and interpreting a text, that is, silent reading. Separately, the term *reading* is often used to describe the activity of recognizing graphic *elocutio* and then producing audible sounds, i.e., reading aloud. Indeed silent reading and reading aloud may be modeled differently:

silent reading: *pronuntiatio* $\rightarrow$ *elocutio* $\rightarrow$ *inventio* $\rightarrow$ *dispositio*

reading aloud:

$$pronuntiatio \rightarrow elocutio \rightarrow pronuntiatio$$

or   *pronuntiatio* $\rightarrow$ *elocutio* $\rightarrow$ *inventio* $\rightarrow$ *dispositio* $\rightarrow$ *pronuntiatio*

The difference in the two sequences for reading aloud is that in the first, the reader is not comprehending the phrases he is performing, not paying attention, whereas in the second, she is constructing meaning as well as performing aloud.

Five Divisions of Rhetoric

provides tools
to analyze
Assimilation

What is
Assimilating?

derivation processes

pronuntiatio ➜ *elocutio* ➜ *inventio* ➜ *dispositio*

attributes

What are types of
Assimilating?

type

type

requires
cognitive
component

Listening

Reading
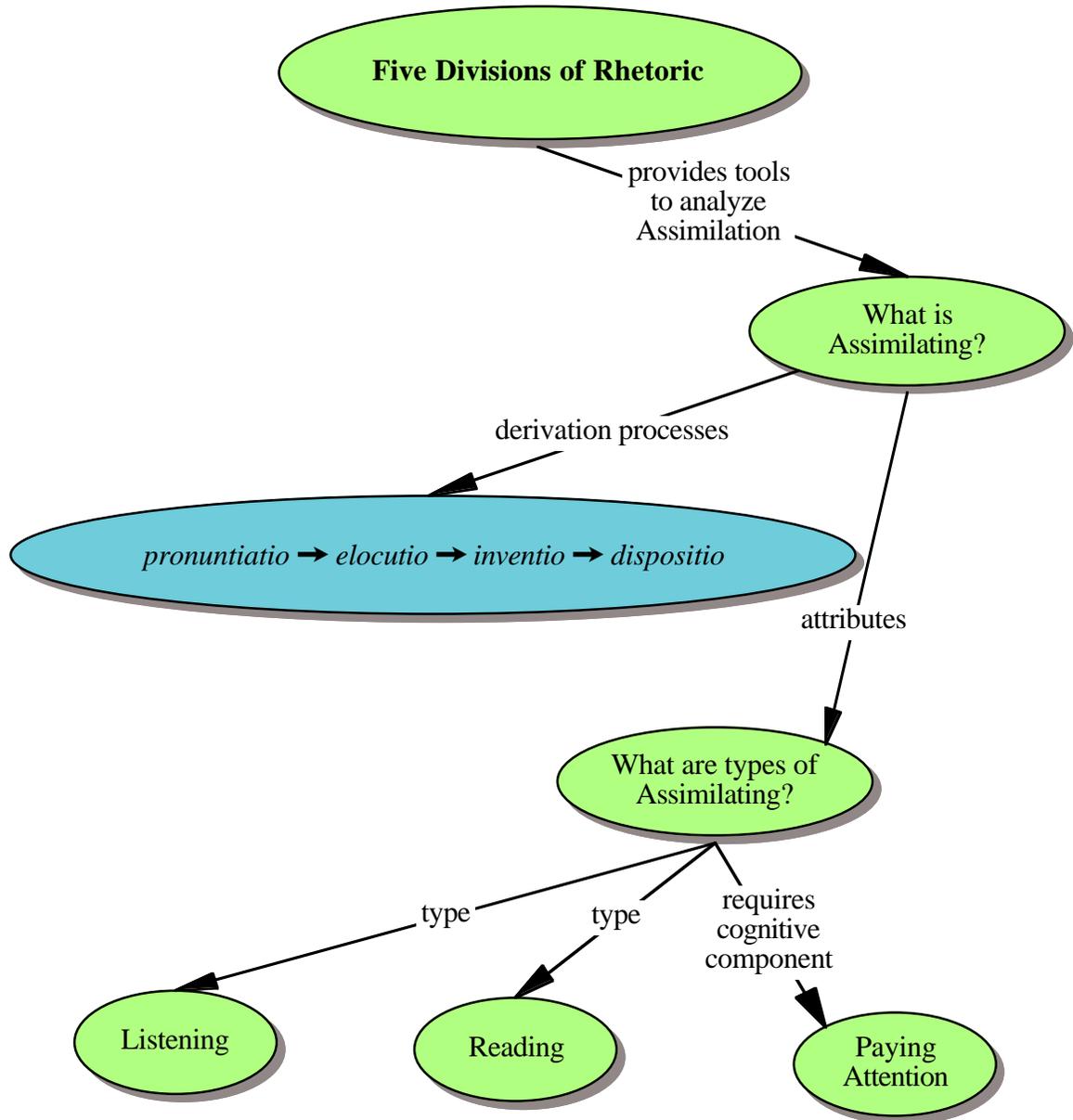
Paying
Attention

Figure II.53(a)

In reading aloud, the reader might or might not also be constructing meaning, depending

on whether he is attending (paying attention) to the task of constructing meaning, or

merely reciting. (Other types of reading are beyond scope here, e.g., the murmured

reading of the monastics in the early Middle Ages [Cavallo Chartier 1999 18].) Many of

the texts on reading theory and the history of reading curiously intermix these two

primary senses of reading, meaningful reading and producing audible performances. Concern here is confined to reading that leads to the learner's construction of meaning, the presumed *raison d'être* for silent reading.

 There is more to conjuring sentence meaning than mere concatenation of term or word senses. Consider the following events, common in everyday life: a learner engages a tangible documentary object (*pronuntiatio*), say, a newspaper or web page. She recognizes terms and images, *elocuti*o (percept, e.g., graphic and phonic) and associates them with previously negotiated intersubjective meaning (as through vocabulary training, dictionary use, or conversation) to evoke general concepts (*inventio*). More complex meanings are then derived (*dispositio*) by recognizing and establishing relations between elements of the new ideas and elements of the learner's prior knowledge.   That is, the reader must apply syntactic, grammatical, and semantic systems to the individual terms and expressions perceived from a document to construct meaning from whole texts.

Miller describes understanding through reading in this way (Figure II.53(b)):

> . . . [L]et us say that you understand a sentence if you know the conditions under which a person would use it. [Miller 1993 364]

> I felt I was doing something constructive when I read. . . . One way to characterize the change that occurs in reading, therefore, is to say that you construct an image as part of the process of understanding the passage. If, after putting down the book, you were asked to repeat what you have read, you would probably not be able to repeat it verbatim [*elocutio*]. Nevertheless, you could reactivate your memory image [*dispositio*] and describe it . . . [Miller 1993 358 (annotation added)]

If the reader-learner has derived multiple possible meanings for a sentence or paragraph, her next task is to select those that she will consider valid, to be believed, or intended by the author, or selected for some other reason:

. . . Now consider models from the reader's point of view. Initially, the
reader has a very general model if he has any at all. The reader is given,
not a model, but a text, a string of descriptive sentences. He must discover
a model that is compatible with those sentences -- a model that includes
the author's model [or not] .. . .   Then his task becomes just the reverse of
the author's: a reader uses the true descriptive sentence to select a model
(Cushing, 1977) [Miller 1993 362 (annotation added)]
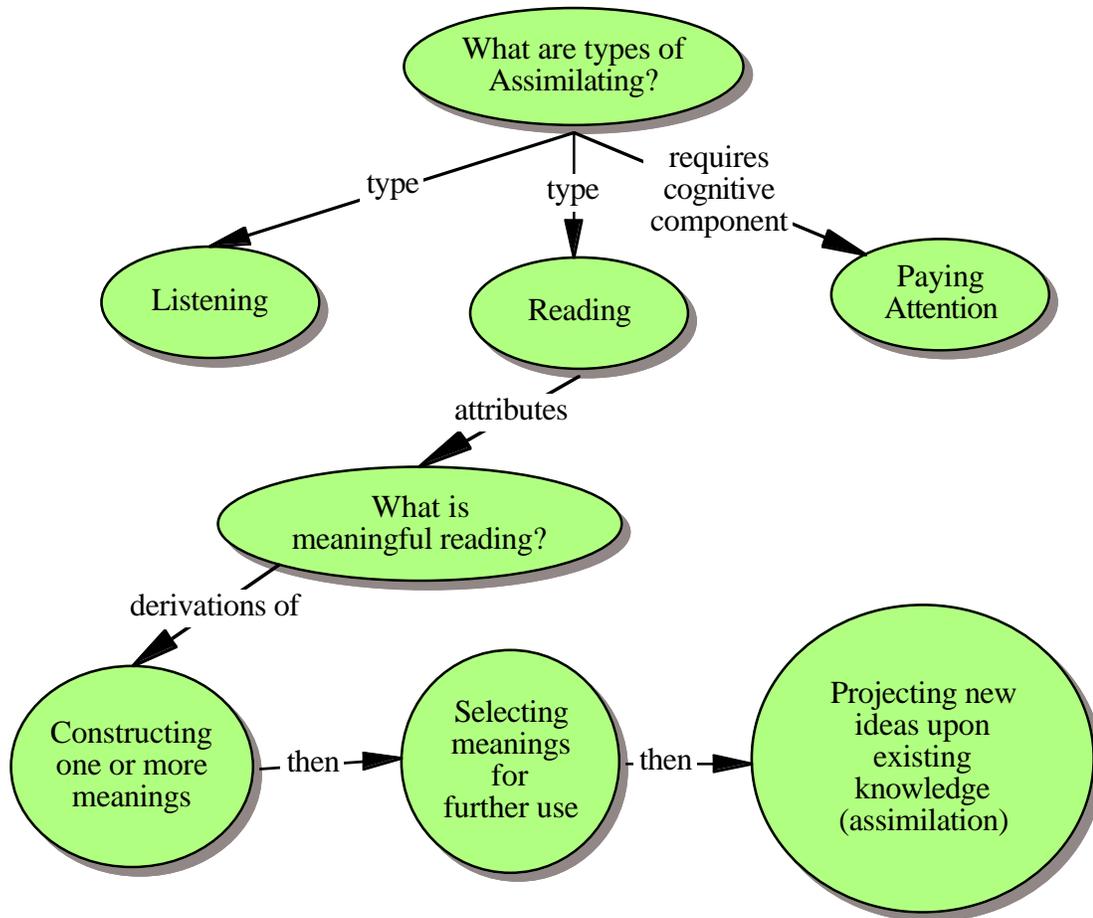
Figure II.53(b)

Thus, reading may be hypothesized as a continuous isomorphic mapping and projection

between the new ideas derived from the text and the reader's ICMs which organize the

newly encountered concepts, that is, sense-making.

Miller's perspective is consonant with the main tenet of Ausubel's Assimilation Theory:

The need to understand how people *relate new ideas to old* is particularly acute in the psychology of reading. . . . What happens as we read a descriptive prose passage? [Miller 1993 358 (emphasis added)]

Why is reading difficult?

Meaningful reading is:

pronuntiatio ➜ *elocutio* ➜ *inventio* ➜ *dispositio*

Why might performing this derivation be difficult?

Figure II.54(a)

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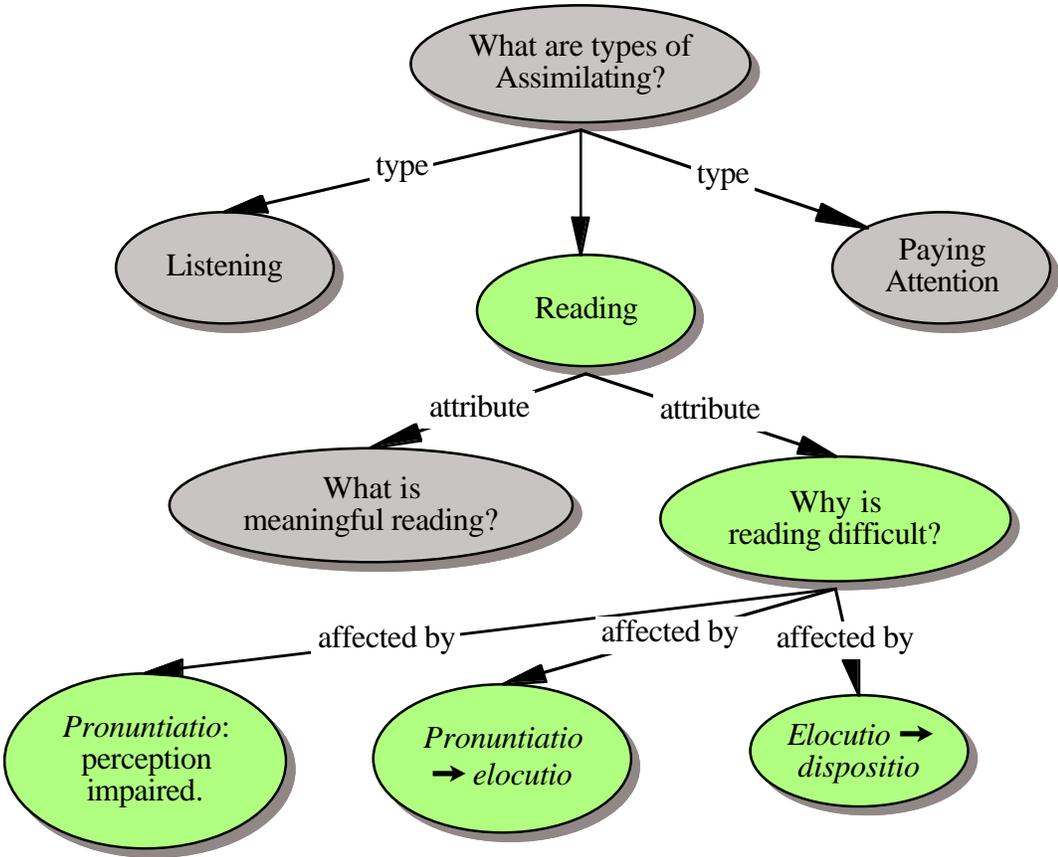
Sources of reading failure may be found at any point in the sequence of derivations of objects of the Divisions. Nevertheless, performing the itemization is an important step toward better recognition of factors that underlie failure modes. Here, the task is only begun. Thorough collection and classification of failure modes is left as future work.

Pronuntiatio: perception impaired. First, if the reader's perceptual (physical sensory) resources are impaired, especially vision, he may be unable to perform derivation of *pronuntiatio* ➡ *elocutio* according to norms, or at all.
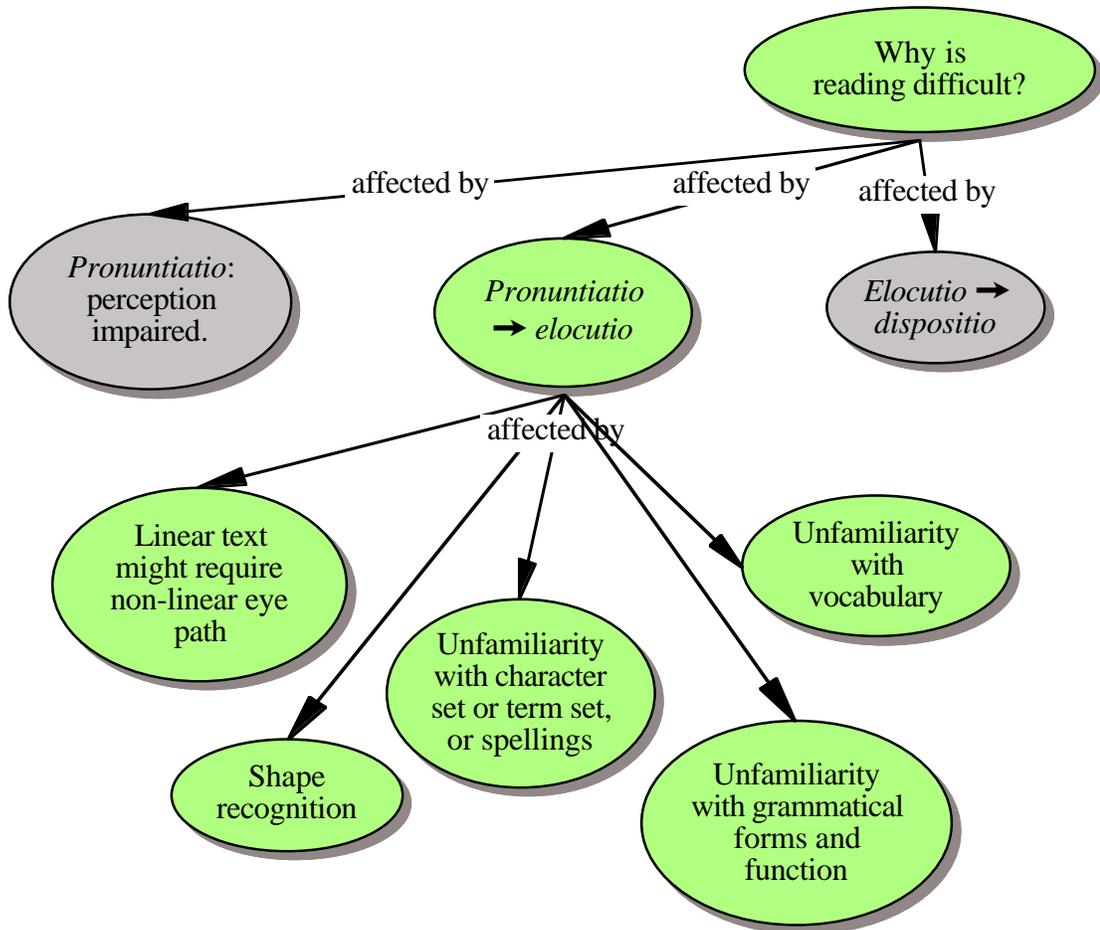
Figure II.54(b)

Pronuntiatio ➤ *elocutio* derivation is the process of provoking the reader to recognize sets of terms of a (so-called) "natural language" such as any dialect of English, French, or Chinese, or other systems of expressions such as mathematical language, Labanotation (for dance), architectural drafting. Reading is obstructed if he cannot.

Linear text might require non-linear eye path. Character-based texts, though linear, might nevertheless demand that the reader's eye follow a non-linear path.

> [W]riting and reading . . . includes complex projections and social
> conventions that we take for granted. For example, to read a book in
> English, we must map speech in time onto linearly ordered locations from
> left to right horizontally on the page, and understand that at the end of the
> line, the speech jumps back to the beginning of the next line, and that
> turning the page (the commonest action we take with a book) has no
> counterpart in the speech space.
> [Fauconnier Turner 2002 210]

In reading question sentences (especially aloud), one must notice both the interrogative at the beginning of the sentence *and* the "?" at the *end*. Recognition of the question mark at the end of the sentence prior to performing the sentence orally is necessary to achieve the interrogatory inflection correctly.

Inflection (which is not generally reflected in the text *per se)* is nevertheless meaningful. Perhaps a good reader performs a "quick read" before a more detailed reading. If so, how does that enable the reader to recognize context and those terms deserving emphasis? What implications does it have for conjuring meaning, i.e., understanding *elocutio* ➤ *dispositio*?

Shape recognition. Fauconnier recognizes shape recognition of character sets as a hurdle that most readers overcome with practice:

> A proficient reader ends up with a general competence for constructing
> integration networks [*dispositio*] for writing and reading. The writing and
> reading blend[s are] of immense cultural importance to us. [They] cannot
> exist without the material anchors of distinctive marks on material
> substances. But . . . these material anchors depends on a very powerful
> prior conceptual blend that compresses a certain infinity of marks [for
> example:] (boy, **boy**, *boy*, boy, Boy BOY, **boy**, . . .) into a single entity,
> the written word "boy" . . . [Fauconnier Turner 2002 210]

Unfamiliarity with character set or term set, or spellings. More frequently, a reader's

physical perception may be performing normally, but they may fail to recognize *elocutio*

as a meaningful term on account of unfamiliarity with either the linguistic system's

character set or its set of graphical character clusters that represent terms. As well, they

may fail to recognize spellings of terms.

Elocutio ➜ *dispositio*: Processes and sub-processes of meaningful reception learning.

Unfamiliarity with grammatical forms and function. Meaningful reading requires the

reader to be able to recognize forms of terms that cue grammatical function, such as the

effect upon meaning of declensions of adjectives or nouns or customs of word order.

Unfamiliarity with vocabulary. The reader's capacity for performing

elocutio (percept) ➜ *elocutio* (semantic) derivations is often characterized as

vocabulary, that is, one's ability to associate meanings with graphical expressions.

Inadequate vocabulary may contribute to the reader's overall difficulty. For example, in

mathematical language, if the reader does not associate the Σ with the concept of

summation or $\varnothing$ with nullness, they will have difficulty constructing an understanding of

passages using those technical symbols.

Changes in vocabulary interpretation over time. Additional labor may be required to read

older texts because the older terms must be mapped into the contemporary text.

<u>Unfamiliarity with other term attributes.</u> The reader's capacity for performing

 elocutio (percept) ➤ *elocutio* (semantic) derivations is potentially obstructed if they

cannot pronounce terms in the language, are unfamiliar with syllabification, or etymology

(especially for Latin-based terms).

Beyond the pitfalls readers encounter with *pronuntiatio*, *elocutio*, and their inter-

Divisional derivations, is a class of cognitive tasks of the kind more frequently addressed

in Assimilation Theory. These include the processes of relating new ideas to prior

knowledge, and include sub-processes such as surveying one's existing knowledge to find

inventio that are candidates for relating to new *inventio*.
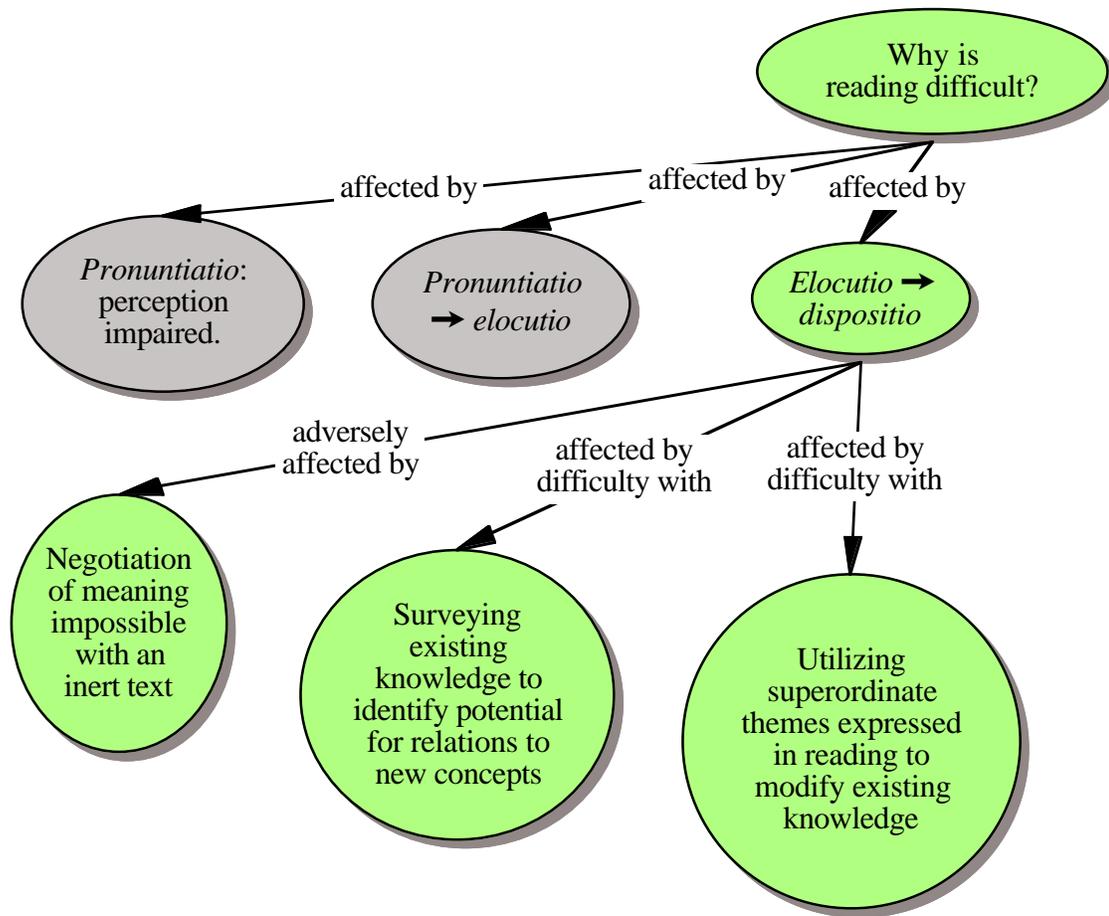
Figure II.54(c)

Recall Ausubel's list of the tasks in meaningful reception learning see (Figure II.54(c)):

> New meanings, in other words, are the product of an active, integrative
> interaction between [1] new instructional materials and [2] relevant ideas
> in the learner's existing structure of knowledge. The conditions of learning
> presuppose additionally the existence of a [3] meaningful learning set in
> the learner and of potentially meaningful learning materials.
> [ARK 40 (numerals inserted)].

Negotiation of meaning impossible with an inert text. Readers, and listeners of *recorded pronuntiatio*, have the disadvantage of having no opportunity for active negotiation of meaning with the inert (recorded) text nor the writer who authored it.   The reader can, at best, recognize alternative senses and select from among them according to criteria they consciously select. Explicative editing and annotation of a document, in some sense, parallels the notion of "having a conversation" with the document.

Surveying existing knowledge to identify potential for relations to new concepts. In terms of meaningful reading, successful sense-making requires not only (1) constructing-selecting *inventio* as a surface meaning of a text, but also (3) deriving new *dispositio* (relating) that surface meaning according to ones existing *dispositio*. This "integrative interaction" requires the reader's capacity to survey their own *dispositio* to ascertain where opportunities lie to relate the surface meanings to one's existing *dispositio*. *Dispositio* objects are complex, having many concepts and relations among them. Booth *et al.* differentiate some of the tasks a reader performs to prepare to relate new ideas to their existing knowledge:

> Step 1: Become familiar with the geography of the source
> Step 2: Locate the point of the argument
> Step 3: Identify key sub-points
> Step 4: Identify themes
> [Booth Colomb Williams 1995 82-83]

Meaningful *reception* learning and reading: Utilizing superordinate themes expressed in
reading to modify existing knowledge. The successful reader recognizes ideas on the
basis of their similarities or relationships to other ideas, their categories. and the role they
play in understanding the remainder of the written work:

> Identify . . . central thematic concepts, then track them though the
> paper. [Booth Colomb Williams 1995 202]

That is, the reader consciously or subconsciously asks, what are the important ideas
expressed by or assumed in this document? What superordinate ideas have an organizing
effect on the detail presented in the text? How do important thematic concepts flow or
relate to one another? From these, can the outline of the conceptual structure of the text
be ascertained? Recognition of thematic threads, expressed or implied, is occasionally
inadequate, being characterized as "having gotten nothing out of that paper" or as "not
seeing the point of the book."   For example, if a student reads a paper about monetary
policy, evocation of his underlying model of how banks work, e.g., from a customer
perspective, will likely help him organize or construct new ideas from the text about
banking, reserve requirements, lending and how these bear upon the money supply.

The successful reader must recognize frequently-used structures, ICMs, and other
patterns, e.g., plots, elements of persuasive writing (claim, evidence, warrant) (see: What
is critical thinking?). Recognition of such elements, especially their absence, is an
essential reading skill.

Many cognitive models are at work in the interpretation of a text. Simone acknowledges
three underlying models that pertain to most reading: supposed pre-eminence of the
author, that the text is perfected for its function of expressing the author's ideas, and that
the text is the product of original work by the author.

. . . important propositions which we tacitly assume every time we pick up a book, being as we are, well-educated and equipped with metalinguistic capacities. Let me give a short list.

(a) The first is the presupposition of the *pre-eminence of the author*. . . . First, as the author generates the text, he or she is responsible for it. This means the author is owner of that text and is therefore obliged to distinguish the original parts (= resulting entirely from his or her own invention) from those which are not original (= resulting from the invention of others). Furthermore, only the author is recognized as having the right . . . to decide when it is *perfectum*. At the precise moment when the text is *perfectum*, and then only, is it closed to others and can the reader gain access in [read-only] modality.

(b) The second presupposition supposes that the text is handed over to the reader by the author in a state of *perfection*, or rather, completeness . . . in the *final* version intended by the author . . .

(c) *originality* of the text . . . author's . . . own ideas . . . to scrupulously distinguish them from those of others

[Simone 1996 240-241, 247]

Other reader skills which, if inadequate, become obstructions to reading (and thinking) are considered elsewhere in this report:

Attention (see: What is paying attention)

Motivation: enthusiasm for questioning-curiosity, formulating a question or inability to recognize the lacuna *consciously* (see: What is inquiry?)

Ability to anticipate meaning (expecting which ideas might be expressed based on prior knowledge as a prerequisite to recognizing expressions of ideas (see: Anticipating idealized cognitive models (ICMs), but also see II.1, Preconceptions, for the detrimental side of *anticipating*)

Ability to *recognize* concepts or models that underlie a text (see: Recognizing basic schema, *dispositio*, or idealized cognitive models (ICMs))

Projecting prior concepts onto new ideas, projecting new ideas onto prior knowledge, or both (see: Isomorphic mapping and isomorphic projection)

Selecting meanings from the possible meanings evoked (see: *Elocutio* ➜ *dispositio* is specification for evoking and selecting meaning)

Constructing or assimilating the new interpreted expressions into one's existing knowledge (see: isomorphic projection, below).

Readers perform all these tasks. Individually, each can be difficult. All together, they can be daunting to the reader. When reading is taken for granted, one might forget that many readers encounter varieties of difficulties in their engaging texts, of which these are only a few. These difficulty modes hardly scratch the surface of the cognitive tasks that confront the reader.

These steps consume cognitive energy and time. The cognitive labor required in meaningful reading is, thus, substantial: cognitive task requirements add to the difficulty of reading.

Why is proofreading difficult?

In the immediately preceding section, many of the factors that contribute to possible explanations as to *why reading can be difficult* have been surveyed. In sum, reading a new text require several types of derivations: *pronuntiatio* ➜ *elocutio*,

elocutio ➤ *inventio*, and *inventio* ➤ *dispositio*. Each of these derivations requires cognitive labor. Humans desire to minimize expenditure of energy, and thus the work of reading is regarded as difficult.

The notion might thus seem to follow that, if a significant portion of this labor, for example, *elocutio* ➤ *inventio*, became unnecessary and did not need to be performed as part of a reading, then the work would be easier and less uncomfortable.

In particular, the task of proofreading a familiar text should, by these lights, be easy because meaning has already been constructed by the reader. What writer has not suffered from acute allergy to proofreading their own text? Few would contend that it is not as difficult or even more difficult than reading an unfamiliar text. Why? In fact, proofreading is difficult for the opposite reason: meaning has already been constructed, *elocutio* ➤ *inventio* and it is difficult to control the isomorphic projection mechanism.

Reading is a form of thinking. It encompasses construction of meaning. As described in greater detail below, one of the most fundamental cognitive mechanisms in human cognition is *isomorphic projection*. Isomorphic projection underlies metaphor, transfer, analogy, and a surprising number of seemingly different or separate phenomena. In essence, isomorphic projection is the sub-cognitive capacity for *filling in* ideas already known and memory-resident, in situations where there is no perceptual provocation to do so. For example, if one is told only that Johnny's teacher has assigned him to solve some arithmetic problems, the recipient of that news need not be told that Johnny's teacher attended university, participated in internships as a student teacher, is inadequately paid, and tends to have summers off. All these concepts are filled in to the immediate concept of *Johnny's teacher* through isomorphic projection from one's prior knowledge onto the specific concept of Johnny's teacher.

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This basic subcognitive process is at work in proofreading as it is in ordinary reading, only more to the reader's detriment than benefit. A proofreader must attend to every grapheme, word and phrase, and idea expressed in the text to be proofread. However, the human capacity for isomorphic projection interferes by conjuring meaning of the text from minimal perceptual cues. With meaning constructed, the proofreader desires to proceed, but without having performed all of the derivations as in reading new material. Consequently, a deliberate effort must be made *not* to proceed based on a sampling of perceptions, but to perform every derivation. This is extremely difficult for many writers when reading their own recently-edited texts. But it is only partially susceptible to control, for the underlying capacity for isomorphic projection is innate and autonomic.

Innovations that mitigate obstacles to meaningful reading

Having surveyed some of the often overlooked cognitive obstacles that confront readers, one is now in position to appreciate several of the conceptual and technological innovations developed over the course of western civilization intended to enable readers to overcome these interruptions to their inquiries. The cognitive dimensions of these innovations are often as invisible as the obstacles they mitigate.

As an example, the function of references found in a back-of-the-book bibliography is generally considered to be twofold, "for the record" and as a pointer to find the source of a particular passage. However, sophisticated readers often survey a book or paper's bibliography to ascertain the invisible colleges, epistemological positions, and thematic foundations upon which the author draws. A brief traversal of the back-of-the-book index sometimes serves this purpose as well. These uses are not trivial, but instead go to the heart of the cognitive work that readers do to interpret a text. For example, if a reader is considering investing effort to read a cognitive science book for a better understanding of learning, but the index does not include entries such as `psychology`, `learning`, or `concepts`, but instead comprises terms related to experiments with rats, the would-be reader might ascertain that the book's approach is not be well-suited to his needs.

Periodical guides, bibliographic citations, and references provide an alternative to sequential processing of fragmented non-collocated texts and conserve cognitive labor by enabling a reader-learner to vector directly to texts expressing ideas that are potentially relevant to an inquiry.

Influence of tangible media, *pronuntiatio* on cognitive labor in reading

Rolls, like modern disk drives, were written to at the next available space. In contrast, the codex could be produced fragmentally, sorted, and organized according to a writer or compiler's conceptual plan.

> Successive generations could build on the work left by sixteenth-century
> polymaths instead of trying to retrieve scattered fragments.
> [Eisenstein 1979 113]

This re-structured the reader's assimilation processing such that books to be read could be identified with particular themes rather than as storage devices that contained whatever was written until writing space was exhausted.

> In any event, the roll did not always coincide with an entire work (in fact,
> it rarely did so). . . . The codex, by contrast, brought together in one
> container, a single volume, a series of organic textual units (one or more
> works by the same author . . .
> [Cavallo 1999 86]

The codex gradually displaced the unbound manuscript and roll beginning in the first century AD, and became predominant by the end of the fifth century:

> The codex, with its pages that facilitated breaking up the text into sections,
> made it easier to reread or compare passages . . .
> [Cavallo Chartier 1999 17]

> [T]he codex was a Roman invention. Beginning in the second century AD
> the book in the form of a roll, which Hellenistic works had introduced to
> Rome centuries before, began to lose ground and eventually lose out
> completely to the codex. When? . . . the moment of the definitive
> affirmation of the codex to have been the early fifth century. In the
> Roman West it may have predominated earlier . . . Martial (late first
> century) tells us that the codex of literary content . . . was produced in
> bookshops . . . the codex won a permanent place among the book practices
> of the Roman West no later than the end of the third century, thus at a

decidedly earlier date than the early fifth century, as was the case in the Greek world.

[Cavallo 1999 83-84]

Pronuntiatio innovations to facilitate _elocutio_ (graphic) perception and subsequent recognition

We often take for granted the simple notion of space between words. Yet as sequences of pictographs gradually evolved into sequences of letter characters to form words, the practice of packing them tightly, presumably to conserve valuable inscribing media (stone, parchment, paper), continued:

> Other things hindered rapid reading as well. Until the first century AD the Romans used *interpuncta*, mid-level dots that indicated word division; but as early as the end of the first century even Latin texts began to be written in the *scriptio continua* that was common practice in the Greek world. Writing had very few internal distinguishing features, and its series of continuous letters made it difficult for an unpracticed eye to discern the limits of individual words and grasp their meaning. This means that vocal articulation was a great help to understanding the meaning of a text: once the graphic structure of the written text had been deciphered, hearing served better than sight for grasping how words followed one another, what each phrase meant, and when the reader should pause. Interpunction and other signs were not only aids to grasping the logical progression of a text, but also a help in clarifying its *rhetorical* structure by signaling where to pause to take a breath and where to break up the rhythm of reading aloud.
>
> *Scriptio continua* had certain advantages. It offered the reader a neutral text on which to mark what he wanted to emphasize and where he planned to pause . . . because the author provided no firm indication of how the text should be read [aloud] and none was inherent in the way the written text was presented, a good reading demanded not only cognitive skills and experience, but also an adequate preparation of the written text to plan

where and how words would be subdivided, pauses signaled,
discriminations drawn between assertions, and questions and metric
structures communicated.
[Cavallo 1999 74-75 (annotation added)]

Innovations in punctuation evolved with the abandonment of *scriptio continua* in favor of word separation:

When Irish scribed copied Latin texts, they abandoned the *scriptio continua* of their exemplars . . . they set out the words by introducing spaces between the parts of speech. . . . Where a scribe has used Rustic Capitals or Square Capitals . . . we may speak literally of *capital letters* as an element of punctuation for the first time.

[I]n the second half of the tenth century, most Western scribes . . . adopted word separation. But it was not until the twelfth century that word separation became consistent.
[Parkes 1999 97, 99]

In contrast to the densely inscribed pages of scholastic (9th - 17th centuries [Footnote II.8]) writing, the humanist camp recast the presentation of the page with sufficient blank space ("white space") to provide for annotations and glosses to be inscribed by the reader [Martin 1994 302-303, 314-316, 328-330], [Cavallo 1999 88].

Other graphical innovations aided the reader's perception and recognition of structural elements of the text, and thus the likelihood of constructing meaning:

[Scholastics inscribed]   the marginal signs in different colors according to the structure [structural element] of the argument.
[Martin 1994 316 (annotation added)]

Each form of punctuation corresponded to a grammatical construct. Some only affected emphasis, while others influenced meaning (e.g., quotation marks differentiated persons to which specific statements were attributed and thus contributed both to the meaning expressed by the text and the reader's understanding of the author of the quotation):

[D]istinctive writing styles that guided the eye from one portion of the text to another -- along with punctuation practices and ways of marking the text designed to aid comprehension
[Cavallo Chartier 1999 17]

The humanists . . hindered by the lack of separation between words . . . and by a punctuation system designed to guide the voice rather than to aid comprehension of the written phrase. . . invented quotation marks by borrowing from twelfth-century manuscripts the triangular sign that served to distinguish the text from the commentary . . [Martin 1994 194]

. . . the end of the fourteenth century when parenthesis marks were first introduced
[Cavallo Chartier 1999 17]

Paragraphs had of course appeared in sixteenth-century works . . .
[Martin 1994 329]

Gradually, the homogenous stream of letters acquired distinctive markup (*distinctiones*) that were meaningful to readers:

. . . a fragmented style of reading, page by page, . . . one segment of text after another that was often fragmented even further by subdivision into short sections (*cola* and *commata* [colon and comma?] visually distinguished by means of . . . enlarged initial letters, initial letters placed outside the body of the text, segments of the text placed out of line or in line, etc. . . . This style had certain advantages: it made "the meaning clearer to the reader," and it aided retrieval and memorization, thanks to a style reliant on aphorisms and to a number of devices that permitted the reader to return to passages already read. Interpunction (*codices distincti*) became the norm. . . . For Cassiodorus the *distinctiones* -- interpunction and diacritical marks -- were paths to meaning that, almost like an illuminating commentary, gave readers the clearest possible instruction.
[Cavallo 1999 88 (annotation added)]

The Cistercian abbey of Beaupré . . . established in 1135, produced in the twelfth and early thirteenth centuries the first large quantity of canonically separated manuscripts replete with a panoply of *prosodiae*, or diacritical marks, enhancing the visual images of words. [Saenger 1999 124]

Differentiation of letters and words through graphic emphasis and punctuation to facilitate various types of reading, including silent reading (and therefore meaning-making), was complemented by evolution of differentiation of structural elements of texts. Through grammar, whose study was central in ancient Greek education, the development of linguistic derivations (*elocutio* (semantic) ➤ *elocutio* (percept)) may be traced, beginning with sentence structure:

> [L]inguistic innovations, like the placing of the adjective before the noun and the adverb before the verb, as well as the use of subject-verb-object word order, had been anticipated by insular sequential construction notes. Scholastic grammarians postulated the subject-verb-object order . . .
> . . .
> In the mid-thirteenth century, Roger Bacon, who set down principles for syntactic punctuation, recognized word order and word proximity as important semiotic aspects of language.
> . . .
> Word separation, word order, emblematic punctuation, discrete clauses, the ordering of both words and clauses within complex sentences, and the use of conjunctions and adverbial conjunctions for the construction of compound and complex sentences all facilitated sequential understanding of meaning successively within the boundaries of clause and sentence. [Saenger 1999 130-131]

Beyond sentences, larger partitions of text enabled readers to organize their understanding of the concepts evoked by texts.

Dictionaries enable readers to perform the reverse derivation:

elocutio (percept) ➤ *elocutio* (semantic)

Larger document structures and their influence upon *dispositio*

> [P]ublishers in Lyons continued to produce books using chapters,
> headings, paragraphs, and the traditional systems of references by incipit,
> replacing these with numbers only when the critical commentaries of the
> new school began to appear.
> [Martin 1994 316 (annotation added)]

> In theatrical works . . . Charles Estienne . . . defined the notions of "act"
> and "scene." [Martin 1994 318]

> [T]he text was subdivided into sections.

> When the page was broken up by a complex series of devices, reading
> could concentrate on particular sections rather than involve the entire text.
> . . .
> Beginning with modest devices for subdividing a text or separating one
> text from another that were known in the early Middle Ages . . . we thus
> move to a genuine system of techniques to aid the reading and
> consultation of books . . . rapid identification of the passage that the
> reader sought: rubrication, paragraph separation and paragraph signs,
> chapter titles, and organic but correlated separation of text and
> commentary, summaries, concordances of terms, indexes and alphabetical
> analytical tables.
> [Cavallo Chartier 1999 18-19]

Cognitive function of summaries, abstracts, incipits, and titles

> [R]eaders know where to find main points, and so after reading the title
> and abstract, they turn to the end.
> [Booth Colomb Williams 1995 247]

Abstracts, summaries, and even reviews generally express superordinate ideas of a longer

document. The cognitive function is to provoke recognition or construction of an

intellectual framework of the document, that is the important concepts which the text

expresses. This function, performed prior to a more labor-intensive close reading, aligns

with Ausubel's theory of a path from general to detailed presentation of subject matter:

> [M]ost learning, and all retention and organization, of subject matter is
> hierarchical in nature, proceeding from the top downwards in terms of
> level of abstraction, generality, and inclusiveness. [ARK 6]

> [T]he most general and inclusive ideas of the discipline are presented first
> and are then progressively differentiated in terms of detail and specificity.
> [ARK 163]

For example, the abstract of a research paper generally presents the research question and

its context, describes the theoretical or analytical work performed, then presents

conclusions. These superordinate level concepts enable the prospective reader to

conserve the considerable amounts and types of labor by facilitating their decision

whether to devote their resources to reading a particular text.

Limits to human cognitive capacity and the need for mitigating devices such as

summaries that efficiently expressed primary ideas of a longer document arose during the

"information explosion" of the twelfth century:

> The literary explosion in the twelfth century made . . . texts so numerous
> that no one person could read them all . . . impossible to be fully informed
> about any topic, given the lack of inventories, indexes and resumes . . .
> The authors of the time were aware of these difficulties, and they relied
> heavily on summaries . . . Among those works were *Glossa ordinaria*, a .
> . . tool for understanding the Bible; Gratian's *Decretum*, which gave jurists
> the materials indispensable to their discipline;
> [Hamesse 1999 108]

Among these were twelfth century equivalents of Cliff's Notes and course readers:

> [University students'] writing skills were often less than excellent . . . hard
> to take notes, thus they turned to the many summaries that circulated in the
> form of tables, abridgements, concordances, indexes and florilegia.

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In general, the literature of compilations, extracts and of abridgements had the unfortunate effect of turning medieval students away from direct consultation of authors' works.

Moreover, the custom of highlighting the more important passages of a text (*notabilia*) was a teaching technique . . . It is hardly surprising that this custom produced even more compilations extracted from professors' textbooks. They provided a ready-to-use documentation.
[Hamesse 1999 114]

The utility of summaries and arrangements of expressions for practical use led to

development of larger anthologies of articles and even encyclopedias:

How could any one person keep abreast of all the books produced and become informed about everything that was being published? The question worried intellectuals. A first solution was to compile encyclopedias . . .
[Hamesse 1999 109]

In contrast to processing less *elocutio*, as in an abstract or summary, is the natural

innovation of simply re-reading material:

The substance of much relatively easy, potentially meaningful material can be grasped after one reading. Typically, however, several readings are required for more difficult learning, for over-learning, for delayed retention, and for transfer. [ARK 184]

Writing genres and their influence on the reader's construction of *dispositio*

Confining the scope of inquiry to reading for intellectual curiosity, specialized genres

arose that privileged reason-oriented thinking over spiritual or meditative thought:

In the twelfth century . . . Organized technical reading won out over spiritual reading. On all levels the encyclopedic point of view replaced

> reading and meditation. Logic, which had been used formerly as a means
> for sharpening the mind, seduced the intellectuals and invaded university
> circles. The art of debate came to be prized over a deep knowledge of
> texts. . . . Working methods changed. In many cases individual creativity
> gave way to a highly structured mode of composition that was locked into
> a strict framework and reliant on typical scholastic phraseology. That
> highly technical language contributed to the inevitable decline of the
> scholastic method. [Hamesse 1999 118]

In this mode of reading and writing, one can easily see the precursor to the scientific journal article with its rigid organizational structure (abstract, research question, methodology, conclusions) and comprehensive references and footnotes.

With the transition from Scholasticism to Humanism, readers developed a sense of questioning the concepts expressed in the writings they read. A reader's understanding of a text now might be left in a dissatisfied state if elementary ideas were not expressed in a text. Thus, the new kind of work developed around organizing and presenting texts that met the critical and cognitive expectations of readers:

> Another technique [to aid in identifying the elements in a text] . . . was to
> apply the rhetoricians' analysis . . . These attributes were known as the
> seven circumstances of human actions (*circumstantiae rerum*): person,
> action, time, place, cause, method, and instrument. They were frequently
> applied in the form of questions: *quis* (who), *quid* (what), *quando* (when),
> *ubi* (where), *quare uel cur* (why), *quomodo* (how), *quibus amminiculis* (by
> what instrument). [Parkes 1999 95-96 (annotation added)]

One example is the text that provokes an image to the reader of a narrator or human agent with whom the reader may communicate or consult, not in actuality but in counterfactuality or imaginary conversation. This bears upon the reader's *dispositio* in several ways: it provides the possibility of mitigating gaps in the reader's knowledge and it imputes trust and credibility of the text on the rationale that the text or its author is responsive to (imagined) inquiries from the reader:

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> Around 1770 even this model of reading, one which fitted with Enlightenment doctrine . . . became more sophisticated. . . . This 'overwhelming desire to make new contact with lives behind the printed page' led to a completely new and incredibly intensive familiarity, even an imaginary friendship between author and reader, the producer of literature and its recipient. [Wittmann 1999 295]

> [T]he book came to have a personality of its own, and it entered into reciprocal relations with its readers, whom it addressed [perhaps by entering annotations into it] and to whom it lent a voice [that is, provided linguistic expressions for thoughts they desired to express].
> [Cavallo Chartier 1999 11 (annotation added)]

Such conversations, imagined rather than actual, are nevertheless psychologically real to the reader. Plato had warned that texts should not be anthropomorphized:

> Written discourse . . . is like a painting: if asked a question, it cannot respond; the best it can do is repeat itself *ad infinitum*. Writing, inert and circulated by means of a material support, has no idea whom it should address (that is, it does not know whether a given person is capable of understanding it) and whom it should not address (because that person is incapable of receiving it.) . . . it has no ideas . . . whose reading will bring out a meaning. Every act of reading thus constitutes a different interpretation of the test directly conditioned by the reader.
> [Cavallo Chartier 1999 6]

> Plato . . . affirms that writing has a "terrible" property in common with painting. The productions of painting look like living beings, but if you ask them a question they maintain a solemn silence. The same holds true of written words . . .
> The written text, in actually taking on stability . . . loses its capacity to meet the receiver's questions and becomes inert.
> . . . separation of the text from the author with the resulting consignment to the reader and the "crystallization" of the text . . . [Simone 1996 245]

Imagined conversations between reader and author are accompanied by dialogs between the reader and himself distributed over time, and as a form of memory. They may be structured as question-and-answer or observations-and-comment, among others. The

codex made it possible, in effect, to personalize a text by enabling the reader to inscribe notes to himself (or others) and to enter into a one-sided conversation the author:

> The practice of writing in a book as one read arose with the codex. . . .
> The codex provided readers with other spaces to write on; entirely or
> partially blank pages, endpapers and the inside surfaces of bindings could
> be used for notations of all sorts . . .   [Cavallo 1999 88]

The examples of genre types described (reason and evidence-based, humanist questioning of assumptions, imagined communication with the author, etc) function as superordinate idealized cognitive models (ICMs) that structure a reader's thoughts and expectations. These are innumerable. Fairy tales, dissertations, calendars, maps, time-tables, detective stories, dictionaries, textbooks, and newspapers are all genres of writing that influence the structure of a reader's thought apart from specific expressions inscribed in them. For example, in fairy tales, a reader may expect events and characters not encountered in their material world and lessons of moral or practical import. In calendars, the reader expect particular sequential arrangements and elements depicted as situated along it.

Written materials manifest cognitive authority

Whether an idea is (a) *known* by a learner is distinct from whether the idea (b) *is* true in the world, and distinct from (c) whether the idea is *regarded as true* by the learner. An important attribute of any concept is the degree to which the learner accepts the idea as true, true-for-limited-purposes, accepted as a matter of faith, emotionally justified, or accepted based on some other criterion. Indeed, this single attribute of concepts and the relations among concepts has motivated philosophy for thousands of years.

One means by which concepts are accepted by learners is by imputing validity through the cognitive authority of other trusted people. For readers, one of the earliest manifestations of trusted cognitive authority were *autograph signatures*. These appeared by the tenth century only to disappear temporarily. [Martin 1994 138].

With the rise of the Renaissance and its turn to Humanism, other forms of cognitive authority became established, including title pages, forewords, and colophons (title, author's name, printer name and date). Not seen in artifacts of the scholastics, these had but one purpose: authorial and publisher interest in building their identities, "branding":

> [T]he traditional dedication was replaced by a foreword -- an *Avis au lecteur* -- claiming to establish a direct relationship between the author and the reader and launching the book on its own without a protector.
> [Martin 1994 315-316]

> Other elements were gradually added to the title and author's name: a laudatory phrase placed at the top of the title page introduced author and title; the bookseller's mark was placed prominently at mid-page, and the foot of the page was reserved for his imprint . . . by the last quarter of the fifteenth century. [Martin 1994 302-303]

> How the title page contributed to the cataloguing of books and the bibliographer's craft scarcely needs to be spelled out. How it contributed to new habits of placing and dating . . . call[s] for further thought.
> [Eisenstein 1979 106]

> By 1500, legal fictions were already being devised to accommodate the patenting of inventions and the assignment of literary properties.
> . . .
> The terms plagiarism and copyright did not exist for the minstrel. It was only after printing that they began to hold significance for the author.
> . . .
> Until it became possible to distinguish between composing a poem and reciting one, or writing a book and copying one . . .
> [Eisenstein 1979 120-121]

Syndetic function and cognitive effects: aid to recall (*memoria*) and discovery

Reading a text generally involves *pronuntiatio* in the form of a (semi-)permanent record (television, scoreboards at football stadiums, and annunciators at train stations excepted). Reading from a record, particularly in service of intellectual objectives may involve both linear and non-linear *pronuntiatio*. As readers construct their own understanding of the text currently in hand or on screen, they selectively determine which text to read subsequently in alignment with the structure of their current knowledge. This structure might or might not align with the linear presentation of a text. Therefore, readers often encounter cognitive conditions that require reading a text located apart from that text to which they currently attend. Various *pronuntiatio* devices and systemic innovations facilitate an essential reading task: *finding pronuntiatio*, that is, finding specific *pronuntiatio* objects that might provoke ideas related to the portion of the reader's knowledge current to focus of their attention.

Tangible forms of texts may be sought for various reasons, including the revisitation of a text previously assimilated, and discovery of a new text relevant to a reader's interests.

Documentary (*pronuntiatio*) forms of *finding* devices and systems are many, and like texts and documents, have developed over centuries. Some are surveyed here for insight into the particular cognitive or meaningful learning functions which they support.

Simple indexicals such as "see" references, and back-of-the-book indices enable a reader to find a potentially useful page, section, or other work.   Bibliographic references facilitate the same steps in obtaining known item, but not usually including a physical (or digital) location from which a copy can be obtained (with respect to a given document, *references* are syndetic pointers to texts outside the document, *citations* are syndetic pointers *to* the document). Catalogs (union, dictionary, whether card or online) fulfill the

function of locating copies of known items, as well as browsing items held in a collection, and selecting items (based on [Cutter 1876]). Syndetic service to readers includes devices such as summaries and abstracts and resources for finding texts such as Reader's Guide and Books in Print.

These examples show that any instance of syndetic function requires three elements, the indexical to a referent, the referent, and the intellectual capacity to evoke the referent from the indexical. For example, an index entry in the back of a book and the page to which it points, or a catalog record for a document and the document itself rely upon the reader's intellectual abilities to identify a term of interest in the index, recognize the syndetic reference as a page number, and then turn (if interested) to the page number indicated to find the expression referred to. The indexical is, itself, bi-partite, comprised of some description and a pointer, such as in index entry for `elephant` in a book about animals, and its corresponding page number. These enable readers to *elocutio* ➤ *pronuntiatio*, that is derive *pronuntiatio*, e.g., a page, given some textual object, e.g., the corresponding page number.

Other kinds of descriptions that comprise syndetic devices include titles, incipits, author names, and musical phrases (thematic catalogs).

Readers cannot always know the description element of the indexical. That is, the student studying piano manufacturing might not know to look under `elephant` in the index. However, readers are able to recognize similarities among ideas that are otherwise quite different. The intellectual capacity to perform such recognition is categorization. Humans categorize. For readers, categorization has been performed on their behalf through subject classification:

> [In the eleventh century,] Papias gives, for the first time, rules for a
> systematic alphabetical classification. Unfortunately, the system he
> advocated did not take hold in his own day, and more than a century
> passed before his principles of classification re-emerged.
> [Hamesse 1999 109]

Thus, our student investigating piano manufacturing, though he might not know the role of elephants in his subject matter, might know that manufacturing requires materials and labor. With this concept, he could eventually identify, locate, and fetch descriptions about particular relevant materials.

Tables of contents not only "clarify the structure" [Martin 1994 453] of a work, but also perform syndetic function by enabling the reader to vector almost directly to a chapter corresponding to particular *dispositio*.

One variant of *finding* a portion of text (*discovery*), is *revisiting* a passage that one wishes to reread.   Among the syndetic devices directed to specific perceptual and cognitive functions to aid the reader in returning to a text include: graduated type sizes (e.g., returning to the beginning of a chapter), numbering of paragraphs and chapters, running heads, and labeled thumb notches as in a dictionary or thesaurus.

> Running heads were introduced and in the late fifteenth century printers
> began to number folios . . .   Pagination proper . . . opened up new
> possibilities for indexing and reference and the modern table of contents
> became possible. [Martin 1994 302-303]

> [S]ystems of reference that have somewhat hastily been credited to
> printing existed well before its invention. One of these was the use of
> signatures and catchwords to help assemble the pages in the right order.
> Other signaling devices aided reading: folios, columns or lines might be
> numbered; the page could be divided up more visibly by the use of
> devices such as ornamented initials, rubrics, and marginal letters; an
> analytical (rather than a simple spatial) relationship between the text and
> its glosses could be set up. Different characters or different colours of ink

could be used to distinguish between text and commentary. Thanks to its
organization in quires and to its clear divisions, the codex, whether
manuscript or printed, was easy to index. Concordances, alphabetical
tables and systematic indexes were common practice even in the age of the
manuscript, and it was in monastic scriptoria and stationers' workshops
that these modes for the organization of written material were invented.
Printers picked them up later.
[Cavallo Chartier 1999 23]

Codified spelling enabled not only recognition of words, but opened the way to use of

indices and other syndetic instruments where the order of entries was alphabetical.

Increasing familiarity with regularly numbered pages, punctuation marks,
section breaks, running heads, indices, and so forth, helped to reorder the
thought of *all* readers . . .
[Eisenstein 1979 105]

An important property of syndetic elements, sometimes overlooked, is the Division of the

referent. The numeral associated with an entry in a back-of-the-book index is commonly

understood to refer to a "page," as in this entry about taxes:

```
taxes,    139
```

Here, "page 139" is an object in the physical world, a specific piece of paper in a specific

document object (or set of copies of the same title and edition), that is, of *pronuntiatio*.

However, consider the index entry,

```
taxes,    see Revenue
```

Here, the pointer is not to a specific page, *pronuntiatio*, but to a specific text, *elocutio*,

which discusses *revenue* and which presumably includes descriptions that apply to taxes.

Text often has a graphic or phonic component, *elocutio* (*percept*), and thus the reader is

directed to expressions about *revenue* that are found inscribed on *pronuntiatio* with those physical or tangible *elocutio* (*percept*) objects, e.g., printed letters.

Now consider the indexical

```
taxes, see your financial advisor
```

This indexical likely intends to point the reader to knowledge (*dispositio*) embodied in any of a set of persons qualified in tax and financial management. The pointer is *not* to a text, *elocutio*, nor to a physical object, *pronuntiatio*, nor to a *particular* person-object. The indexical is to *particular knowledge*, *dispositio*.

Thus, the writer may inscribe pointers (comprised of *pronuntiatio* and *elocutio*) to *pronuntiatio*, to *elocutio*, or to *dispositio*. The reader is confronted with the task of differentiating among these possibilities, and ascertaining which. On many occasions, a reader's mistaking one Division's object for another, e.g., a physical page for an idea, is unproblematic because, in finding the one, she is able to provoke or evoke the other. However, earlier in this part, the adverse consequences of mistaking objects of one Division of Rhetoric for another Division were explored generally (see: Mistaking objects of one Division of Rhetoric for objects of another).

Innovations in modern texts that support readers

> The print shop performed a significant, albeit neglected function -- by bringing together intellectual and commercial activities which reinforced each other.
> [Eisenstein 1979 93]

Perritt describes a taxonomy of structural support tasks performed by publishers on behalf of readers:

Process	Type of Value	Print Examples
Organizing	chunking & tagging	Organization boundaries: sections, paragraphs, pagination, chapters; headings and titles, running headers and footers, page numbers
	internal pointers	Tables of contents, indexes, hyperlinks
	external pointers	Bibliographies (locators, identifiers) hyperlinks
Retrieval & assembly	presentation	Print on paper; video displays
	duplication	All copies resemble original (uniformity)
	distribution	Transmitting from writers to readers
	integrity assurance	Guaranteeing the accuracy, expertise of suppliers in each type of value; guaranteeing against forgery or tampering

(summarized from [Perritt 1993])

The advent of hypertext only partially removes the limitation of linear reading. While it enables the reader to vector to varying texts, assimilation of a complete sentence or paragraph still follows a linear, if interrupted, path.

What is *paying attention*?

> A major cause of everyday forgetting perhaps in most instances of undue
> loss of ostensibly learned material (including subject matter) is failure to
> pay proper *attention* at the time of learning. Generally speaking, what is
> not attended to is neither learned nor remembered.
> [ARK 200 (emphasis added)]

> Anyone who can draw as many people into situations related to learning
> as . . . Nintendo, knows something that educators who have trouble
> holding the *attention* of 30 children for 40 minutes should want to learn.
> [Papert 1996 13 (emphasis added)]

This discussion extends the discussion of Assimilation Theory in Part II.1 (Motivation

and attention). The present reader is encouraged to review the observations by Benyon *et

al.* above (see: Human-computer interaction (HCI)).

Ausubel acknowledges that *attention* is indispensable to *thinking* (learning) and thus to

writing and reading.

> **Attention**
> Much of the facilitating effect of motivation is apparently mediated by an increase
> in *attention*. Merely directing students' attention to certain aspects of subject
> matter, irrespective of how this is done, promotes *learning*.
> [ARK 200 (emphasis added)]

However, reading is sometimes misperceived by learners as more passive than thinking

or writing, that is, reading somehow requires less effort than writing or sheer thought.

Perhaps readers and listeners rely on automatic subcognitive abilities and thus assume

comprehension will occur. Perhaps, to some degree, some subcognitive comprehension

does occur. Or, in reading particular texts for entertainment, perhaps less intellectual

effort than other types of reading. Nevertheless, *meaningful* reading requires conscious

intellectual labor just as does other forms of meaningful learning such as speaking,

writing, analyzing, or problem solving. Because attention is more easily overlooked in reading, it is all the more important in an account of reading, and thus is considered at this point in the present report.

On occasion, a reader might become aware that he is "reading" but not "paying attention" to "what" he reads, that is, to the concepts expressed by the text and integrating those concepts with his existing knowledge. Perhaps he is thinking about something else as well, or thinking about something else subconsciously. He might be recognizing marks on the page and even deriving a grammatical or surface meaning of the sentence (or not), but not actively or consciously surveying his existing knowledge for connections to the ideas expressed in the written material, not constructing its *implications* according to his existing knowledge, that is, not *attending* to constructing his own personal, new meaning. The reader might then commit to "try harder" or to "focus," and perhaps this time, "get it," "it" being a sense of expected meaning.

In this scenario, what does it mean to *try harder*? What does one do cognitively or psychologically in the act of *focusing*? What does one actually *do* when one *pays attention*? Learners appear to have conscious control over attention just as with motor control of muscles or limbs, yet, when the reader flexes this muscle, *pays attention*, nothing moves! Is *paying attention* subject to some phenomenon like motor control, like lifting an arm or smiling?

The notion of *attention* is embraced by Ausubel in his distinction between *rote* and *meaningful*. If the reader is merely memorizing *elocutio*, or even evoking only surface meaning, Assimilation Theory characterizes this effort as *rote*. In contrast, if one is relating the ideas expressed by text to one's prior knowledge, which requires, in part, *paying attention*, then one is learning meaningfully, *assimilating*. *Inattention* is

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comparable to rote learning because surface concepts derived from a text are not then integrated into the readers existing knowledge.

Perhaps the present reader has had the experience, while driving an automobile along a seemingly endless stretch of interstate highway, of musing about some issue of interest, then, realizing after some time, that he has "*not* been paying attention" to the road, and yet, successfully driving within the lanes and with proper distance between vehicles: You *have* been paying attention (to driving), but at some level other than primary consciousness. Are there, then, multiple levels of *attending*?

In reading can be found the same range of degrees of attention, from meaningful attentive reading, to an superficial reading that does not result in *grasping* expected concepts. As described above, attention can be focused or divided, and its capacity can be limited (see: Human-computer interaction (HCI), above).

That there are at least these two modes of reading, attentive and inattentive, is, perhaps, not so interesting. More so is that, with apparently deliberate ease, the reader can switch back and forth, and has some mechanism to carry out the change of modes. After a period of inattentive reading, a reader can construct a conversation with a cognitive homunculus to whom one says, "hey, I didn't get that," and he (i.e., an alter ego) responds,, "Oh, we'll do it over and this time the *attention* switch will be set to the **on** position." Of course, there is no homunculus -- the cognitive model of the man-controls-machine metaphor adds little to our understanding of *attending*. But how then does one realize that one was not attentive? And what does one do differently when one re-reads meaningfully, attentively?

The difference between attentive and inattentive thinking, including in reading, is, as found at the core of Ausubel's theory, the cognitive labor of relating new meaning to

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existing knowledge. In the case of reading, this comprises a second stage of effort, beyond constructing or selecting a surface level of meaning of a sentence or text: one of constructing implications of the new meaning *according to* one's existing knowledge.

The Divisions of Rhetoric communications reference model facilitates differentiating attentive reading from inattentive reading. In inattentive reading, *pronuntiatio* ➔ *elocutio* occurs to some degree, that is, terms are recognized, and even surface *elocutio* ➔ *inventio* derivations and constructions are produced. However, the second stage, the *elocutio* ➔ *inventio* ➔ *dispositio* is not produced where *inventio* ➔ *dispositio* represents constructing relations (*dispositio*), *meaning* or *implications*, of new concepts to existing structured knowledge.

That is, meaningful reading *is*: ➔ *dispositio* (*deriving dispositio*), not merely reconstructing understandings of the ideas expressed in the reading material, but the second step of establishing relations between those new ideas and one's existing knowledge, i.e., *meaning*. The inattentive reader might perform *elocutio* ➔ *inventio*, that is construct understandings expressed in the new material, but neglect performing the second step, appreciating how those new ideas bear upon their existing knowledge. For example, an inattentive reader may read their biology textbook, constructing superficial understandings of new concepts of *meiosis* and *mitosis* as types of cell division resulting in new cells with either half or the normal number of chromosomes respectively. However, the attentive reader will apply their understanding of each of these processes to their understanding of characteristics carried by offspring, etc.

Deriving *meaning* (as from expressions, *elocutio* ➔ *inventio* ➔ *dispositio*) implies *grasp*, that is, *comprehension.* In the context of reading, some refer to grasp as "a close reading" or a critical reading where recognition of assumptions implies thorough or

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comprehensive recognition and evaluation of relations ideas evoked by written material

and the reader's *dispositio*.

Hofstadter describes the boundary between attention under conscious control and

subconscious attention.

> In 1980, Simon . . . declared . . . "Everything of interest in cognition
> happens above the 100-millisecond level -- the time it takes you to
> recognize your mother." Well, our disagreement is simple; namely, I take
> exactly the opposite viewpoint: "Everything interesting in cognition
> happens BELOW the 100-millisecond level -- the time it takes you to
> recognize your mother." To me, the major question . . . is this: "What in
> the world is going on to enable you to convert from 100,000,000 retinal
> dots into one single word "mother" in one tenth of a second?" Perception
> is where it's at! [Hofstadter 1982]

Benyon acknowledges a boundary between conscious and sub-conscious cognitive labor,

but does not cite the 100-millisecond level as does Hofstadter:

> Controlled processing makes heavy demands on attentional resources, is
> slow and limited in capacity, and involves consciously directing attention
> towards a task.
> Automatic processing makes no demands on attentional resources, is fast,
> unaffected by capacity limitations, unavoidable and difficult to modify,
> and is not subject of conscious awareness.
> There is no one agreed account of attention. . . . [It is] difficult to define
> what actually constitutes attention.
> [Benyon Turner Turner 2005 108]

What criteria might be used to determine if one is paying attention?

When, during reading, one experiences a sensation of "Eureka, I get it" (see: The

Eureka! event), such is evidence that the learner-reader is establishing relations between

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their existing knowledge and ideas expressed in the written text. This implies *paying attention*, and thus characterizes meaningful reading. (see: [Reis 2006 #689]).

Summary of meaningful reading

Reading is not merely noticing images on the page (*pronuntiatio*). Nor is reading merely term recognition, although unfamiliarity with terms can certainly present an obstacle to constructing both surface meaning and meaning within one's structured knowledge. Meaningful reading, a form of meaningful reception learning, requires capacity for recognizing and projecting central thematic concepts for sentence, paragraph and whole text comprehension, and *paying attention*, constructing implications of ideas expressed in the reading material as related to the readers existing knowledge.

Exercises

1. Consider a document that you have "read" casually during the last eight hours, e.g., a newspaper story. Reread it to achieve greater comprehension, attending to what changes you are making in your approach to reading it that result in a fuller understanding.

Identify cognitive tasks you performed in "trying" to understand the article.

Characterize expenditures of labor and energy attributable to the re-reading that did not obtain in the casual reading.

What is listening?

How is listening different from mere hearing? Hearing is a perceptual task performed by a learner's auditory system. Hearing senses aural *pronuntiatio*. Looking and hearing imply perceptual function only: that one has perceived some physical phenomena.

Listening is more. *Listening is meaningful hearing*, that is, hearing, deriving concepts expressed, and assimilating them with existing knowledge. Listening demands *attention* (see: What is paying attention? above), *anticipating* (expecting which ideas might be expressed based on prior knowledge (but see II.1, Preconceptions, for the detrimental side of *anticipating*), *recognizing* and *applying* models of thought that the text might express (see: Idealized cognitive models, below), *interpreting* the expressions received (see: What is isomorphic mapping?, below). These constitute *assimilating* aural expressions into one's existing knowledge, and thus imply *thinking*.

Both *reading* and *listening* imply the cognitive work of deriving meaning and constructing implications that bear upon the listener's existing knowledge, i.e., *meaning*.

Thus, while hearing (or looking) is:

$$\textit{pronuntiatio} \rightarrow \textit{elocutio},$$

listening (and meaningful reading) is:

$$\textit{pronuntiatio} \rightarrow \textit{elocutio} \rightarrow \textit{inventio} \rightarrow \textit{dispositio}$$

Musically, listening implies the same, not merely recognizing surface phenomena such as melodic type, relative equality or inequality of parts, or orchestration, but particular musical phenomena, e.g., harmonic shifts over large architectures and stylistic characteristics of a musical genre.

What is writing?

The sequence of derivations:

$$inventio \rightarrow dispositio \rightarrow elocutio \rightarrow pronuntiatio$$

may be described as ***expressing*** (*writing*, *speaking, or performing*). According to this communications reference model, expressing may be regarded as beginning with ideas (*inventio*), organizing those ideas (*dispositio*), selecting appropriate linguistic expressions (*elocutio*), and then delivering those renderings in a transmittable form (*pronuntiatio*) (Figure II.55(a)).
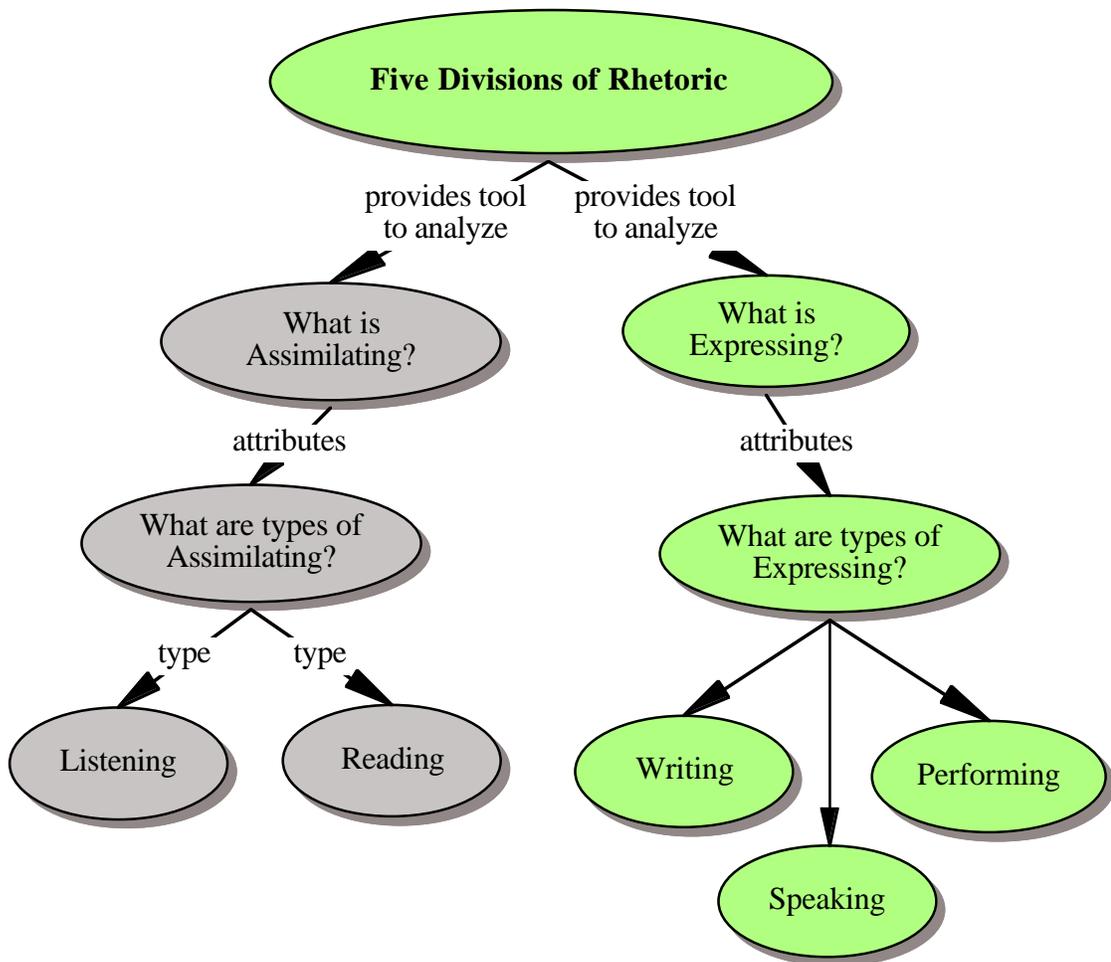
Figure II.55(a)

Assimilating (reading, listening) bears upon the Basic Relationship of how people become informed. Because the same elements (i.e., of the Divisions of Rhetoric communications reference model) are involved in *expressing* as in *assimilating*, understanding of the Basic Relationship may be furthered through understanding *expressing*. Innovations in writing can, in turn, benefit readers, and their meaningful learning in particular.

Writing is concerned with the tasks of coordinating one idea with another, then expressing the ideas and the relationship, in the hope that readers will recognize the concepts intended to be coordinated.

Senses of *writing*

As with the term reading, *writing* can be used in several senses referring to segments of this overall model (Figure II.55(b). Sometimes *writing* is intended to describe the cognitive labor of *inventio* ➡ *dispositio,* that is*,* organizing *inventio*, producing *dispositio*. In other cases, *writing* refers to selecting linguistic expressions. As well, *writing* is used to refer to the act of producing inscriptions on tangible media, such as ink on paper or graphemes on digital screens or files. As with reading, the focus here is on *meaningful* writing, i.e., that which encompasses *inventio* ➡ *dispositio.*

Figure II.55(b)

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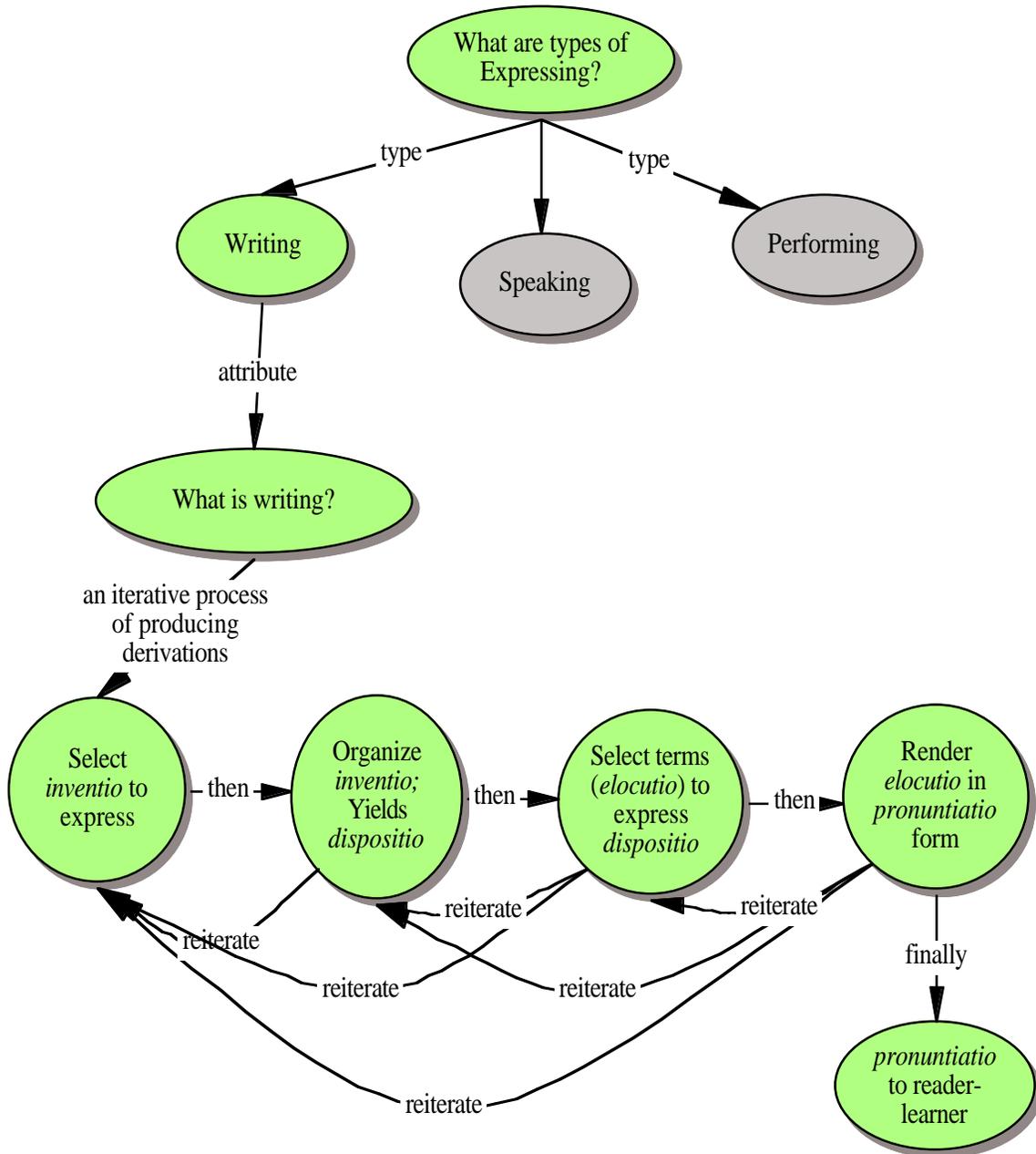
Fragmentation facilitates arranging

The benefits of granularity and the notion of partitioning granules to facilitate organization of texts according to the writer-speaker's intentions has been alluded to above (see: Interaction with paper). The innovation of *incremental text* provides for incorporation by reference as a substitute for duplicating already-published writings.

Writers evoke concepts (*inventio*). Then, writers *arrange*. They arrange ideas (*inventio* ➤ *dispositio*), they arrange expressions (e.g., paragraphs into chapters), and they arrange tangible inscriptions (appearance of objects on the page). The reader also *arranges*, for texts rendered as tangible inscriptions often do not correspond to whole systems of *dispositio*. Instead, fragments (texts) are collected and assembled from which the reader hopefully evokes a meaningful understanding. Writers make use of the cognitive importation, arranging, and synthesis expected of the reader. Saracevic observed that the modern scientific publishing paradigm evolved from one of primarily whole texts, works, to one of fragments to which individual authors contributed smaller clusters of *dispositio*:

> Modern science has developed a particular mechanism of communication which began with the appearance of the first scientific journals in the 17th century and has remained the same to this date. This mechanism is based on the following: the systematic and selective publication of fragments of work -- items of knowledge related to a broader problem rather than complete treatise; the selective derivation from and selective integration into a network of other works; and an evaluation before and after publication. [Saracevic 1975 323]

Value of writing to meaningful learning

Ausubel does not devote a substantial portion of this theory specifically to writing either as a general learning activity or in terms of his processes. However, his salient claim as to the constructive cognitive work of writing reveals his unorthodox view that successive chapters should not be written at the same intellectual level on a sequence of topics, but rather the breadth of topics should be covered in each chapter with increasing degree of specificity as the text progresses:

> It is perfectly logical from the standpoint of a mature scholar, for example, to write a textbook in which topically homogeneous materials are segregated into discrete chapters and treated throughout at a uniform level of conceptualization. But, how congruent is this approach with highly suggestive findings that one of the major cognitive processes involved in the learning of any new subject involves progressive differentiation of an originally undifferentiated field?
> . . . The issue of concreteness versus abstractness is relevant when both general and explanatory ideas, on the one hand, and relatively specific and factual material, on the other, are present in the same learning exercise and both influence the learner's cognitive structure and become incorporated within it. [ARK 22]

Indeed [ARK] itself is written in this style, with seemingly the same concepts presented in chapter after chapter. However, each successive chapter presents each concept either with greater detail or from a different perspective. The repetition can, at first read, seem inefficient, and requires extraordinarily careful indexing to facilitate subsequent revisiting of passages ([ARK] includes *no* back-of-the-book index!). Nevertheless, such structured writing overtly follows Ausubel's dicta of connecting new ideas to concepts the reader has already encountered, and of progressive differentiation.

> [P]articular antecedent knowledge . . . is necessary for learning new sequentially-dependent instructional material. [ARK xii]

Ausubel strongly advocates expressing concepts in a sequence such that the student is always acquainted with the concepts required for the next subject matter. For example, a calculus teacher will first ensure that her new students understand algebraic concepts and operations. In some cases, however, precisely the opposite style of writing is required. The fiction writer organizes the elements of *plots* so that the reader's sense of mystery (or knowledge gap) unfolds without their knowing the solution too early. The scholarly writer organizes her ideas such that each is preceded with context that can enable the reader to comprehend the new ideas expressed in the journal article. Thus, tasks in each of the Divisions, and derivations one from another, are inherent in writing, hence the synonym *composition*:

> Composition in the medium of Gothic cursive on quires and sheets of parchment meant that authors could revise and rearrange their texts while composing them. This capacity aided thirteenth-century scholastic writers in preparing texts rich in cross-references, which presupposed that the reader, like the author, could flip from folio to folio in order to relate arguments to their logical antecedents and to compare comments on related but disparate passages of Scripture.
>
> He could see his manuscript as a whole, and by means of cross-references develop internal relationships [derived from *dispositio*] and eliminate redundancies common to the dictated literature of the twelfth century. He could also . . . easily add supplements and revisions . . .
> [Saenger 1999 132 (annotation added)]

It is the *inventio* ➜ *dispositio* derivation (i.e., thinking, the work of relating ideas to other ideas), that often presents the greatest difficulty to writers:

> . . . writing prompts new sorts of connections in the reasoning process. This means that the new medium [writing] surpasses its initial object [as memory aid] and comes to have a role of its own in the linked stages of the cognitive process. [Martin 1994 87 (annotation added)]

However, the greater the difficulty in organizing ideas, the greater the potential benefit in solving how to overcome such obstacles, and hence the value of writing to both writer and learner. The overall process of *inventio* ➤ *dispositio* ➤ *elocutio* ➤ *pronuntiatio* has value to the writer in compelling her to organize her *inventio* into *dispositio*. Thus, the primary value of writing is not limited to communication. The cognitive benefit of writing, as distinct from the communicative value, encompasses the organizing of teaching materials for a course or presentation and review of a self-written text to ascertain whether it provokes the reader-listener to evoke intended concepts, or might provoke ideas contrary to those intended.

Revision is an essential component of the writing process (see also: *Dispositio* ➤ *elocutio* compels speaker-writer to (re-)organize *dispositio*). Revision may be required at any stage in the Divisions of Rhetoric model   For example, the writer might differentiate (progressively) her ideas (*dispositio*) as she writes. Or, she may have drafted a text by expressing ideas as they occurred, but then recognize a need to re-arrange the terms such that successive expressions build on concepts already known or presented to the reader. Champagne and Kouba remind us that segments of *inventio* ➤ *dispositio* ➤ *elocutio* ➤ *pronuntiatio* are often not linear, but iterative, with the writer continuously questioning the text they have written and revising:

> Writing serves another purpose in inquiry. Assuming that the writer has mental models of what constitutes [values] and knows how to check the accuracy of information, the process of matching what has been written against those models is likely to result in the writer making new corrections . . . [Champagne and Kouba 2000 235]

How does a writer decide which ideas to express next?

Arrangements, models, plots, themes, plans

Writers often have in mind some sort of plan that enables them to arrange the portions of text they write, know what text needs to be written next, and know when the work is complete. Such plans have various synonyms, e.g., themes, plots, guidelines for researchers submitting articles (to scholarly journals).

ICMs are a category of conceptual structure that includes these various types of plans. (see: Species of *dispositio*: Idealized cognitive models, above). Isomorphic projection and isomorphic mapping of ICMs onto skeletal texts are the fundamental method by which writers organize new *dispositio*. Here the stage is set by identifying some of the types of models or plans that writers use to organize their ideas, their texts, and their tangible inscriptions.

A *plot* is an ICM that, among other elements, specifies event sequences:

> boy meets girl
>
> conflict, boy and girl part
>
> resolution, boy and girl live happily ever after

Thus, plots are plans which keeps readers of fiction moving forward on a *path*, a linear sequence of events. Paths have endpoints: initial and terminal (see: Process characteristics: endpoints, II.1). They may lead to a pleasant endpoint (happy ending), an unpleasant end, or end abruptly for no apparent reason. Compound plots can interweave multiple paths, but they are nonetheless *paths*, linear event sequences.

Plots may also require the establishment of particular conditions. For example, a story based on a rags-to-riches plot may fail if the main character is the offspring of Bill Gates,

because such a character did not start from a position of poverty. A story about such a person who overcame his upbringing and background to survive in the jungle or deserts of the Middle East might be considered a rags-to-riches story if the riches were perceived as survival knowledge or skills.

In folk mythology secular stories can often be recognized, structurally, as based upon one of a small number of plots. Certainly some plot ICMs are encountered in writing more frequently than others. Plots are not confined to fiction.

A *story* is not a *plot*. A plot is a generic structure and a story is a specific instance of it, with specific characters, settings, etc. The learner-reader's view of events (written or daily life) might begin at a point after *the story* has begun. Thus, some event elements of a plot ICM may have occurred in the past.

Not every element of a plot is expressed by *elocutio* in a story. Unexpressed ideas or ICMs are called *subtext*s.

> Jessie's first line is a seemingly innocuous question to her mother: Does
> she have any old towels she doesn't want? It's an odd request. But we have
> to spend 8 more pages with her before we understand how ominous it
> really is. . . .
>
> This is what would happen if Jessie spoke all of her Subtext . . .
> JESSIE:
> Do we have any old towels, plastic sheeting or foam rubber padding? I'm
> going to commit suicide in the bedroom tonight with Daddy's pistol as
> soon as I get everything done for you and I need the towels so all the
> blood won't make a mess on your floor. [Toscan Playwriting]

The climax of a plot has climactic *effect* because the learner-reader-observer first performs a mapping from the ideas expressed by the *elocutio* to some (*but not all*) of the concepts that comprise his or her mental model, then the reader performs the projection

from other conceptual elements of their existing mental model not provoked by the text, thus filling-in the missing plot elements.

In the passage above, inclusion of Jessie's *subtext* into her spoken dialogue would dispel the mystery about why she's requesting old towels:

> When we seek a deeper meaning in an artistic work, this often requires noticing one or more covert target domains. . . . In reading literature, we often confront a problem that is quite the reverse of the standard difficulty that arises in solving problems by analogy. The problem solver faces an inadequately understood target and must find a useful source analog. The reader, on the other hand, encounters a text that may provide a metaphorical source and often has to discover the target domain that is the underlying topic. [Holyoak Thagard 1995 224-225]

In some cases, recognition of a superordinate ICM *dispositio*, even a plot ICM *dispositio* may be considered an imaginative insight, as in the recognition and *projection* of the bank robbery-by-tunneling plot ICM (and thus the motivation for privacy) in Sherlock Holmes' case of the Red Headed League:

> It seemed altogether past belief that anyone . . . would pay such a sum for doing anything so simple as copying out the Encyclopedia Britannica.
> . . .
> "You see, Watson," . . . "it was perfectly obvious from the first that the only possible object of this rather fantastic business of the . . . copying of the Encyclopedia, must be to get this not over-bright pawnbroker out of the way for a number of hours every day.
> . . .
> "But how could you guess what the motive was?"
>
> He was doing something in the cellar -- something which took many hours a day for months on end. . . .
> I could think of nothing save that he was running a tunnel to some other building.
>
> ". . . one of the most determined attempts at bank robbery that have ever

come within my experience."
[Doyle The Red-headed League]

Themes are *dispositio* that matter to the learner-reader.

> Some examples of themes in contemporary plays
> Racial stereotypes blind you to reality.(Hwang's M. BUTTERFLY)
> A heavy price is paid by women who were the career path-makers (THE
> HEIDI CHRONICLES)
> Overly sensitive people are crippled by the lies of the world we live in.
> (Tennessee Williams' CAT ON A HOT TIN ROOF)
> [Toscan Playwriting]

Frames are used consciously perhaps less frequently than plots or themes. Frames have initial conditions, perhaps actors, changes of state, and ending conditions. Writers can organize texts by describing the initial states, actors, changes, and final states.

Teachers can guide writing students in several ways. If the writer does not have a clear plan, she can be encouraged to evoke or select one. Where the writer's text appears to stray from the plan or include expressions that conflict with or are not relevant to the plan, the teacher may offer such observations. If the writer has arranged expressions in a different order than a path, or if steps in a path are missing, the student may be advised to revise accordingly. If assumptions are made in the writer's model, the teacher may constructively challenge them. If a writer fails to express a thematic element or believe he has expressed it but the reader-teacher finds that such element is not, for him, evoked as a result of reading the text, the writer may be advised accordingly. If the writer has activated a theme, and is unaware of it, the reader may call the writer's attention to it.

Anticipating and satisfying the reader's expectations

How may the writer *inventio* ➔ *dispositio* ➔ *elocutio* ➔ *pronuntiatio* so as to satisfy the reader's *pronuntiatio* ➔ *elocutio* ➔ *dispositio*? Readers generally bring particular expectations to their engagement with a text. In some cases, a writer's efforts influence the extent to which the reader's expectations are satisfied.

> Readers never begin with a blank slate . . . They read with expectations;
> some they bring with them, others [the writer] must create . . .
> [Booth Colomb Williams 1995 202 (annotation added)]

One basic expectation is that the writer must convince the reader they have exposed some idea or artifact that may bear significance for the reader and thus be worth the reader's attention. Thus the writer might express such significance deliberately.

Readers often expect the writer to present ideas that are new, interesting, and as described in the previous section, follow some theme, model, plot, or superordinate ICM with which they are familiar.

The writer influences the reader to the extent that the reader is provoked to take into account the ideas and belief structure the reader either has or is likely to have, the fundamental tenet of Assimilation Theory. He may structure the text such that claims are sure to stand on concepts already assimilated by the reader, and to which credibility has likely been imputed by the reader.

With regard to claims, especially in formalized or academic writing, Booth suggests providing an exposition of each specific element of an argument to enable the learner-reader to reconstruct the writer's intended claims (*dispositio*):

> *claim*, (concepts the writer intends readers to believe or know)
> *evidence*, (reasons readers should impute credibility to claims author

        intends to provoke)
    warrant (a general principle that explains why evidence is relevant to the
        claim, i.e., bears on relations to neighboring *dispositio*), and,
    qualifications (to make claim more precise)
    [Booth Colomb Williams 1995 89 (annotation added)]

Readers are skeptical of claims and evidence. The writer is likely to intend to provoke the reader to change their minds, i.e., to alter their *dispositio*; the reader's inclination is to resist because that *dispositio* already has some number of relations established to other ideas that might have to be changed, or at least re-evaluated, both of which require labor. Thus, readers resist change because they resist expenditure of energy for performing cognitive labor.

Consciously or subconsciously, the reader may expect to have warrants for evidence expressed, and be persuaded as to why they should accept the writer's claims (argument, *inventio*). (For descriptions of processes resulting in imputation of *belief* and *trust* attributes to concepts within the learner's knowledge, see What is critical thinking?, below, specifically where Booth *et al*. illustrate the relationship between three of these elements: claim, evidence, and warrant (Figure II.66)).

In reading, a generally linear endeavor, readers often rely subconsciously on the ICM of a *path*. A path generally has endpoints, a beginning point and a final destination (see: Process characteristics: endpoints, II.1). Thus readers conceptualize (subconsciously) the text as a journey from where they are (current knowledge) to where they or the writer wants them to go (new knowledge). In taking a journey, they desire to stay on the path. To facilitate this, it is helpful to know where the path leads in advance and what diversions and obstructions might be in store. Maps, abstracts, book reviews, etc. are objects that reader-learners use to know where their path leads:

> Readers want you to start them off with a strong sense of the path ahead
> and then to keep them posted along the way
> Readers begin looking for the main point of a section at the end of its
> introduction.
> Readers look for the main point in the last sentence of that introduction.
> . . .
> Readers prefer to move from what they know to what they don't. . . .
> Begin by reviewing what [concepts the writer is expecting the] . . . readers
> [to] know so they can move to what they will think is new.
> [Booth Colomb Williams 1995 161, 163 (annotation added)]

Despite these expectations and whether a writer has met those for a particular reader, the reader-learner may construct their own understanding different from the author-writer's knowledge structure.

> Most creative moments of [writing] occur not when . . . deciding what . . .
> to put in your report but when . . . thinking about what your readers must
> see there if they are to read it well and trust its conclusions.
> [Booth Colomb Williams 1995 265]

Thus, the writer's imaginative task encompasses not only expressing the concepts they wish to communicate, but anticipating the reader's ideas and those they might conjure, and what relations the writer must express on a path between the reader's prior knowledge and the ideas the writer desires to communicate.

Why is writing difficult?

> Writing is a process in which the private world of the mind is made overt.
> Inquirers sometimes engage in the process of writing simply to get ideas
> down on paper to clarify their own thinking. Often, however, the writer's
> purpose is to communicate ideas to others.
> The writer must ask if what has been written will make sense to the reader

> and if it will be convincing to the reader.
> [Champagne and Kouba 2000 234]

Writing is difficult. It consumes time and the writer's energy: it requires labor. In fact, writing requires labor of several types: evoking *inventio*, organizing *dispositio*, selecting *elocutio*, inscribing *pronuntiatio*, and delivering *pronuntiatio*, (Figure II.55(c)), not to mention revising, illustrating, indexing, or publishing. Producing *pronuntiatio* is not the only difficult part of writing, unless one is confronted with a faulty ink pen, temperamental typewriter, a bad printer cartridge, or a bug-infested text editor. Difficulty in originating new, or even familiar arguments, *inventio*-as-process, or of arranging or recognizing relations among ideas (*dispositio*), is termed *writer's block*. While this task might be taken for granted by many, K-12 students often struggle with evoking ideas or themes around which to write. This step in writing can be a significant block.

In evoking or selecting *inventio*, the writer must identify the underlying models (ICMs) both to aid in organizing his own *dispositio* and so as to give the reader the benefit of using the superordinate concepts through which they (the reader) can make sense of the more detailed concepts. For example, a writer who intends to describe how the American banking system operates might begin by expressing the fundamental concepts of money supply and reserve requirements, without which, the behavior of banking institutions might make little sense. Identifying such superordinate ideas might be difficult for a writer if the concept is so prevalent that the writer is no longer conscious of them. As the old adage says, the fish is often the last to notice the water.

Finding effective terms to express one's ideas (*elocutio*-as-process), then re-iterating because the text still doesn't quite "say what one wants it to say," all make writing a challenge.

Writing

attribute — What is writing?

attribute — Why is writing difficult?

difficult — evoking *inventio*

very difficult — organizing *dispositio,*

difficult — selecting *elocutio*

less difficult — inscribing *pronuntiatio*

external — delivering *pronuntiatio*

Recalling ideas

Recognizing ideas

Imagining reader's perspective
  of ideas expressed

Expending energy, overcoming
  inertia

Recalling vocabulary

Recalling spelling

Recalling grammatical
  constructs

Recognizing superordinate ideas

Recognizing similarities of ideas
  (Isomorphic mapping)

Recognizing relations among ideas

Recognizing relation types

Expending energy, overcoming inertia

Establishing relations
  (Isomorphic projection)

Motor skills

Utensil skills
  (manual or digital)

Figure II.55(c)

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Following Miller's speculation (see: The derivation *elocutio* ➜ *dispositio* is specification for evoking and selecting meaning, above), the writer who intends his expressions to be interpreted by others to recognize or construct specific *inventio* or *dispositio*, takes into account the conditions under which those readers would reach the intended constructions, all without interacting iteratively with his readers. A writer's objective of provoking ideas in the minds of others, readers, not having means of direct control of readers' thoughts, is, at best, an imperfect and indirectly controlled undertaking. It requires additional imagination on the part of the writer, not only evoking the ideas he wishes to express, but imagining the ideational structure of the reader, and further imagining how to provoke relations between the reader's imagined existing knowledge and the ideas intended for the reader to evoke. This is the task of focusing on the reader, the audience, and is occasionally overlooked. An organist or ensemble instrumentalists accustomed to performing in a dry or minimally resonant room who then receives the opportunity to perform in a centuries-old European church or cathedral must adjust their *pronuntiatio* "to the room," that is, allow for how the sound will be received by listeners in various parts of the room. Coordination that may seem "tight" in the dry concert room will be "off" in the more resonant sanctuary. Successful writers attempt to take into account how readers will interpret their texts - to "put themselves in their readers' shoes." This communicative task adds to cognitive challenges inherent in writing. Reviewing one's own text is a difficulty, however, because one cannot interpret the text afresh as readers must do to instigate the process of construction of meaning.

Occasionally, a writer's intention may be not to communicate intended concepts, but to provoke the reader into constructing their (the reader's) own various meanings, as is sometimes the case in poetry. However, in the more frequent writing scenario, the author intends the text to provoke the reader to evoke meanings, draw conclusions, or establish

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beliefs that he imagines are substantially similar to his own, i.e., particular meanings. A formidable difficulty for the writer is viewing his own draft text from the perspective of the reader, as Ausubel suggests ("ascertain what the learner already knows and teach accordingly").

> Most creative moments of [writing] occur not when . . . deciding what . . .
> to put in your report but when . . . thinking about what your readers must
> see there if they are to read it well and trust its conclusions.
> [Booth Colomb Williams 1995 265]

To the extent that readers unknown to the author evoke unambiguous meanings intended by the author, the writing is regarded as "clear" or "explicit". Where readers unknown to the author evoke unintended meanings or both intended and unintended meanings, the writing may be regarded as ambiguous. Of course, the author-writer may no longer be available to conduct such evaluations by the time readers acquire the tangible *pronuntiatio* and engage the text. Beyond these observations, assimilating the philosophical notion of intentionality into reading and writing theory is left for others.

Factors that contribute to difficulty in *thinking* of course influence the act of *writing*. Among those that have particular impact on writing is, for want of a better term, *velocity* (see: Cognitive velocity). Unobstructed thinking is much faster than unobstructed reading, which is faster than unobstructed speaking or writing. The physical acts of *elocutio --> pronuntiatio*, inscribing paper, typing, or making oral utterances have inherent physical speed constraints.

Innovations that mitigate obstacles to writing

Innovations that operate to aid the writer are different in an important way from those that pertain to readers. For readers, innovations are implemented either by the writer for the reader, or by an intermediary for the reader. That is, the reader is receiving aid from other parties. In contrast, for those engaged in the suite of tasks regarded as *writing*, there is little external intermediation available to the writer. Writing, even more than reading, is (most often) private. (Tasks performed by publishers such as editing, monitoring the market for particular types of texts, financing the various stages of production, advertising and marketing, transportation of physical volumes or provision of internet access, etc., are regarded as peripheral to the cognitive undertaking of writing.)

The writer produces texts through the processes described earlier, according to the Divisions of Rhetoric communications reference model. Some forms of conceptual and technical innovation are utilized by writers: They converse and communicate with colleagues, and even collaborate on the production of texts occasionally. Indeed technological innovations in collaborative support continue at a rapid pace. But what aids or techniques does the writer, alone with her thoughts and her inscription devices, have at her disposal?

Evoking *inventio*. A first challenge faced by some writers is that of evoking ideas about which to write, although this sort of writer's block occurs mostly in high school. A different but related sort of block however is difficulty encountered in becoming conscious of underlying models, themes, arrangements, or plots that structure the writer's ideas. Other than various "how to" texts on writing, there is little to assist the writer. The innovations of teachers, schools, universities, and reading have, as a primary cognitive purpose, the aim of preparing writers to evoke ideas, to perform conceptual

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tasks. An older innovation is for the writer simply to ask someone to read the text afresh in the hope that fundamental concepts, occurring or omitted, are recognized.

Inventio ➤ *dispositio.* For writing blocks in this category, mitigating innovations are somewhat more readily available. Proddings from teachers and others to "practice writing," even if only a few minutes a day, might be regarded as encouraging writers to practice organizing their ideas, for one can hardly write without doing so.

A more tangible innovation, beyond commitment to practice, is *fragmentation* of texts, as described above. Fragmentation of ideas enables writers to encapsulate their ideas in a well-bounded text, and also to rely on the reader having assimilated ideas already expressed in other, earlier texts.

In Part II.1, the potential value of concept maps to writers was outlined. Concept maps compel the writer to select simple labels for concepts, and more importantly, specify relationships among ideas. That writers are reluctant to use this method reveals that the cognitive labor of recognizing and thinking about relationships among ideas is not willingly expended and that another specific type of writer's block, reluctance to organize thoughts, is a significant hurdle for people.

Ausubel emphasizes one function of *inventio* ➤ *dispositio*: progressive differentiation, for example, from the *inventio* `tree`, differentiating apple trees, pine trees, family trees, tree diagrams, etc. Dictionaries and encyclopedias are used by writers to assist in differentiating the senses of general concepts.

Sometimes a writer (or speaker) expresses concepts that rely on other concepts that have not yet been assimilated, contrary to Ausubel's prime directive of "ascertain what the learner knows and teach accordingly".

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> Readers prefer to move from what they know to what they don't
> Begin by reviewing what your readers know so they can move to what
> they will think is new.
> [Booth Colomb Williams 1995 163]

> [Writers] cannot experience your own prose as readers will, because you
> know too much about it. When you come to a passage that your readers
> might stumble over, you sail right through, because you aren't actually
> reading it; you are only reminding yourself of what you were thinking
> when you wrote it.
> To overcome intractable subjectivity, [use] mechanical ways . . . to
> analyze, diagnose, and revise.
> [Booth Colomb Williams 1995 202]

A loose parallel to confronting the issue of attempting to build on conceptual building blocks not yet in place is found in the legal domain of civil procedure where an objection of "improper foundation" may arise when evidence has not been presented showing that the witness has personal knowledge of the fact in question. The forum provided to writers through which such objections may be received is the innovation of Letters to the Editor or Communications found in scholarly journals. However, there is no widely-used device or cognitive practice that easily enables a writer to detect and mitigate the building upon concepts that have not been established other than use of concept maps. The reason is important and common to most difficulties confronting the writer: All the labor, that is, all the derivations of all the Divisions except *pronuntiatio*, are cognitive, internal to the writer where other persons and intermediating devices cannot enter.

dispositio ➤ *elocutio.* In deriving *elocutio* from *dispositio*, the writer has a variety of innovations available. For example, thesauri provide alternative terms from which the writer may select, assuming she is able to identify at least one term expressive of her *dispositio* through which she may find others. Thesauri are structured to assist a writers confronted with particular cognitive circumstances, e.g.,:

The writer who knows a term but needs a narrower or broader term.

The writer who can evoke a term that is inadequately satisfactory because it evokes a sense different than the writer intends.

The writer who cannot recall a word, but would recognize it if she saw it in a list associated with terms within the same subject matter domain.

Thesauri are built around the writer's cognitive gap between concepts evoked by a term (available to the writer) that is minimally suitable and concepts evoked by other, perhaps more suitable terms:

> . . . the system originated by Peter Mark Roget for his first edition in 1852
> -- the arrangement of words and phrases according to their meanings.
> This plan brings together in one place all the terms associated with a
> single thought or concept;
> . . . within a book of modest size, without the space-consuming repetitions
> that so severely limit the scope of thesauruses done in a dictionary format,
> with A to Z entries [that is, there is an index to all terms in the back]
>
> .. . a pinpoint reference system that directs the user quickly from the index
> to numbered paragraphs of the right words.
> . . . terms most frequently used in a given context are in bold type
> [Roget's Thesaurus 4th ed. jacket notes]

Roget's instrument is based upon the assumption that meanings of terms are shared by readers, which is probably more true for words, idioms, and phrases than for sentences or larger text objects.

Writers often use different vocabulary for writing in specific genres, e.g., scholarly writing, than for speaking or other kinds of writing. Thus, a primary source of *elocutio* for a particular type of writing is reading other texts within the genre. Writers tend to use the vocabulary of their peers.

Other innovations for aiding the writer to overcome blocks in selecting terms and expressions likely have escaped notice here.

We have already mentioned earlier in this chapter that the innovation of *incremental text* provides for incorporation by reference as a substitute for duplicative writing.

elocutio ➤ *pronuntiatio.* In crossing from the intellectual realm to the tangible world, technological innovations have an entry point into the writer's overall suite of tasks. The breadth of innovations can be appreciated by considering any list of features of a modern word processors. Among these are spelling checkers, grammar checkers, font changing, embedded hypertext linking, automatic indexing and footnote production and formatting, embedded audio and graphic images, and many more.

Each *pronuntiatio* provides the writer the *possibility* of provoking the reader to evoke particular concepts: spell checkers facilitate perceptual and intellectual recognition of terms. Grammar checkers enable the writer to render a text according to the expectations of an anticipated audience of readers. Fonts, and changing of fonts, provoke particular meaning to a reader. For example changing from a font generally used for prose such as this (Times 12 point) `to a fixed font such as this (Courier 12 point)` can be used to indicate text intended to be interpreted in a different way, e.g., text entered into a system vis-à-vis a system response, a label identifying the actor in a play differentiated from the text the actor performs, etc. The beginning of a new paragraph is generally interpreted as a signal that the following text describes a different idea than the preceding paragraph.

Innovations apparently absent. Despite the contributions of technology to derivations of *elocutio* ➤ *pronuntiatio*, the other tasks in the overall task suite of writing have seen few innovations other than the establishment of formal education programs. No evidence has

arisen that evoking ideas, deriving *dispositio* (arranging ideas, differentiating concepts), or expressing ideas is much easier, much faster, or requires cognitive effort in more economical quantities now than in the past.

Exercises

Undertaking exercises, which imply writing tasks in addition to reading tasks, often cause one to reread a text with which they are associated. For example, in undertaking the exercises following the chapter in a mathematics textbook, the learner my need to re-read the presentation of the concepts or the examples or both.

1. Select a textbook that is familiar to you that includes assignments, questions, or exercise at the ends of chapters. Select an intermediate chapter that you have read recently, but for which you have not attempted the exercises. Attempt the exercises until you reach a point that you determine you must re-read some portion of the accompanying chapter. Before re-reading, depict the concepts and relations expressed by the question or exercise in a concept map. Attempt to characterize the "missing concepts" or missing relations from concepts you have depicted that may be required for explanation or completion of the question.

2. Perform the re-reading anticipated in the exercise above. Complete the exercise or write responses to the questions it poses. Then extend the concept map prepared in the exercise above to include:

(a) the concepts and relations expressed in the textbook that you felt "missing" prior to re-reading

(b) the concepts and relations that form an explanation or response to the posed question.

3. Select a document or a portion (no more than five pages) you have edited extensively very recently. Consider the task of proofreading it. If you experience reluctance to do so, attempt to write an explanation of that reluctance.

4. In the same document as (3), proofread until you find one error or expression that evokes an idea differently than you intended. Did you experience difficulty in reading the text carefully? Were you tempted to assume that a passage or paragraph was satisfactory and move on without actually vetting it?

To what cause might your reluctance to re-read be attributed?

To what cause might your inability to attend to the writing in sufficient detail be attributed?

What is interpretation?

Interpretation is a polysemous noun, used to refer to *process* and alternatively an *object* that is a product of a process. As *process*, *interpretation* encompasses:

 assimilating (e.g., learning, reading, listening):

$$\textit{pronuntiatio} \longrightarrow \textit{elocutio} \longrightarrow \textit{dispositio (inventio)}$$

 and *expressing* (e.g., writing, speaking, acting, painting, violin playing):

$$\textit{inventio} \longrightarrow \textit{dispositio} \longrightarrow \textit{elocutio} \longrightarrow \textit{pronuntiatio}$$

The *objects* produced in *reifying pronuntiatio*, e.g., documents, musical or stage performances, paintings, etc., are also referred to as *interpretations*.

The *objects* produced in *assimilating*, i.e., ideas, *dispositio*, are also *interpretations*.

Assimilating is: *pronuntiatio* ➜ *elocutio* ➜ *dispositio*

Successful assimilation requires *each* of these derivations to be performed. That is,

> A learner's mere receipt of *pronuntiatio* does not constitute interpretation
> nor learning.

> A learner's mere derivation of *elocutio* does not constitute interpretation
> nor learning.

Expressing is: *inventio* ➜ *dispositio* ➜ *elocutio* ➜ *pronuntiatio*

When one reads, one begins with a physical record, *pronuntiatio*, and ultimately constructs an understanding, an interpretation. For example, a dance company's interpretation of Swan Lake may begin with a musical score and a given choreography (*pronuntiatio*). The *elocutio* consists of the choreographic notation or improvisational vocabulary and musical expressions from which a performance is derived.

Conversely, when a writer begins with concepts and expresses them in a form transmittable to others, such is an interpretative act. For example, an author, sculptor, or choreographer may each have subject matter, *dispositio*, they wish to express. For the author, the ideas may be associated with mathematics or current events. For the sculptor, the ideas may be to attempt to connect some theme with an inert three-dimensional expression of that theme. For the choreographer, the ideas will be terpsichorean, musical, or both. Each selects a linguistic system, and perhaps a particular dialect (mathematics and algebra, modeling clay, or modern ballet) each having its own vocabulary patterns, and stylistic norms. From these linguistic systems, specific *elocutio* are selected to express their ideas. After iterating many times between *dispositio* and *elocutio* (Mozart excepted) to achieve a *work* such that the mathematical or terpsichorean ideas are organized and expressed satisfactorily, the expressions may be instantiated in tangible form (*pronuntiatio*), recorded or not, but all regarded as *interpretation*.

As noted earlier, the derivations of *dispositio* ➜ *elocutio* and *elocutio* ➜ *dispositio* may also require structural shifts, e.g., linear-to-web or web-to-linear format, or other transformations.

Other specific senses of *interpretation* obtain. Historically, the hermeneutical procedures and dogma employed during early and medieval eras for Biblical exegesis operated to control tightly the conclusions that could be drawn from texts:

> The preliminary stages of reading led to the exercise of Christian hermeneutics . . . to produce personal readings or exegeses of the text. Gregory the Great argued that the processes of readings ought to be a dialog with the text -- particularly the text of the Bible.
> [Parkes 1999 99]

Controlled interpretation of texts is found in modern legal systems where fundamental documents such as the U.S. Constitution are rigidly interpreted then projected onto circumstances never imaginable to its authors. Judicial decision-making and patent application examination are essentially interpretative enterprises

Interpretation is found wherever isomorphic projection (see below) is performed, Miller draws our attention to the relation between warrant (grounding) and interpretation:

> The reader can discover the *grounds* for the claimed resemblance, and that is the central problem of *interpretation*.
> [Miller 1993 372 (emphasis added)]

> Interpretation is not a search for a unique paraphrase of the implicit comparison, but rather a search for *grounds* that will constrain the basis of the comparison to a plausible set of alternatives.
> [Miller 1993 392   (emphasis added)]

> Finding *appropriate classes of referents* and relata is, strictly speaking, part of the task of interpretation. [Miller 1993 393 (emphasis added)]

In literary interpretation, a central task is the recognition of *subtexts*, important ideas implied rather than expressed. This form of interpretation may require recognition of underlying models or ICMs (see below) which the reader-listener must first evoke, then project onto a particular fact pattern in order to construct an intended meaning, a subtext.

In discussion of the notion of *subtexts*, concepts conveyed by double entendre, situation, and context rather than expressed directly, use of the terms *explicit* and *implicit* is tempting. One might prefer to say that subtexts refer to conditions where a reader-listener constructs meaning that is *implicit* in a text rather than *explicitly* expressed. However, these terms are best avoided if conduit metaphor error is to be eschewed. Meaning is not *in* terms, but constructed from them by a reader-listener-learner. A meaning apparently *explicitly* derived from a particular term for one reader might be considered *implicit* by another. Whether a term can be regarded as *explicit* can best be decided in the whole communication context of speaker-listener, writer-reader where the particular reader-listener constructs a meaning *unambiguously* through engagement with a particular text. If there are multiple possible meanings from which a reader-learner must select, then the meanings are likely to be considered *implicit*. For example, if a speaker intends the listener to evoke the concept of *money*, then it matters not if he uses the term *money* or *bread* so long as the receiver evokes the concept *money*.

Biblical exegesis (*hermeneutics* is the study and establishment of principles by which texts are to be interpreted; *exegesis* is the act of interpretation itself), is a codified system of positions as to whether statements are assigned literal meaning, moral, allegorical, metaphorical, or figurative meaning. Like judicial interpretation, exegesis imposes painstaking exposition of warrants for drawing conclusions.

There are a number of fields whose *central* concern is interpretation. These include the arts, architecture, music, dance, poetry and literature, theater. They may employ quite different linguistic systems, ballet, atonal music, a romantic genre, Bauhaus, baroque, or impressionistic, to name a few. But procedurally, they usually operate as in ordinary writing: They begin with ideas, arrange them, select terms to express those ideas, and finally they are rendered in physical form, exposed to the physical world.

What is thinking?

Having considered an overall communications model for meaningful *reception* learning, that is, learning inclusive of engagement with external *pronuntiatio*, attention may now turn to how *dispositio* is constructed, that is, how *thinking* works (Figure II.49(b)).

Lakoff and Johnson describe cognitive science in terms that track the Divisions of Rhetoric communications reference model outlined above:

> In cognitive science, the term *cognitive* is used for any kind of mental operation or structure that can be studied in precise terms. Most of these structures and operations have been found to be unconscious. Thus visual processing falls under the cognitive, as does auditory processing. Obviously, neither of these is conscious, since we are not and could not possibly be aware of each of the neural processes involved in the vastly complicated total process that gives rise to conscious visual and auditory experience. Memory and attention fall under the cognitive [*memoria*]. All aspects of thought [*dispositio* and *inventio*] and language [*elocutio*], conscious or unconscious, are thus cognitive.   This includes phonology, grammar, conceptual systems, the mental lexicon, and all unconscious inference of any sort. Menial imagery, emotions, and the conception of motor operations have also been studied from such a cognitive perspective. And neural modeling of any cognitive operation is also part of cognitive science.
> [Lakoff Johnson 1999 11 (annotation added)]

What is *mind*?

Mind is the term used here for the totality of (1) mental processes (thinking), and (2) the resulting objects, thought (*inventio*, *dispositio*).
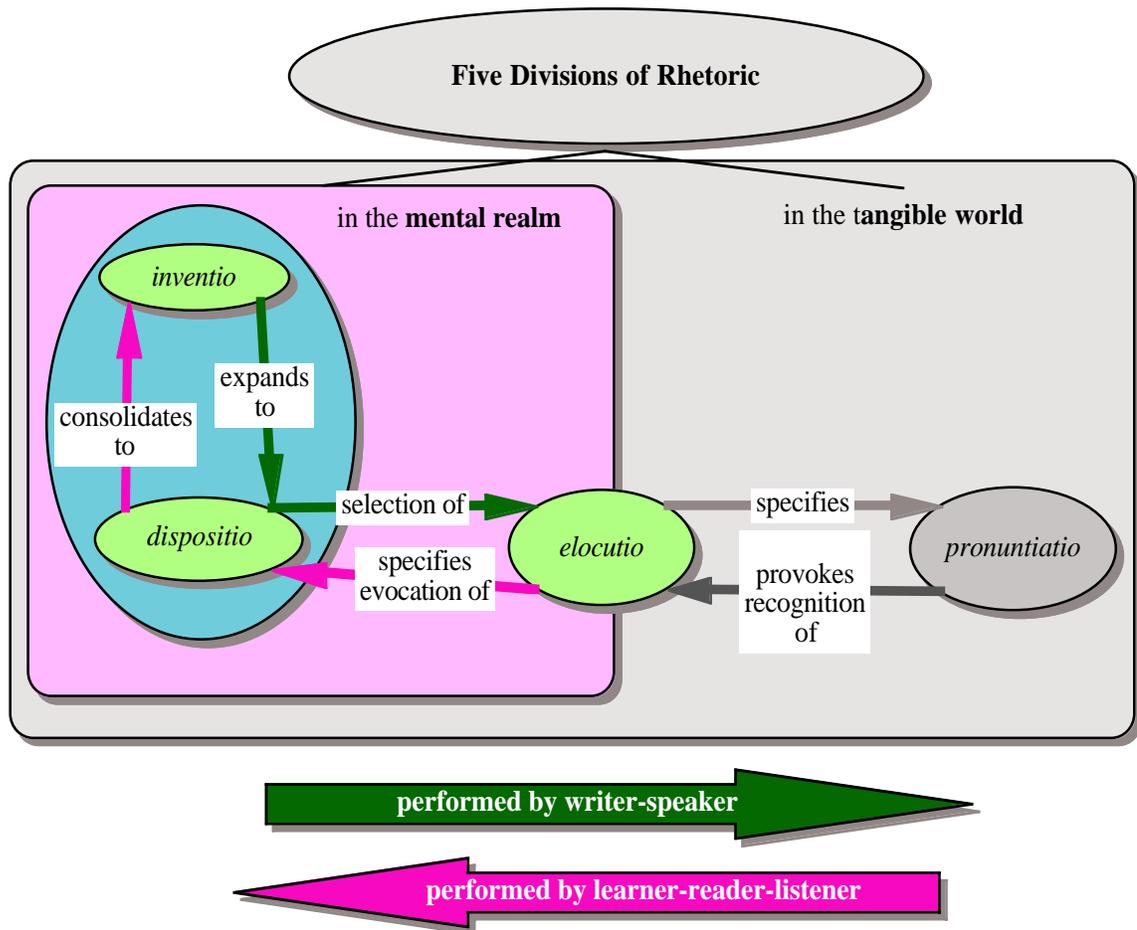
Figure II.49(b)

What do learners do when they think?

Ausubel recognizes that *learning*, and his theory of it, are part of *thinking* ("cognitive capabilities"), and thus rely on fundamental aspects of thought:

> The distinctively human capacity for meaningful verbal learning is
> dependent, of course, upon such cognitive capabilities as symbolic
> representation, *abstraction, categorization, and generalization*. It is the
> possession of these latter abilities that ultimately makes possible the
> original discovery and subsequent learning of generic concepts and
> propositions and, hence, the later acquisition of the more detailed,
> relatable information and ideas comprising the bulk of knowledge.
> [ARK 78 (emphasis added)]

Of all the intellectual phenomena oriented to an individual's private realm (in contrast to communication, addressed above), Ausubel chose to acknowledge, in the passage, *abstraction*, *categorization*, *generalization* as fundamental to thought, and the basis for *transfer* and the four process conceptualizations he originated.

Symbolic representation is best interpreted as *elocutio* rather than in the artificial intelligence sense where minds are simply computers that draw conclusions exclusively by manipulating symbols. On account of the ambiguity in Ausubel's claim, that is, from the two senses of *symbolic representation*, the notion is not drawn upon in this essay.

Abstraction, categorization, generalization, and transfer are each a direct product of a pair of fundamental processes that establish and coordinate relations among concepts, *meaning*, and which underlie many, perhaps surprisingly many, cognitive phenomena:

isomorphic mapping and **isomorphic projection**.

Why does one thought lead to another?

Isomorphic mapping and isomorphic projection are cognitive mechanisms that cause a thought to evoke a subsequent thought. These are outlined, and their roles in transfer, progressive differentiation, subsumption, superordinate learning described.

A distinction might be made between *how to think* about a question as differentiated from thinking about the question. *How* to think about a question may be regarded as selecting which conceptual models will be used for mapping and projection. Actually thinking about the question is the actual mapping and projection between model and specific instance of a question.

Isomorphic mapping and isomorphic projection

This is a continuation of the discussion of *Transfer* (Section II.1, above).

Ausubel acknowledged the underlying mechanism of transfer and metaphor as a projection of one mental structure onto another:

> This (lateral *transfer*) involves the generalizability of the residue of one
> set of existing learnings both to the comprehension and problem solution
> of tangentially or *metaphorically* related problems in a somewhat different
> but related area of knowledge or problem-solving experience.
> [ARK 147 (emphasis added)]

Thus, the notions of isomorphic mapping and isomorphic projection are not merely adjacent to, but part of, Assimilation Theory, even if not described with those specific labels. The segue from Assimilation Theory to contemporary metaphor theory (cognitive structure theory) is synergistic.

Ausubel alludes to the construction of meaning through *interaction among conceptual structures*, and he makes scattered references to cognitive mapping, but in the *pronuntiatio* sense of Novak's concept maps rather than in the *dispositio* sense of relations among *inventio*.

> [T]he learner's generation of new meanings which he purportedly 'constructs' from the interaction between presented and related potential meanings in the latter's cognitive structure. [ARK xi].

> Availability of relevant ideas in cognitive structure may be ascertained by . . . "cognitive mapping." [ARK 148]

Ausubel does not explain or diagram at the sub-*dispositio* level, *how* one structure is coordinated or integrated to another. Cognitive scientists, linguists, and philosophers explain concepts that Ausubel does not: the mechanisms *underlying* transfer and Ausubel's other processes, *viz.*, isomorphic mapping and isomorphic projection. Indeed, isomorphic projection is shown (below) to be the basis of other phenomena generally regarded as having little in common.

Isomorphic mapping and isomorphic projection occur rapidly and iteratively (see: Continuous derivations, below).

What is isomorphic mapping?

Isomorphic mapping is a comparative operation between two structures:

> The word 'isomorphism' applies when two complex structures can be mapped onto each other, in such a way that to each part of one structure there is a corresponding part in the other structure, where 'corresponding' means that the two parts play similar roles in their respective structures. [Hofstadter 1979 49]

Mapping, that is, establishing a relation among corresponding elements of two *dispositio* structures first requires that recognition of the comparable attributes occurs:

> The first steps toward analogical thinking require the recognition that two different things can be treated the same.
> [Holyoak Thagard 1995 39]

> *Identity*. The *recognition of identity, sameness, equivalenc*e … is in fact a spectacular product of complex, imaginative, unconscious work. … But identity and opposition are finished products provided to consciousness after elaborate work.
> [Fauconnier Turner 2002 6]

Indeed, isomorphic mapping is comparable to Fauconnier's *identifying*.

> Identity [isomorphic mapping], integration [isomorphic projection], and imagination . . . are at the heart of even the simplest possible meanings. … These basic operations are the key to both the invention of everyday meaning and exceptional human creativity.
> [Fauconnier Turner 2002 xi (annotation added)]

> Identification of elements. This principle states than an expression that names or describes an element in one mental space can be used to access a counterpart of that element in another mental space:

> | Access Principle |
> | --- |
> | If two elements a and b are linked by a connector F (b=F(a)), then element b can be identified by name, describing, or pointing to its counterpart a. |

> [Fauconnier 1997 41]

Isomorphic mapping is the coordination of at least one substantially similar *inventio* (concept) or relation from a source *dispositio*, with a counterpart *inventio* or relation in a target *dispositio* (Figure II.56).

Upon recognition of as little as one *inventio* among a first *dispositio* in common with an *inventio* among a second *dispositio*, or even a single relation in common, the learner may

deliberately or subconsciously initiate mapping one structure onto the other. The purpose

is to find and identify other commonalties among the two structures.
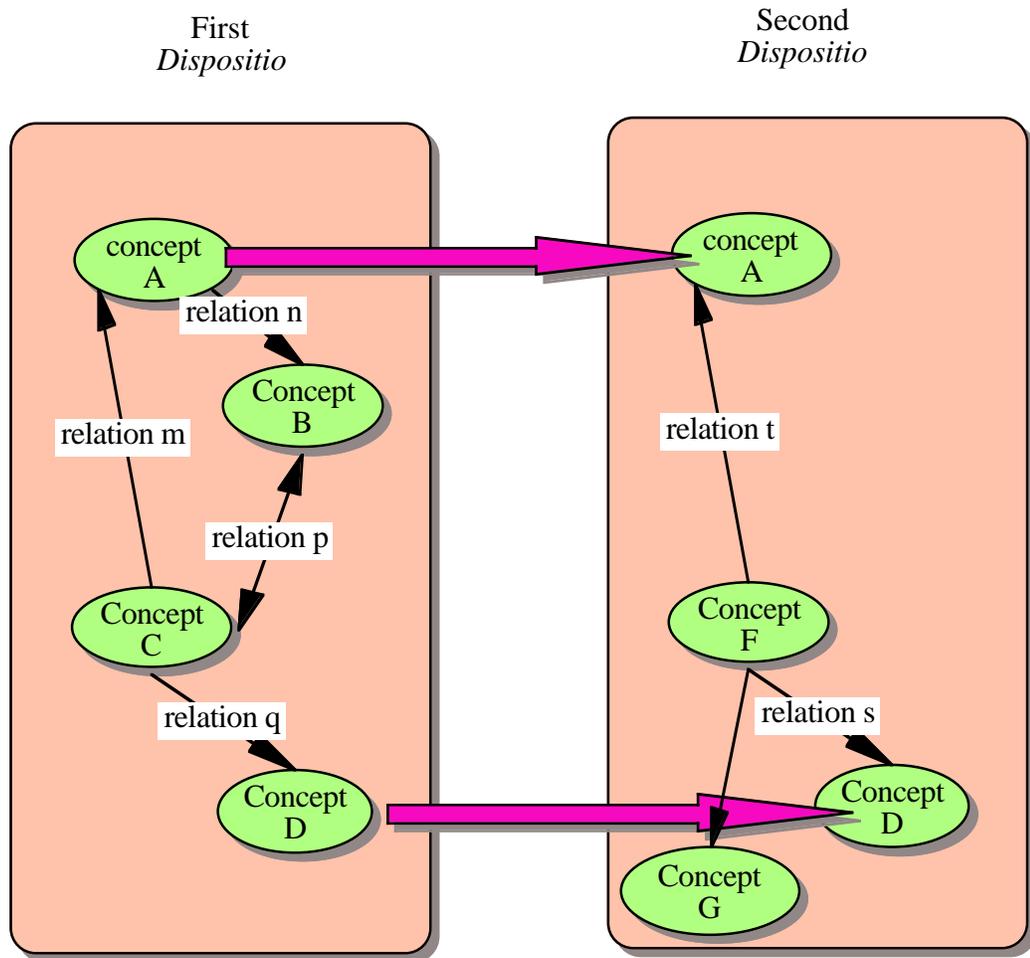
Two similar ideas, portions of a learner's knowledge structure,
and two concepts (*inventio*), Concept A and Concept D in source mapped to
corresponding *inventio* in target.

Figure II.56

What steps occur in isomorphic mapping?

> The faculty for perceiving analogies is the best indication of genius.
> Some people are far more sensitive to resemblances, and far more ready to
> point out wherein they consist, than others are. They are the wits, the
> poets, the inventors, the scientific men, the practical geniuses.
> [James 1890 Vol. 1. p. 530, Ch. XIII, Discrimination and Comparison]
>
> The flash of similarity between an apple and the moon, between the
> rivalry for food in nature and the rivalry for man's selection, was too
> recondite to have occurred to any but exceptional minds. Genius, then, as
> has been already said, is identical with the possession of similar
> association to an extreme degree.
> [James 1890 Vol. 2, p. 361, Ch. XX, Reasoning]

Upon recognition of an *inventio* among a first *dispositio* in common with an *inventio* among a second *dispositio*, the learner may initiate mapping one structure onto the other. The more commonalties identified, generally, the greater possibility to two *dispositio* may consolidate into one structure, either through subsumption or superordinate learning, or, if the two retain their distinct identities, the richer *dispositio* will be called upon to "fill in" missing structure in the sparser *dispositio* in a second process, isomorphic projection (*transfer*) (see: What is isomorphic projection, below).

Isomorphic mapping process comprises (1) (optionally) *becoming motivated* consciously or subconsciously, to perform a mapping, (2) *searching* for *inventio* or relations in the target domain that match the element of interest in the source domain, (3) *recognition* of matching elements, (4) *identification* of the matching concepts and relations, (5) optionally, *recognition of differences* of *inventio* and relation, or degree (duration, intensity) of relations in the two structures, and (6) recognition of "unknown" concepts or where the target manifests a gap, i.e., a missing concept or relation relative to the source *dispositio*.

Determining whether two concepts are "the same"

Differentiating among concepts (*inventio*, *dispositio*) is often determined on the basis of one particular attribute: its *elocutio*, i.e., the word, phrase, or set of terms utilized to express it. This popular approach, of course, often leads to misunderstanding and incomprehension. The particular *inventio* components of *dispositio*, and the relations among them, as well as their *elocutio*, constitute a particular concept for a particular learner. Thus, differentiating among concepts is best performed by contrasting their elemental *inventio* and relations, not just by the name they are called.

One idea might have substantially the same *inventio* and relations among them as occur in another concept, yet they might not be one and the same if the second comprises all of the first and additional *inventio* or relational elements not in the first. For example, all the elements of the *dispositio* (idea) of a blank sheet of typing paper might be found in the *dispositio* of a ream of such paper, but with the additional attributes of '500,' its packaging, pricing per ream, etc.

Of course, if two concepts appeared to be identical, there would not be two concepts, but one. So, "the same" implies "substantially the same," perhaps with similar attributes and different *elocutio* (name or label), or same label but different attributes.

What is isomorphic projection?

Ausubel's Assimilation theory is grounded in the principle of *constructivism*, a learner's inclination to "construct" structured knowledge in contrast to "receiving" structured concepts themselves. Thus, *construction* is often presented as if it is an end in itself, rarely with an explanation of how, exactly, construction works in the conceptual sense. One of the most prevalent mechanisms of conceptual constructions is *isomorphic projection*.

Isomorphic projection is a separate process that fills in a portion of the target *dispositio* by deriving replica *inventio* from the source structure. It operates upon two structures already partially coordinated through isomorphic mapping, but takes the additional step of importing a replica of an structure (existing or new) into another structure (new or existing) (Figure II.57).

Isomorphic projection is not accomplished though mapping or recognition of similarities alone, but incorporates the *construction* of a *new* portion of *dispositio* derived from another concept. This creation of new structure may be regarded as *creative* or *imaginative*.

Isomorphic projection is comparable to Fauconnier's (and Ausubel's) *integration*

> *Integration*. Finding identities and oppositions is part of a much more complicated process of conceptual integration . . .
> Conceptual integration, which we also call *conceptual blending*, is another basic mental operation, highly imaginative but crucial to even the simplest kinds of thought.
> [Fauconnier Turner 2002 6, 18]

First
Dispositio

Second
Dispositio

concept
A

concept
A

relation n

relation n

Concept
B

relation n

Concept
B

relation m

relation k

relation p

Concept
C

Concept
F

relation q

relation h

Concept
D

Concept
D

Concept
G

A mapping
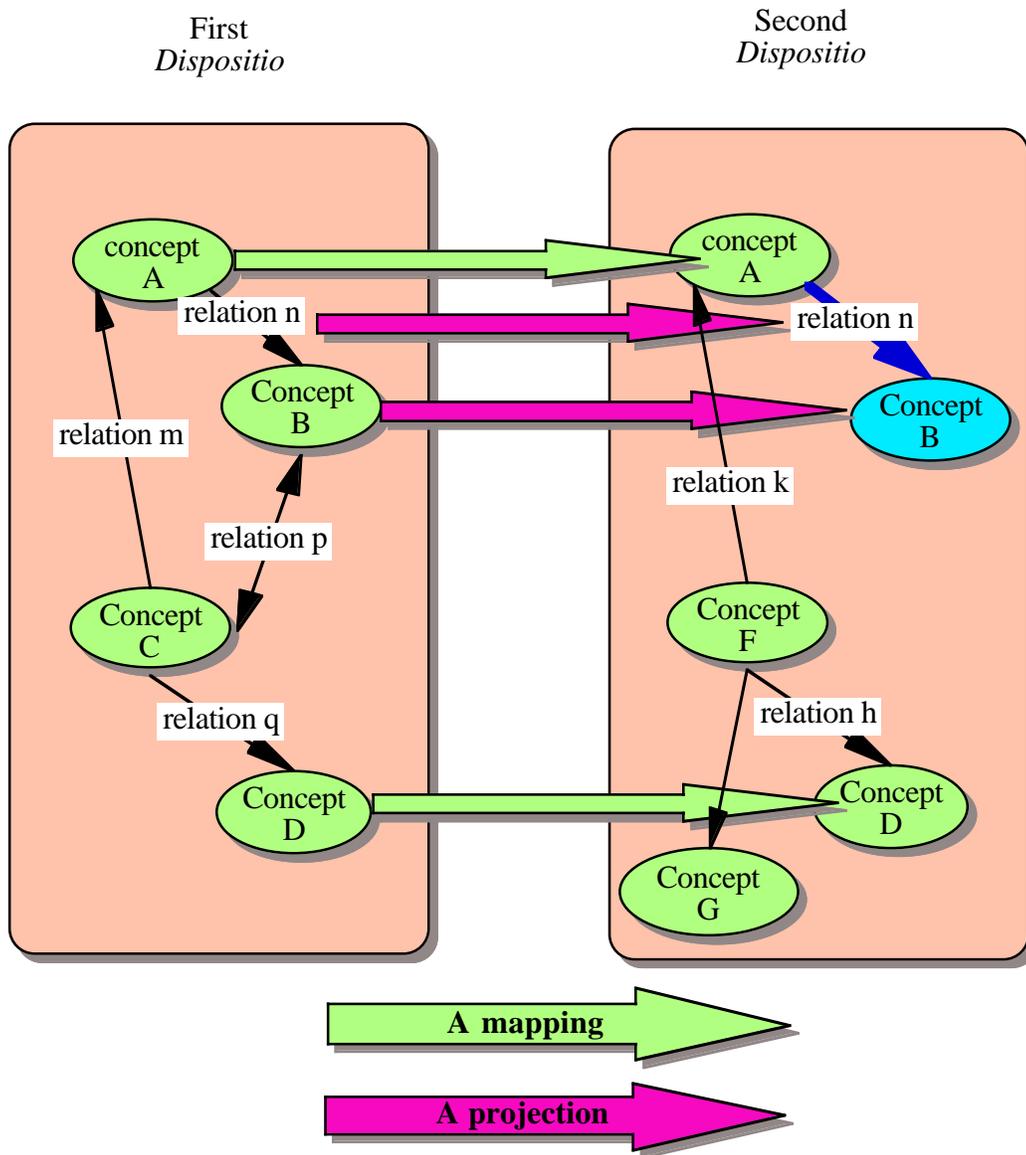
A projection

Concept B and relation n isomorphically projected from source to target

Figure II.57

What steps occur in isomorphic projection?

Mayer articulates the steps of isomorphic mapping and projection (in the context of *transfer*):

> [P]roblem solving *transfer* occurs when three cognitive conditions are
> met: selecting, organizing, and integrating.
> [Mayer 1993 572-573 (emphasis added)].

The integration, that is isomorphic projection, itself requires isomorphic mapping from first *dispositio* to second *dispositio*, followed by determining which of the second *dispositio* will be projected to the first *dispositio*, which relations of the second *dispositio* will be projected to the first *dispositio*, and to which of the first *dispositio* they appropriately connect. In some cases, each *dispositio*, first and second, may project onto the other. Other tasks such as *discrimination* (recognition of differences), setting relation strength or other characteristics, or *disambiguation* may occur.

Isomorphic projection is thus, a construction.

> Constructions are combined by superimposition.
>
> Each grammatical construction is a form of meaning-pairing with the
>
> structure of a cognitive model. . . . sentences are processed by general
>
> cognitive processes. [Lakoff 1988 122]

When *new* relations are constructed in isomorphic projection, the learner has constructed new *meaning*, that is, the *relations are meaningful*:

> Meaningful learning requires . . . that the material they learn be
> potentially meaningful to them, namely, *relatable* to their particular
> structures of knowledge . . .
> (Ausubel, 196la) [ARK 68 (emphasis added)]

Suppose isomorphic projection results in new *inventio*. Can there be new concepts with no new relations? In meaningful learning, new ideas are integrated with (i.e., new relations are established) the learner's prior knowledge. If not, the new concepts are regarded as rotely learned rather than meaningfully learned.

Perhaps the most detailed description of isomorphic projection is provided by Black, in the context of metaphor:

> A brief summary of the preferred interactive view [of metaphor] might consist of the following claims . . .
> 1. . . . two distinct subjects, to be identified as the primary "subject" and the "secondary" one. . . .
>
> 2. the secondary subject is to be regarded as a system [*dispositio*] rather than an individual thing [*inventio*] . . . [Footnote II.9]
>
> 3. The metaphorical utterance works by "***projecting*** upon" the primary subject a set of "associated implications," comprised in the implicative complex, that are predicable of the secondary subject. . . .
>
> 4. The maker of a metaphorical statement selects, emphasizes, suppresses, and organizes features of the primary subject by applying to it statements ***isomorphic*** with the members of the secondary subject's implicative complex.
>
> 5. In the context of a particular metaphorical statement, the two subjects "interact" in the following ways: (a) the presence of the primary subject incites the hearer to select some of the secondary subject's properties; and (b) invites him to construct a parallel implication-complex that can fit the primary subject; and (c) reciprocally induces parallel changes in the secondary subject.
>
> Then the two systems have, as mathematicians say, the same "structure";
>
> In "Poverty is a crime," "crime" and "poverty" are nodes of isomorphic networks, in which assertions about crime are correlated one-to-one with

corresponding statements about poverty.

Hence, every metaphor may be said to mediate an analogy or structural correspondence.
[Black 1993 27-30 (annotation added)]

Blends

Arthur Koestler . . . defines creative acts as the *combination of previously unrelated structures* in such a way that you get more out of the *emergent* whole than you have put in. [Adams 1974 35]

According to Assimilation Theory, upon conclusion of a projection event (i.e., a meaningful learning event), both the target and the source *dispositio* are changed: they now each have at least one new relation, a relation to each other:

In meaningful learning the very process of acquiring information results in a modification of both the *newly* acquired information and of the specifically relevant aspect of cognitive structure to which the new information is linked. [ARK 3]

In Fauconnier's conceptualization of projection, the operation upon the target does not result in a modified target, but the creation of a new third object, a blend:

Conceptual integration, which we also call *conceptual blending*, is another basic mental operation, highly imaginative but crucial to even the simplest kinds of thought. [Fauconnier Turner 2002 18]

Cognitive mappings and blendings are at the heart of meaning construction. [Fauconnier 1994 xliv]

In these passages, "mappings" may be regarded as isomorphic mappings, and "blendings" may be regarded as isomorphic projections.

Conceptual blends do not simply project one *dispositio*, source, onto a second, a target, resulting in a changed target (and changed source, as well). Instead, both source and target *dispositio* remain unchanged, and the product of the projection is a new third intellectual object, that is, a *dispositio* with both the properties of the target *and with* the attributes projected from the source (Figure II.58). Moreover, the resulting blend will have features that were not in either original domain (e.g., relation W in Figure II.58):

Concept B and relation n isomorphically projected from source to target,
resulting in a *Blend*
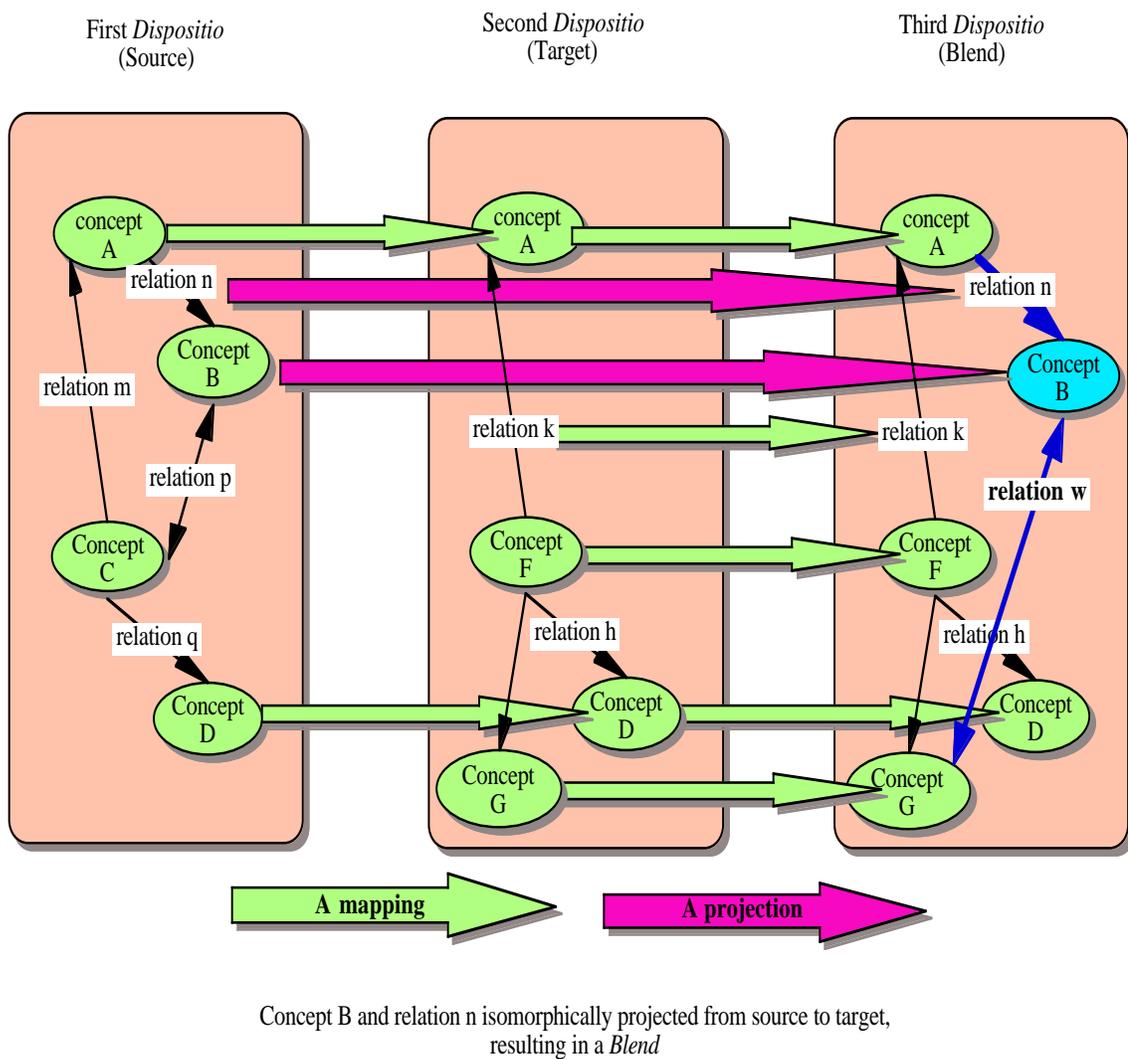
Figure II.58

Fauconnier provides a historical example of blending:

> . . . specific examples of what we call blending . . . The earliest such
> observation that we have found comes from Aristotle. It occurs in Book 3
> of Aristotle's *Rhetoric*:
>
>> The address of Gorgias to the swallow, when she had let her
>> droppings fall on him as she flew overhead, is in the best tragic
>> manner. He said, "Nay, shame, O Philomela." considering her as
>> a bird, you could not call her act shameful; considering her as a
>> girl, you could: and so it was a good gibe to address her as what
>> she was once and not what she is.
>
> The shameful act exists only in the blend: The act is impossible for the
> girl, and the shame is impossible for the swallow.
> [Fauconnier Turner 2002 36]

Fauconnier provides a more commonplace example:

> As neuroscience has shown, the many aspects of the cup of coffee -- the
> color of the cup, the shape of the opening, the topology of the handle, the
> smell of the coffee, the texture of the surface of the cup . . . are
> apprehended and processed differently in anatomically different locations
> and there is not single site in the brain where these various apprehensions
> are brought together. How can the coffee cup, so obviously a single thing
> for us at the conscious level, be so many different things and operations
> for the neuroscientist looking at the unconscious level? . . . How we
> apprehend one thing *as one thing* has come to be regarded as a central
> problem of cognitive neuroscience, called the "binding problem." . . . We
> do not ask ourselves how we can see one thing as one thing because we
> assume that the unity comes from the thing itself, not from our mental
> work, just as we assume that the meaning of the picture is in the picture
> rather than in our interpretation of its form. The generalized Eliza effect
> leads us to think the form is causing our perception of unity, but it is not.
>
> *We see the coffee cup as one thing because our brains and bodies work
> to give it that status.*
>
> The lumping together of points as the "same" is a mental achievement that

creates an integrated object.
[Fauconnier Turner 2002 7, 12 (emphasis added)]

Fauconnier illustrates the power of isomorphic projection, of blends:

In cases of lottery depression, the lottery player, before the drawing, is living in parallel blends -- one in which he has won and one in which the ticket is incidental, for fun only -- but it is only when depression sets in and has to be explained that it becomes clear that the player had been living in the blend in which he won.
[Fauconnier Turner 2002 233]

In these ideas, Fauconnier parallels and extends Ausubel's integration-centric focus of the processes he (Ausubel) advocates, transfer, integrative reconciliation, subsumption, superordinate learning (with the exception of progressive differentiation):

New meanings . . . are the product of an active, *integrative* interaction between new instructional materials and relevant ideas in the learner's existing structure of knowledge. [ARK 40]

Counterfactual blends

Fauconnier introduces a particularly important species of *dispositio*, a particular type of blend: the *counterfactual*:

The great evolutionary change that produced cognitively modern human beings was a matter of evolving an organism that could run off-line cognitive simulations . . .   Human beings can run several scenarios, mentally check the outcomes, and make choices . . .
[Fauconnier Turner 2002 217]

Use of subjunctive terms such as *if*, *should*, *would*, or *could*, create a frame, a *dispositio* that a learner can *know*, to which he can impute practicality, but does *not* necessarily *believe*, i.e., does not associate with a *truth* attribute. Yet, he *knows* the idea and is able

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to use it in intellectual processes (isomorphic mapping and projection, transfer, superordinate learning, integrative reconciliation, etc.) as any other *dispositio*):

> *if* sets up a conditional mental space . . . a counterfactual.
> [Fauconnier 1994 xiv]

> A counterfactual blend like "If Churchill had been prime minister in 1956, there would have been no Suez disaster" implicitly assumes an essential character for Churchill that can be projected to a time and circumstance when he was no longer active.
> [Fauconnier Turner 2002 250]

A counterfactual is not necessarily untrue. Indeed, *truth* is beyond our scope, which is limited to what the learner is able to deem true, i.e., believe. A counterfactual is distinct from the idea to which it is compared or contrasted:

> A space [*dispositio*] will be counterfactual depending on the point of view one takes . . . [W]e use *counterfactual* to mean that one space has forced incompatibility with respect to another. But there is a narrower and more common use of the term to mean that one space has forced incompatibility with respect to space we take to be "actual."
> [Fauconnier Turner 2002 230]

> If an author says that x is y when we know in fact that x is not y, we must try to imagine a world in which x is y. This act of imagination is facilitated if, in the real world, x is like y in some respects, for then we can take their similarities as the author's grounds for saying that x is y.
> [Miller 1993 367]

A routine use of counterfactuals is in games where a player imaginatively assumes a role relevant to the game, e.g., bluffing in poker, property developer in monopoly, or the role of winner in buying a lotto ticket. One *must* assume the role if one is to play the game successfully.

Advertisements rely on counterfactuals. An effective advertisement puts the listener into a counterfactual *dispositio* where he believes that if he buys the car, he will be popular or

sexy, if he buys the prescription drug his ailment will disappear, and if he purchases the detergent, his laundry will come out blindingly white. Counterfactuals are not necessarily *believed*, but belief is sufficiently suspended to try the product.

A superordinate concept, an idealized cognitive model, may be a counterfactual. For example, the concept of *Santa Claus* organizes many disparate ideas (gifts, retail sales, decorated pine trees, a behavior-based reward paradigm, flying reindeer, etc.). Yet, there is no actual Santa Claus, only the idea of Santa Claus and multitudes of partial performances of the character. Thus, *Santa Claus* is a not only a counterfactual but a superordinate idealized cognitive model that explains diverse phenomena: e.g., why children sometimes modify their behavior in December, why consumer debt increases in December, and why retail executives receive little vacation time during the summer. Superordinate counterfactuals facilitate the playing out of scenarios (to a child: if you're good, Santa will bring you the bicycle you want!" or to consumers: "If Santa is too generous this year, the Federal Reserve might raise interest rates to counteract inflation."). Thus, counterfactuals are *theories*, not necessarily true, but useful.

In counterfactuals, one can see the license for imagination and creativity (see: What is the role of imagination in thinking? and What is creativity? below).

In sum, counterfactuals are a form of *dispositio* distinct from knowledge that is believed to be the case. They can be used to run hypothetical scenarios for problem solving, entertainment, or other intellectual tasks. They are imaginative because they comprise ideas for which the learner might not have evidence, indeed, might be purely fanciful.

> Reason is *imaginative* in that bodily inference forms are mapped onto
> abstract modes of inference by metaphor. [Lakoff Johnson 1999 77]

Exercises

1. Construct a concept map to depict your understanding the factors responsible for current gasoline prices. Use no more than eight to ten concepts depictions. Show all salient relations among the concepts.

2.   Construct a concept map to depict your understanding of the effects on your region if gasoline prices increased to $8 per gallon. Use no more than eight to ten concepts depictions. Show all salient relations among the concepts.

3.   Construct a concept map to depict your understanding of the effects on your region if gasoline prices decreased to $1 per gallon. Use no more than eight to ten concepts depictions. Show all salient relations among the concepts.

4. You are an energy policy wonk in Washington, D.C. Select concepts from the counterfactuals in (2) and (3), and projecting onto the structure in (1) such that this fourth concept map shows an explanatory conceptual *path* from current conditions to resolution of a problem about which your constituents care deeply.

What motivates isomorphic mapping and isomorphic projection?

Because isomorphic mapping and projection occur at such a basic conceptual level, the conditions that account for initiating them may be so rapid and outside the boundaries of conscious or deliberate awareness that they are an innate part of the evocation of thought (see: Most isomorphic operation is subconscious). That is, upon evocation of an object of *inventio*, the learner cannot help but to map or "fill in" the thought by connecting to other *inventio*. This is the intrinsic creative nature of the human mind, to imaginatively construct *dispositio*. Humans are meaning makers. These processes operate upon objects of *inventio*, which might be subconscious, to construct *dispositio* that become available in the conscious.

At the level of conscious awareness, any number of communicative events and internal intellectual tasks might set isomorphic mapping and projection into operation, creating felt sensations of distressing ignorance [Buckland 1991a], constructive discontent (see: Curiosity-as-feeling)**,** and similar intellectual conditions that motivate thought.

Consideration of the nature of *inquiry* (comprising cognitive and linguistic questions, curiosity, explanations, the roles of creativity and imagination) is deferred to the end of this section. For the present discussion, the reader may assume that a learner's motivation to "fill in" concepts they know arises, in part, from consciousness -- perhaps to varying degrees in different individuals. Ausubel described (above) forms of external motivation. Thus, motivation for thought is assumed in this discussion of isomorphic mapping and isomorphic projection.

Isomorphic projection underlies *transfer*

> For Herbart (1898) "apperception" was a general term for those mental processes whereby an attended experience is brought into relation with an already acquired and familiar conceptual system. Today our psychological journals are full of terms like "encoding," "*mapping*," "categorizing," "inference," "assimilation and accommodation" . . . perhaps "apperception" would be a useful superordinate for all of them.

> If I understand Herbart correctly, his general claim was that new things are learned by being related to things already known; he built his educational psychology on the belief that if teachers know what their pupils know, they can relate ideas they want to teach to ideas the pupil has already mastered. . . . maximizing *transfer* . . . seems as sensible now as it did a century ago. [Miller 1993 357]

The concept of transfer in education has been outlined above (Section II.1) as the projection of knowledge held by a learner in one context or situation to a different context. *Transfer* is known to other fields by other names. To computer scientists, a similar fill-in function is called *inheritance* implied by hierarchical structure.

Isomorphic mapping and isomorphic projection underlie the processes to which Ausubel attributes learning, including transfer. Figure II.57 (above) illustrates the *transfer* of Concept B and relations n and p from the source *dispositio* to the target *dispositio*.

Adopting Ausubel's terminology of meaningful learning, Mayer depicts an example of isomorphic mapping (as a text frame rather than a concept map), though conflating analogy (isomorphic mapping only) with *transfer* and *metaphor* (Figure II.59):

> [P]roblem solving *transfer* occurs when three cognitive conditions are met: selecting, organizing, and integrating.

First *Dispositio* "Metaphoric Domain"		Second *Dispositio* "Target Domain"
throw ball	⟷	transmit radio wave
↓		↓
ball bounces	⟷	radio wave reflected
↓		↓
ball returns	⟷	radio wave returns
↓		↓
measure time	⟷	measure time
↓		↓
convert to distance	⟷	convert to distance
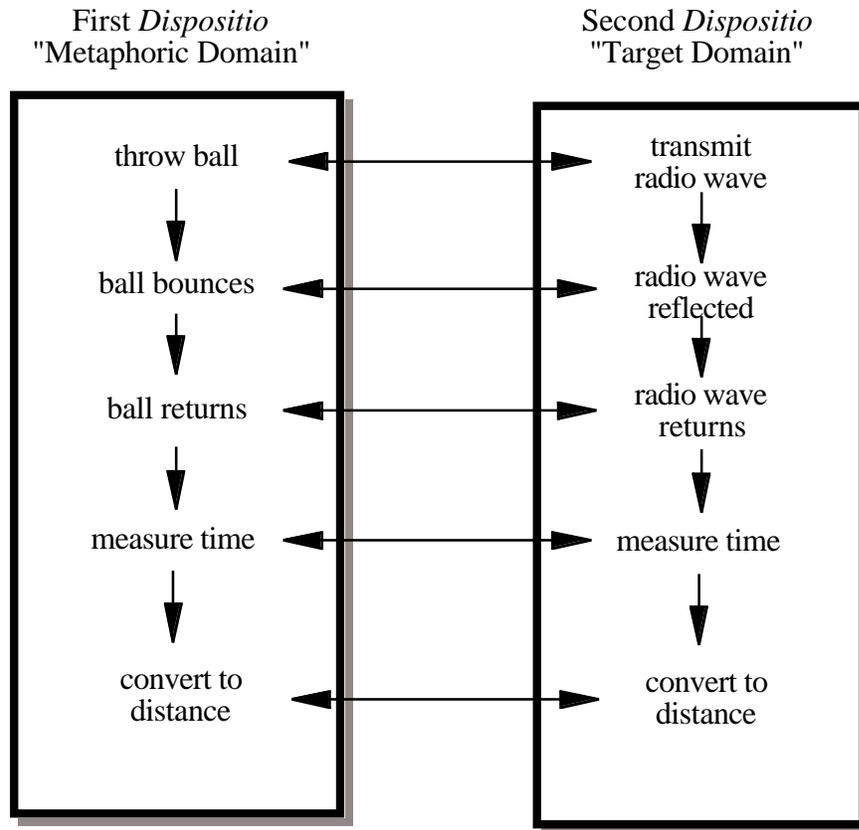
Figure 24.1. Radar as a bouncing pulse
[Mayer 1993 574]

Figure II.59

Unfortunately, however, students often fail to create an effective *analogy* between radar and bouncing pulses (or dropping pebbles) thus failing to meet the second and third criteria for *meaningful learning* (organizing and integrating). For example, our results showed that students did not perform well on tests of problem-solving transfer after reading the radar passage. [Mayer 1993 572-573 (emphasis added)].

Closely related to transfer is inference. Isomorphic projection underlies inference, the process of drawing a conclusion as to a *new* question (conceptual relation) based upon conclusions *already* drawn.

Isomorphic projection underlies *abstraction*

George Lakoff claims that abstract thought arises from sensory experience:

> Conceptual structure arises from our sensorimotor experience and the
> neural structures that give rise to it. The very notion of "structure" in our
> conceptual system is characterized by such things as image schemas and
> motor schemas.
> [Lakoff Johnson 1999 77]

> The first generation of cognitive science research was, for the most part,
> based on the following assumption:
>
>> Thought is the mechanical manipulation of arbitrary symbols, as in
>> a computer program. The symbols are meaningless in themselves,
>> but get their meaning by being associated with things in the
>> external mind-free world.
>
> The second generation of cognitive science research turned up
> considerable empirical evidence showing that the earlier view is incorrect,
> and that thought is not of this character at all. Instead,
>
>> Thought is embodied, in the sense that it is grounded in and shaped
>> by the sensorimotor systems and by our bodily interaction in the
>> world. That is, reason grows out of the nature of the physical brain
>> and body, rather than being something abstract and disembodied.
>> Human reason also makes extensive and fundamental use of
>> *imaginative mechanisms such as metaphor and metonymy*.
>> [Lakoff Ling105 (emphasis added)]

What are the properties of an abstraction? An idea is an abstraction of another object,
even another idea, if it is, in some sense, distinct from material instances of the object.

Isomorphic mapping results in the recognition of substantially identical elements of one
structure occurring in a second structure. To the extent that the second structure lacks
important elements of the first, it is distinct from the first and thus an abstraction of the
first. For example, imagine a first object, say, a United States president. For a second
object, imagine the likeness of the first's face carved in rock, substantially recognizable as

a likeness of the president. The first object, the president, has, or at one time, had, an entire body, skin blood, bones, a history, perhaps a set of ideas with which he identified. The second object lacks all of these, being comprised only of the facial likeness in stone. Thus, the stone likeness is an abstraction of the president.

Isomorphic projection begins and ends with a second object that is an abstraction of the first, even though the second may be richer in other respects. For example, recall Figure II.57, the second *dispositio* is, in one sense, richer than the first because it includes Concept G, which the first does not. Nevertheless, the second is still an abstraction of the first because the second does not comprise Concept C, as does the first.

It may thus be seen that the isomorphic projection nearly always results in an abstraction since a newly constructed *dispositio* is virtually always lacking some attributes of the *dispositio* projected onto it.

Isomorphic projection underlies *categorizing*

Aristotle handed down a notion of *category* having rigid boundaries. Objects were either distinctly a member of a category or not. Objects in a category possessed *all* attributes of the category. The attributes that give the category its identity were properties of every member of the category.

By the late Twentieth Century, some linguists and philosophers (Wittgenstein, Rosch) reached a contrary conclusion: Category members do indeed have common properties, but no common properties are necessarily shared by all instances of category members. Instead, categories are conceived as structured according to family resemblance, centrality, sensory (bodily) experience, among a host of other attributes:

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family resemblance: idea that members of a category may be related to one another without all members having any properties in common that define the category.

centrality: idea that some members of a category may be better examples of the category than others. A robin may be regarded as a better example of (having more properties of) birds than an ostrich.

Some of the philosophical and linguistic advances of this period comport with constructivist epistemology and many do not. From an Assimilation Theory standpoint, Ausubel's conception of category is traditional:

> Concepts themselves consist of the abstracted criterial attributes that are common to a given category of objects, events, or phenomena, despite diversity along dimensions other than those characterizing the criterial attributes shared by all members of the category. [ARK 2]

Consider the earliest steps in isomorphic mapping: identification of an object of *inventio* or relation in a second *dispositio* that is substantially an object of *inventio* or relation in a first *dispositio* (Figure II.60). The mapping in this Figure reflects the conventional view of categories:

> Categories on the traditional view are characterized solely by the properties shared by their members. . . . that is, (a) independently of the bodily nature of the beings doing the categorizing and (b) literally, with no imaginative mechanisms (metaphor, metonymy, and imagery) entering into the nature of categories.
> [Lakoff 1987 xi-xii]

This simplistic notion of *category* is giving way to one that conceptualizes it less as an outcome of reason and more as a product of the innate biologically-based subconscious:
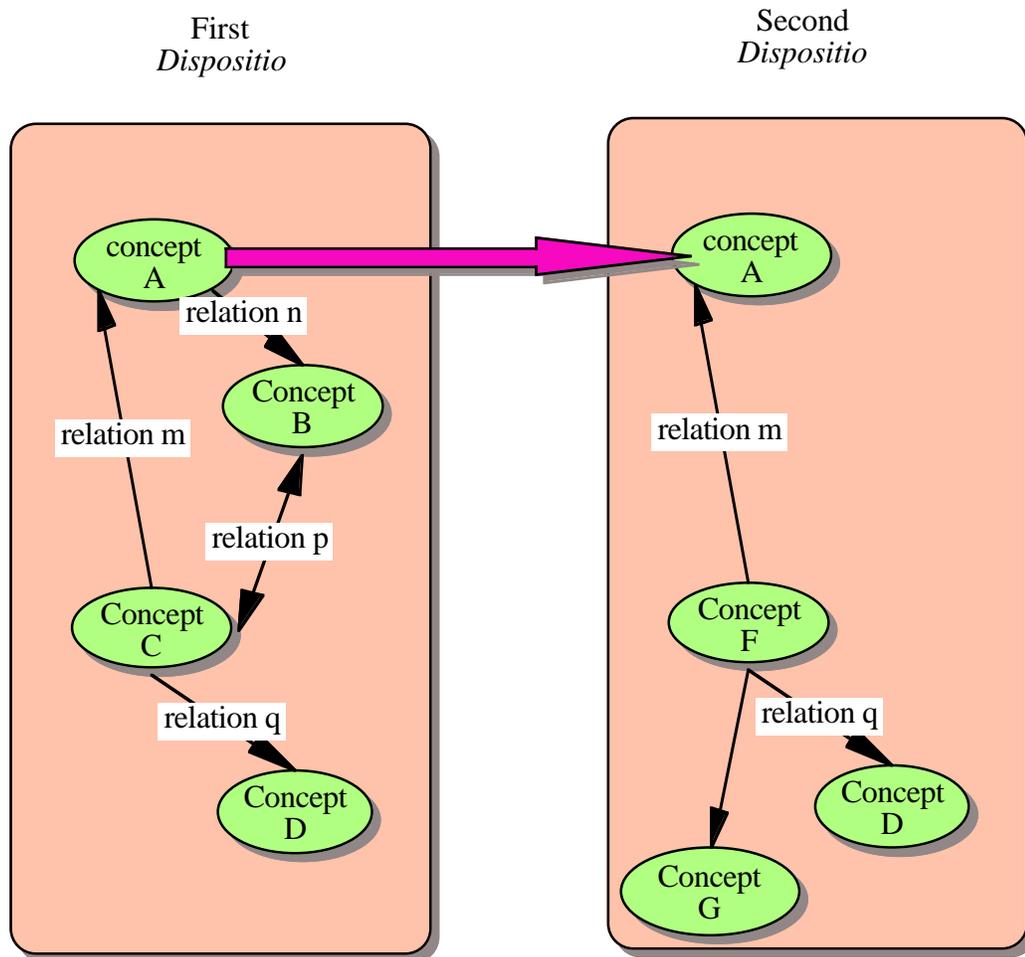
Two similar ideas, portions of a learner's knowledge structure,
and a concept (*inventio*), Concept A in source
mapped to a corresponding *inventio* in target.
This object-in-common constitutes a category, "Concept A"

Figure II.60

Categorization is, for the most part, not a product of conscious reasoning.
. . . The first and most important thing to realize about categorization is
that it is an inescapable consequence of our biological makeup. . . . It is
common in the brain for information to be passed from one dense
ensemble of neurons to another via a relatively sparse set of connections.
Whenever this happens, the pattern of activation distributed over the first
set of neurons is too great to be represented in a one-to-one manner in the
sparse set of connections. Therefore, the sparse set of connections
necessarily groups together certain input patterns in mapping them across
to the output ensemble. Whenever a neural ensemble provides the same

output with different inputs, there is a neural categorization.
[Lakoff Johnson 1999 18]

Were Figure II.60 to be redrawn with each concept representation depicted as many, perhaps millions, of small granules, (*dispositio*) rather than as single objects of *inventio*, Lakoff's conceptualization of category might be better reflected. Such a substitution does not change the validity of the underlying model.

Categories may be regarded as the *inventio*-in-common among domains.

When multiple structures possess an *inventio*-in-common named *foo*, one may say that they are members of the category *foo*. Thus, a single component *inventio* can constitute a category, although Rosch's work on prototype theory finds otherwise.

For example, if a learner's idea of the apparatus under the hood of his automobile is categorized as an engine (based on the sensory experience of opening the hood and seeing, feeling, smelling, and hearing), *then*, he is likely to project onto his engine other properties associated with his *dispositio* of the category engines: e.g., used for locomotion, consumes fuel, measured in horsepower and cubic inches, etc.

Thus, isomorphic mapping, by virtue of recognizing *inventio*-in-common in multiple *dispositio*, underlies the process of *categorizing*. The term *category* thus may be regarded as a cognitive (often subconscious) use of a commonality among structures. *Categorization* is thus distinct from *classification* which is a human-controlled constructed grouping-and-labeling of recognized commonalties.

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Isomorphic projection underlies *generalization*

Ausubel sees generalization as deriving from specific instances as experienced by children, then restrictions on the properties that an object must possess to be a category member are gradually removed (reduced) through learning:

> As children advance in age and as words begin to represent concepts or generic ideas, such words become concept names and are equated in meaning with more abstract, generalized, and categorical cognitive content. The word "dog" to a toddler may just signify a cognitive image of his own pet and of the particular dogs in his neighborhood; to the older preschool child, however, it refers to the criterial at tributes of a composite dog-image which he himself has discovered inductively from his own concrete-empirical experience with dogs. (This latter discovery process is called "concept formation.") [ARK 85]

Generalization is the absence or reduction of limiting attributes. The fewer properties associated with an object, mental or real, the more general it is.

Generalization may be understood as negative or reductionistic isomorphic projection, where a first *dispositio* is projected to a second *dispositio*, but some of the elements of the first are not projected (Figure II.61).

This reductionistic notion has been briefly visited above, *dispositio* ➤ *inventio*, that is, as a selective consolidation of attributes of a *dispositio*.

Stereotyping, which is culturally unacceptable in some contexts, and generalizing, which is generally acceptable, are procedurally the same. They differ only in the cultural values associated with the concepts that are projected.

First
Dispositio

Second
Dispositio

concept
A

relation n

Concept
B

relation m

relation p

Concept
C

relation q

Concept
D

concept
A

relation m

Concept
C
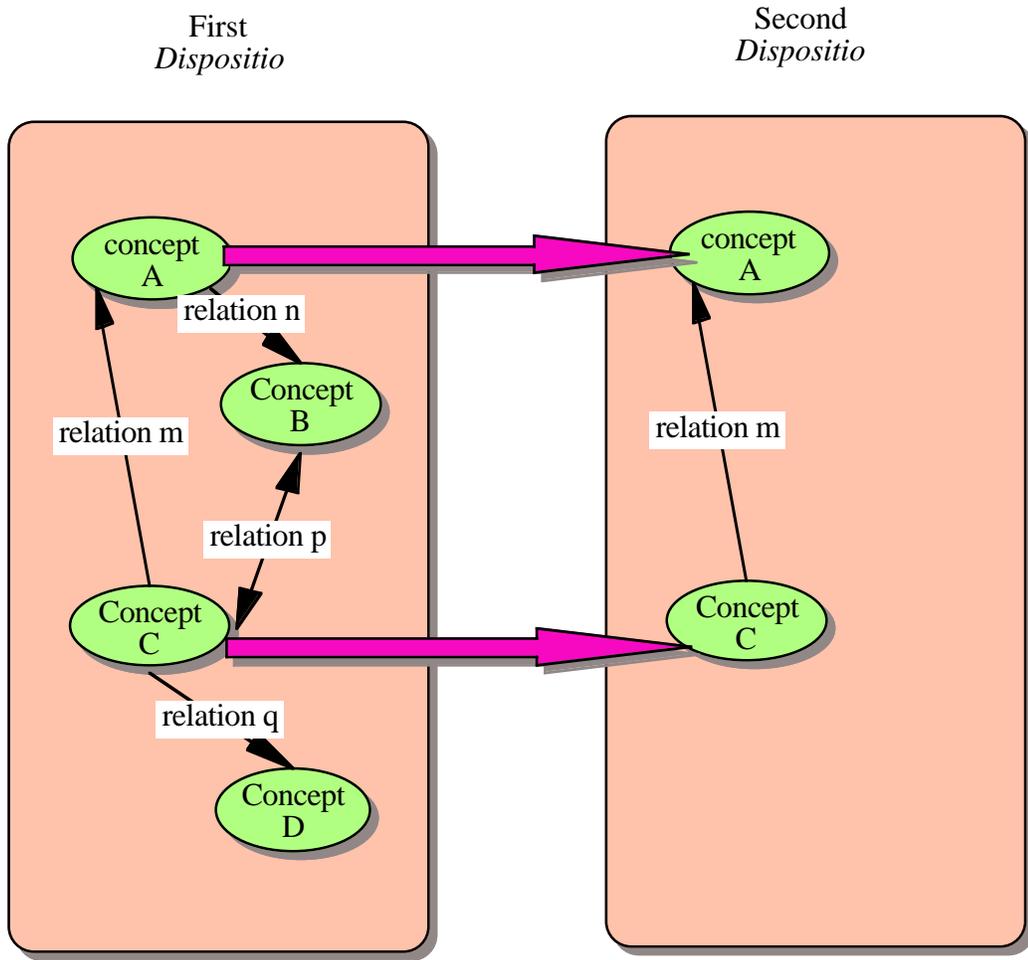
Second *Dispositio* is a generalization of the First *Dispositio* because some of the
attributes of the First *Dispositio* are not projected to the Second

Figure II.61

Isomorphic projection underlies many other cognitive activities

Categories, generalizations, abstractions, inheritance in hierarchies, and reductionism
operate on an isomorphic mechanism: borrowing a preconstructed conceptual relation
for reuse, to fill in properties of other objects categorized together.   Isomorphic mapping
and isomorphic projection are the foundation of numerous conscious tasks. The presence
of these two processes is worth noting because of their broad prevalence. Some of the
variants of isomorphic mapping and isomorphic projection are outlined below.

Isomorphic projection underlies metaphor.

Among the most detailed theoretical discussions where accounts of isomorphic mapping
and isomorphic projection are found are in the literature of contemporary metaphor
research.

> Human reason also makes extensive and fundamental use of *imaginative*
> *mechanisms such as metaphor and metonymy*.
> [Lakoff Ling105 (emphasis added)]

What are *imaginative mechanisms such as metaphor and metonymy*?

> The fundamental role of metaphor is to *project* inference patterns from the
> source domain to the target domain. Much of our reasoning is therefore
> metaphorical. [Lakoff Johnson 1999]

Reference to one cognitive object *in terms of* another cognitive object, results in (partial)
projection. This is metaphor. The cognitive purpose of metaphor is to evoke and
construct a *dispositio* by filling-in attributes from another, that is, to evoke one idea by
activating another.

A metaphor consists of two cognitive parts or *dispositio*: a *source* from which the attributes are mapped and a *target* to which they are projected (tenor and vehicle, referent and relatum, etc.). For example,

JAQUES:
All the world's a stage,
And all the men and women merely players:
They have their exits and their entrances;
[Shakespeare As You Like It   Act II, scene VII]

Attributes of the *dispositio* theatrical stage, the source, are projected onto the *dispositio* of "the world," the target.

Metaphor is a figure of thought, not a figure of language

Contemporary metaphor theory [Lakoff 1993] recognizes metaphor, conventionally regarded as a figure of *speech*, instead as figures of *thought*. That is, metaphor is an interaction between two concept structures rather than between a concept structure and a linguistic expression:

> From a conceptual point of view, primary metaphors are cross-domain mappings, from a source domain (the sensorimotor domain) to a target domain (the domain of subject experience), preserving inference and sometimes preserving lexical representation. Indeed, the preservation of inference is the most salient property of conceptual metaphors.
> [Lakoff 1993 58]

> What constitutes . . . metaphor is not any particular word or expression. It is the ontological mapping across conceptual domains, from the source domain . . . to the target domain . . . .   The metaphor is not just a matter of language, but of thought and reason. The language is secondary. The mapping is primary, in that it sanctions the use of source domain language and inference patterns for target domain concepts. The mapping is

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conventional, that is, it is a fixed part of our conceptual system, one of our conventional ways of conceptualizing . . . relationships.
[Lakoff 1993 208-209]

In classical theories of language, metaphor was seen as a matter of language, not thought. . . .   The generalizations governing poetic metaphorical expressions are not in language, but in thought: they are general mappings across conceptual domains. Moreover, these general principles which take the form of conceptual mappings, apply not just to novel poetic expressions, but to much of ordinary everyday language. In short, the locus of metaphor is not in language at all, but in the way we conceptualize one mental domain in terms of another. The general theory of metaphor is given by characterizing such cross-domain mappings. . . . metaphor *is* cross-domain mapping . . . [Lakoff 1993 202-203]

It is also important to stress that not all conceptual metaphors are manifested in the words of a language. Some are manifested in grammar, others in gesture, art, or ritual. These nonlinguistic [non "natural language"] metaphors may, however, be secondarily expressed through language and other symbolic means.
[Lakoff Johnson 1999 57]

Recognition of metaphor as figure of *thought* predates contemporary theory, however.

Clark, relied upon above for his exposition of the Divisions of Rhetoric, makes the

distinction crystal clear as early as 1957:

I [Clark] shall follow Quintilian because his views have dominated subsequent theories on the figures.
His list starts with metaphor, the most important of tropes . . .
The figures of thought and figures of language are next in order . . .
Now figures of thought deal with conception of ideas, and the figures of language deal with their expression.
[Clark 1957 89 ff.]

A *metaphorical expression* is a linguistic expression (*elocutio*) that may provoke a

listener-reader to initiate the isomorphic mapping and isomorphic projection processes of

metaphor:

[C]ontemporary metaphor theorists commonly use the term "metaphor" to refer to the conceptual mapping, and the term "metaphorical expression" to refer to an individual linguistic expression . . . that is sanctioned by a mapping. . . . Metaphor . . . involves both conceptual mappings and individual linguistic expressions. It is important to keep them distinct. [Lakoff 1993 208-209]

I take it for granted that the underlying principles governing metaphor are of a general psychological sort and are thus not specifically linguistic. While the intellectual faculties that are involved might be prerequisites to speech, they are independent of it. [Saddock 1993 42]

Indeed, Lakoff showed that metaphors, as cognitive phenomena (isomorphic mapping and projection among *dispositio*), are distinct from metaphorical expressions (*elocutio*) by uncovering evidence that *one* metaphor may be evoked by *many different elocutio*:

Metaphor: Anger is Heat
     Source Domain: heat
     Target Domain: anger
     Multiple *elocutio* that provoke the isomorphic mapping and projection:
          He's a real hothead
          Let her stew
          He got all steamed up.
          He erupted
          He boiled over
          He blew his top
          He exploded
[Lakoff Metaphor website]

Metaphoric operation is a *partial* isomorphic projection

Black's detailed description of isomorphic mapping and isomorphic projection, summarized above, provides a detailed description of metaphoric operation:

> "*Projection*" is of course, a metaphor . . . [Black 1993 28]

> I have said that there is a similarity, analogy, or more generally, an identity of structure between the secondary implication-complex of a metaphor and the set of assertions -- the primary implication-complex -- that it *maps*. In "Poverty is a crime," "crime" and "poverty" are nodes of *isomorphic networks*, in which assertions about crime are correlated one-to-one with corresponding statements about poverty.

> [E]very metaphor may be said to mediate an analogy of structural correspondence. [Black 1993 30 (emphasis added)].

> I have been presenting . . . a conception of metaphors which postulates interactions between two systems, grounded in analogies of structure (partly created [isomorphic projection] partly discovered [isomorphic projection]). The imputed isomorphisms . . . can be held [as] insight [meaning] into the systems to which they refer. [Black 1993 39 (annotation added)].

A metaphor *is* the (isomorphic) mapping and projection:

> The mapping is a set of correspondences. . . . [M]etaphors are mappings, that is, sets of conceptual correspondences. [Lakoff 1993 207]

> The mapping is tightly structured.   There are ontological correspondences according to which entities . . . correspond systematically to entities in the other domain . . . [Lakoff 1993 207]

> Metaphors are conceptual mappings across conceptual domains that structure our reasoning, our experience, and our everyday language. [Lakoff Johnson 1999 47]

An example based upon Figure II.57 (Figure II.62(a)):

First
Dispositio

Second
Dispositio

irrational behavior

characteristic of

a clown

expected

called a

circus employee

compensated with

wears

hourly wage

big silly shoes

irrational behavior

characteristic of

a clown

not expected

is a

Stockbroker Smith

compensated with

wears

black wingtips

salary

A mapping

A projection

relation constructed from a metaphorical expression

(a)
Clown *dispositio* isomorphically projected to the image (*dispositio*) of Mr. Smith,
motivated by a metaphorical expression, "Smith is a clown."

Figure II.62(a)

First
Dispositio

Second
Dispositio

irrational behavior

irrational behavior

characteristic of

characteristic of

a clown

a clown

expected

not expected

called a

is a

circus employee

Stockbroker Smith

compensated with

compensated with

wears

wears

hourly wage

salary

big silly shoes

black wingtips

A mapping

A projection

relation constructed from a metaphorical expression

An *inventio* **not** projected

(b)
Hourly wage and big silly shoe *inventio* **not** projected to Smith,
therefore Smith is not understood to be an actual *clown*.

Figure II.62(b)

However, metaphors are only *partial* projections of the source to the target, otherwise they are not metaphors, but an identity or an instance of the source (Figure II.62(b)):

> What these properties are I may, but need not, specify. They cannot be *all* the properties common to wolves, otherwise I should intend that man is actually a wolf. [T]hus when I say that man is a wolf (metaphorically speaking) I intend that he shares *some* of the properties of wolves but not enough of them to be classified as an actual wolf.
> [Turbayne 1970 15 (emphasis added)]

Metaphor operates by associating only *selected* characteristics of one idea to some other idea. In selecting some characteristics, others are ignored. The primary use of a metaphor or any model is its predictive power or the capacity to transfer characteristics that obtain in one case to a similar but distinct case. Some aspects of the source *dispositio*, if projected, might render its transfer of meaning to be incredible. Thus, metaphors can be "carried only so far."

If, after projection, a target possesses *all* the attributes projected by the source, then there is no metaphor, and the expression provoking these *dispositio* may be regarded as *literal*. For example, in "Smith is a clown," if the man is not only behaving like a clown, but is also wears clown shoes and is employed as a clown, then there is no metaphor. Smith is literally a clown.

Significant adverse consequences obtain when the distinction between metaphoric and literal interpretation is forgotten, and metaphoric "shortcuts" become treated literally with *all* the properties of the metaphoric source concept rather than projecting only those that pertain to the target.

For example, one might casually analyze the statement, "The manager has time to play golf this afternoon" such that the verb "has" does not mean "owns" or even "possession

of," but that "has" is merely a shortcut to a complex metaphor for arranging activities such that the manager plays golf and then later attends to business obligations. Most would interpret "has" in this way. However, Michael Reddy and others warn of how easily metaphoric interpretation can slide into unjustified literal interpretation, and the detrimental consequences of doing so. Here, use of "has" is metaphoric rather than literal because some characteristics of "has," such as ownership rights (e.g., legal possession) and physical possession are *not* projected onto the target idea of the manager's after-school recreation. Yet, the manager could easily receive a call on his cell phone from his CEO asking him to return to the office to prepare a report. Now the manager might reason, even respond, "Whoa, wait a minute coach, this afternoon is *my* time, I have *set this time aside* for golf today." Clearly, this individual is now projecting not merely some, but virtually all the properties of "has" onto his current situation. In claiming that the afternoon is *my* time, he is claiming an ownership right in time. In claiming that he has *set this time aside*, he is asserting that he has ownership and possession of it, perhaps manifested physically on his calendar. He is no longer interpreting "has" metaphorically, but instead literally, and further, cognitively constructing understandings and conclusions that are counter to that of his boss.

The reader can speculate for themselves as to the possible adverse consequence for the manager if he does not abandon both his golf game and his literal interpretation of "has" to return to the office. A more dangerous instance of this conduit metaphor, as mentioned above, is:

Knowledge is in the book.

This too may be regarded merely as a shortcut. However, many treat it not as a short cut, but with a literal interpretation: that knowledge really is *in* the book. The adverse

consequence of such an interpretation is that the cognitive work that learners do is ignored. Technicians develop systems to operate upon books or texts genuinely believing that they can "get the knowledge out of the text" if they can just program the computer program adequately. They cannot. Knowledge is not *in* the book. It is created by and in the learner, derived *from* the book, and thus no amount of automated processing on the text alone, absent engagement with the learner, can result in meaningful learning.

Therefore, caution is warranted in dismissing metaphoric interpretations as mere rhetorical shortcuts, implying that, despite the spoken use of the shortcut, the speaker cognitively retains a correct structure of the term in their mind and does not slip into literal interpretation and wrongfully apply characteristics of the metaphor. In fact, the metaphor *is* often and easily lost and attribute of terms applied inappropriately.

Another consequence of the partial nature of metaphors is that, in provoking more than one metaphor, the metaphors might conflict with one another with respect to some attributes. This is analogous to a manager retaining multiple employees, each with their specialized skills, even though they often disagree with one another. In the larger view, it is to the organization's advantage to have the benefit of the contributions of each employee, even at the cost of sporadic discord.

Impact of metaphor, as isomorphic operation, on learning

Why is the nature of metaphor and its relationship to isomorphic mapping and isomorphic projection so important? Metaphor is an instance of isomorphic mapping and thus a mechanism for construction of new concepts and relations in the learner's conceptual structure. *The mechanism of metaphor creates new knowledge*.

> The fundamental role of metaphor is to *project* inference patterns from the source domain to the target domain. Much of our reasoning is therefore metaphorical. [Lakoff Johnson 1999 128]

Isomorphic projection, i.e., metaphoric processes, is implicated in virtually all of our abstract thought, and thus, learning:

> Abstract concepts are largely metaphorical.
>
> Metaphorical thought is what makes abstract scientific theorizing possible.
>
> [O]ur most fundamental concepts -- time, events, causation, the mind, the self, and morality -- are multiply metaphorical. . . . if one somehow managed to eliminate metaphorical thought, the remaining skeletal concepts would be so impoverished that none of us could do any substantial everyday reasoning.
> Conceptual metaphor is what makes most abstract thought possible. Not only can it not be avoided, but it is not something to be lamented. On the contrary, it is the very means by which we are able to made sense of our experience. [Lakoff Johnson 1999 3, 128-129].

Indeed, some thought is literal, but:

> [T]he metaphorical nature of our conceptual system, if unrecognized, can lead philosophers [and others] astray. Two things lead to such philosophical errors. First, a philosopher may fail to recognize conceptual metaphor and hence may see metaphorical sentences as literal and take them at face value. [that is, that *all* elements of the source are projected to the target, and thus the target has all the properties of the source] Once

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one takes a metaphor as being literal, the second error is to assume the correspondence theory of truth and therefore regard the objective world as structured by the metaphor. [Lakoff Johnson 1999 156]

That is, the metaphorical expression is regarded as *true*. Recognition of *partial* isomorphic projection, as distinct from projection of all component *inventio* in a source *dispositio*, enables learners to differentiate between metaphor and literal interpretation.

Experienced practitioners of a language recognize and distinguish between literal and metaphoric interpretation subconsciously. Learners working in the early portion of a learning curve for a particular subject matter, if aware of a metaphoric interpretation as a possibility, might decide at the conscious level which interpretation to apply:

> From the point of view of the student [reader], the metaphor is something to be comprehended. To comprehend the metaphor, the student must first infer that the teacher means the student to shift from a mode of cognition in which ideas are being fitted to an existing knowledge structure, to a metaphorical mode in which the construction of a third knowledge structure consisting of the relations educed between the two domains referenced by the metaphor is accomplished.
> [Sticht 1993 624-625 (annotation added)]

Because metaphorical mappings are partial, a writer-speaker may need to provoke more than one metaphor to the learner-reader to communicate a complex *dispositio* to a learner-reader.

Isomorphic projection also underlies . . .

> Many writers notice . . . conceptual blending . . . Erving Goffman, Len Talmy, H. Fong, David Moser and Douglas Hofstadter, and Z. Kunda, D.T. Miller, and T. Clare.
> . . .
> One writer who did succeed in going beyond the particular and local features of individual examples . . . is Arthur Koestler, in *The Act of Creation* (1964). he gave it the name "bisociation of matrices" . . . But Koestler did not make the next leap: *to discover that the general mental operation involved in these striking cases is also ubiquitous in everyday thought and language.*
> . . .
> Our own research program has come up with decisive evidence from many fields that conceptual blending is a general, basic mental operation [Fauconnier Turner 2002 37 (emphasis added)] [Footnote II.10]

With the essential relation between isomorphic projection and metaphor, and our fundamental reliance on metaphor, it is not surprising to find that isomorphic projection underlies many cognitive phenomena in daily life generally thought to be unrelated.

Lakoff echoes Reddy's warning earlier that avoiding metaphors and their influence on human thought is difficult if not impossible, even with conscious attempts to do so:

> Metaphorical thought is what makes abstract scientific theorizing possible.
> . . . Conceptual metaphor is what makes most abstract thought possible. Not only can it not be avoided, but it is not something to be lamented. On the contrary, it is the very means by which we are able to made sense of our experience. [Lakoff Johnson 1999 128-129].

> Conduit metaphor is difficult to overcome even if one is cognizant of it. It is embedded in our language and thus, in our minds.
> [Reddy 1993 176, 181]

Isomorphic projection in analysis and synthesis

Suppose a Learner's knowledge consists of *Idea* (Figure II.63(a)):
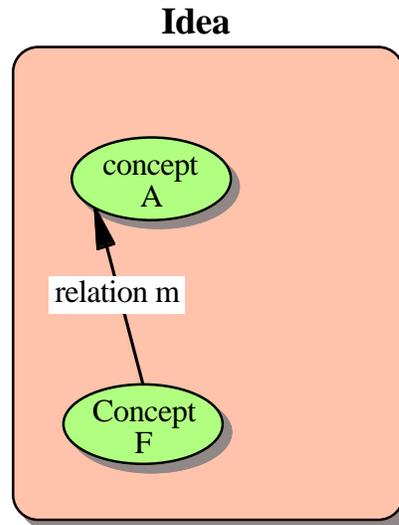
(a)
Learner's knowledge consists of a *dispositio*, Idea,
with a simple structure.

Figure II.63(a)

Suppose further, she subsequently becomes motivated to *analyze* her *Idea*. What event happens first? She may select another *dispositio*, *Source Dispositio*, perhaps based on its having some *inventio*-in-common with her Idea, for example, Concept A. Operationally, this requires isomorphic mapping between Concept A in *Source Dispositio* to Concept A in her *Idea*:
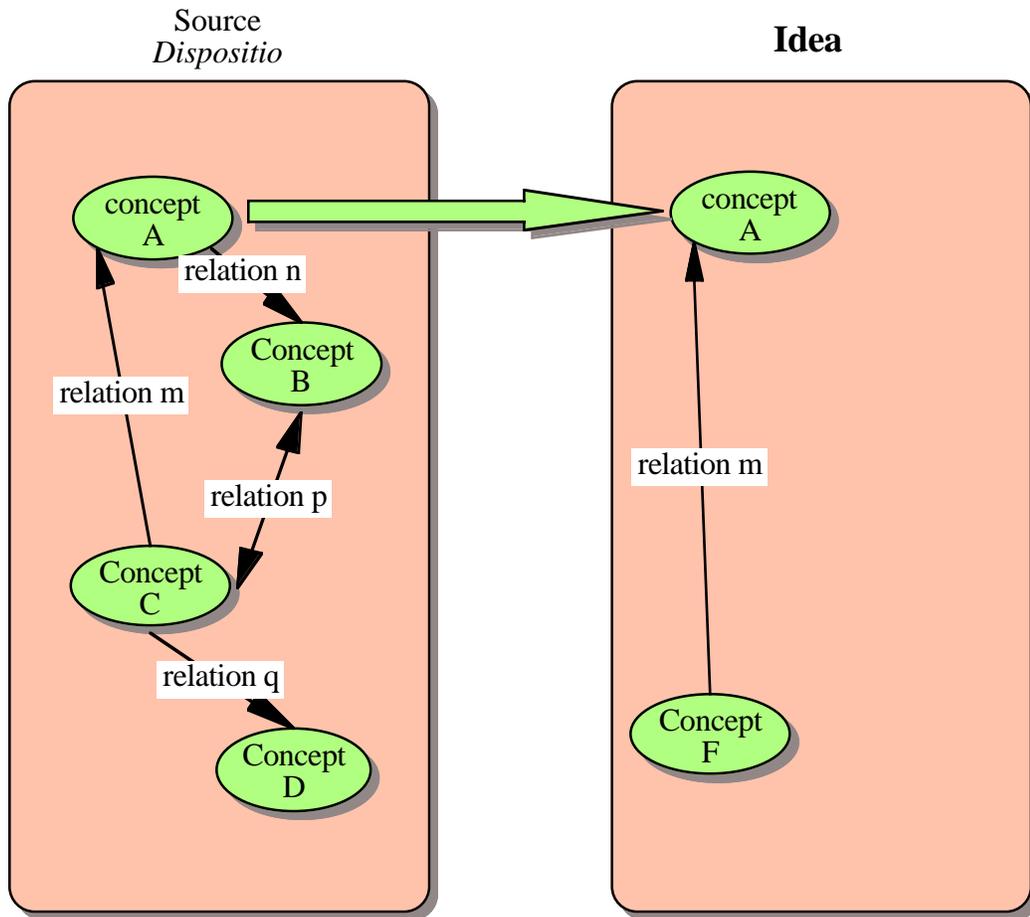
(b)
Learner's *Idea* is *analyzed* according to *Source Dispositio*,
first by mapping *inventio* in common, that is Concept A

Figure II.63(b)

Finally, analysis of her *Idea* is completed by isomorphic projection of selected *inventio* from *Source Dispositio* onto *Idea*:
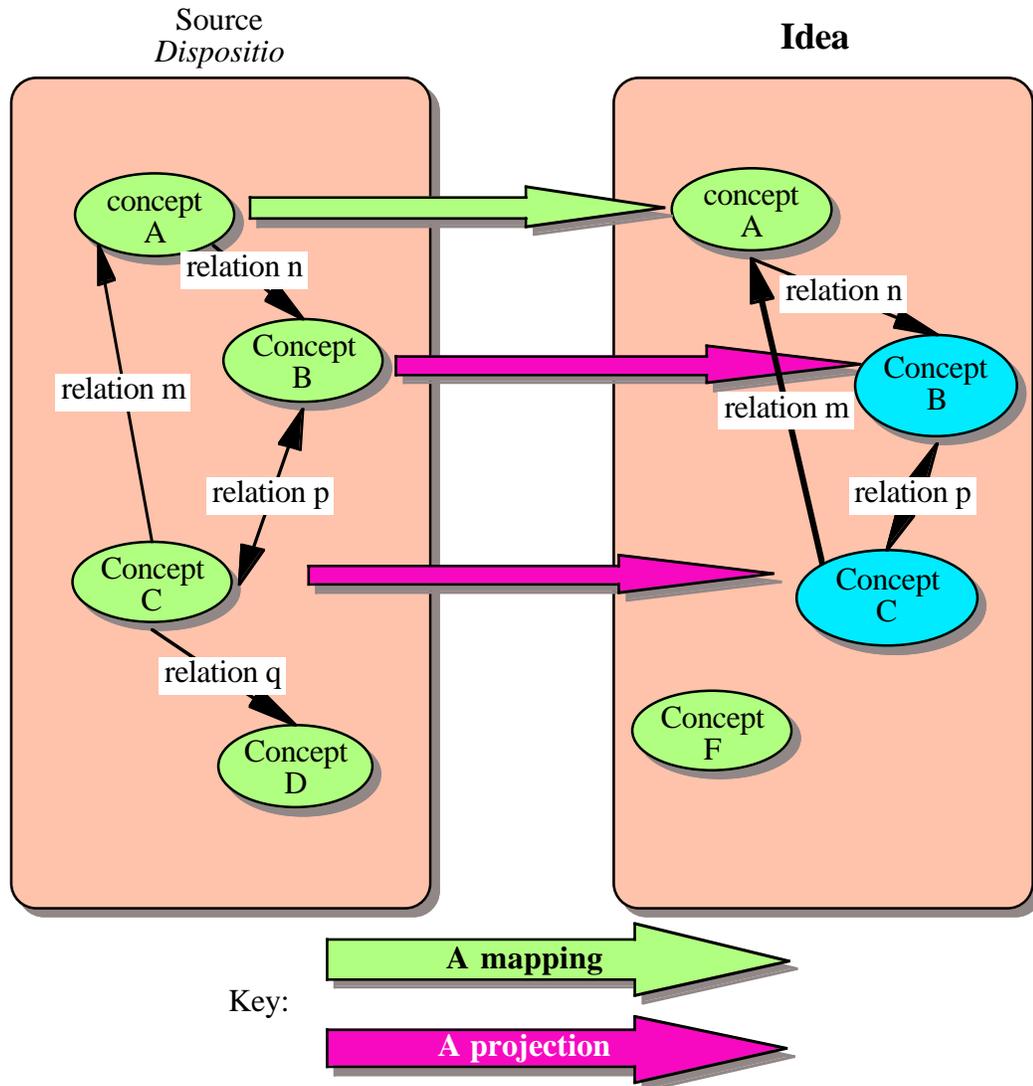
(c)
Idea is analyzed by recognition that, as in the *Source Dispositio*,

Concept A in Idea may be related to Concept B and Concept C,
but not Concept D, and
Concept C is related to Concept A by relation m

Figure II.63(c)

Synthesis operates in a corresponding way. Suppose a Learner has Ideas A and B:
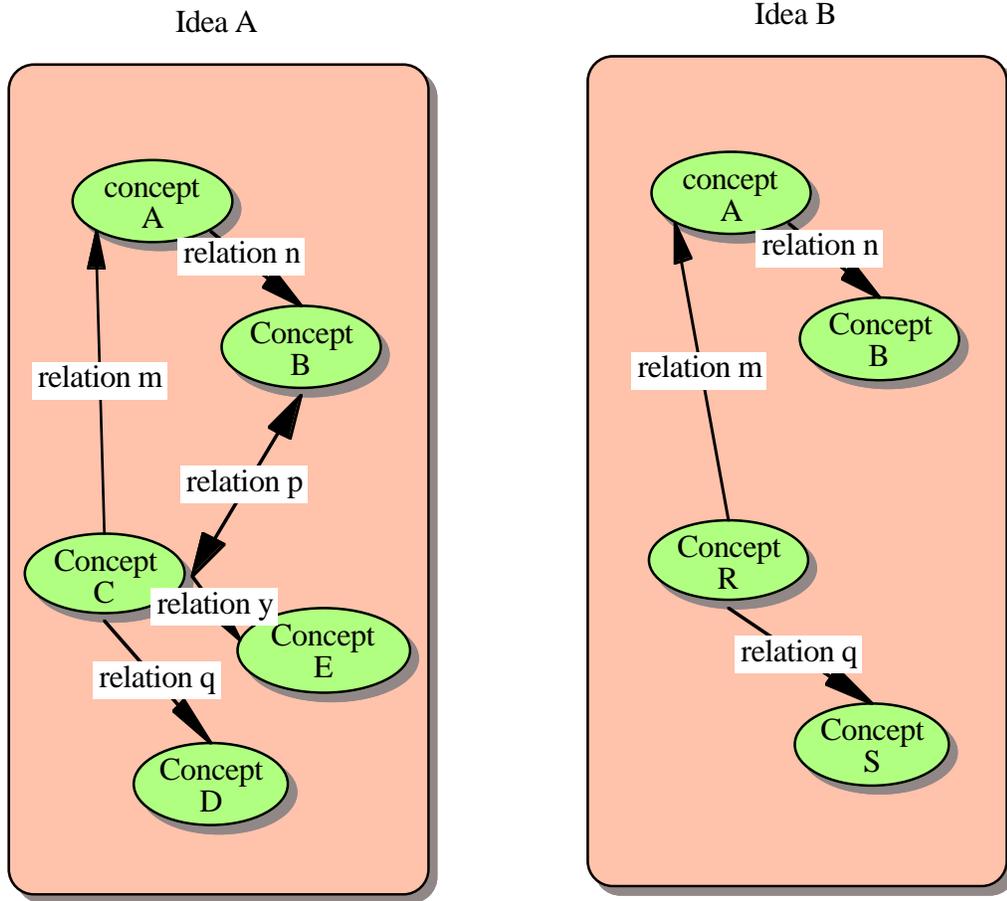
(a)
Idea A and Idea B

Figure II.64(a)

Our Learner becomes motivated to synthesize Idea A and Idea B. He begins by

isomorphically mapping the elements in Idea A with substantially similar *inventio*

Concepts A and B, then selectively isomorphically projects remaining *inventio* in Idea A

upon Idea B. This is virtually identical to Ausubel's subsumption learning:
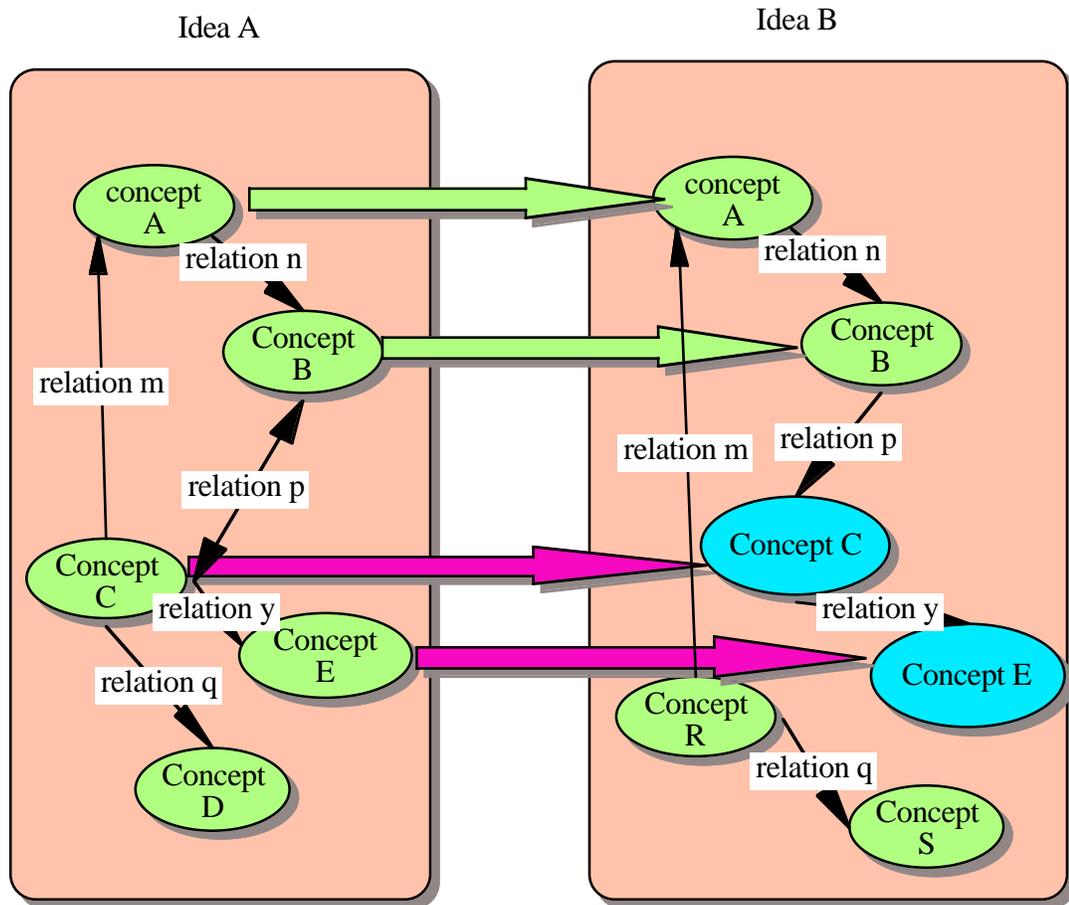
(b)
Concepts A and Concept B of Idea A mapped to corresponding
Concept A and Concept B in Idea B,

and, Concept C and Concept E, but not Concept D
isomorphically projected to Idea B

Idea B is the synthesis of Idea A and Idea B

Figure II.64(b)

Models and schema (or schemata) are preconstructed structures that operate to project

their properties upon new data and return predictions:

> [S]chemata are powerful forces in learning. . . . Schematic knowledge has
> a significant effect on organization of ambiguous or disorganized stories.
> [Perry P540]

A theory is a preconstructed set of relations among ideas (perhaps supported by evidence, *facts*) that fills in explanations of phenomena. Theories and models are often used for predicting, which projects either past experience or other sources onto a *dispositio* for understanding of the future. Consistency and certainty generally imply applying concepts from one context by filling in gaps of a sparser but similar concept, such that the latter behaves reliably similar to the original.

Drawing conclusions (both inductively and deductively), estimating (based upon the statistical likelihood that objects with similar properties will behave similarly under similar circumstances), and making assumptions all are based upon mapping elements of a general model to corresponding elements in the particular, then projecting addition elements from the general onto the particular. Reductionism can occur where a selective projection is performed from source to target (*generalization* above).

Reason is, in part, the construction of beliefs projected from other conclusions or beliefs:

> Reason is embodied in that our fundamental forms of inference arise from
> sensorimotor and other body-based forms of inference.
> Reason is imaginative in that bodily inference forms are mapped onto
> abstract modes of inference by metaphor.
> [Lakoff Johnson 1999 77]

Logic, the quest for certainty, algebra, and other arithmetical procedures may be regarded as isomorphic projection limited to specific projections from accepted axioms, i.e., if conditions specified by a particular proposition match those specified by an axiom, then the axiom's conclusion may be projected onto the particular instance. For example, given the "all widgets are red" axiom, and a single instance, "this is a widget," the relation between *widget* and *red* in the axiom can be projected from the *widget* in the specific instance, with the result that *red* is isomorphically projected onto the specific instance. Arithmetically, when one wants to "calculate" how much it will cost, at $38 per ticket, to

attend an event where the Giants play the Cardinals, one projects upon his prior

knowledge: $38 and the number of attendees, a source *dispositio* frame that performs 38

+ 38 + 38 ... and has an end state of a number (*inventio*), expressed as a numeral

(*elocutio*).

Tropes, such as metonymy and synecdoche are figures of speech, *elocutio*, that provoke a

learner to evoke isomorphic operations that project one idea onto another to yield a new

idea. For example, "They lent the farmer a hand" projects not only the remainder of a

body connected to *hand*, but evokes a structure that relates the body to the labor that a

person performs. An enthymeme projects a missing premise into a construct so that

contradictory elements of a paradox are resolved by projection of a third organizing idea.

Analogies are inferences to the effect that if two or more objects cohere with one another

with respect to some elements, they will exhibit similar properties with regard to other

elements. Again, the labor conserved is the cognitive effort of constructing a new

relationship, here between an object and its characteristics, and instead imputing the

characteristics based on others. Memory palaces conserve cognitive labor by relying on

known associations about physical places that are projected onto related memories to

evoke recollection of ideas. This requires less effort than integrating a particular set of

ideas, e.g., a long poem or religious text, directly into memory.

Photographs provoke isomorphic projection:

> When we see a picture of the newborn baby, we cannot suppress our
> feeling that we are seeing a baby. In fact, the two-dimensional
> arrangement of colors in the photograph has almost nothing in common
> with a baby, and it takes a brain evolved over three billion years and
> trained through several months of early life to construct the identity
> between the picture and the baby. Because the brain does this instantly
> and unconsciously, we take the construction of meaning for granted. Or

rather, we tend to take the meaning as emanating from its formal
representation, the picture, when in fact it is being actively constructed by
staggeringly complex mental operations in the brain of the viewer.
[Fauconnier Turner 2002 5]

Humor may, in some cases, be understood structurally as a projection that creates or

resolves conflicting or unexpected relations between *dispositio*. Though there are many

types of humor, in many cases the humorous meaning arises not from the evocation of a

dissonant or unexpected relation between two *dispositio*, but the act of projection.

The structure of mapping a humorous anecdote or joke is bipartite: (1) there is generally

some conflicting, but subconscious, relation between some aspect of one ICM and a

corresponding element of another ICM, and (2) a conscious projection or filling-in of the

dissonant relation. It is the second, the projection, not merely the relation itself, that is

meaningful, i.e., makes the humor. If the relation were there already known or presented

early in the story, or expected, it would be meaningfully dissonant, but not humorous.

But when the listener cognitively performs the projection, the *elocutio* laughter derives.

For example, consider the following story:

> Two men were sitting in a pub, drinking some Guinness, when one turns
> to the other and says "Excuse me sir, but I overheard you say that you're
> from Dublin. "I'm from Dublin too."
>
> The other says, "Oh, what part of Dublin? "
>
> "McCarthy street", the second man replies,
>
> "Why, me too! What school did you attend?", the first man inquires.
>
> "Oh, St. Mary's, of course!"
>
> The second man, shocked says, "Me too! What year were you born?"
>
> The first man replies, "Why, 1955"
>
> The second man awestruck says, "Me too! This is unbelievable!"
>
> The two men go on to reminisce.

A second bartender arrives for his shift, greets the first and asks "What's new today?" "Oh, it's going to be a long night" says the first bartender. "The Murphy twins are drunk again."

In this story, there is a first ICM "conversation," which, cognitively amounts to pure isomorphic mapping and isomorphic projection: each interlocutor looks for mappings to attributes in common with the other, then expresses the remaining personal portions of their experience by talking with the intention that their listener will projects or fills-in the other's personal experience into their own. In the story, there is a second related ICM of "getting acquainted" which encompasses the "conversation" ICM and additionally has elements of trust and whether or not there is desire for further contact (Figure II.65(a)).

Getting Acquainted
ICM (*Dispositio)*
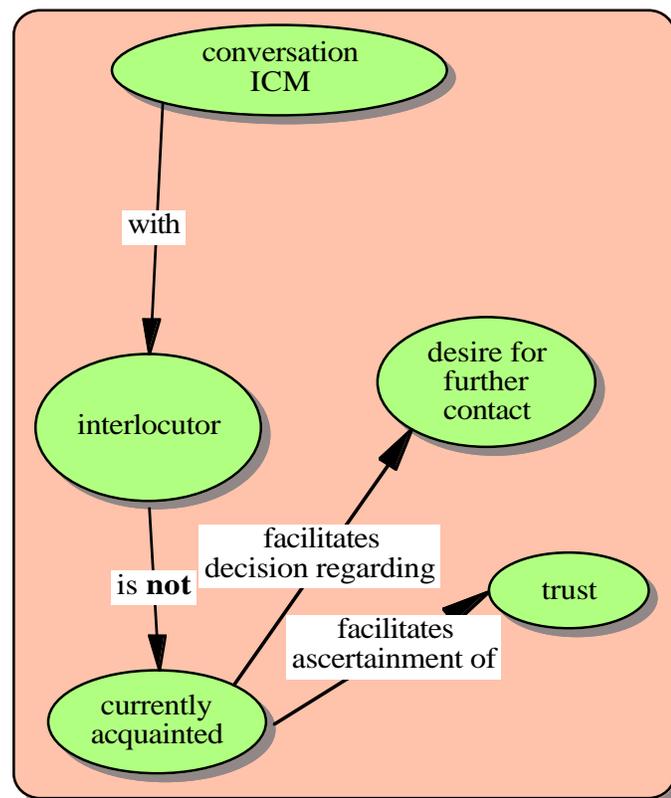
Figure II.65(a)

The third significant ICM is the rich notion of twins, with all the characteristics of twins that can be activated by the *elocutio* expression, "twins" (Figure II.65(b)).

One of the properties of the "getting acquainted" ICM is, of course, that the parties are not already acquainted. The opposite property obtains to the "twins" ICM since twins are, in most cases, raised together. At the climax of the story, the punchline, when the "twins" *dispositio* is projected into the story, which already comprises the "conversation," "getting acquainted," "Irish pub," and "two guys at a bar" ICMs, the conflict occurs between the "currently acquainted" attribute of "getting acquainted" and "twins."

Twins
ICM (*Dispositio)*

Figure II.65(b)

The Story (*Dispositio*)

Twins
ICM (*Dispositio*)

A mapping

Two guys

located
in

Irish
Pub

communication
ICM

conversation
ICM

has one sibling

with

possesses

likely

same birth
parents

similar
physical
characteristics

Getting Acquainted
ICM (*Dispositio*)

with

interlocutor

desire for
further
contact

raised in
same
household

facilitates
decision regarding

is
(therefore)

A projection

is **not**

trust

facilitates
ascertainment of

currently
acquainted

A mapping

currently
acquainted

Figure II.65(c)

What cause provokes the (cognitive, emotional, sensory, or combination) feeling that a
cognitive condition of humor, which, in turn, evokes the *elocutio* of laughter, sometimes
accompanied by the performance, *pronuntiatio*, of laughter?   The dissonant relation

alone is *not* sufficient. The evidence is that the story could have informed the reader at the beginning that the two barflies were twins. The story might have seemed strange, but not humorous.

Thus, it is *not* merely the dissonant relation that constitutes humorous meaning, but, the act of the listener exerting the cognitive effort to fill-in that creates the condition of humor: the "twins" ICM projects onto the story *dispositio*, specifically onto the "getting acquainted" ICM, results in the obliteration of the "currently acquainted" *inventio* with its negative status, and replaces it with a positively charged "currently acquainted" *inventio* (Figure II.65(c)). This cognitive labor on the listener's part, the fill-in, is meaningful in a way that evokes the laughter *elocutio*, and perhaps the corresponding *pronuntiatio*.

Fables, morality plays, fairy tales, parables, and allegories all rely on isomorphic projection with the intended result of creating or reinforcing specific meanings, i.e., instructing the reader.

Conversation, becoming acquainted, reacquainted, and reunions comprise mapping of one person's experience to that same person's impression of another person's experience, followed by projection of ideas of events or experiences about which others might be interested.

The notions of example, precedent and evidence, are prevalent in reason and especially strong in judicial analysis. Cases are important in the study and practice of law because, from them, practitioners are expected to apply their properties, *transfer* appropriately their *inventio* to other *dispositio*, i.e., other circumstances. The role evidence plays in drawing conclusions relies on isomorphic mapping and isomorphic projection at multiple simultaneous levels of specificity.

Classification (as distinct from categorization), in synonymy and use of thesauri for broader or narrower terms rely on mapping like terms from the writer's vocabulary to classification structure or thesaurus, and then projecting classification identifiers or related terms in the thesaurus onto the writer's concept structure.

Hierarchy and heredity project attributes from one *dispositio* (parent) to another (child) based on an ancestral mapping. The notion of *organizing* is grounded in isomorphic projection: People organize objects (e.g., ideas, books, goods in grocery stores) for retrieval and *use* of the whole based on the organized or collocated attribute of the object. For example, if a shopper is seeking canned peaches in the grocery store, he may seek the aisle based on the attribute *canned goods*, relying on projection to fill-in *peaches* as part of the category *canned goods*.

Constructing beliefs, branding, much advertising, granting academic degrees, vouching for someone or something, political and other endorsements, and testimonials all rely upon projection of cognitive authority ("if it's good enough for them, it's good enough for me") mechanism.

> [R]esearch done by others determines most of what any of us believes.
> [Booth Colomb Williams 1995 6]

As alluded to above, even *pronuntiatio*, the only element of the Divisions of Rhetoric communications reference model that does not inhabit the intellectual realm, occasionally contributes to a learner's construction of meaning. Although it is as easy to print a lie as to print the truth, readers often impute credibility to ideas expressed in books and "white papers" which they might ignore or eschew if printed in different formats. Similarly, *elocutio* influences credibility. Writing continues to have the effect of reinforcing cognitive authority where the reader reasons, "if the statement is in a book or article like this, it is likely to be true."

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> Writing was a guarantee of authenticity. . . . [T]he authority naturally
> invested in the Bible was transferred to other forms of religious writings.
> [Gilmont 1999 233]

Thus, by virtue even of attributes of *pronuntiatio* or *elocutio*, a reader's inclination to project the credibility of a form (e.g., a book) or set of terms (e.g., medical terms), operates to project an additional attribute upon the new ideas constructed from those expressed by a document: credibility, believability, even *truth*.

Physical artifacts of authority generally, such as <u>identification badges</u>, <u>ribbons</u> and <u>badges</u> worn on uniforms (including neckties) and <u>drivers' licenses</u> are *pronuntiatio* forms that perform *elocutio* expressions which, in turn, provoke isomorphic projection: one does not possess certain identities (*dispositio*) without these. But with possession, the authority of the issuer is projected onto the cognitive structure of the bearer by the mind of those who demand to vet one's identification. Absence of these *pronuntiatio*, such as absence of a necktie or driver's license can similarly result in the projection of images of unprofessionalism or immigrant status by the inspector. Beniger [Beniger 1986] claims that the primary purpose of "information" is to project concepts to the minds of reader-learners, such projecting having the effect of intellectual *control*. When Gutenberg's press provided for multiplying the number of copies that could be produced, it also amplified control over the kind and number of ideas people held.

Function of isomorphic mapping and projection: labor saving

All the examples above have the same purpose: labor-saving: They conserve cognitive energy by reusing the meaning of the source *dispositio*, preconstructed structure, that is projected onto the target, and thus avoiding the cognitive labor of searching for,

identifying, and constructing relations one-by-one. A premanufactured house is faster to install than one that is "stick-built." Of course, the owner of a premanufactured house has to accept the style, the objects and relations among them of the manufacturer rather than having the intellectual luxury of specifying them himself.

This is not mere convenience. Cognitive scientists have made various types of calculations about human cognitive capacity. One implication of these is that human cognitive systems, including memory, do not comprise the physical resources to store or represent each individual perception, experience, or idea separately. Rather, the received wisdom is that only clues and cues are committed to memory along with methods (avoiding terms such as formula or algorithm) which, in conjunction with the skeletal cues and clues, can result in the reconstruction of *dispositio* in lieu of storing it.

Most isomorphic operation is subconscious

> The process of *consciously* identifying conceptual blocks takes one quite a
> distance toward *overpowering* them. [Adams 1974 75 (emphasis added)]

Hofstadter's claim as to the importance of cognitive activity below the 100-millisecond level was cited earlier (What is paying attention?). His argument is:

> In 1980, Simon . . . declared . . . "Everything of interest in cognition
> happens above the 100-millisecond level -- the time it takes you to
> recognize your mother." Well, our disagreement is simple; namely, I take
> exactly the opposite viewpoint: "Everything interesting in cognition
> happens BELOW the 100-millisecond level -- the time it takes you to
> recognize your mother." To me, the major question . . . is this: "What in
> the world is going on to enable you to convert from 100,000,000 retinal
> dots into one single word "mother" in one tenth of a second?" Perception
> is where it's at! [Hofstadter 1982]

Metaphoric activity (isomorphic mapping and isomorphic projection) is mostly below the threshold of consciousness.

> Thought is mostly unconscious. [3]
> . . .
> Real human beings are not, for the most part, in conscious control of - or even consciously aware of - their reasoning. Most of their reason, besides, is based on various kinds of prototypes, framings, and metaphors. [5]
> . . .
> In cognitive science, the term *cognitive* is used for any kind of mental operation or structure that can be studied in precise terms. *Most of these structures and operations have been found to be unconscious*. [11]
> . . .
> Cognitive science is the scientific discipline that studies conceptual systems. . . . our thought is unconscious . . . it operates beneath the level of cognitive awareness, inaccessible to consciousness and operating too quickly to be focused on.
> . . .
> The very existence of the cognitive unconscious, a fact fundamental to all conceptions of cognitive science, has important implications . . . It means that we can have no direct conscious awareness of most of what goes on in our minds. . . . [12]
> Conscious thought is the tip of an enormous iceberg. It is the rule of thumb among cognitive scientists that *unconscious thought is 95 per cent of all thought* -- and that may be a serious underestimate. Moreover, the 95 percent below the surface of conscious awareness shapes and structures all conscious thought. [13]
> [Lakoff Johnson 1999 (specific page numbers in braces; emphasis added)]

Thus, intervention, either self-intervention or by an intermediary, e.g., a teacher, requires methods and instruments that bring to the learner's consciousness the objects resulting from isomorphic mapping and isomorphic projection.

Reliance on this subconscious activity for a prolonged period (i.e., hours or days, rather than seconds) is referred to as *incubation* (see: What is *incubation*?).

Why is thinking difficult?

> It is cause for joy when a mathematician discovers an isomorphism
> between two structures which he knows. It is often a "bolt from the blue,"
> and a source of wonderment.
> The perception of an *isomorphism* between two known structures is a
> significant advance in knowledge -- and I claim that it is such perceptions
> of isomorphism which create *meanings* in the minds of people.
> [Hofstadter 1979 50 (emphasis added)]

Thought, viewed as isomorphic mapping and isomorphic projection, involves many sub-tasks. These require resources to be available (e.g., related concepts, relations among concepts, procedural intuition, energy, functional physio-neurological infrastructure including sensory perception and motor control). Failure or degradation of any of these can result in a failure of meaningful learning.

These sub-task-level operations are important for their collective impact on macro-level cognitive operations. A few of these are surveyed, leaving production of more complete accounts as future work.

Cognitive velocity

Hofstadter's claim [Hofstadter 1982] as to the importance of cognitive activity below the 100-millisecond level has been mentioned several times.

Experiments with below-perception-threshold reading of subliminal messages placed in the television advertising realm were, at one time, notorious for their influence as "hidden persuaders" according to Vance Packard.

Cognitively, organizing ones thoughts and expressing them, *dispositio --> elocutio*, ranges from lightening fast to 'obstructed,' but most often benefits from at least

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momentary constructive intellectual labor (term selection). Conversely, *pronuntiatio* -->
elocutio varies in speed even among trained readers depending upon the physical object
read or audited, and the reader-listener's familiarity with the textual or graphic language.
Similarly, *elocutio --> dispositio* speed varies with the learner's "learning set" and
familiarity with the subject matter.

Velocity is a term native to the physical sciences, and thus implies standard units of
measure. However, there is no generally accepted measure or units of thinking because
the term encompasses so many kinds of tasks. However, one can say that *elocutio* ➜
pronuntiatio is generally slower than *pronuntiatio* ➜ *elocutio* on account of the physical
mass that must come into motion in producing written or spoken *pronuntiatio*.

Expert chess players recognize conditions that evoke particular ICMs and thus these
players can rapidly select appropriate moves. Recognizing and using the ICM is faster
than if the chess player has to learn it, that is, perform the careful construction of relations
among the particular *inventio* that comprise the ICM *dispositio*.

We recognized earlier that, similarly, *attention* can be focused or divided, and its capacity
can be limited (see: Human-computer interaction (HCI), above).

Mental workload

Is theory or technique available to predict how much and which knowledge can be
meaningfully learned or cannot be learned? In asking, "how much" one implies some
units of measurement. What measurements are appropriate?

> Mental workload addresses issues such as how busy is the user or
> operator? How difficult are the tasks assigned to him or her -- can he or

she be able to deal with an additional workload?
[Benyon Turner Turner 2005 378]

Incorporated in workload measurement are mental demand of the work (how much

thinking, deciding,), physical demand, temporal demand (pressure to meet deadlines),

performance (how well was the work performed, results), effort level (how hard was the

work), and frustration level.

Miller's [Miller 1956] theoretical *seven plus or minus 2* limitation on cognitive

processing capacity, number of ideas, number of processes, number of relations has been

cited earlier in this report (see: Cognitive capacity, above).

> Cognitive work analysis (CWA) has evolved from the work of Jens
> Rasmussen and his colleagues (Rasmussen, 1986, 1987; Vicente and
> Rasmussen, 1992) originally working at the Risø National Laboratory in
> Denmark. . . .
> One principle underlying CWA is that when designing computer systems
> or any other 'cognitive artifact' we are developing a complete work
> system, which means that the system includes people and artificial
> artifacts. Seeing the whole as a work system enables designers to
> recognize that this system is more than the sum of its parts; it has
> emergent properties. [Benyon Turner Turner 2005 383]

While recognition of the relevance of the learner is praiseworthy, CWA mirrors analysis

of industrial systems comprised largely of non-cognitive artifacts and needs assessment.

Thinking strategy

A fascinating differentiation of humans over digital computational system is that if a

learner doesn't have sufficient data to make a decision, he is unlikely to be obstructed.

He will use the closest mental model or data available as a point of departure, even if it's

way off, *mutatis mutandis*. However, one may have difficulty recognizing the best model

or concepts to use even if already assimilated in the learner's mind. Thus, availability of criteria for use in determining which models to apply to a particular procedure or fact pattern can be useful but consumes effort in identifying such criteria.

Memory dysfunction

The impact of *memoria* on thought and language has been sketched above. Dysfunction can be grounded in medical or physiological conditions. Less discussed is that forgetting can occur as a result of cognitive processes, much as a computer user might inadvertently delete a directory of important files, that is, commit a cognitive error rather than a mechanical error or material failure.

These examples, of course, are not a comprehensive itemization of evidence that thinking is difficult. Indeed, numerous obstructions can arise to a learner at each point in the Division of Rhetoric communications reference model. A more thorough enumeration is beyond the scope of this report, and left for future development of extended Assimilation Theory.

Innovations that mitigate obstacles to thinking

Perhaps the most predominant innovation in thinking is *analysis*, that is, partitioning a problem into pieces or components (e.g., conceptual sub-structures of inadequate *dispositio*), then resolving each piece. Folk-theoretically, if all the pieces can be solved, then the whole problem is solved. In practice, and depending on circumstances (e.g., the dimensions on which the partitioning was performed), this approach has an admirable but imperfect track record. Partitioning a "problem" can include setting "a boundary around the problem," that is, a conceptual scope discriminating those concepts that the problem encompasses from those that it does not.

For meaningful reception learning, Ausubel invokes the notion of *cognitive analysis*:

> Meaningful reception learning is inherently an active process because it
> requires, at the very least (1) the kind of *cognitive analysis* "necessary for
> ascertaining which aspects of existing cognitive structure are most
> relevant to the new potentially meaningful material;"
> [ARK 5 (emphasis added)]

Ausubel's prescription for how cognitive analysis is to be performed is not a separate component of Assimilation Theory that one may review separately from other elements, but underlies the whole of it. In essence, the learner's knowledge structure is analyzed by a teacher to ascertain the concepts and relations among them. The teacher then uses that analysis to determine how to present new concepts and enable the learner to establish relations between those new concepts and their prior knowledge -- assimilation.

One flavor of *cognitive analysis*, i.e., *partitioning* a concept into components and identifying their relations, is *differentiation*, i.e., ascertaining the attributes and relations of an idea that distinguish it from others. *Differentiation* is substantially similar to

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comparative analysis. Ausubel's exposition of progressive differentiation is summarized above (see: Part II.1).

An innovation complementary to *analysis* is *synthesis*, that is identifying relations among disparate concepts. From *synthesis* can arise *synergy*, whereby conceptual structure not found in any particular group if ideas *emerges* as a new concept.

Within the domain of analysis, may be found related fields of mathematical analysis, analysis according to the methods of physical sciences (so-called scientific method), and logical analysis. Certainly, exposition of these innovations is well beyond the scope of this essay as well, but future investigation will need to account for how they work cognitively as Lakoff has undertaken to do [Lakoff Núñez 2000]. The phenomenalist position that developing, understanding, and using mathematics is essentially a human activity may be evident to many; yet it is not to others, among them mathematicians who instead regard mathematics as *truths* that exist in nature. Lakoff underscores the notion that without humans, there would be no *mathematics*, no *time*, no physical laws, no laws of any kind. These all exist only in the human mental realm. To employ mathematical or scientific analyses, learners must be adequately trained. Logical analysis is a professional discipline in its own right, yet the most basic elements are learned and practiced even by young children. These fundamental cognitive logical devices are referred to as *reason*, the ability to comprehend in a *rational* manner.

Qualitative analysis focuses upon non-numerical attributes, and encompasses, for example, discourse analysis, ethnography, and needs assessment.

A complement to *reason* is, of course, *faith*. Many learners find explanations in analysis according to *religious* conceptual constructs.

What is *incubation*?

Subconscious assimilation activity, such as isomorphic mapping, isomorphic projection, subsumption, superordinate learning, or integrative reconciliation for a prolonged period (i.e., hours or days, rather than seconds) is sometimes referred to as *incubation*.

The iterative processes of re-forming one's *dispositio* though continuous construction (and demolition) of *new* relations among existing *inventio* may be regarded as the Ideas stimulate other ideas motor (see: Figure II.50). Incubation *is* this iterative process, over tim**e**. Because these processes operate below the 100-millisecond threshold of consciousness (see: Continuous derivations, and Most isomorphic operation is subconscious) from the learner's perspective, the learner may be unaware of deliberate effort, suspend attention, and stop effortful deliberation about the inadequate *dispositio*. Some time later, a solution might appear or an essential concept might arise as if from nowhere. Unaware of their own cognitive effort, all the learner may be aware of, other than the gap being bridged or block being overcome, is that the process occurred over time.

Adams [Adams 1974 57] cites inability to incubate as a barrier to conceptual blockbusting. Although conceptual processes operate largely beyond the reach of deliberate conscious control, Adams suggest several strategies for overcoming blocks or preconceptions [Adams 1974 66-67] such as considering many alternatives to a blocking concept, then, through process of elimination of the least desirable, selection of replacement concepts for the blocking one. Prior to mitigating a block, however, must come recognition of it.

What is critical thinking?

If *curiosity* is probing one's *dispositio* for *apparent* inadequacies (e.g., "how can that plant survive with so little water?") (see: What is curiosity?, below), then *critical thinking* is the complement: probing ideas that do *not* manifest apparent inadequacies.

Buckland differentiates *critical thinking* from both *science* and *scholarship* for its focus on questioning assumptions:

> *Ideas*. In dealing with ideas we need to be scholarly, scientific, and *critical*, all three, as best we can. This trinity of academic virtue--being scholarly, being scientific, and being critical--deserve some attention for they are not the same. Being scholarly is . . . characterized by the affirmative search for evidence that might contradict our best ideas. . . . Being scientific means constructing formal, refutable explanations of phenomena of interest, but being scientific is not always feasible. . . . Being "*critical*," in this context, does not mean being hostile, but *questioning the assumptions* and procedures being used in scholarship, scientific or not. Critical commentary, in this sense, is important, but, because it challenges assumptions, does not make for popularity. [Buckland 2000 (emphasis added)].

Generally, *critical thinking* encompasses the tasks of probing for, recognizing, identifying, and examining *assumptions* underlying an idea. Recognition of an underlying *assumption* can be a difficult task. That task is considered next.

How can assumptions be recognized?

How can assumptions be recognized? First Ausubel is consulted, for guidance:

> Teachers can help foster the related objective of *critical thinking* with
> regard to subject-matter content by encouraging students to recognize and
> challenge the assumptions underlying new propositions, to distinguish
> between facts and hypotheses, and between *warranted* and *unwarranted*
> inferences. Much good use can also be made of Socratic questioning in
> exposing pseudo-understanding, in transmitting precise meanings, in
> reconciling *contradictions*, and in encouraging a critical attitude toward
> knowledge. [ARK 53 (emphasis added)]

While Ausubel does draw attention to the basic notions of recognizing *contradictions*,

challenging *assumptions*, distinguishing concepts to which various forms of *reliability*,

e.g., *truth*, *belief*, or *trust* have been imputed, and the notion of *warrants*, he does not

provide a coherent *structural* description of critical thinking.

Structurally, an *assumption* is, to the first approximation, an idea like any other *inventio*.

It gains the status of an *assumption* when it (1) becomes related to *another* idea, a *claim*,

(2) operates as a criterion for imputing *truth*, *belief*, *trust*, or *usefulness* to that claim.

Ideas often become recognized as assumptions when the attribute of *reliability* is, or

becomes, *absent* from the *claim*. For example:

> *claim*: Joe will prosper if he takes that job at Amalgamated Widgets.

A second idea related to this *claim* idea might be, for example

> Joe will prosper because the other employees prosper.

Indeed, there is ample *evidence* that other employees prosper:

Employees have good working conditions; received 6% raises this year;

have excellent benefits; and receive free widgets on their birthday.

The second idea is not merely a random one, loosely related to the claim. This idea,

called a *warrant*, is related to the claim in a particular way: it acts as a criterion for

interpreting evidence that justifies the claim and imputes *reliability*. Booth et al. present

the elements of argument and their diagram is reproduced in Figure II.66:

> *claim*, (concepts the writer intends readers to believe or know)
> *evidence*, (reasons readers should impute credibility to claims author
> 　　　intends to provoke)
> *warrant* (a general principle that explains why evidence is relevant to the
> 　　　claim, i.e., bears on relations to neighboring *dispositio*), and,
> *qualifications* (to make claim more precise)
> [Booth Colomb Williams 1995 89 (annotation added)]
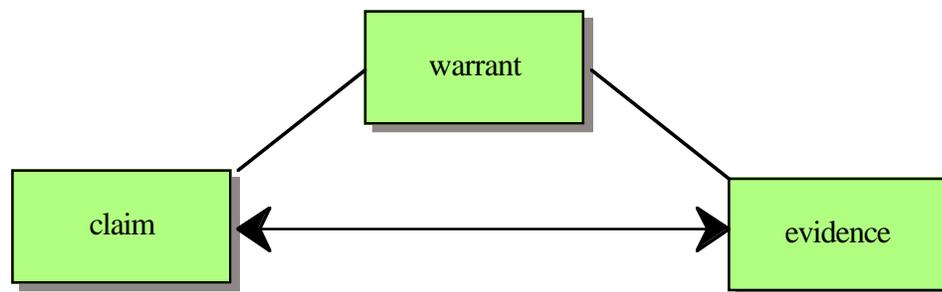
Figure II.66

Booth describes the relation between warrant and evidence:

> The warrant of an argument is its general principle, an assumption or
> premise that *bridges* the claim and its supporting evidence connecting
> them into a logically related pair.
> Evidence must lead to recognition of relations and construction of
> understanding, otherwise it is just "raw data."
> [Booth Colomb Williams 1995 90 and 103 (emphasis added]

Warrants possess an interesting characteristic: they are regarded as knowledge, truth, or practical commonsense so long as the claim is not contradicted. However, when conditions argue for the claim to be regarded as *contradicted*, despite the continued existence of the previous evidence upon which trust was imputed to the warrant, but now losing the attribute of *true*, *known*, or *trustable*, the warrant takes on a new name, it becomes regarded as an *assumption*. The warrant, as a criterion for acceptance of an idea as true or reliable, is generally an idea that has been part of the learner's knowledge long enough to have several experiences that resulted in reinforcing the reliability of the idea. That is, the warrant concept may be regarded as a *preconception*. If the warrant-assumption-preconception is exposed to contradictory ideas, the process of overcoming the preconception comes into play (see: Preconceptions, II.1). Preconceptions can operate to displace new concepts or relations, i.e., new meaning.

In our example above, suppose Joe intimated to friends that he received continuous promotions and benefits for several years. His friends might regard his claim as true or believable because they have the *evidence* listed above, apply the warrant, and respond:

"We're not surprised. Everyone *knows* that Amalgamated Widget people prosper."

That is, the criterion for imputing *reliability* to Joe's claim is that he prospers because the *class* of Amalgamated Widget employees do.

However, suppose the following year, Joe is laid off. He relates this unfortunate news to his friends. The existing evidence still obtains, but the claim, Joe will prosper at AW, now has contradictory evidence: Joe has been fired. How do Joe's friends think about these ideas? They might look at why they accepted the idea that Joe would prosper given the idea that Joe will do well if others do well. They did, but he did not. Thus, the

warrant now is no longer *reliable*, no longer a criterion for imputing truth. And, it now takes on the moniker of an *assumption*.

If a claim is *reliable*, it is characterized as *truth*, *knowledge*, or *law*, etc. If exceptions are encountered in its *reliability*, its warrant becomes regarded as an *assumption*. Joe's friends might say, in the case above, "Our assumption was wrong."

In contrast to ordinary usage, in critical thinking, *warrants* are regarded as *assumptions at inception*, rather than awaiting contradiction. And, as *assumptions*, they must be probed.

If this characterization of an assumption or warrant seems more the work of a logical positivist than humanist, recall that most meaningful cognitive activity occurs below the 100-millisecond threshold of consciousness:

> "Everything interesting in cognition happens BELOW the 100-millisecond level -- the time it takes you to recognize your mother." [Hofstadter 1982]

That is, the cognitive process of applying a warrant to evidence operates so quickly that people do not usually perceive the process of applying warrant to evidence and deriving a conclusion that a claim is justified or not. *Critical thinking* intervenes to insert, at the conscious level, the task of probing the warrant, i.e., the assumption, to circumvent the "automatic" conclusions that occur below the 100-millisecond threshold in the event that the warrant is inadequate.

How does warrant probing operate in critical thinking?

> When I collect arguments for my cases, I make it a practice not to count
> them, but to weigh them." [Cicero *De partitione oratoria*, II.1 xxvi.309)]

Let us return to the circumstances under with learners impute *belief*, *trust*, and *truth*, or other *credibility* attributes to ideas (see: *Elocutio* only indirectly correlates to meaning, *dispositio*, and, How reading facilitates imputation of credibility to concepts or their selection for subsequent use, and the paragraph on Branding in Isomorphic projection also underlies . . .). Our first step on this explanatory path begins with guidance from Ausubel's protégé, Novak:

> Building *trust* requires the use of mutually understandable explicit
> language and often prolonged socialization or two-way face-to-face dialog
> that provides *reassurance* about points of doubt and leads to willingness to
> respect the other party's sincerity. [Novak 1998 158].

If probative critical thinking was regarded strictly as a cold, logical operation of ascribing truth values, Novak puts that misconception to pasture.

Reason is commonly understood to be generally accepted practices involving claims, evidence, and warrants. Claims accepted without warrant or evidence are *believed*, perhaps on faith. Concepts (e.g., claims) accepted based on evidence for which the learner has *warrant*, are concepts to which are imputed *trust*, *belief*, *cognitive authority*, etc. Without this structure, ideas are merely opinions:

> Opinions are philosophically uninteresting because they are merely
> unsupported claims. [McLaughlin undated]

Two evaluations must occur: evaluation of the *warrant* to determine whether it is sufficient, and then evaluation of the *evidence* according to the *warrant*. These two tests of a claim or any *inventio* are basic elements of critical thinking.

To carry out these evaluations, the critical thinker must construct counterfactual probes, then isomorphically project them onto the idea to be evaluated. If each test returns expected results, that is, is *reliable*, then the claim (*dispositio*) may be sound. If results are returned that are not consonant with other knowledge, then, perhaps, one's critical thinking has detected a defect in the idea. Consider the following example,

> A vacuum cleaner salesman offers to sell a customer a new machine at a substantial discount. The vendor indicates that, as an authorized retailer, he honors all factory warranties. He operates from a store on the main street in town and states that he has been in business thirty years. He willingly provides manufacturer sales literature and demonstrates the machine to your satisfaction.

> The *idea* of purchasing a vacuum from such a vendor seems sound.

> To apply critical thinking however, we must probe with counterfactuals. For example, we ask the salesman, "Suppose the motor burns out. Can you show me in the warranty where the defect is covered."

> The salesman waves the warranty and says "It will be covered." The customer says, "Show me where it says that." Upon inspection of the warranty, particular electrical components are explicitly not covered.

> The salesman then rails that he has been in business thirty years and could not do so if he did not cover such defects. The prospective customer then asks, "Do you mean that you would pay for the cost of the repairs?" The salesman hedges, saying, "We will take care of it."

This exercise in critical thinking has uncovered the apparent relation that if the machine's electric motor is defective, the printed warranty indicates that the manufacture will not cover the cost of repairing it and neither will the local vendor. With this counterfactual probe, that of the new never-used vacuum cleaner malfunctioning, the prospective buyer might no longer view the original claim, *viz*., the idea of purchasing the machine from the local vendor, as sound.

Critical thinking can be regarded as directed to *overcoming* preconceptions, that is, relations such as trust, and cognitive authority *already* imputed to ideas (see: II.1, Preconceptions). Learners build such relations carefully, using warrants and evidence. Thus, overcoming them requires the mental labor of seeking and finding defects in the warrants and evidence used to establish the claim or idea as *true*, *believed*, or *useful*.

Methodologies for producing and evaluating counterfactual interpretations (to probe warrants) include hypothesis generation and testing, and question formulation (see: What are questions?), from elementary how?, who?, what?, where?, when?, why?, and what if? questions to projection of hypothetical situations (if event *x* occurs, then what event *y* happens?), and evaluation questions (is *x* good or bad? beneficial or detrimental? Why? Which criteria are to be used for deciding?). Critical thinking operates through isomorphic mapping and projection for their roles comparing and contrasting ideas according other baseline ideas.

Reliability, the quest for certainty: belief, trust, truth, knowledge, cognitive authority, etc.

An essential element of critical thinking and probing of warrants or assumptions is the rationale of the learner for doing so, usually that of achieving sufficient *certainty*, and, in turn, economizing expenditure of cognitive energy in verifying credibility that has already been confirmed. The concept of *reliability* centers around notions of *certainty* and *truth*.

Philosophers are partitioned into different camps as to whether humans *can know* with certainty whether a concept is *true* throughout the world or universe and applies to

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everyone. Ausubel takes a practical approach to *truth*, grounded in epistemological individualism: Important is the learner's view of whether a concept is *true*, perhaps in contrast to an external conceptual reference structure such as a teacher's knowledge:

> *actual* (phenomenological or psychological) meaning, which is a product of a meaningful learning process . . . [ARK 73]

Ausubel, however, uses these terms loosely and interchangeably:

> Second, unless one assigns a sacrosanct status to "endogenous motivation," there is little *warrant for believing* either that it alone is *truly* reflective of the child's *genuine* developmental requirement . . . [ARK 32 (emphasis added)]

> This confusion is partly responsible for the widespread but *unwarranted twin beliefs* . . . [ARK 49 (emphasis added)]

> Teachers can help foster the related objective of critical thinking with regard to subject-matter content by encouraging students to recognize and challenge the assumptions underlying new propositions, to distinguish between facts and hypotheses, and between *warranted and unwarranted* inferences. [ARK 53 (emphasis added)]

Can a learner know false "information"? An idea that is not *true*? That is not *believed*? Not *trusted*? Indeed (see: Counterfactual blends, above). Every concept is comprised of many attributes. *Truth*, *trust*, or *belief* attributes are only some of those that a learner imputes to concepts. Apart from these, a learner can *know of* other component *inventio* and relations (structure) of a concept, even if they do not believe or trust it ((Figure II.42).

Where do plans come from?

> If you don't know where you are going, you will probably end up
> somewhere else. [attributed to Laurence J. Peter and Raymond Hull]

Planning is a complementary concept to the constructivist metaphor for learning. Before constructing a building, one must construct a *plan*. What is plan in terms of meaningful learning?

In school settings, the concepts to be learned are often planned by instructors. As learners mature intellectually, they take a greater responsibility for planning the *dispositio* they will attempt to construct. Whether teacher or learner performs the planning, it involves characterizing the desired *dispositio*, then discovering and obtaining *pronuntiatio* that might provoke the learner to assimilate or evoke the desired *dispositio*.

One of the familiar properties of *planning* is that it can be useful and effective in avoiding and surmounting obstacles. Of course, this conceptualization has had projected onto it properties of several idealized cognitive models (ICMs):

> Purposes are Destinations,
>
> Starting a Purposeful Action is Starting out on a Path (a linear sequence),
>
> Difficulties are Blockages,
>
> Reason is a Force (that can, for example, move a blockage),
>
> Structure of an Idea is the Structure of an Object
>
> etc.

Planning in the everyday world generally entails analysis, problem identification, risk assessment, resource deployment, and completion and termination criteria, among others. A learner, when confronted with the prospect of performing an inquiry, likely performs

such tasks subconsciously, perhaps some not at all, to varying degrees of effectiveness. Moreover, in doing so beneath the conscious threshold, cognitive plans are less deliberately prepared than adopted in a pre-formed state, that is, as idealized cognitive models. That is, the objects that most closely resemble plans at the subcognitive, and often the cognitive levels, are mental models (see: Species of *dispositio*: Idealized cognitive models).

Ausubel adopts Gagné's view that the elements of planning performed by the teacher for a learner's process of assimilation center around sequencing learning material so that each new concept builds on ideas already presented and assimilated, that is to take into account the learner's prior knowledge and teach accordingly:

> Further, in superordinate learning it is essential to ensure that both subordinate concepts and propositions and the component conceptual elements of each proposition are previously mastered. Gagné (1977) states the problem very well in the following statement:
>
>> The *planning* that precedes effective design for learning is a matter of specifying with some care what may be called the learning structure of any subject to be acquired. In order to determine what comes before what, the subject must be analyzed in terms of the learning involved in it. The acquisition of knowledge is a process in which every new capability builds on a foundation established by previously learned capabilities. . . . The importance of mapping the sequence of learnings is mainly just this: That it enables one to avoid the mistakes that arise from "skipping" essential steps in the acquisition of knowledge of a [particular] content area (Gagné, 1977).
>
> [ARK 169]

Ausubel's exposition of *planning* in the context of superordinate learning is not coincidence. Plans originate as concepts. Concepts that organize more detailed concepts are superordinate concepts (Ausubel) or idealized cognitive models (Lakoff). Having an overarching mental model of an enterprise enables the learner to recognize which

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learning sub-tasks must precede others and what task should be tackled next. A learner who 'knows what to do next' demonstrates mastery of the ICMs that pertain to the subject matter she is learning.

In the course of learning, learners will likely encounter cognitive (structural) obstacles in the form of *inadequate dispositio* (see: *Inadequate dispositio*: *gaps* and *blocks*) such as inadequate relations, non-existent relations, or inadequate or missing *inventio*. A plan, i.e., a model or ICM, enables the learner to isomorphically project reliable relations and *inventio* onto her inadequate *dispositio*, thus informing it.

Formulation of instructional plans may be derived from the recognition of the gaps and misconceptions revealed in contrasting a inquirer's concept map with a reference map.

To return to the shoreline analogy (the location where one's grounded knowledge meets the sea of unknown concepts), one does not go to the construction site (at the beach) in ordinary clothing, without tools, without materials, without lunch. One *plans*, by wearing proper attire, bringing resources, etc. Learners must bring appropriate resources and be able to apply them, as Ausubel has taught (see: II.1, Learning set):

> [B]ut it is primarily the superiority in meaningful learning *processes* (i.e., the learner's *meaningful learning set* and the nonarbitrary, nonverbatim relatability of the instructional materials to relevant anchoring ideas in cognitive structure) that basically accounts for the superior learning and retention outcomes. [ARK 15]

Edwards sketches some elements of cognitive planning suited to scholarly reading:

> As soon as you start to read, begin trying to find out four things:
> - Who is the author?
> - What are the book's arguments?
> - What is the evidence that supports these?
> - What are the book's conclusions?

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Once you've got a grip on these, start trying to determine:
- What are the weaknesses of these arguments, evidence, and conclusions?
- What do you think about the arguments, evidence, and conclusions?
- How does (or how could) the author respond to these weaknesses, and to your own criticisms?   . . .

More specific (narrow) information (supporting evidence, details, etc.) is presented in the middle [of a text]. [Edwards 2000 2 (annotation added)]

The model described at the end of this Part (see: What is inquiry?) may be regarded as an ICM for plan of inquiry.

Another characteristic of plans and paths is that they usually have *endpoints*, that is, an *initiation* and a *termination* (see: Process characteristics: endpoints, II.1). People like tasks to "get finished". Plans fulfill the role of serving as the learner's criteria for knowing when they have reached the terminal endpoint of their inquiry. Terminal endpoints are cognitive, but may be experienced in conjunction with the satisfaction or exhaustion of physical resources (time indications of a clock, money, printer paper, etc.).

Consideration of each sub-task of cognitive planning is left as subject matter for future research, other than to acknowledge Ausubel's acceptance of Gagne's starting point: *determine what comes before what . . . building on . . . previously learned capabilities*, and recognition that, unless performed deliberately and consciously, learners use pre-formed superordinate or idealized cognitive models to guide their learning, i.e., as *plans*. Thus, where learning falters, one may look to the models evoked by the learner and evaluate their efficacy for learning the intended subject matter.

Important to take into account is the readiness-to-learn principle whereby learners learn an idea best at the moment that idea is important to them (see: Readiness to learn, II.1).

What is the role of imagination in thinking? What is creativity?

Several writers have recognized that, despite the apparent algorithmic and procedural aspects of thought and learning, creative and imaginative elements also obtain. Ausubel mentions the imaginative character of thought only infrequently:

> motivational variables . . . can only influence retention, apart from learning, during the reproductive phase of memory by elevating thresholds of availability and by shaping the qualitative aspects of *imaginative reconstruction*. [ARK 198]

In this, Ausubel associated imaginative phenomena with the constructive labor (*reconstruction*) that is inherent in *isomorphic projection*.

Novak felt creativity to be sufficiently important that he included the term in the title of his book on Assimilation Theory, *Learning, Creating, and Using Knowledge*. He equates creativity to Ausubel's processes of integrative reconciliation and superordinate learning:

> My view is that creativity is simply successful integrative reconciliation or superordinate learning and the emotional desire to do this.
> [Novak 1998 73]

Imaginative capacity is inherent in the discovery of superordinate ideas. Superordinate ideas extend their relations broadly. They cannot generally be discovered by other processes described by Ausubel. They require creatively hypothesizing, seeking, and recognizing attributes of the superordinate idea that extend beyond the expected boundaries, "seeing the big picture," recognizing an underlying organizing metaphor, an idealized cognitive model (ICM) (see below).

James provides examples of imaginative recognition of ICMs that reorganized major portions of scientific knowledge:

The flash of similarity between an apple and the moon, between the
rivalry for food in nature and the rivalry for man's selection, was too
recondite to have occurred to any but exceptional minds. Genius, then, as
has been already said, is identical with the possession of similar
association to an extreme degree .
[James 1890 Vol. 2, p. 361, Ch.. XX, Reasoning]

These recognitions arose from isomorphic projection, where isomorphic mapping first

coordinated two *dispositio* (derivative of two sets of circumstances), then projected the

relation *between* apple and ground onto sun and earth. Thus,

isomorphic projection is an imaginative, creative act.

Further, to the extent that thought relies upon superordinate thinking and isomorphic

projection, and virtually all meaningful thought does, then

selection of appropriate *dispositio*, models, ICMs from which to project,

is also an essential and imaginative, creative act.

Linguistic and cognitive science theory cited throughout this Part acknowledges the

imaginative character of these two cognitive operations:

Reason is not purely literal, but largely metaphorical and *imaginative*.
[Lakoff Johnson 1999 4 (emphasis added)]

Reason is *imaginative* in that bodily inference forms are *mapped onto*
abstract modes of inference by metaphor.
[Lakoff Johnson 1999 77 (emphasis added)]

Philosophy . . . turns out to be very different from what we thought before.
Instead of being the activity of pure reason, it is the activity of an
embodied reason. It operates through the cognitive unconscious and thus
makes use of all the *imaginative* resources of the cognitive unconscious.
It is grounded in and constrained by *structures* that depend on the nature
of our bodies and the environments we live in.
[Lakoff Johnson 1999 540]

Fauconnier, following Lakoff, finds evidence of imagination in isomorphic projection:

> *Identity*. The recognition of identity, sameness, equivalence . . . is in fact a spectacular product of complex, *imaginative*, unconscious work. . . . But identity and opposition are finished products provided to consciousness after elaborate work. [Fauconnier Turner 2002 6]

> Conceptual integration, which we also call *conceptual blending*, is another basic mental operation, highly *imaginative* but crucial to even the simplest kinds of thought. [Fauconnier Turner 2002 6, 18]

> Identity [isomorphic mapping], integration [isomorphic projection], and *imagination* . . . are at the heart of even the simplest possible meanings. . . . These basic operations are the key to both the invention of everyday meaning and exceptional human creativity.
> [Fauconnier Turner 2002 xi (annotation added)]

> *Imagination*. Identity and integration cannot account for meaning and its development without . . . *imagination*. Even in the absence of external stimulus, the brain can run imaginative simulations. . . . The products of conceptual blending are always imaginative and creative.
> [Fauconnier Turner 2002 6 (emphasis added)]

> Conceptual integration is at the heart of *imagination*. It connects input spaces, projects selectively to a blended space, and develops emergent structure through composition, completion [fill-in], and elaboration in the blend. [Fauconnier Turner 2002 89 (emphasis added)]

> . . . conceptual integration is also *creative*, delivering new *emergent* structure that is intelligible because it is tied to stable structures.
> [Fauconnier Turner 2002 396 (emphasis added)]

Selection of appropriate source *dispositio*, and isomorphic projection result in construction of a *new* portion of *dispositio* derived from another concept. This creation of new structure is *imaginative*.

Imagination *is* isomorphic projection of counterfactual concepts

Imagination further encompasses the ability to construct and test *counterfactual*

dispositio, that is conceptual structure that *conflicts* with other, trusted, conceptual

structure within the same *dispositio* (see: Counterfactual blends, this Part).

Counterfactuals can be used to evoke hypothetical scenarios for problem solving, game

playing, entertainment, or other intellectual tasks. They are imaginative, in part, because

they comprise ideas for which the learner might not have evidence, indeed, might be

purely fanciful. As with non-counterfactual isomorphic projection, projection of a

counterfactual results in emergent conceptual structure and relations that did not exist

prior to the cognitive operation:

> If an author says that x is y when we know in fact that x is not y, we must
> try to imagine a world in which x is y. This act of *imagination* is
> facilitated if, in the real world, x is like y in some respects, for then we can
> take their similarities as the author's grounds for saying that x is y.
> [Miller 1993 367 (emphasis added)]

When one exhorts another to, "Imagine!" one is inviting the listener to perform an

isomorphic projection of a *counterfactual* concept onto an existing set of ideas .

As an example, consider an instructor or magazine's description of a new technology

such as nanotechnology, where computational devices with telecommunications

capability are able to be manufactured on the scale (size and weight) of dust particles that

float through the air. The teacher or author might then exhort,

> *Imagine* what nanotechnology might mean for the heating-ventilation-air
> conditioning (HVAC) industry. Trillions of these small machines might
> float around in a building, monitoring temperature and humidity, and
> sending instructions to central equipment to engage furnaces, air
> conditioners, or vent air as needed.

Here, the superordinate *dispositio* of "nanotechnology" is projected onto a specific existing *dispositio*, the idea of *a building too warm*, and its component-concept of *excess-heat-needs-to-be-detected* concept. This is isomorphically *mapped* to the *detection of excess heat condition* component concept of the nanotechnology *dispositio*. Having established a mapping, a concept-in-common, *detection of excess heat*, the nanotechnology *dispositio projects* hypothetically one of its component ideas, *telecommunication connection* onto the *central HVAC system* concept. These new meanings are stimulated by the command, *Imagine!*

Macro isomorphic operations: Idealized cognitive models

In the discussion in the preceding sections, isomorphic mapping and isomorphic projection may be regarded as describing micro-isomorphic processes, that is, mapping among, and projection of, small numbers of *dispositio*. Consider now some characteristics of macro-isomorphic process, that is: how the isomorphic mapping and projection operations scale up for analysis of the complex every-day ideas people use in conscious and near-conscious learning, thinking, communicating, and confronting matters that commandeer our conscious attention.

How are Lakoff's notion of *idealized cognitive models* and Fauconnier's complementary idea of conceptual blending [Fauconnier 1994] and [Fauconnier 1997]) essential to meaningful learning of complex everyday *dispositio*? The role of macro-isomorphic operations using richly textured ICMs yields comparably rich *new* meanings:

> The main thesis . . . is that we organize our knowledge by means of structures called idealized cognitive models, or ICMs, and that category structures and prototype effects are by-products of that organization.

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Each ICM is a complex structured whole, a gestalt, which uses four kinds of structuring principles:
- prepositional structure, as in Fillmore's frames
- image-schematic structure, as in Langacker's cognitive grammar
- metaphoric mappings, as described by Lakoff and Johnson
- metonymic mappings, as described by Lakoff and Johnson
. . .
Each ICM, as used, structures a mental space, as described by Fauconnier.
. . .
Take the English word Tuesday. Tuesday can be defined only relative to an idealized model that includes the natural cycle defined by the movement of the sun, the standard means of characterizing the end of one day and the beginning of the next, and a larger seven-day calendric cycle-- the week. In the idealized model, the week is a whole with seven parts organized in a linear sequence, each part is called a day, and the third is Tuesday.
. . .
Our model of a week is idealized. Seven-day weeks do not exist objectively in nature. They are created by human beings.
[Lakoff 1987 68-69]

Idealized cognitive models are thus richly textured *dispositio*, comparable to Ausubel's superordinate concepts. Any such concept may function as an ICM. Their primary function is to operate isomorphically, as a template, filling-in concepts onto the learner's momentary interest. Both Lakoff and Ausubel acknowledge this "organizing" function:

The assimilation hypothesis can also help explain how knowledge is *organized* in cognitive structure. If new ideas are stored in linked relationships to correspondingly relevant existing ideas in cognitive structure [and if it is also true both that one member of the linked pair is typically *superordinate* to or more inclusive than the other and that the superordinate member (at least, once it is established) is the more stable member of the pair], then it necessarily follows that the cumulative residue of what is learned, retained, and forgotten (the psychological structure of knowledge or cognitive structure as a whole) conforms to the

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organizational principle of progressive differentiation.
[ARK 103 (emphasis added)]

[I]n general, we have found that mappings are at the superordinate rather than the basic level. . . . A mapping at the superordinate level maximizes the possibilities for mapping rich conceptual structures in the source domain onto the target domain, since it permits many basic level instances, each of which is information rich. [Lakoff 1993 212]

Where a learner is blocked or misconceptualizing about a cluster of concepts of the complexity ordinarily encountered in daily life, provision of a new or a different idealized cognitive model can enable him to resolve the learning obstructions by projecting the model onto the confusing fact pattern.

For example, suppose a learner is having difficulty comprehending the causes for the American Civil War because he is subconsciously applying an idealized cognitive model of "Causes are Conditions": He is able to identify many conditions that obtained at the time of the Civil War, e.g., unequal rights, property rights in people, etc., but none of which differed significantly from earlier pre-war conditions, and thus he has difficulty understanding causes that actually led to the start of the War. Suppose then an instructor recognizes the "Causes are Conditions" ICM as inadequate and provides the student with an alternative ICM, a "Causes are Forces" idealized cognitive model by saying,

"Lincoln's insistence that citizens not own slaves put economic *pressure* on the plantation owners fearful of losing their workforce."

Now, the cause of war is modeled not as a passive *condition* but as a *force*, *pressure* from which the learner may isomorphically project a general notion of *force* on to a specific notion of *war*, in this case, the Civil War. This requires the learner to perform an additional mapping of a physical force (from sensory experience) to an abstract force (economic fear).

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How do a learner's ICMs differ from the examples of micro-projection described in earlier sections? Richly textured (i.e., many component *inventio* and relations) structure, rather than simple, single concepts are projected onto the learner's inadequate *dispositio*.

If these macro-scale *dispositio*, idealized cognitive models or superordinate ideas, are important in influencing learning, how can they be recognized, and how can their use be instrumented to improve learning?

Recognizing basic schema, *dispositio*, or idealized cognitive models (ICMs)

Suppose you overheard the following conversation between two college-age apartment-mates:

A: Did you order it?

B: Yeah, it will be here in about 45 minutes.

A: Oh... Well, I've got to leave before then. But save me a couple of slices, okay? And a beer or two to wash them down with?

Do you know what the roommates are talking about? Chances are, you're pretty sure they are discussing a pizza they have ordered. But how can you know this? You've never heard this exact conversation, so you're not recalling it from memory. . . . Schema theory would suggest that we understand this because we have activated our schema for pizza (or perhaps our schema for "ordering pizza for delivery") and used that schema to comprehend this scenario.

A schema (plural schemata) is a hypothetical mental structure for representing generic concepts stored in memory. It's a sort of framework, or plan, or script. [Perry P540]

While the anecdote above uses *schema* rather than *ICM* or *superordinate concept* terminology, it provides a straightforward example of ICM recognition based on concept properties, *dispositio*, rather than concept labels or words, *elocutio*.

Lakoff suggests that a learner's ability to recognize a tractable number of core ICMs might be sufficient to improve learning outcomes.

> The study of spatial-relations concepts within cognitive linguistics has revealed that there is a relatively small collection of primitive image schemas that structure systems of spatial relations in the world's languages. Here are some examples . . . : part-whole, center-periphery, link, cycle . . .
> There are hundreds of primary metaphors. Together these metaphors provide subjective experience with extremely rich inferential structure, imagery, and qualitative "feel," when the networks for subjective experience and the sensorimotor networks neurally connected to them are coactivated. [Lakoff Johnson 1999 34 & 59]

Many of these superordinate *dispositio* are itemized in Lakoff ([Lakoff 1987 68-76], [Lakoff Johnson 1999 170-266], and [Lakoff Metaphor website]. Recognizing ICMs benefits from familiarity with these descriptions. A sampling of these provides a sense of their characteristics:

The Moving Time Metaphor

> There is a lone, stationary observer facing in a fixed direction. There is an indefinitely long sequence of objects moving past the observer from front to back. The moving objects are conceptualized as having fronts in their direction of motion.

> This schema provides the basis for a metaphorical mapping in which elements and structures of this spatial schema are mapped onto the target domain to time.

Objects	Time
Motion of Objects Past Observer	The "Passage" of Time

. . .

Location of the Observer	The Present
The Space in Front of Observer	The Future
The Space Behind Observer	The Past

A complementary ICM has the observer moving, with times fixed on the landscape:

The Moving Observer [on the] Landscape of Time

Here the observer, instead of being fixed in one location, is moving. Each location in the observer's path is a time. The observer's location is the present. . . .

Locations of Observer's Path of Motion	Times
Motion of Observer	The "Passage" of Time
Distance Moved by Observer	The Amount of Time Passed
Location of the Observer	The Present
The Space in Front of Observer	The Future
The Space Behind Observer	The Past

Since time is a path on the ground . . . it can be measured. Hence an amount of time can be long or short. An extent of time can also be bounded; therefore, one can perform an action within an allotted time. This metaphorical mapping gives rise to expressions like:
There's going to be trouble *down the road*. . . . We *passed* the deadline.
[Lakoff Johnson 1999 141-146

Where a learner subconsciously projects the "Fixed Observer -- Moving Time" ICM onto

a target *dispositio* of immediate concern, for example, onto their study of the Civil War,

they may see the period as simply a series of events that "washed past" the nation. If,

instead, they are stimulated to project the "Moving Observer on the Landscape of Time"

idealized cognitive model onto their knowledge structure about the Civil War, they may

be able to construct a meaningful understanding the period by noting that, during the

course of the War, an Observer who was always at the location of battles would have had

a southward progression. The realization of a southward progression of the War would

not likely have been gained from the "Fixed Observer -- Moving Time" ICM, that is, for example, of someone in New York reading daily newspaper accounts of the conflict.

Other important idealized cognitive models include

> States (i.e., conditions) are Locations
> Causes are Forces
> Purposes are Destinations
> Goals are a Sequence of Conditions
>   (e.g., graduated from college, married, family raised, retired)
> Movements are Changes
> Difficulties are Impediments to Movement
> Construction, learning are Travelling-on-a-path, step-taking

Part of the teacher's task is to (1) *recognize* where the learner might be projecting an inappropriate ICM or failing to project a better ICM, then (2) to communicate a more appropriate ICM *dispositio* through which the learner extends their knowledge, that is, meaningfully learns.

> Language always comes with what is called "framing." Every word is defined relative to a conceptual framework. If you have something like "revolt," that implies a population that is being ruled unfairly, or assumes it is being ruled unfairly, and that they are throwing off their rulers, which would be considered a good thing. That's a frame. [Powell 2003]

> The important thing is not to accept their framing of the issues, nor just negate their framing — that just reinforces it. Simply confronting them with facts won't help. Frames trump facts. The facts alone will not set you free. You have to reframe the issues before the facts can become meaningful and powerful. [Powell 2004]

By way of example, if the subject matter at hand is literature, the instructor will likely be well-versed in literary plots (see: Arrangements, models, plots, themes, plans, above) and can readily point them out. Similarly in other scholarly fields, the instructor will draw the learner's attention to the most important underlying ICMs, be it *supply-and-*

demand in economics, *figured bass* in pre-classic music, or *mitosis* in biology, each an indispensable organizing concept for learners in those respective fields.

The solitary reader, absent guidance from teacher or other intermediary, assumes responsibility for recognizing superordinate ICMs that organize the disparate detail expressed in a text. An ICM that underlies the rich concepts of *book* is *authorial intent,* which presumes (1) that the author or publisher had in mind some important ideas underlying all the detail of the *elocutio* expressions that appear as *pronuntiatio*, and (2) that the reader desires or is expected to recognize those ICMs.

Anticipating idealized cognitive models (ICMs)

Recognition of relevant ICM *dispositio*, for both learner and teacher, may be easier if the particular ICM *dispositio* is anticipated. Learners who "know what to expect," that is, which ideas to search for, know the plan, know where the "line of thought is going," learn more meaningfully by definition because they have integrated their prior knowledge (ICM *dispositio*) to new (target) ideas in order to be able to recognize the underlying models that isomorphically project onto the new knowledge they are constructing.

Recognizing, anticipating, mapping, and projecting macro-level *dispositio*, that is, superordinate concepts or idealized cognitive models, is as important in meaningful learning as cognitive processes operating on micro-level *dispositio*. Reading, for example, may be regarded, in part, as attempts to ascertain from the provided *elocutio* which ICMs, or *dispositio* the author is attempting to provoke the reader-learner to evoke.

Subconscious influence of an ICM is *a perspective* or a *preconception*

When a learner's current *dispositio* has been influenced, i.e., organized by, an ICM, the learner is regarded as understanding the current idea *from the perspective of* the source ICM. For example, if the learner is reading a newspaper story about squatters inhabiting a building and then evokes the thought "the squatters are trespassing -- they ought to be removed," then the learner is projecting a Property Rights ICM, under which private property rights trump others' rights, onto the newspaper story. That is, the story is understood from the perspective of philosophical positions privileging these ideas.

The learner's challenge to recognize an ICM expressed by a text, especially one to which they have not imputed importance, is a counterpart to the challenge of recognizing an ICM to which too much importance has been imputed, that is, preconceptions and misconceptions (see: Preconceptions (II.1) above). Assimilated ICMs, being superordinate to many other of the learner's *inventio* and thus having relations established with them, are resistant to change. Where a learner is suffering from a misconception, that is, an ICM adjudged to be incorrect or that should be replaced, it might be insufficient simply to indicate to the learner that their conceptualization is in error because the influence of the ICM is reinforced through so many established relations to other *inventio*. Instead, the troublesome ICM must be debugged, with all its effects on relations to other ideas identified and adjusted appropriately. [Footnote II.11]

Dichotomy: anticipating concepts is indispensable, but anticipation can also be misconception

On one hand, a learner's ability to *anticipate* which concepts may be expressed by a document (to evoke relevant conceptual constructs) is essential to deriving meaning from texts and thus, important to successful interpretation (see: *Anticipating* idealized cognitive models (ICMs), and Recognizing *dispositio* as explanatory).

On the other hand, it can also be a detriment, that is a preconception to be overcome if contrary to new ideas to be learned (see: II.1, Preconceptions, and, Unconscious influence of an ICM is *a perspective* or *preconception*, this chapter).

Thus, anticipated and recognized ICMs are best subjected to critical thinking (see: What is critical thinking?) to evaluate both.

Exercises

The reader is encouraged to review both the section Basic *inventio* and abstract *inventio*, and macro-isomorphic operations: Idealized cognitive models, prior to attempting these exercises.

1. In the passage, identify metaphoric abstract concepts, the basic concepts from which they arise.

> Four score and seven years ago our fathers brought forth on this continent, a new nation, conceived in Liberty, and dedicated to the proposition that all men are created equal.
>
> Now we are engaged in a great civil war, testing whether that nation, or any nation so conceived and so dedicated, can long endure. We are met on a great

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battle-field of that war. We have come to dedicate a portion of that field, as a final resting place for those who here gave their lives that that nation might live. It is altogether fitting and proper that we should do this.

But, in a larger sense, we can not dedicate -- we can not consecrate -- we can not hallow -- this ground. The brave men, living and dead, who struggled here, have consecrated it, far above our poor power to add or detract. The world will little note, nor long remember what we say here, but it can never forget what they did here. It is for us the living, rather, to be dedicated here to the unfinished work which they who fought here have thus far so nobly advanced. It is rather for us to be here dedicated to the great task remaining before us -- that from these honored dead we take increased devotion to that cause for which they gave the last full measure of devotion -- that we here highly resolve that these dead shall not have died in vain -- that this nation, under God, shall have a new birth of freedom -- and that government of the people, by the people, for the people, shall not perish from the earth.
[Lincoln 1863]

Ans.   Abstract concept "a new nation" derives from sensory comfort of commingling with family for protection and sustenance.

Abstract concept "liberty" derives from sensory experience of being confined.

Abstract concept "the unfinished work which they who fought here have thus far so nobly advanced" derives from the physical act of moving forward toward a goal, e.g., food, comfort.

Abstract concept "*gave* their lives" (mortality and act of honor) derived from sensory act of passing an object from oneself to another.

Abstract concept "a new *birth* of freedom" derived from physical act of giving birth.

2. Identify the superordinate ICMs that organize your thinking about the subject for the same passage.

Ans.   Expression "the unfinished work which they who fought here have thus far so nobly advanced" derives the superordinate that *work* is a *path* from a task to a goal. Progress toward the goal is *advancing* along the *path*.

3. Select a story from today's newspaper or news website. Identify metaphoric abstract concepts, the basic concepts from which they arise.

4. From the same news story as (#3) above, identify the superordinate ICMs that organize your thinking about the subject.

The *Eureka!* event

> *Eureka* ('Eureka!', or 'Heureka') is a famous exclamation attributed to
> Archimedes. He reportedly uttered the word when he suddenly
> understood that the volume of an irregular object could be calculated by
> finding the volume of water displaced when the object was submerged in
> water, subsequently leaping out of his bathtub and running through the
> streets of Syracuse naked. "Heureka" is the 1st person singular perfect
> indicative active of the Greek verb *heuriskein*, meaning "to find"; it means
> "I have found it!", or more accurately, "I am in a state of having found it".
> As a result, "Eureka!" has become an interjection which is used to
> celebrate a discovery (whether a major scientific truth or something as
> minor as the finding of a lost item). **A *Eureka step* is the step in a proof
> that cracks the problem and paves the way to the solution.**
> [Wikipedia *Eureka (word)* (emphasis added)]

We have observed during the course of this report (see: Evidence that a learner has

constructed meaning) that evidence of successful meaningful learning can be of two

kinds: a cognitive improvement in the learner's knowledge, or a felt *sensation* that

displaces the "constructive discontent" or "distressing ignorance" that arises from

inadequate *dispositio*. The former has been explored in some detail. Here the latter

receives attention.

The cognitive event of interest here is not the assimilation of a mere fact or even simple

relations like construction of the concept that whales hold membership in the category

mammal rather than the category *fish*. Instead, of interest here is the relation between

sensations and assimilation of superordinate ideas that establishes relations among, or

makes sense of many other ideas that were unrelated or even in conflict with one another.

Again James' passage is apt:

> The flash of similarity between an apple and the moon, between the
> rivalry for food in nature and the rivalry for man's selection, was too
> recondite to have occurred to any but exceptional minds. Genius, then, as

has been already said, is identical with the possession of similar
association to an extreme degree.
[James 1890 Vol. 2, p. 361, Ch. XX, Reasoning]

People are meaning-makers. *Meaning* is privileged so highly it becomes invisible to
critical examination. People seem to be appeased with the most terrible events and
conditions *so long as* they can come to *understand* them. Some have claimed that
religion provides meaningful explanations of events and conditions that other systems of
thought cannot address. When a tragedy occurs, such as an aircraft accident or 9/11,
what do people do? They analyze it. They attempt to understand it. Of course, they may
intend to use the understanding to prevent future incidents, but such does not account for
our addiction to comprehension. Human are meaning makers.

We will find, in the example below, that the degree of felt sensation of the Eureka event
corresponds to the magnitude of (1) the improvement of the learner's inadequate
dispositio, distress, or discontent, (2) the magnitude of the disparate *dispositio* that a new
idea organizes and (3) the "distance" as indicated by the traversal of subject matter
boundaries one reaches to import the projection into the subject domain of interest.

To place our focus upon the event of comprehension, exposition of some specimens of
the sorts of successful meaningful learning to which learners might aspire will serve as a
first step, and followed by consideration as to how such events differ from ordinary
learning, even successful ordinary learning.

An example of imaginative comprehension events

An acceptable solution in the following example (from [Holyoak Thagard 1995 110-112]) comprises two requirements: destruction of a tumor and protection of surrounding tissue; however no dosage achieves both requirements:

The Tumor and the Fortress

The Tumor Problem
Suppose you are a doctor faced with a patient who has a malignant tumor in his stomach. It is impossible to operate on the patient, but unless the tumor is destroyed, the patient will die. There is a kind of ray that can be used to destroy the tumor. If the rays reach the tumor all at once at a sufficiently high intensity, the tumor will be destroyed. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumor will also be destroyed. At lower intensities the rays are harmless to healthy tissue, but they will not affect the tumor either. What type of procedure might be used to destroy the tumor with the rays and at the same time avoid destroying the health tissue?

Intensity A:

small
dose
protects

tumor
survives

Radiation

Surrounding
Tissue

Tumor

Intensity B:

large
dose
destroys

kills
tumor
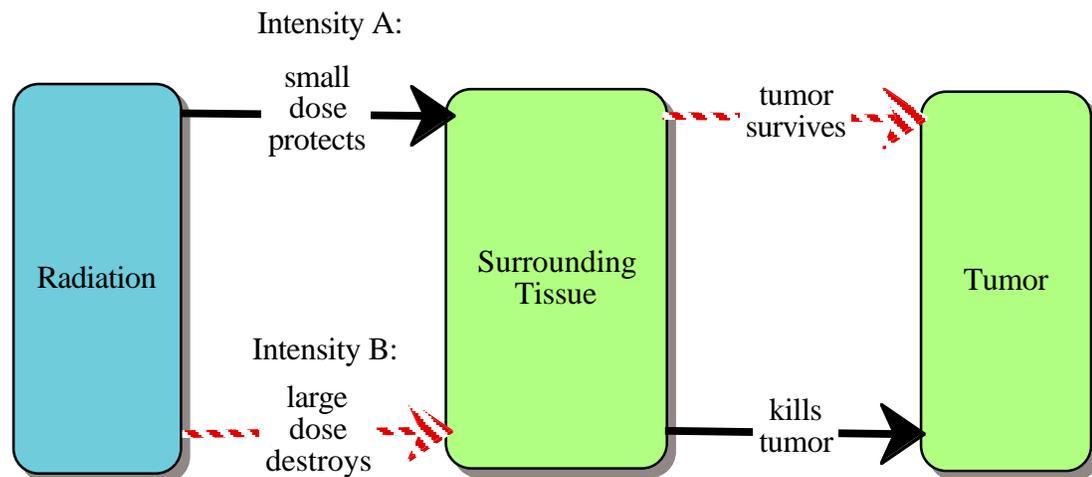
Figure II.67(a)

Most people find it hard to think of a satisfying solution. The crux of the problem is that it seems that the rays will have the same effect on the

health tissue as on the tumor . . . How can the rays be made to impact selectively on the tumor while sparing the surrounding tissue?

Now consider the fortress story.

The Fortress Story

A small country fell under the iron rule of a dictator. The dictator ruled the country from a strong fortress. The fortress was situated in the middle of the country, surrounded by farms and villages. Many roads radiated outward from the fortress like spokes on a wheel.

A great general arose who raised a large army at the border and vowed to capture the fortress and free the country of the dictator. The general knew that if his entire army could attack the fortress at once it could be captured. His troops were poised at the head of one of the roads leading to the fortress, ready to attack.

However, a spy brought the general a disturbing report. The ruthless dictator had planted mines on each of the roads. The mines were set so that small platoons of men could pass over them safely, since the dictator needed to be able to move troops and workers to and from the fortress. However, any large force would detonate the mines. Not only would this blow up the road and render it impassable, but the dictator would destroy many villages in retaliation. A full-scale direct attack on the fortress therefore appeared impossible.

The general, however, was undaunted. He divided his army up into small platoons and dispatched each to the head of a different road. When all was ready, he gave the signal, and each platoon charged down a different road. All of the groups passed safely over the mines, and the army then attacked the fortress in full strength. In this way, the general was able to capture the fortress and overthrow the dictator.

Plan A:

Plan B:
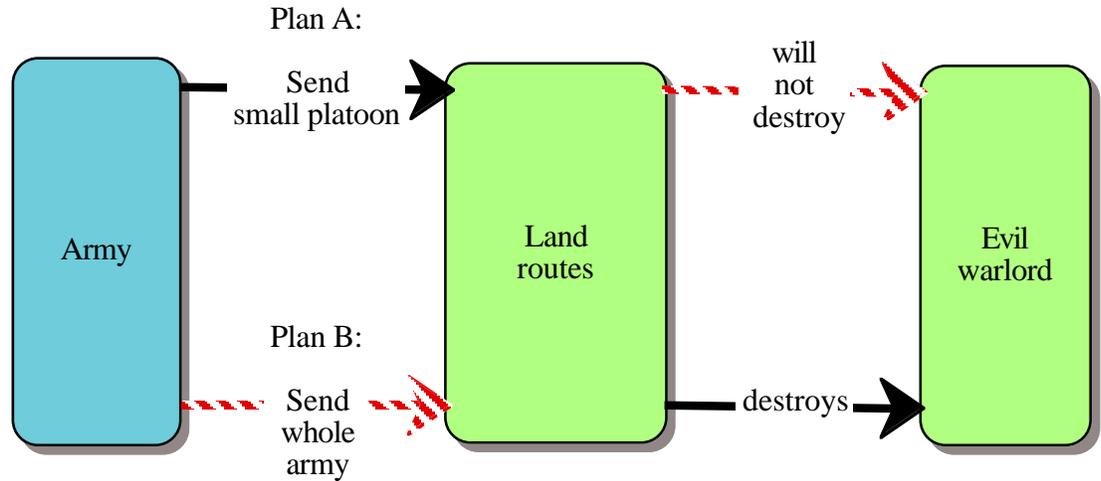
Figure II.67(b)

Structurally, the general's solution may be depicted:

Plan C:
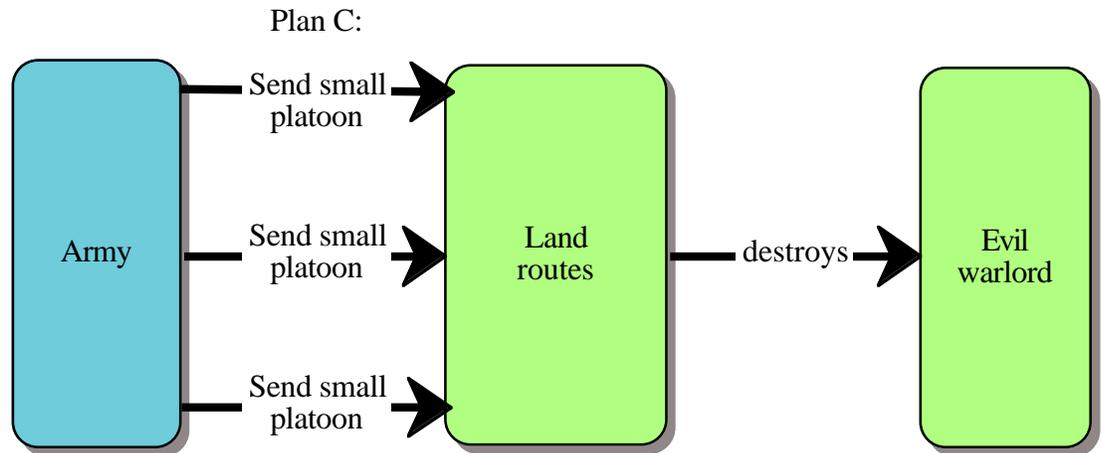
Figure II.67(c)

The major mappings between objects such as

        fortress ↔ tumor

        army ↔ rays

        general ↔ doctor

connect objects with little or no similarity based on their attributes. . . .
However, the major similarities between the two analogs involve higher-
order [superordinate ICMs] that describe the goals and constraints in the
two situations -- causal connections, such as providing a reason, being a
desire, or preventing or enabling an action.
[Holyoak Thagard 1995 110-112]

Source *dispositio*:
General attacks warlord

Army

Plan C:

Send small platoon

Send small platoon

Send small platoon

Land routes

destroys

Evil warlord

isomorphic mapping to

isomorphic projection

isomorphic mapping to

isomorphic mapping to

Radiation

small dose protects

small dose protects

small dose protects

Surrounding Tissue

destroys

Tumor

Target *dispositio*:
Tumor treatment method
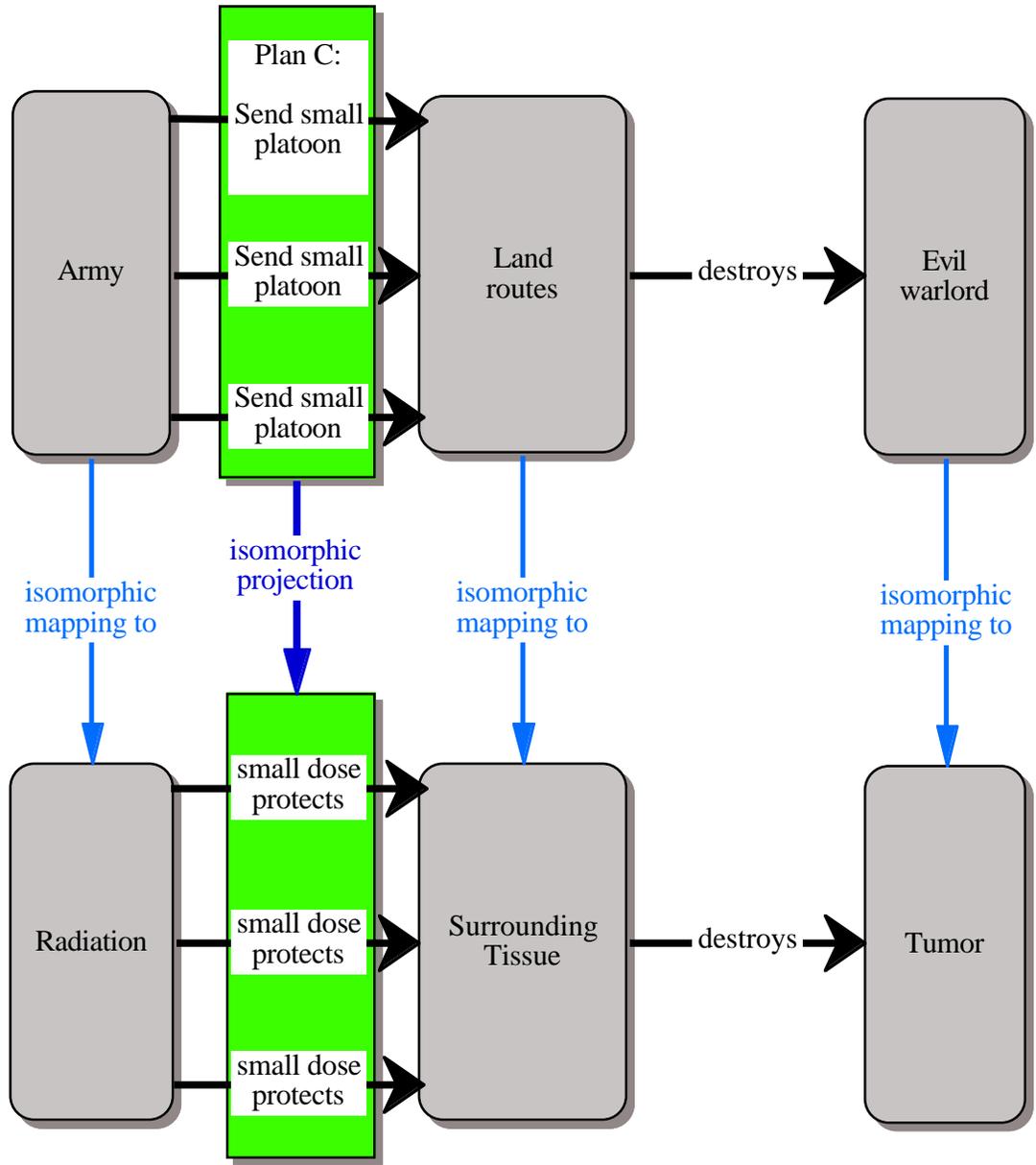
Figure II.67(d)

Figure II.67(d) depicts the structural mapping and the important projection.

The imaginative elements of the resolution are *two*: identification of a source *dispositio*, and then the projection of elements of the source onto the target that resolve the inadequacy. Holyoak and Thagard conducted an experiment comprised of those who were able to perform the projection, in two groups: those who first assimilated the source *dispositio* (general attacks the warlord), and those who did not:

> When Mary Gick and Keith Holyoak asked college students to solve the
> tumor problem, only about 10 percent of them produced the convergence
> solution in the absence of a prior analogy. In contrast, about 75 percent
> succeeded when they first read the fortress story.
> [Holyoak Thagard 1995 110-112]

This is evidence that isomorphic projection alone does not account for the imaginative labor required to resolve the dissonant relations. Both groups performed the projection. However, those who first assimilated a superordinate ICM, a model (*selection*), were more likely to perform the projection. This evidence suggests that selection of an appropriate source ICM *dispositio* is a primary factor for the successful construction of meaning.

The emergent or *Eureka!* quality comes not merely from the projection of a relation to where it is missing, but from the *selection* of a source *dispositio* comprising that relation. Observe first that its selection suggests a cure for cancer, historically a feat of awesome magnitude. Secondly, the projection organizes contradictory *dispositio*, the right amount of radiation to kill the tumor is the wrong amount for delivery path.

Finally, drawing upon a medieval story to solve a medical problem is reaching to a distant subject matter. These combined are hypothesized to account for the felt sensation of comprehension that rises to the magnitude of a Eureka event. Holyoak and Thagard

claim that a constraint on *selection* is that learners limit their search and selection of superordinate ICM *dispositio* to those that have similar non-structural attributes, thus limiting their reservoir of potential solution ideas:

> People trying to solve the tumor problem are likely to try to remember what they know about cancer treatment, rather than about military strategy.   It is perfectly sensible, of course, to search for knowledge directly related to the problem at hand. But the cost of searching close at hand is that remote analogs may be easily missed.
> [Holyoak Thagard 1995 110-112]

This teaches that subject matter is not necessarily an essential element in mapping one *dispositio* to another, but instead that the underlying conceptual structure (themes, ICMs, concept structures that *do* have counterparts in the target) are most important.

Relations among *inventio*, not *inventio* themselves, are best determiner of underlying structure

We observed in the Tumor-Warlord example that the domain of ideas from which source *dispositio* are selected can be adversely affected where that domain is limited to "nearby" subject matter.

Holyoak and Thagard provide empirical evidence from a concise experiment: They consider two drawings (not reproduced here), one of a woman receiving groceries from a delivery truck, and the other of a woman feeding a squirrel in a park. If asked to map only a single attribute of one drawing to one attribute of the other, Holyoak found that most map the woman in one picture to the woman in the other, presumably because they are mapping *inventio* to *inventio*, not structural relations to other structural relations. However:

> If people are asked to match not just one object but three . . . they are led
> to build an integrated representation of the relations among the objects and
> of higher-order relations between relations. Consequently, people who
> map three objects at once are more likely to map the woman to the squirrel
> on the basis of their similar relational roles than are people who map the
> woman alone. Active mapping of multiple objects seems to encourage
> people to [recognize, identify, and] process relations, which in turn
> changes the apparent similarities of individual objects.
> [Holyoak Thagard 1995 122]

The learner's inclination to rely upon subject matter *inventio* for limiting the domain of

source *dispositio*, rather than by relation structure is pervasive:

> Paradoxically, it is easier to think of differences between similar objects
> than between dissimilar objects, even though dissimilar objects obviously
> must be more different.

> It is harder to list differences between such dissimilar objects as cars and
> grapefruits [than between cars and motorcycles], since virtually all their
> differences will be unmapped.

> The reason is that similar objects produce a clearer mapping which makes
> the mapped differences explicit. Unmapped differences, which the
> mapping process drops rather than highlights, are the most likely to lead to
> unexpected failures . . .
> [Holyoak Thagard 1995 132 (annotation added)]

What is inquiry?

Ausubel does not theorize about the inquiry-as-process other than to suggest that it's outcome is meaningful learning:

> [T]he ability to solve a particular class of problems efficiently also presupposes . . . identifying fruitful approaches that minimize costly risk and unnecessary cognitive strain, in using *systematic and economic methods of inquiry*, and in maintaining a flexible and meaningful learning set. [ARK 192]

Again, complementary theory provides a way toward explication of an important learning concept, in this instance, *inquiry*.

The objective of *inquiry* is, in Assimilation Theory terms, *meaningful learning*, or for LIS, *becoming informed*. *Understanding* is used synonymously in this section with both. *Inquiry*, in the sense intended here, refers not merely or only to a brief search for a simple fact, but a sustained engagement with external resources with the goal of constructing ideational structure. Elements of a model of inquiry are described below and depicted (Figure II.68).

Inquiry encompasses the entire Divisions of Rhetoric reference model in full circle:

dispositio (*inventio*) ➜ *elocutio* ➜ *pronuntiatio* ➜

| intellectual engagement with records (documents) | ➜

➜ *pronuntiatio* ➜ *elocutio* ➜ *dispositio* (*inventio*)

Elements of a model of inquiry

Why and how inquiries originate within the learner-inquirer and how they construct ideas from responses received must be accounted for. To do so, the principles described above culminate in a model of *inquiry* comprised of these elements (objects and processes) (Figure II.68):

By teacher-subject specialist (intermediary)

(0)   Over the course of their professional career, a teacher-subject specialist develops and maintains their own conceptual structure, i.e., subject-specific knowledge of their field, a *conceptual reference structure.*

By inquirer

(1)   Learner impels *curiosity* (probing *dispositio*)

(2a)   Learner's recognition of their *inadequate dispositio*, that is, a *cognitive question*, is evoked, from which

(2b)   a set of linguistic terms is derived, an *expressed question* (*elocutio*), is produced, from which,

(2c)   An expressed *question* (*elocutio*) (2b) may be performed (produced and transmitted) to a teacher-subject specialist.

By teacher-subject specialist

(3)   The teacher may, preliminarily, ascertain whether the learner's request is of a type that may be satisfied by explanation, or instead is for mere facts (*inventio*-only, e.g., Who was the third President of the U.S.?), for *elocutio* (How is the name of the third President spelled?), or for *pronuntiatio*

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(Please write the name of the third President on the board. I lost my copy of the homework assignment; may I have another copy?).

(3a)   The teacher or subject specialist receives from the learner expressions of their cognitive question as a first step toward producing a reconstruction of the inquirer's cognitive question and context (adjacent concepts) (2a) by *unpacking* (*pronuntiatio* ➜ *elocutio* ➜ *dispositio*) the *pronuntiatio*. However, the learner can only express the concepts they know, not those they do not know. The teacher-specialist may pose questions to the learner to identify concepts that are part of the learner's knowledge structure but not yet expressed.

(3b)   The teacher-subject specialist then performs *isomorphic mapping **from*** concepts expressed in their *re-construction of the inquirer's conceptual structure* (3a) ***to*** their own *reference structure* (0). This is the second step of *ascertaining the inquirer's prior knowledg*e, and gaps and obstructions in the inquirer's knowledge relative to the teacher-subject specialist's own.

Steps (3a) and (3b) may iterate until (i) the learner is satisfied that they have expressed the important concepts of their cognitive question and that the teacher-specialist has recognized the gaps or obstructions, and until (ii) the teacher-specialist has reached the same determination based upon mapping comparable concepts from their reference structure. From the learner's perspective, they are not only expressing their cognitive question, but *browsing* the teacher-specialist's intellectual realm for terminology to express their question and for concepts that are also part of their knowledge structure that they might have neglected to express.

> Browsing is based on the psychological principle that recognition memory
> is different from recall memory.
> [Interview with Alan Kay, Psychology Today, December 1983. p. 56]

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Thus, both learner and teacher-specialist are browsing one another's knowledge structures, searching for endpoint concepts in common, each attempting to conclude that their interlocutor has a substantially similar concept structure as their own.

(3c) Having ascertained that the learner's cognitive question (i.e., prior knowledge, and gaps and obstructions in conceptual paths) is recognized, the teacher-subject specialist then performs *isomorphic projection* of concepts and relations *from* portions of their *reference structure* selected to ameliorate the inquirer's cognitive question (3b), *onto* their *re-construction of the inquirer's conceptual structure* (3a), forming an *explanatory path*.

(3d) Linguistic terms, *elocutio*, expressive of the *isomorphic mapping* performed (3b) and the *isomorphic projection* performed, i.e., the *explanatory path* (3c), are derived; and,

(3e) Identification of texts expressive of *dispositio* (concepts and relations among concepts) that comprise the explanatory path (3c), is performed by the teacher-subject specialist, including indication of how and where the concepts and relations that comprise the *isomorphic projection* are expressed in the document.

(3f) *Elocutio* derivations of the *explanatory path* (3d), and the identification of texts expressive of the explanatory path (3e), may be performed as *pronuntiatio*, and transmitted to the inquirer.

By inquirer

(4a)   The inquirer, through their physical senses, perceives transmitted

        pronuntiatio (3f).

(4b)   The inquirer unpacks (*pronuntiatio* ➤ *elocutio* ➤ *dispositio*) the

        transmission from the teacher-subject specialist (3f), followed by:

(4c)   With the *dispositio* re-constructed (4b), the learner-inquirer performs

        isomorphic projection (and other assimilation processes) of those new

        concepts onto (4b) their own *conceptual structure* (2a).

(4d)   Through engagement with the *dispositio* expressed by the texts

        recommended (3f), the learner-inquirer performs further isomorphic

        projection (and other assimilation processes) of those new concepts onto

        their cognitive question (2a).

(4c) and (4d) constitute *explanations*, that is, conceptual *explanatory paths*, (a.k.a.
sequences of *inventio*, that mitigate inadequate *dispositio*.

(5a)   Through (4c) and (4d), the learner-inquirer assimilates, that is,

        relates new concepts to their existing knowledge, thus becoming

        dispositio. Only at this point has the learner-inquirer *become informed*.

(5b)   Through use of inquirer's prior knowledge, such as concepts of *warrant*,

        cognitive authority, and other ICMs, the inquirer not only relates new

        concepts to existing knowledge, but also imputes attributes of trust, belief,

        truth, or relevance, or alternatively, as counterfactual or prevarication.

(6)   Understanding: meaningful learning, becoming in-*form*-ed (*dispositio*).

(7)   Iteration, feedback. This model and portions of it may, of course, iterate, that is, with feedback communication between inquirer and teacher-subject specialist, prior to fuller comprehension at element (6), *understanding* (meaningful learning or becoming informed).

Subsets of these elements, (1) *curiosity*, (2a) recognition of inadequate *dispositio*, and (2b) *expressed questions*, are iterative, like an *inner* motor, a *curiosity motor*, generating inquiry *expressions*. Figure II.69 depicts this inquirer-specific subset of the model of inquiry above (Figure II.68) (Also, compare *ideas stimulate other ideas* motor, Figure II.50). The products of these motors are concept sequences that can eventually form a *path*, a structure, that connects existing knowledge to new concepts, that is, mitigates the learner's inadequate *dispositio* (see: An explanation is a conceptual *path* that displaces a cognitive question).

Inquiry as a whole is, of course, iterative as also shown in Figure II.69. The more concepts a learner learns, the more they might realize they don't know, and the more they might be motivated to continue learning.

Elements (0) and (3a)-(3f) of the above Model of Inquiry may be regarded as intermediation.

Many of the elements of this model of inquiry have already been examined in this chapter (II.2). Similarly, the concept of (6) *understanding* has been examined in II.1. These concepts are considered for their role in *inquiry*.

(6)
Understanding

(5b)
Inquirer imputes attributes of trust, belief, or truth to new knowledge

(5a)
Inquirer relates newly projected concepts to their existing knowledge

(4d)
Intellectual engagement with records

(4c)
Inquirer replicates isomorphic projection in (3c) (an imaginative creative act)

(4b)
Inquirer unpacks *pronuntiatio* into *dispositio*

(4a)
Inquirer perceiving *pronuntiatio*

Inquirer

(1)
curiosity

Model of Inquiry

(2a)
Recognition of *cognitive question* (see Figure II.69)

(2b)
Terms selected to express *cognitive question* (*elocutio*)

(2c)
Cognitive question performed and transmitted (*pronuntiatio*)

intermediation

Teacher-Subject matter specialist

(0)
Conceptual reference structure developed and maintained by teacher-subject specialist

(3e)
Published texts identified

(3d)
Expressing the concepts projected

(3c)
Isomorphically projecting concepts from a *conceptual reference structure* onto their *reconstruction of the inquirer's cognitive question* (an imaginative act)

(3a)
Reconstruction of the inquirer's cognitive question

(3b)
Mapping the inquirer's cognitive question onto a *conceptual reference structure*

Figure II.68

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Inquiry processes within the intellectual realm of the inquirer

(1) curiosity

Alternatively, an external prompt, e.g., question posed by teacher

stimulate

can result in

can result in

the curiosity motor

(2a) question
An expression that renders inadequate *dispositio* as *elocutio*

Question: "Why is C influencing E?"

dispositio → elocutio

(2) recognition of inadequate *dispositio*

concept A

relation A-D

relation A-B

relation A-E

concept B

concept D

concept E

relation B-C

relation C-D

concept C

?

(3) drive motivates engagement with

feeds

(4) external records and texts (see Parts II.1 and II.2)

Inquiry, the engine of learning

(6) result: *understanding*

Eureka: recognition of explanation

concept A

relation A-D

relation A-B

relation A-E

concept B

concept D

concept E

(5) *explanation*

relation B-C

relation C-D

concept C

concept N

concept E

assimilated into knowledge structure

concept C

(new) concept N

(new) concept N

Figure II.69

(0)   What is a *conceptual reference structure*?

Four conceptual structures obtain in this model of inquiry, two belonging to the inquirer, two belonging to the teacher-subject specialist. Only one of these is a *reference* structure (Figure II.68(a) (0)). All four conceptual structures inhabit the intellectual realm.

First, the inquirer possesses their own conceptual structure, *knowledge*. Second, the inquirer might construct, as part of (2b), a mental model of the teacher-subject specialist-library collection, more specifically, of the concepts they express and their context. Third, the teacher-subject specialist re-constructs (3a) an understanding of the inquirer's knowledge. None of these three are characterized in this model of inquiry as *reference structures*.

The fourth conceptual structure, the *reference structure* ((Figure II.68(a) (0)) is external to the inquirer, that is, is an object developed and maintained by the teacher-subject-matter specialist, in sum, all their knowledge. This *reference structure* is used by the teacher-subject-matter specialist to compare and contrast against their reconstruction of the inquirer's knowledge, and, as a source *from* which selected salient concepts can be projected *onto* their reconstruction of the inquirer's knowledge. These projections are *explanations*, and subsequently expressed to the inquirer.

Some bibliographic instruments, such as collections, classifications, may also be regarded as *expressive of* a conceptual reference structures. For example, a classification scheme, as understood by its creators or maintainers, is a conceptual reference structure. However, this is distinct from its derivation expressed in linguistic terms, or manifested as a sensory-susceptible object, *pronuntiatio*, such as an online system or card catalog.

The third structure, a teacher or system's reconstruction of an inquirer's cognitive question (3a) is formed through user warrant: concepts in the structure as expressed by the inquirer. The fourth, the reference structure, is based on literary warrant: the objects in the set (or collection) over which the teacher or system has mastery.

 A machine might be capable of producing a *pronuntiatio* derivation of a conceptual reference structure manifesting an *elocutio* derivation of it. But the machine cannot evoke a conceptual structure itself, and therefore not a reference structure. Similarly, an authored text is a derivation of the author's conceptual structure, but the text itself and its performance in physical form, are only that, *derivations*, not conceptual structures.

Model of Inquiry

(6)
Understanding
(meaningful learning,
becoming informed)

(5b)
Inquirer imputes attributes
of trust, belief, or truth to
new knowledge

(5a)
Inquirer relates newly
projected concepts to their
existing knowledge

(4d)
Intellectual engagement with
records

(4c)
Inquirer replicates isomorphic
projection in (3c)
(an imaginative creative act)

(4b)
Inquirer unpacks
pronuntiatio into *dispositio*

(4a)
Inquirer perceiving
pronuntiatio

Inquirer's knowledge structure

(1)
curiosity

(2a)
Recognition of *cognitive question*
(see Figure II.69)

Inquirer's mental model of intermediary

(2b)
Terms selected to express
cognitive question
(*elocutio*)

(2c)
Cognitive question
performed and transmitted
(*pronuntiatio*)

Inquirer

**Teacher-Subject-
matter specialist**

(0)
Conceptual reference structure developed and
maintained by teacher-subject specialist

intermediation

(3e)
Published texts identified

projection (3c)

mapping (3b)

(3a)
Reconstruction of the inquirer's
cognitive question

(3d)
Expressing the concepts
projected

(3c)
Isomorphically projecting concepts
from a *conceptual reference structure*
onto their *reconstruction of the inquirer's cognitive question*
(an imaginative act)

(3b)
Mapping the inquirer's
cognitive question onto a
*conceptual reference
structure*

Figure II.68(a)

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(1) What is *curiosity*?

How does the learner-inquirer determine "inadequacy" of *dispositio*? Humans think, feel, and act [Novak 1998 12]. Recognition of inadequate *dispositio* may be accomplished, in particular, through both feeling and reason.

Curiosity-as-drive

This extends the discussion of motivation as presented by Ausubel (see: Motivation and attention Part II.1).

The motivation (need or desire) e.g., find an answer or solution, or to avoid the adverse affects of an inadequate *dispositio*, is described by Ausubel:

> What is generally regarded as achievement motivation in school settings is by no means the reflection of a unitary or homogeneous drive. It has at least three different components. One of these which we shall encounter soon is *cognitive drive—the need for acquiring knowledge and solving academic type problems as ends in themselves.*   . . .
> It is completely task-oriented in the sense that the motive for becoming involved in the task in question (i.e., acquiring a particular segment of knowledge) is intrinsic to the task itself; it is simply the need to know. Hence, the reward (the actual attainment of this knowledge) also inheres completely in the task itself since it is capable of wholly satisfying the underlying motive. [ARK 202 (emphasis added)]

Ausubel does not generally differentiate the terms *curiosity* and *motivation* to *resolve* the inadequate *dispositio*. Rather, Ausubel's term for the *motivation* that actually invokes processes (as described by Ausubel, see II.1) to in*form* inadequate *dispositio*, is *drive*. He recognizes three types, but emphasizes *cognitive drive*:

Cognitive Drive

At the human level, cognitive drive (the *desire for knowledge as an end in itself*) is more important in meaningful than in rote or instrumental learning. It is, at least potentially, *the most important kind of motivation* in classroom learning. This is so because of its inherent potency and because meaningful learning, unlike these other kinds of human learning, automatically provides its own reward. . . . It also exerts a purely cognitive effect by highlighting or emphasizing what is to be learned, and by providing confirmatory and corrective feedback.
[ARK 202 (emphasis added)]

Curiosity-as-feeling

In this sense, that is one of emotion or even physical sensation, curiosity is either a *desire* to know or *fear* of consequences of not knowing. Ausubel acknowledges a relationship between *felt needs* and meaningful learning, though not expressed as *curiosity*:

> [I]t is undoubtedly true that subject matter as a whole must still be related to *felt needs* if appreciable degrees of long-term meaningful learning are to occur. Inability to see any need for a subject is the reason students mention most frequently for losing interest in high-school studies and dropping out. [ARK 197 (emphasis added)]

> One of the primary functions of education, in fact, should be to stimulate the development of motivations and interests that are currently nonexistent. It is true that academic achievement is greatest when pupils manifest *felt needs* to acquire knowledge as an end in itself. Such needs, however, are not endogenous but acquired—and largely through exposure to provocative, meaningful, and developmentally appropriate instruction. [ARK 33 (emphasis added)]

A *feeling* of inadequate knowledge, *dispositio*, is described as "distressing ignorance" [Buckland 1991a 87-88] and as "constructive discontent" [Adams 1974 77]:

> In a fascinating book called The Universal Traveler. A Soft-Systems Guide to: Creativity, Problem-Solving, and the Process of Design, the authors Don Koberg and Jim Bagnall discuss what they call "Constructive Discontent":
>
>> Arrival at the age of 16 is usually all that is required for achieving half of this important attribute of creativity. It is unusual to find a "contented" young person; discontent goes with that time of life. To the young, everything needs improvement. . . As we age, our discontent wanes; we learn from our society that "fault-finders" disturb the status quo of the normal, average "others." Squelch tactics are introduced. It becomes "good" not to "make waves" or "rock the boat" and to "let sleeping dogs lie" and "be seen but not heard." It is "good" to be invisible and enjoy your "autonomy."   It is "bad" to be a problem-maker. And so everything is upside-down for creativity and its development. Thus, constructive attitudes are necessary for a dynamic condition; discontent is prerequisite to problem-solving. Combined, they define a primary quality of the creative problem-solver: a constantly developing Constructive Discontent. [Adams 1974 77]

Curiosity as a rational process: critical thinking

In contrast to *inquiry*-as-feeling, *inquiry*-as-reason is not merely a possible outcome of a process (reason), but is a primary manifestation of it:

> Reason includes not only our capacity for logical inference, but also our ability *to conduct inquiry*, to solve problems, to evaluate, to criticize, to deliberate about how we should act, and to reach an understanding of ourselves, other people, and the world. [Lakoff Johnson 1999 77]

Curiosity-as-rational-process is *critical thinking*, one's systematic probing of one's own knowledge structure (or interrogating another's) for both concepts and relations that

might be "inadequate" or absent. Thus, the concept of *curiosity* may be regarded as an *exploratory* process.

Probing for *missing* ideas or relations, i.e., for an object that does not exist, can be achieved by use of isomorphic projection (contrasting a source *dispositio* with a reference *dispositio* to identify missing concepts and relations in the source) and counterfactuals (see: Counterfactuals, above), i.e., by asking, "How *might* a particular knowledge structure work if it included a particular concept or if particular relations among concepts obtained?" If the result is satisfactory, then the counterfactual concepts or relations may be assimilated. The conjuring of a hypothetical concept with which to experiment as a counterfactual is the imaginative or creative aspect of human intellect.

Regardless of the form of *motivation*, emotional or rational, appetites for meaning vary, and thus do degrees of curiosity. Some are nearly insatiable, others are easily satisfied. In sum, *motivation* of *recognition* of inadequate knowledge, *curiosity*, can in turn, motivate the learner to expend labor toward meaningful learning.

The degree to which a learner-inquirer is motivated to probe their conceptual structure for inadequate *dispositio* varies over time according to the influence of situational (non-cognitive) factors.

(2a)   The *cognitive* question: inadequate *dispositio* (*gaps* and *blocks*)

Dispositio recognized as inadequate may be regarded as a cognitive object, a question. To differentiate such cognitive objects from their manifestations as natural language expressions, the terms *cognitive question* and *expressed question* will be used.

Cognitive questions are of at least two kinds of inadequate *dispositio*:

> a *gap* is a missing relation between *inventio*, preventing one from activating the other
>
> a *block* is an existing relation, a preconception, that prevents establishment of a new idea or relation from one *inventio* to another

The qualifier *inadequate* is preferable to, and more inclusive than, *wrong*, which implies either that truth is knowable or the positivist notion that questions have true and correct answers. Thus, this term, its implications, and the epistemological baggage accompanying them are forfeited in favor of *inadequate*.

Gaps

> . . . bridging the *gap* between what the learner already knows, and what he needs to know . . . [ARK 11, 148 (emphasis added)]

A conceptual structure is *dispositio* and is distinct from derivations of it: distinct from text, *elocutio* (e.g., a classification system), and distinct from performances of the text, i.e., *pronuntiatio*, e.g., a printed or online classification system or a depiction of a concept map on a page.
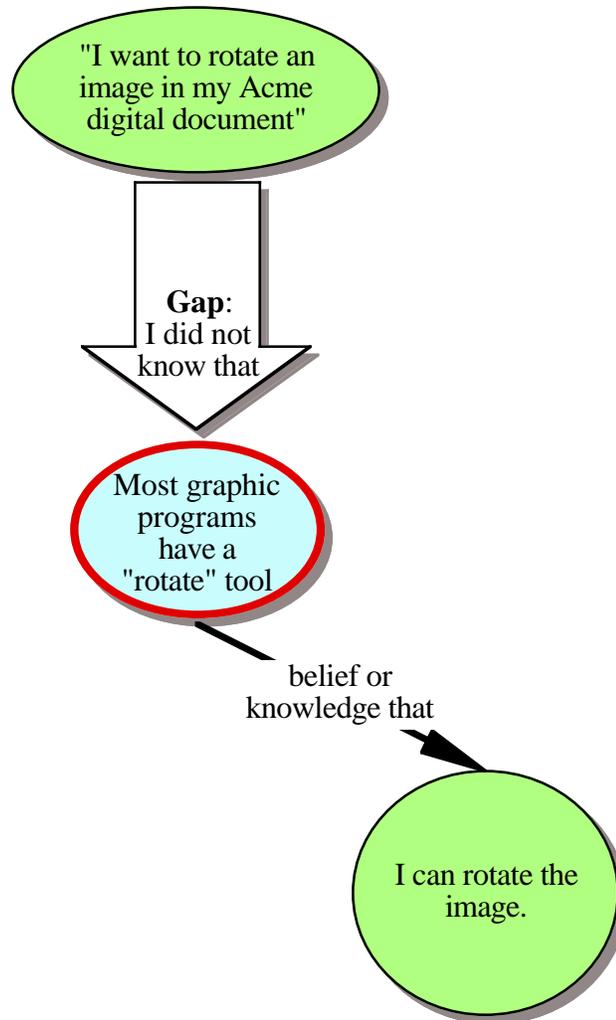
Figure II.70

Gaps have been characterized above (see: Concepts missing (relative to an external conceptual *reference structure*); Gaps, II.1) above.

Gaps put the learner in the position of having to describe the very knowledge they do not possess, a *gap* in their knowledge. The location of *inquiry* centers upon this gap, a shoreline where the learner's knowledge structure meets the "sea of the unknown concepts." This boundary is not rigid or a bright line, but porous.

The specific conditions that may be described as *gaps* include:

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Unsatisfactory or null (missing) relations among *dispositio*

Unsatisfactory or null (missing) concepts

Unsatisfactory or null (missing) structure (concepts and relations)

A variant conceptualization of cognitive questions is as discontinuities (gaps) in *explanatory paths* (see: An *explanation* is a conceptual *path* that displaces a cognitive question) (Figure II.70).

Figure II.70 illustrates a gap between the idea "I want to rotate an image in my file" and the idea that "graphics programs have a rotate tool." Because the later concept does not exist in the inquirer's structured knowledge, he cannot reach his desired idea, that he can rotate the image. Here, the relation "I did not know that" (white-filled arrow) and both concepts (in green) comprise the *cognitive question*.

Blocks

Similarly, *blocks* have been considered above as preconceptions (see: Preconceptions, II.1) above. Blocks, inadequate preconceptions, or inadequate assumptions obstruct the learner from recognizing and constructing an adequate path of *dispositio* to reach a destination *dispositio*. Extended Assimilation Theory concerned with mitigating blocks is addressed below (see: What is critical thinking?). Figure II.71 illustrates a block.

Figure II.71 illustrates a conceptual block as a cognitive question. The idea that my Acme software does not have a "rotate" tool blocks a conceptual explanatory path that leads to the desired goal, the knowledge that I *can* have a rotated image in my Acme file. The red relations and their source concepts constitute a *conceptual block*. In this case the *cognitive question* consists of all of the structure (concepts and relations) between the

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initial endpoint "I want to rotate . . . " (in green), and the terminal endpoint "Goal

Concept" (in blue):
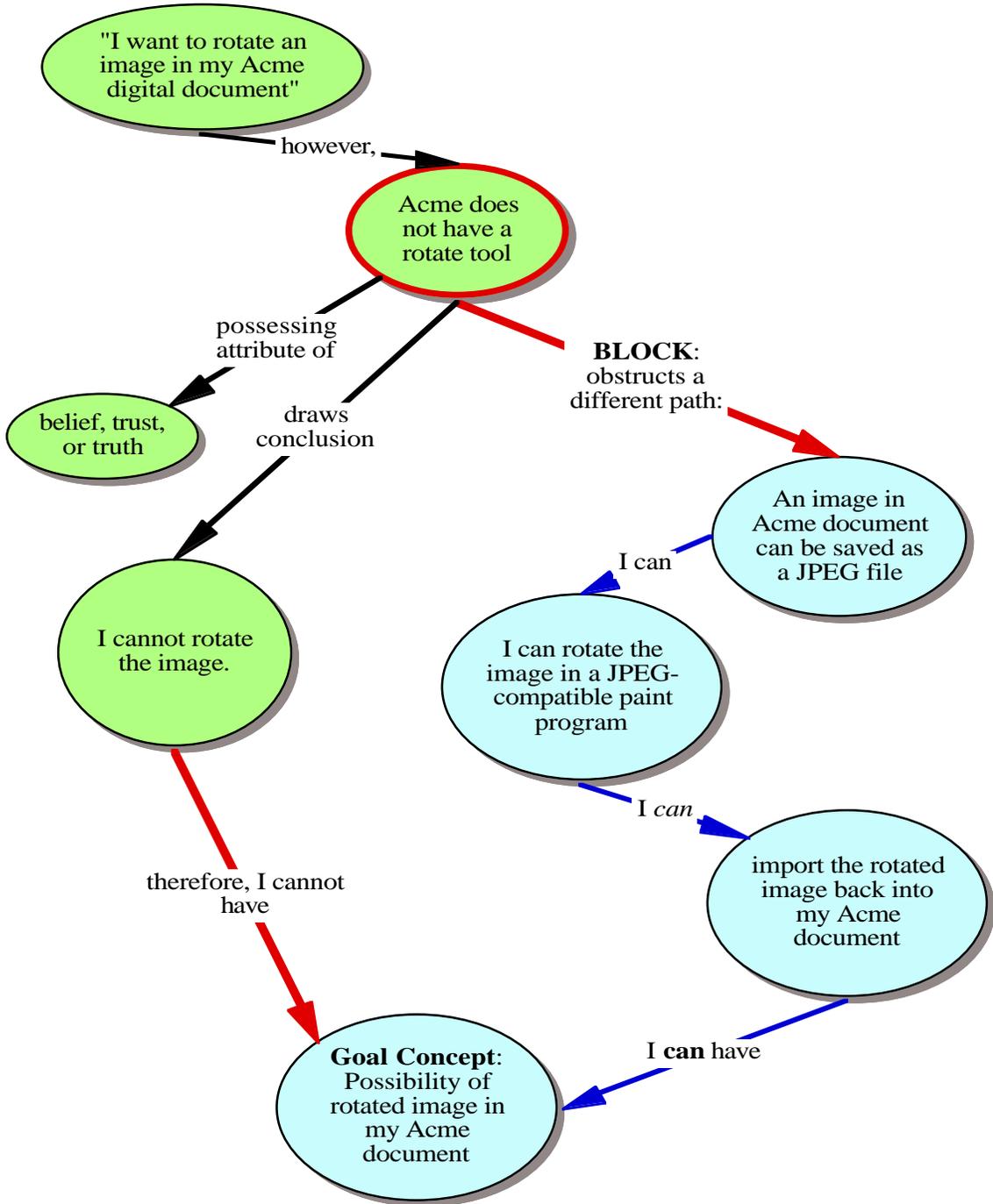
Figure II.71

How does a learner-inquirer recognize cognitive questions (inadequate *dispositio*)?

The *gap* indicated in Figure II.70 and the *block* expressed in Figure II.71 (red lines) are cognitive inadequacies, distressing ignorance, referred to here as *cognitive questions*. A *cognitive question* is the inadequacy in the currently activated conceptual path (see: Figure II.70(a) and Figure II.71(a).
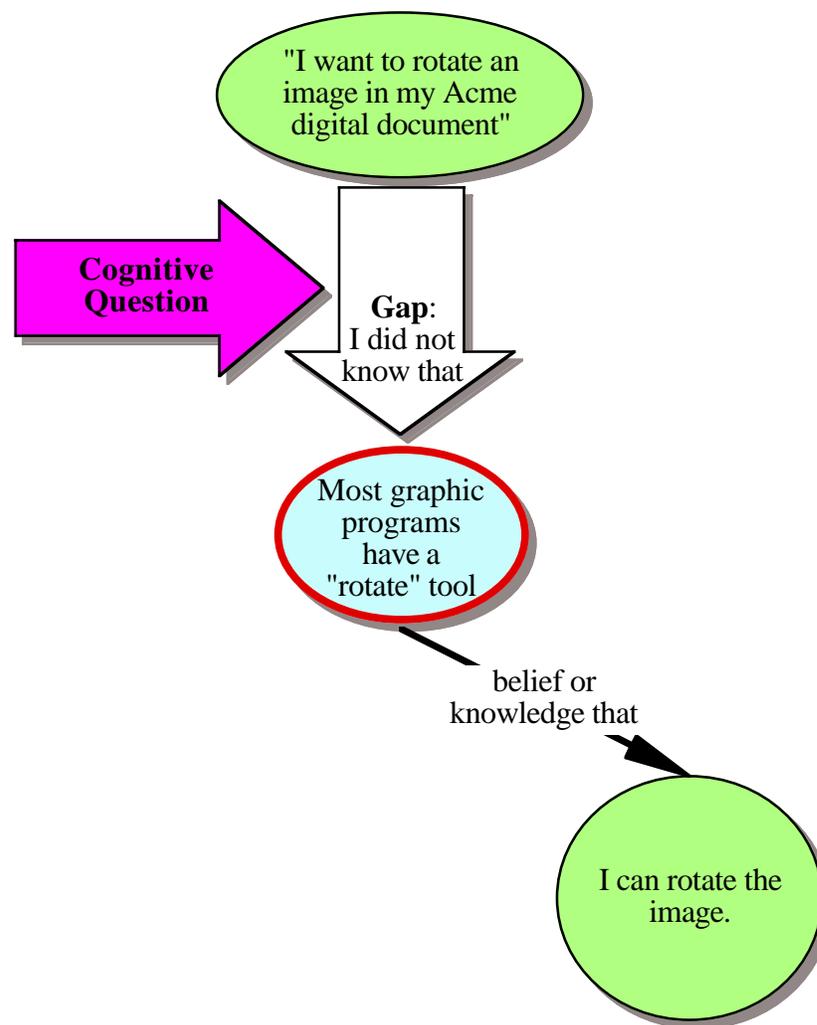
Figure II.70(a)

Figure II.71(a)

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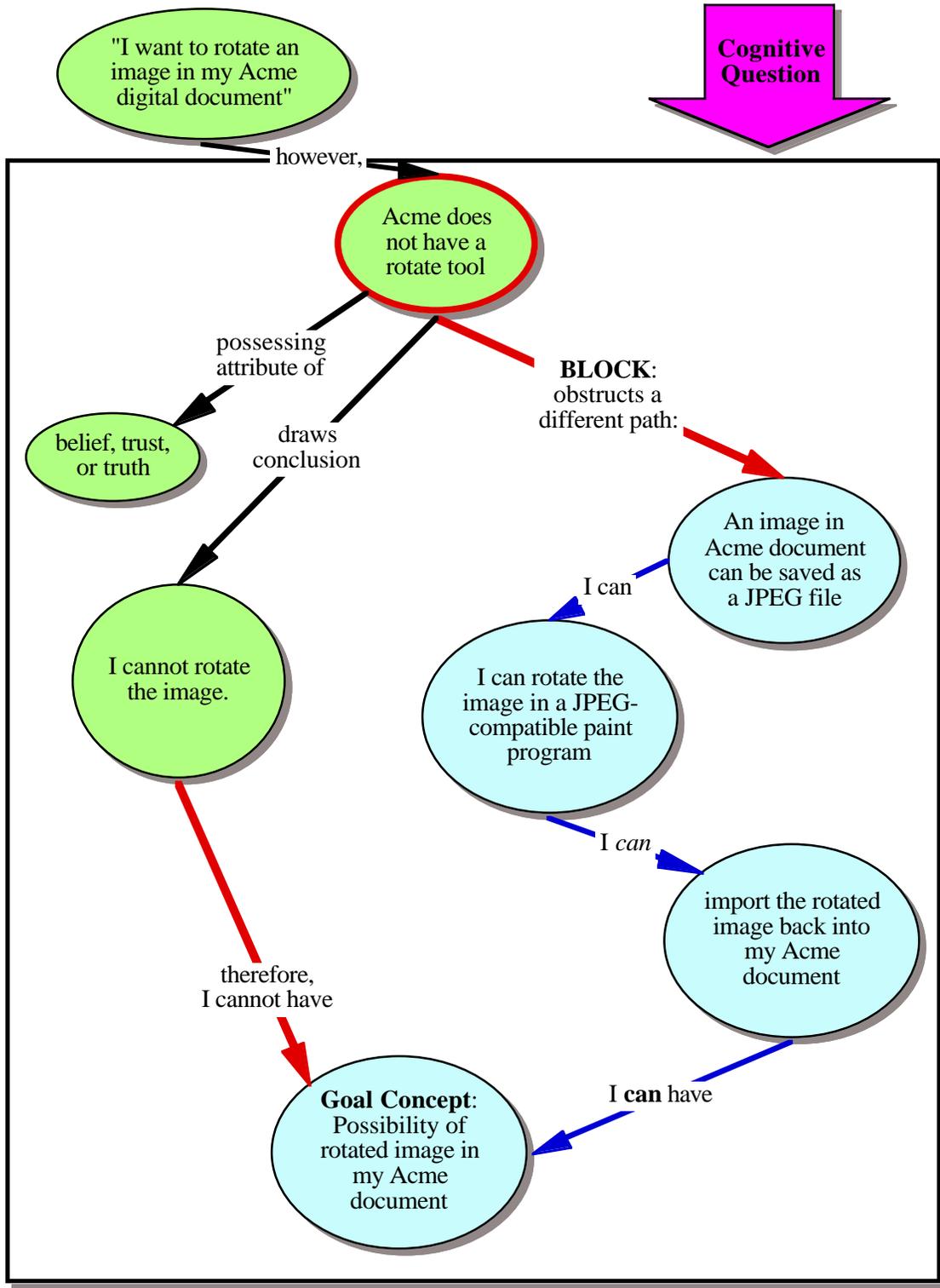
Recognition of inadequate *dispositio* may arise from both of the two types of curiosity (above), curiosity-as-feeling and curiosity-as-reason. The learner may have a sense of something missing or something wrong, but cannot consciously identify the troubling concept. Such recognition of inadequate *dispositio* may present itself as a vague feeling rather than as a specific reason or fact.

In another dimension, two sources of stimuli are described for recognition of cognitive questions: internal, as with *curiosity* (see above), and external, through exchange of *pronuntiatio*, e.g., expression of a question or statement from a teacher or document (see: Figure II.69). Here, the latter is acknowledged, but the former considered, primarily because even the influence of the external source can be traced through to derivation of new *dispositio* by the learner-inquirer which, in turn, provokes their probing of prior knowledge and subsequent recognition of inadequate *dispositio*.

As discussed previously (II.1), *dispositio* structure may be found inadequate either *relative to* some *reference dispositio*, or simply insufficiently rich, i.e., a *dispositio* comprised of too few relations to other *inventio*. A learner's knowledge *gap* can be reified by contrasting the learner's inadequate concept structure with an conceptual *reference structure* that includes objects that correspond to the learner's concepts, and additional concepts that may be regarded as more comprehensive and which are also missing in the learner's knowledge (see: Figure II.63(b)). Mapping of a learner's knowledge to a conceptual *reference structure* implies that both are in the mind of a teacher, reference specialist, parent, expert, coach. These structures may be expressed as text, as *elocutio*, and performed as *pronuntiatio*, for example, in a computer system. A derivation of the learner's concept structure must be constructed for the mapping to be performed: the teacher must construct an understanding, an approximation to be sure, of the student's understanding.

One form of this approach is to attempt to recognize relationships among concepts that conflict with *expectations*, then analyze the variance. Expectations constitute a *cognitive question*. For example, suppose a learner has constructed a *dispositio* of *inventio* related to airline travel, and notices that the fare from New York to Chicago on Airline A is different than on Airline B. The relation, `Airline A is $23 more expensive than Airline B`, is one of conflict of expectation (similar products and services are priced similarly) and can provoke an intellectual condition of a *cognitive question*, that in turn, can provoke a search for factors that account for the relation, a decision to impute truth to the claim (concept), and even a decision to purchase one ticket rather than another.

Often the relation among *inventio* that gives rise to a question is null (a gap), that is, there is no relation where one is "expected." For example Airline A purports to provide service to Chicago and to Cucamonga, yet they do not publish a fare or offer a flight between those two destinations. This too, gives rise to the mental condition of a *cognitive question*, but the relation from which it is derived is of the null type, and might lead to subsequent mental and tangible activities that differ from the prior example.

Using a different approach, a *dispositio* may be determined to be inadequate though conjuring a counterfactual (a hypothetical idea) and comparing it to one's existing knowledge, then evaluating the contrast. Where the counterfactual is deemed more satisfactory and comprises concepts or relations not extant in prior knowledge, those concepts or relations may be considered 'missing' from prior knowledge.

When recognition of inadequate *dispositio*, i.e., a *cognitive question*, reaches the learner's consciousness, the learner may elect to derive an expression in a natural or other language (*elocutio*). The resulting object is an *expressed question*.

If describing concepts that are held in an unsatisfactory state is difficult for the learner-inquirer, then describing concepts that do not exist in their knowledge structure can be even more frustrating. This is especially true in English because that which does not exist can only be described in terms of *some* existence. Thus, idioms like "Nothing is better than Acme cheese" are used. Yet, if *nothing* is indeed better, then that's what belongs on one's pizza.

One strategy for describing concepts one has not assimilated is simply to refer to them by a pronoun, especially the pronoun *what*. The following exchanges are illustrative:

> Learner to instructor: I want to know *what* influences the money supply. Can you help?
>
> Instructor to learner: Sure. *What* would you like to know?

or

> Learner to reference librarian: I need to find out *what* causes global warming. Can you help?
>
> Reference librarian to learner: Sure. *What* do you need to know?

Of course, if the learner could answer such questions, they might not have needed to ask.

While the instructor and librarian in these anecdotes are, perhaps, less helpful than most, nevertheless, learners are frequently confronted with variants of the question,

<p style="text-align:center">What would you like to know?</p>

The learner uses a general pronoun because they do not know which specific nouns express their missing concepts. Thus, the learner often adopts one of these strategies:

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1. Ask someone who knows (almost always the best)

2. Ask someone who doesn't know, but who knows how to help by providing objects that might express ideas that would mitigate the inadequate *dispositio*.

The second strategy requires the learner to describe those ideas in their existing knowledge that they believe to be adjacent to the gap, the shoreline, the precipice, then hope the helper recognizes them and can express new concepts related to the inadequate *dispositio*.

Expressed questions are often recognized as the initiation (initial endpoint) of an inquiry, but it is the conceptualization of a cognitive question that must precede any other step in originating an inquiry.

Exercises

1. Look for instances of the pronoun *what*. Identify the noun for which *what* is used as a pronoun. Does the noun refer to *pronuntiatio*, *elocutio*, or *dispositio*?

> Example 1: What the violinist knows about performance practice is partially from formal education and partially from intuition.

Ans. In this example, *what* is a pronoun for musical *concepts* of articulation and phrasing, ornamentation, etc. that reflect particular styles or genres of musical literature, that is, *dispositio*.

2. Same instruction.

> Example 2: Joe asked, "What time is it?"

Ans. Time does not exist in the world. If there were no people, there would not be the concepts of years or days or hours, nor concepts at all. *What* is a pronoun for a concept, a specific measurement of time, i.e., *dispositio*.

3. Same instruction.

> Example 3: What is the best source to find the correct spelling of
> parliamentary terms?

Ans. What may be a pronoun for the *pronuntiatio* of a physical object (a physical book or online website) comprising marks arranged in certain ways that express *elocutio* expressions that are identified by the name *dictionary*.

Or, under some circumstances, *What* may refer to the *elocutio* itself, as in "The dictionary says to spell it this way" regardless of whether one has come into contact with a physical object labeled dictionary.

4. Same instruction.

> Example 4: "What's that all about?" an inquiry made by Caitlin with
> regard to a newspaper article.

Ans. *What* might be a pronoun for the chunk of newsprint that a nearby person sees in the newspaper reader's hand. Or, what might refer to the linguistic expressions article, as *elocutio*. Or, most likely, the inquirer uses *what* to refer to the concepts expressed by the newspaper article.

(2b)   The cognitive *question*-as-expression (expressed question), *elocutio*

What are *questions*? Two forms were identified (above):

> The *cognitive* question: one's recognition of inadequate *dispositio*,

and,

> The *expressed* question: a cognitive question (inadequate *dispositio*) expressed in
> linguistic terms, *elocutio*.

When the cognitive question reaches the learner's consciousness, the learner may elect to

derive an expression in a natural or other language (*elocutio*). The resulting object is a

expressed question.

Ausubel acknowledges asked (expressed) questions as a component of meaningful

learning:

> The student takes appropriate responsibility for his own learning . . .
> 4. When he takes it upon himself to ask the necessary *questions* about
> what he does not understand. [ARK 34 (emphasis added)]

How does the learner formulate an expressed question?

How does a learner formulate a question expression from inadequate *dispositio*?

The formulation of expressed questions *first* benefits from detection of an interruption,

discontinuity, or inadequacy in the conceptual path from a learner's knowledge to the

concepts they desire: their inadequate *dispositio*, the gap. Sometimes, the learner might

formulate a question without this recognition, and the resulting question is unlikely to lead to the learner's receipt of expressions that advance meaningful learning:

> If you don't know what the question is, you won't know when you've
> found the answer and when to stop looking for an answer. [old adage]

If the learner is able to recognize and identify concepts adjacent to his inadequate *dispositio*, his *context*, then expression of those is the point of departure for formulating questions. This type of formulation of an expressed question is not, however, a description of the explanatory concepts needed but missing.

The labor of deriving an expressed question sometimes leads to a modified *dispositio* that is no longer inadequate, or less so. Thus, if the learner chooses not to perform the intellectual labor of clothing their inadequate *dispositio* with an interrogatory expression, there may be a cost of not constructing one's own explanatory path.

In some instances, expressed questions are not a manifestation of an inadequate or null *dispositio*, but indeed, of "an answer." The question arises for the purpose of eliciting the explanatory relation(s) as part of a larger explanatory path or to facilitate testing criteria which, if satisfied, enable the learner to determine that the inquiry has reached an endpoint (see: II.1, Endpoints).

Criteria for formulating expressed questions are not found specifically in Ausubel's description of Assimilation Theory. In situations where the learner is conditioned to shape their expressed questions according to their perception of what performance is *expected* of them by teachers, parents, or online query languages, their interrogatory expressions might not be derived from the structure of their *dispositio* that gives rise to their genuine desire to know. Instead, they might change their questions to ones that might be more successful, that is, viewed favorably by instructors, search engines, etc.

Both expressed questions and cognitive questions can activate meaningful *reception* learning processes, such as engagement with teachers, documents, and other external resources, that is, *inquiry* (this section).

The learner may formulate an expressed question by correlating a type of cognitive question with certain *elocutio* expressions. Reis [Reis 2006 #736] differentiates eight question types:

> Questions that ask for more evidence
>
> Questions that ask for clarification
>
> Open questions
>
> Linking or extension questions
>
> Hypothetical questions
>
> Cause-and-effect (or any relation type) questions
>
> Summary and synthesis questions

This particular list is not comprehensive (examples of missing types might include compare-and-contrast question, relationships, research questions), nor is any list likely to be complete. But it is valuable because it draws attention to the notion that there are different kinds of questions that correspond to different types of inadequate *dispositio*.

Questions that ask for more evidence are directed to *inventio* attributes affiliated with credibility, belief, trust, and cognitive authority (see: How reading facilitates imputation of credibility to concepts or their selection for subsequent use). They are asked when:

> participants state an opinion that seems unconnected to [claims] . . .
> examples:
> > How do you know that?
> > What data is that claim based on?
> > What evidence would you give to someone who doubted your

interpretation?
[Reis 2006 #736]

Questions that ask for more evidence may be accompanied by those that inquire as to the warrant for accepting evidence (see: What is critical thinking?, above) to evaluate a claim.

Questions that ask for clarification are posed by an learner-inquirer with the presumed goal of disambiguating the meaning imputed to the text (see: Can *elocutio* specify meaning *explicitly*?, above) based on contextual concepts held in common with the writer-speaker. Examples include:

> Can you put that another way?
> What's a good example of what you are talking about?
> Can you explain the term you just used?
> [Reis 2006 #736]

Open questions are intended not to invite one or only a limited set of responses, but rather to stimulate curiosity (probing one's knowledge for inadequacy) and interest in constructing new knowledge. They can lead to adjacent *dispositio* and are more likely posed by writers and teachers than by learner-inquirers. Open questions often begin with how or why. For example:

> Why might the economy be an important factor in the next election?
> How does changing demographics influence national politics?

Hypothetical questions are those based upon counterfactual concepts (see: Counterfactual blends) and provoke speculation about:

> . . . how changing the circumstances of a case might alter the outcome.
> They require students to draw on their knowledge and experience to come
> up with plausible scenarios. . . . the hypothetical question can provoke
> flights of fancy that can take a group to a new level of engagement and
> understanding,

Here are some examples of hypothetical questions:
How might World War II have turned out if Hitler had not decided to attack the Soviet Union in 1941?
If Shakespeare had intended Iago to be a tragic or more sympathetic figure, how might he have changed the narrative of Othello?
[Reis 2006 #736]

Inquirers may also craft their *elocutio* according to a conceptual model they construct of who will be receiving the question. Their term selection for expressing the cognitive question can differ depending on whether the receiver is, say, a subject matter expert, a teacher, a novice, a computer data base, or a child. Whether the inquirer knows or is known by the party to whom the question is directed can also influence the selection of linguistic terms derived to express the question.

(2c) Performing the *expressed* question to a teacher-subject specialist

The expressed question (2b), may be performed (produced and transmitted) to a teacher-subject specialist. The derivation *elocutio* ➜ *pronuntiatio* and transmission (see: *Pronuntiatio*) have been described earlier in this Part.

3. Intermediation

Elements (0) and (3a)-(3f) of the above model of inquiry may be regarded as *intermediation*.

(3a) Reconstructing the inquirer's cognitive question

The teacher or subject specialist produces reconstruction of the inquirer's cognitive question and context (adjacent concepts) (2a) by *unpacking* (*pronuntiatio* ➔ *elocutio* ➔ *dispositio*) the *pronuntiatio* transmitted by the inquirer. The derivations bundled within *pronuntiatio* ➔ *dispositio* have been described earlier in this Part.

This element (3a) *is* the ascertainment element of Ausubel's Assimilation Theory. To accomplish the task of ascertaining the inquirer's prior knowledge, particularly their cognitive question (in the structural, rather than linguistic sense), element (3a) and elements (2a)-(2b)-(2c) may iterate, as in the conversation between a reference specialist or teacher and the student (blue arrows in Figure II.68(b)).

(3b) Mapping the inquirer's cognitive question to a conceptual reference structure

The teacher-subject specialist performs *isomorphic mapping from* concepts expressed in their reconstruction of the inquirer's cognitive question (3a) *to* their own *conceptual reference structure* (0) as described above (see: What is isomorphic mapping?).

Model of Inquiry

(6)
Understanding
(meaningful learning,
becoming informed)

(5b)
Inquirer imputes attributes
of trust, belief, or truth to
new knowledge

(5a)
Inquirer relates newly
projected concepts to their
existing knowledge

(4d)
Intellectual engagement with
records

(4c)
Inquirer replicates isomorphic
projection in (3c)
(an imaginative creative act)

(4b)
Inquirer unpacks
pronuntiatio into *dispositio*

(4a)
Inquirer perceiving
pronuntiatio

**Teacher-Subject-
matter specialist**

(0)
Conceptual reference structure developed and
maintained by teacher-subject specialist

(3e)
Published texts identified

(3d)
Expressing the concepts
projected

projection (3c)

mapping (3b)

(3c)
Isomorphically projecting concepts
from a *conceptual reference structure*
onto their *reconstruction of the inquirer's cognitive question*
(an imaginative act)

(3b)
Mapping the inquirer's
cognitive question onto a
*conceptual reference
structure*

Inquirer

Inquirer's knowledge structure

(1)
curiosity

(2a)
Recognition of *cognitive question*
(see Figure II.69)

Inquirer's mental model of intermediary

(2b)
Terms selected to express
cognitive question
(*elocutio*)

(2c)
Cognitive question
performed and transmitted
(*pronuntiatio*)

intermediation

(3a)
Reconstruction of the inquirer's
cognitive question

Figure II.68(b)

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The inquirer's cognitive question (3a) is mapped onto the teacher or subject-matter specialist's own knowledge, their conceptual *reference structure* (0), relevant to the cognitive question. Because relations among concepts constitute meaning, and knowledge is "meaningful by definition" according to Ausubel, a mapping between conceptual structures, as in this mapping between the teacher-subject specialist's reconstruction of the inquirer's cognitive question (3a) and their own *conceptual reference structure* (0), may be regarded as knowledge. A mapping, i.e., established relations, *is* knowledge. Thus, the teacher-subject specialist may be regarded as having, to some degree, become knowledgeable about the inquirer's inquiry and conceptual structure.

A learner-inquirer's conceptual structure may be considered inadequate with respect to another structure, the teacher-subject-matter specialist's *reference structure*.

(3c)   Projecting explanatory concepts from the conceptual reference structure to the inquirer's cognitive question

The teacher-subject specialist performs *isomorphic projection* of concepts and relations to address the gaps and blocks that comprise the inquirer's *cognitive question* (2a). *Dispositio* is *isomorphically projected* (3b) by the teacher-subject specialist *from* their conceptual reference structure (0) *to* their reconstruction of that *cognitive question* (3a), forming an *explanatory path*. Isomorphic projection has been described earlier in this Part in What is isomorphic projection?

Just as relations, including isomorphic mappings, may be regarded as knowledge, isomorphic projections may be regarded as imaginative and creative because they result

in new conceptual structure, that is, new ideas (see: What is the role of imagination in thinking? What is creativity?, this Part).

Explanations (as concepts, i.e., differentiated from explanations-as-*elocutio expressions* of concepts) are conceptual paths that relate an inquirer's existing concept structure to new ideas. Such a conceptual path, related to the inquirer's prior knowledge (conceptual structure), is *understanding*.

In meaningful reception learning, *both* the teacher and the student perform isomorphic mappings and projections. A model or practice that excludes (3c) places the burden of performing the *original* projection of explanatory concepts onto the inquirer. Ausubel deems such an approach to be discovery learning. Assimilation Theory is differentiated from discovery learning.

(3d)   Expressing the concepts projected

Linguistic terms, *elocutio*, expressive of the *isomorphic mapping* performed (3b) and the *isomorphic projection* performed (3c), i.e., the *explanatory path*, are derived. The derivation *dispositio* ➜ *elocutio* has been described earlier in this Part.

(3e)   Published texts identified

The teacher or subject specialist may indicate texts expressive of *dispositio* (concepts and relations among concepts) that comprise the explanatory path (3c). These indications might describe how and where the concepts are expressed in the document.

The expenditure of cognitive labor by the inquirer, in some cases, is changed to the extent that an authored text expresses the result of isomorphic projections, other assimilation operations, or the construction of other relations (3c). This constitutes reception learning and is distinct from the inquirer having to construct a projection without the benefit of the projection being expressed by a teacher or authored text (discovery learning).

(3f) Transmitting *pronuntiatio* to the inquirer

Elocutio derivations of the *explanatory path* (3d), and the identification of texts expressive of the explanatory path (3e), may be performed, *pronuntiatio*, and transmitted to the inquirer. *Pronuntiatio transmission* has been characterized in the description of *pronuntiatio* in this Part.

(4a) Inquirer perceiving *pronuntiatio*

A learner-inquirer's perceptual resources for reading have been described (this Part).

(4b) Inquirer unpacks *pronuntiatio* into *dispositio*

The inquirer *unpacks*, that is, performs the derivation sequence (*pronuntiatio* ➤ *elocutio* ➤ *dispositio*), upon receipt of *pronuntiatio* from the transmission from the teacher-subject specialist (3f). The derivation *pronuntiatio* ➤ *elocutio* ➤ *dispositio* has been described earlier in this Part.

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(4c) Inquirer replicates isomorphic projection

In meaningful reception learning, *both* the teacher and the student perform isomorphic mappings and projections. In (4c), the learner-inquirer *replicates* performance of the isomorphic mappings and isomorphic projections performed in (3b) and (3c) by the teacher-subject specialist, (and other assimilation processes). The projections result in the creation of new concepts for the inquirer.

However, this is not an original projection, but is guided by the reconstructed *dispositio* in (4b). This it is *reception* learning, *not discovery* learning in Ausubel's terms.

(4d) Intellectual engagement with records

Through engagement with the *dispositio* expressed by the texts recommended in (3e), the learner-inquirer replicates further isomorphic projection (and other assimilation processes). The whole of Part II.1 and Part II.2 is devoted to intellectual engagement with external resources.

Elements (4c) and (4d) constitute *explanations*, that is, *explanatory paths*, *inventio*, that mitigate inadequate *dispositio*. Through (4c) and (4d), the learner-inquirer re-constructs *explanations* (explanatory path segments), i.e., *inventio*, that mitigate the inadequate *dispositio* in their knowledge structure.

Explanations mitigate inadequate *dispositio*

An *explanation* is (often) new *dispositio* that mitigates the learner's prior inadequate *dispositio* (see: Figure II.69). Linguistic (*elocutio*) manifestations of explanations are *explanatory expressions*.

Learners whose tolerance level is low for perceived inadequate *dispositio* (e.g., dissonance and gaps) attempt to resolve such conflicts by formulating concepts and relations among concepts that establish explanatory paths (below) and thus mitigate the dissonance and voids. Indeed, generation of new cognitive objects that mitigate inadequate *dispositio* <u>is</u> meaningful learning, the core of Assimilation Theory (II.1).

An *explanation* is a conceptual *path* that displaces a cognitive question

The notion of *path* has been alluded to in this Part and its properties acknowledged. An elementary principle of public speaking is that a speaker should "take the listeners from where they are to where the speaker wants them to go." To do so implies that the speaker can ascertain "where the listener is", or in Ausubel's terms,

> The most important single factor influencing learning is what the learner already knows. *Ascertain this* . . .
> [Ausubel Novak Hanesian 1978, iv (flyleaf) (emphasis added)]

The essence of *path* is *not* one of *elocutio*, but of *inventio* and *dispositio*. An *explanation* is a *conceptual* path of connected concepts that leads from the learner's existing knowledge to the *dispositio* to be assimilated and displaces a cognitive question:

> [A] detailed *trace of the reasoning* that was used to answer a particular problem . . . [Lakoff 1988 194]

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The function of *explanation* is:

> . . . bridging the gap between what the learner already knows, and what he needs to know . . . [ARK 11, 148]

The segment of the path of connected concepts between ideas the learner already knows and goal concept that displaces the cognitive question may be regarded as *an explanation*. For example, in the case of the cognitive question arising from a gap (Figure II.70), an explanatory path is one that displaces the gap with new structure (Figure II.70(b) or Figure II.71(b)).
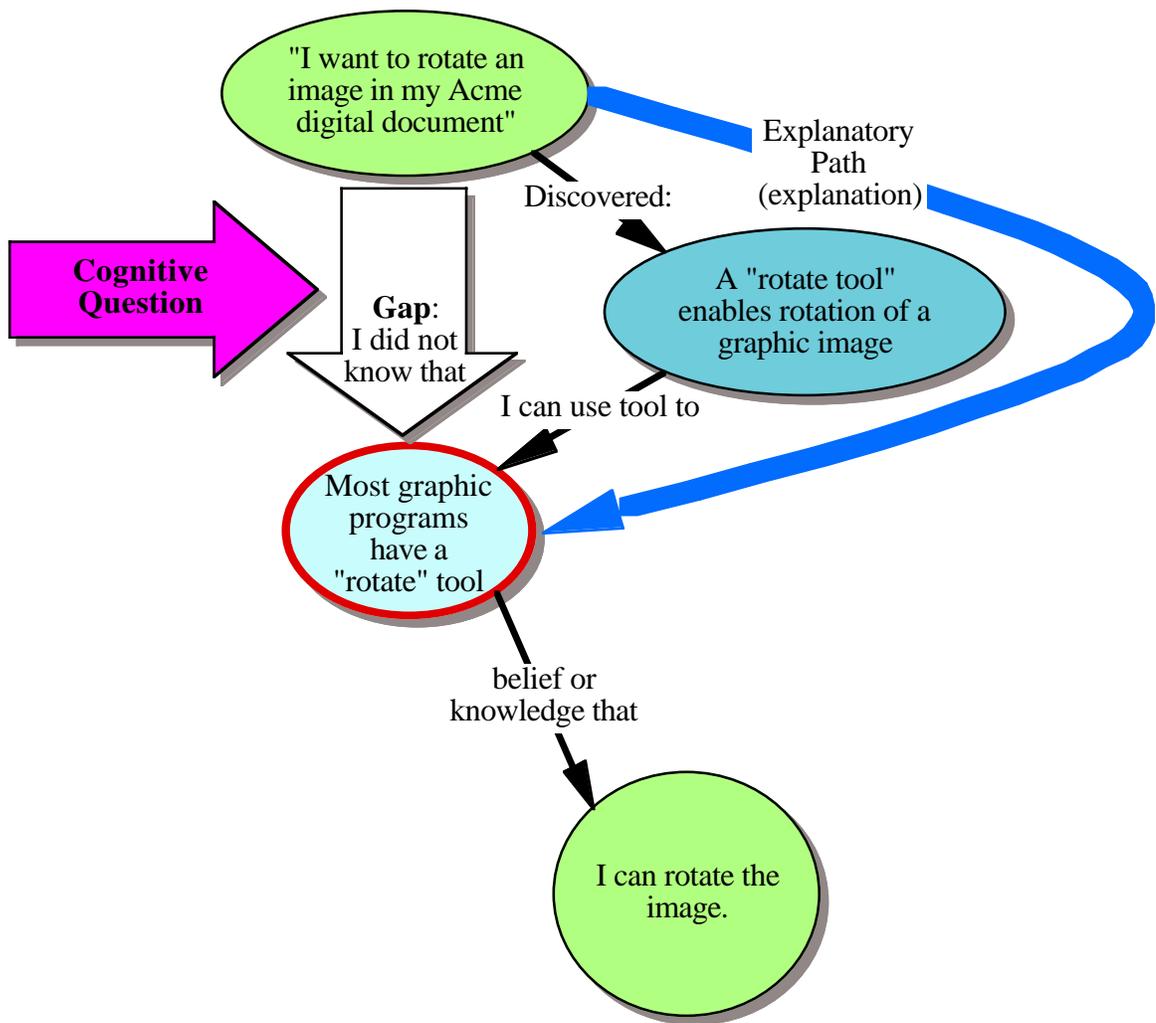
Figure II.70(b)
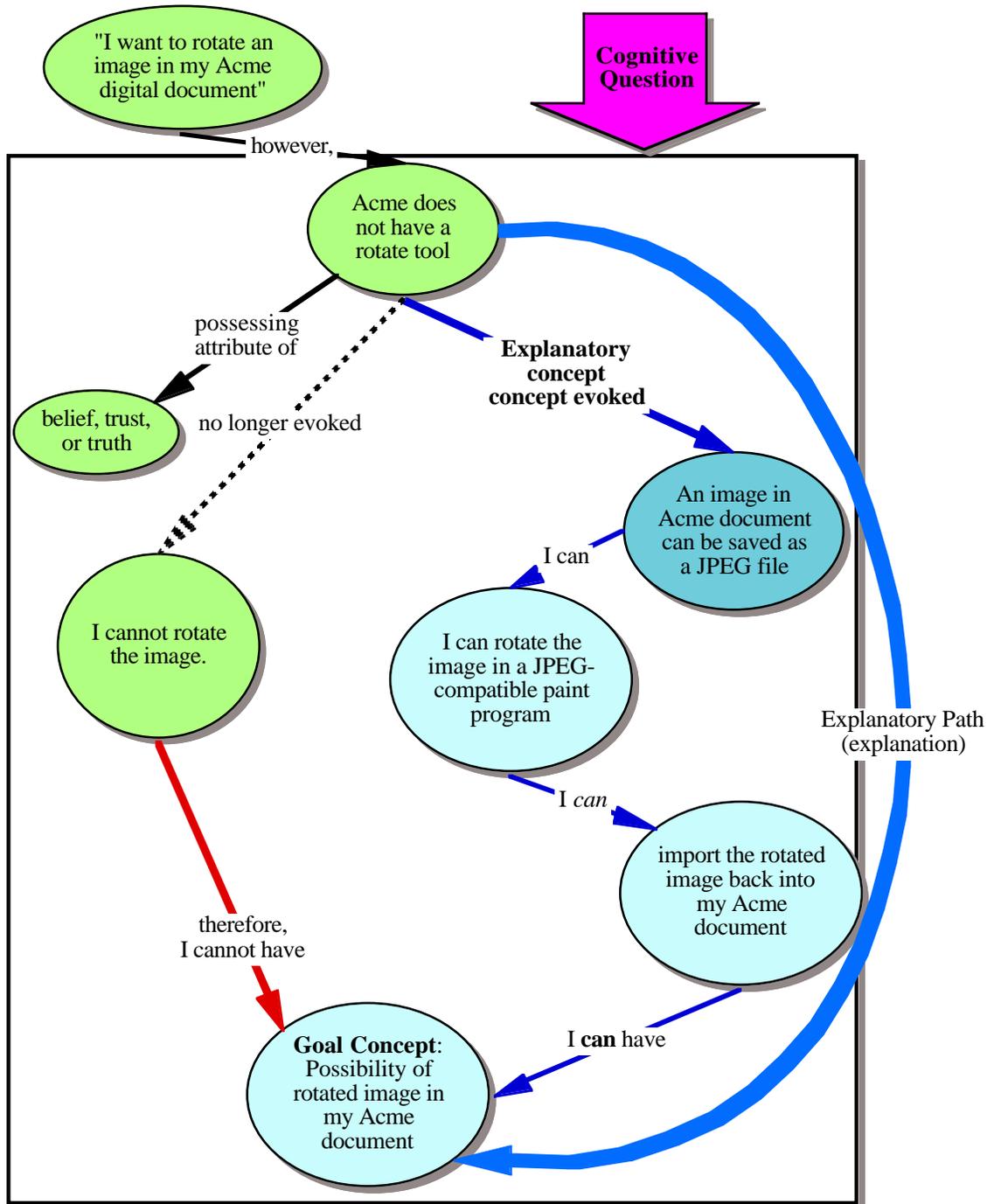
Figure II.71(b)

Paths are constructed primarily through *continuous derivation* (see: Continuous derivation, above, and iteration and feed back, element (7) below, results in constructing new relations from existing ideas and even from *inventio* evoked by linguistic terms. Because continuous derivation often operates below the conscious threshold, tracing the path of concepts and relations to prior or succeeding concepts can be difficult. From the learner's perspective, the terminal *dispositio* may emerge as if by magic from nowhere, a creative, imaginative event. However, whether or not the specific steps in the path can be *consciously* traced, the construction of a path is nevertheless a cognitive, imaginative act.

Explanation itself is *not* the terminal endpoint of an inquiry, but rather the assimilation of the explanation into the learner's *dispositio* is the terminal endpoint of an inquiry event:

> "Meaningful learning," by definition, involves the acquisition of new meanings. *New meanings, conversely, are the end-products* of meaningful learning. [ARK 67 (emphasis added)]

An *explanatory expression* (*elocutio*) cannot be "an answer" to a question unless and until the learner has constructed meaning (*dispositio*) from it that forms a connected path as described. If the learner did not understand the answer (*elocutio*) to a given question, then neither the explanatory expression nor the *dispositio* the learner evokes from it, mitigate the inadequate *dispositio*, and a terminal endpoint has not been reached.

In the context of classroom learning, *inquiry* is regarded as a finite process although some of a learner's inquiries might last a lifetime. The terminal endpoint is generally either some sense of cognitive satisfaction that a "line of reasoning," *path*, new meaning has been constructed, or exhaustion has set in.

What attributes constitute a *complete* explanation? A partial or insufficient one? Philosophical issues regarding completeness are beyond the scope of this report.

Lastly, one might observe that concepts evoked by a learner-inquirer as a result of engagement with intermediation might either be (a) new to the learner-inquirer and thus be an *explanation* that mitigates a *cognitive question*, or (b) have already been known to the learner-inquirer and thus, rather than *explanation*, be regarded as *confirmation*.

(5a)   Inquirer relates new concepts to their existing knowledge

The inquirer *assimilates*, that is, relates new concepts to their existing knowledge, thus deriving *dispositio* from *inventio*.   Only at this point has the learner-inquirer *become informed*.

Recognizing *dispositio* as explanatory

> Martin's law: You can't learn anything unless you almost know it already.
> [Winston, P. H. Artificial intelligence. Addison-Wesley. 1984.]

How does the learner recognize the answer to a cognitive question as explanatory, should he evoke it? Not only need the learner be satisfied with the explanatory conceptual connection that annuls the inadequate *dispositio*, but the learner must *recognize* the new meaning *as* explanation (also see Role of memory, above).

Recognition of an idea *as an explanation* is operationalized either by the learner's evocation of a conceptual structure into which the explanation *fits*, or construction of an estimate of conceptual attributes the eventual explanation might comprise (see: *Anticipating* idealized cognitive models (ICMs)). A corollary to the old adage that "If you don't know the question, you won't recognize when you've got the answer" might be

"If you don't have an idea of the properties of the explanation you're seeking, you might not recognize it when you have it." This anticipation may be characterized as isomorphically projecting a skeletal idea upon a potential explanatory *dispositio* sufficient to provoke recognition of an explanatory path.

> [T]o make an observation one must have an idea of what could be seen, and a framework of beliefs into which new observations, both confirming and disconfirming, may be interwoven. Thus observation is the interface between perception and learning. Prior learning is invoked to structure new perception, and new perceptions are used to advance learning in the form of theory construction and modification.
> [Ahl Allen 1996 13]

Further, ideas cannot be recognized *as* resolution to inadequate *dispositio* until they are *thought of*, that is, evoked and assimilated To isomorphically project an idea onto a *dispositio* structure manifesting some inadequacy, the learner must first have evoked that idea.

Occasionally, a learner is unable to evoke the explanatory *dispositio* desired, as from an explanatory expression. Possibly, some explanations (as *dispositio*) are not found because there are no linguistic terms to describe the idea that is the explanation. Explanatory expressions can be ineffective or unrecognized *as explanations* if they are not associated with the same linguistic terms as the expressions of inadequate *dispositio*, i.e., problem statements. These cognitive dysfunctions are briefly discussed (see: *Memoria*, above).

(5b) Inquirer imputes attributes of trust, belief, or truth to new knowledge

Through use of inquirer's prior knowledge, such as concepts of *warrant*, cognitive authority, and other ICMs, the inquirer not only relates new concepts to existing knowledge, but also imputes attributes of trust, belief, or truth (see: *Dispositio* attributes: belief, trust, truth, this Part), or alternatively, as counterfactual or prevarication (see: Counterfactual blends, this Part).

(6) *Understanding* (meaningful learning or becoming informed)

Understanding is synonymous with meaningful learning and thus explored throughout this Part. Here, only the characteristics of understanding (comprehension) that particularly pertain to *inquiry* need be considered:

The verb *to understand* refers to the cognitive process that results in the integration of a new concept or relation into existing *dispositio* structure.   For example, when a young learner-inquirer cognitively establishes the relation *grows into* between their existing concepts of *seeds* and *plants*, they are regarded as *understanding* both plants and seeds a little better, one relation better to be precise. Thus, a goal of *inquiry* is to assimilate concepts and relations among concepts toward an endpoint of *understanding*.

Achievement of a condition of *understanding* is a terminal endpoint (see: Endpoints, II.1) of a specific inquiry event. Types of terminal endpoint events that comprise the achievement of an understanding include decisions, conclusions, and beliefs.

Assimilation Theory claims that meaningful learning results when the learner actively integrates new ideas with their prior knowledge:

> New meanings . . . are the product of an active, integrative interaction [processes (2)] between [4] new instructional materials and [1] relevant ideas in the learner's existing structure of knowledge. The conditions of learning presuppose additionally the existence of [3] a meaningful learning set in the learner . . . [ARK 40 (enumeration added)]

Thus, *explanations* become *new meanings* when a learner's assimilation of such explanations into their existing knowledge is completed, resulting in *understanding*.

As a noun, *understanding* is the condition of having constructed meaning such that the learner's *dispositio* has become re-structured, in*form*ed, and further that the learner's felt and rational effects of the existence of a cognitive question, i.e., of inadequate *dispositio*, have been mitigated. The condition of understanding is often accompanied by the sensation of *making sense*, in contrast to the sensation of the frustration that arises from inadequate *dispositio*.

(7)   Iteration and feedback

This model of inquiry and portions of it, iterate as described above. One type of iteration is at the level of the model as a whole, with feedback communication between inquirer and teacher-subject specialist (see: Negotiation of meaning, this Part).

This concludes the search for Stage Two analysis criteria.

Part III

Selecting texts for analysis. Findings and Implications

III.1 Selecting texts for analysis

This Part briefly describes the selection of objects for analysis (LIS texts), then reports the findings of the application of <u>Stage Two</u> analytic criteria to those texts and finally, their implications.

What is the domain of analysis?

Having identified appropriate Assimilation Theory-based criteria for analysis of LIS texts (Assimilation Theory as extended by the ideas described in Part II.2), the next task is to select specific texts. At the overview level, the basis for selection of objects for analysis is straightforward: texts selected are a sample of those that express LIS understandings of the Basic Relationship as interpreted by the selector.

What criteria are used to ascertain whether a text "best expresses LIS understandings of the Basic Relationship"? The customary procedure for selection of sample objects for analysis is a statistically random sample of objects in the domain. Scientific methodology for selection is foregone here for two reasons. First, in several topic domains, such as IR, there are many texts that possess virtually identical properties. No benefit would accrue to analyzing a proportionate sample of statistical IR papers for elements of Assimilation Theory. Instead, the most expressive writings over the breadth of the field, in the judgment of the investigator, were selected. (Despite this criterion, a small number of items did not meet the "most expressive" requirement. Analysis was performed upon these nevertheless, albeit usually resulting in an abbreviated inspection with a null evaluation relative to the Research Question.)

Another common approach to selection, also not utilized for this investigation, is to reason: "to select LIS texts, one must be able to say what and whose work is to be deemed as LIS texts, and thus one must be able to say what concepts serve as criteria for determining whether a text is or is not an LIS text." This line of thought inevitably segues to an attempt to describe or even define "What is LIS?" This entanglement is avoided by recognizing that the nature of the field is better ascertained *after* the analysis phase, as part of the findings, rather than as preparatory work, provided that the texts are broadly accepted to be within the field.

The focal point of the Research Question,

> . . . the character of the relationship between *how inquirers become informed* and *how LIS systems intermediate to serve that inquirer* (the Basic Relationship) . . .

is intended, in part, to *discover* afresh the concepts and doctrines underlying the field, not to assume them. Thus, the option of defining *a priori* what *is* and what *is not* LIS subject matter is foreclosed. Instead, the investigation stands on an assumption that each thematic group, and each text associated with each group, is potentially expressive of LIS ideas relevant to the research question at hand.

LIS themes selected for this investigation

To achieve conceptual breadth across the spectrum of concerns and interests, theories, practices, and doctrines that comprise LIS-as-field, first prominent themes in the field are identified, and then texts associated with each theme are selected.

The thematic groups selected for this project are synthesized from familiar partitionings of the field such as examination fields in LIS graduate programs, special interest group designations in scholarly societies, and scholarly discussions about the field *per se* (e.g., the First i-Conference among schools of information convened in 2005).

Some themes that are only of interest within LIS, but which are central to other fields, are excluded. For example, writings descriptive of social approaches to LIS, but classified in the general social sciences (the LC "H" classification), are not included in this study. For parallel reasons, texts native to political science (the "J" classification, including public policy issues), law ("K," including privacy and intellectual property issues, particularly patents and trademarks), and general technology ("T," including understanding of how computers and digital networks themselves operate, design of systems, and data security) are omitted, even though these topics frequently arise in LIS discussions. Economic topics are confined to those centered on inquirers and their *becoming informed* through engagement with LIS resources.

In this report, the inquirer is assumed to be motivated, else they would not be engaged in their inquiry. Consequently texts directed to the determinants of motivational factors of inquirers are outside the scope of selection.

Further, LIS "applied" texts such as pertaining to specific communities, e.g., "scientific and technical information," medical informatics, management of government documents, and the idiosyncrasies of organization and access to legal case law and other legal research materials, are similarly deemed beyond scope.

The astute reader may find an implicit epistemological position taken in the list of themes included and excluded: Included themes are concerned with a willing inquirer becoming informed and also an LIS infrastructure that promotes successful inquiry. This indeed

excludes some favorite LIS themes, e.g., data security, copyright protection, development of computer algorithms and operations, government and social policy, and use of texts or libraries for purposes other than *becoming informed*.

As is characteristic of categories generally, the ideas reflected in these thematic groupings (at least to the present writer), are not mutually exclusive, but overlap. Any individual text might be categorized with multiple themes. Indeed, several of the thematic groups may be regarded as bundles of other LIS themes. For example, "information retrieval" might be viewed as a combination of "identifying" (classification), "relevance," and algorithms (computer science). Similarly, the thematic group of "digital libraries" might be regarded as no more than the intersection of collections, cataloging, human-computer interfaces (HCI), and information retrieval (IR). Some see HCI as computer science subject matter, some as LIS subject matter, some as a subcomponent of IR. Indeed, HCI has been seen as a confection of computing, psychology, and ergonomics. Some regard IR as a subcomponent of computer science, and thus regard all of LIS is encompassed by computer science! [Footnote III.1]   Thus a sub-theme or a text has potential for association with multiple thematic groups. Here, texts selected for analysis are listed with only *one* thematic group because analysis of the text is governed only by the Stage Two criteria, not characteristics of the thematic group to which it was assigned in this study.

Moreover, not every text listed is examined in whole. Some are examined only in parts that pertain to the Basic Relationship.

The thirteen thematic clusters are:

Theme 1   Philosophical treatises

Theme 2   LIS-as-scholarly-field, as multidisciplinary, as interdisciplinary

Theme 3   Foundations encountered in LIS training

Theme 4   Collection development and maintenance, access (reference service), archiving and preservation

Theme 5   Bibliographic description and instruments (catalogs, classification systems, thesauri, indexing and abstracting, other indexing languages, concepts of bibliography, metadata)

Theme 6   Digital libraries and infrastructure: digital libraries, information systems technology, artificial intelligence as used in information systems

Theme 7   Knowledge management, information architecture

Theme 8   Cognitive orientation in LIS research (the "cognitive viewpoint", relevance, cognitive psychology, mental models, sense-making theory, and conceptual structures expressed in disjoint literatures)

Theme 9   Needs assessment, usability, human-computer interaction (HCI)

Theme 10   Communications, semiotics, linguistic theories, documents, reading, writing, and publishing

Theme 11   Quantification, measuring, bibliometrics

Theme 12   Information retrieval (IR), filtering, overload and data mining, browsing (navigation), "information seeking."

Theme 13   Economics of becoming informed (limited to how value is ascribed to texts)

Selection of LIS texts from each theme

Several categorical filters shaped the selections and corresponding quantity of texts in each thematic group. Selected texts were either (a) published in an LIS venue, i.e., a journal, annual review, or as part of LIS course materials, or (b) written by an author who has established credentials in LIS (e.g., degree, teaching position), or (c) both written and published in a field other than LIS but sufficiently frequently cited by LIS texts that the concepts it expresses have become assimilated into LIS literature, as with texts in human factors, user studies, and knowledge management.

Selection of texts for analysis was overseen by the dissertation committee.

Currency of texts analyzed

Periodicals and annual reviews published through October 2006 have been included in the pool from which texts were selected.   The journals reviewed for current articles included *Information Processing and Management*, the *Journal of the American Society for Information Science and Technology*, the *Journal of Documentation*, the *Journal of Academic Librarianship*, *Library & Information Science Research*, *Library Trends*, and *Library Quarterly*.

III.2 Findings

Analytical results
Primary Finding
Validity
Discussion
Assimilation Theory and psychological theory in LIS
Highlights of findings by theme group
Highlights of findings by criteria group

Analytical results

Each of 413 LIS texts were analyzed according to 569 <u>Stage Two</u> criteria. Results were

recorded on the working document for each text. Each instance was scored as *consonant*

with the specific analytic criterion, as *dissonant* with it, as merely *mentioning* the concept

of the criterion, or as *not mentioning* it. Additional annotations were made on working

documents of contextual and other observations. At the conclusion of analysis of each

text, the whole text was evaluated for its overall consonance, dissonance or silence as to

the set of analytic criteria. Finally, as an experimental control, a faculty committee

member separately administered the <u>Stage Two</u> criteria to selected texts and

independently reached substantially similar judgments.

A text was deemed to express "substantial mention" if it mentioned all or nearly all of the

core criteria, or substantially all of the model-of-inquiry criteria (in the 900 series). The

set of core criteria includes:

Draws upon educational psychology, learning theory, cognitive linguistics, or

cognate fields (113, 300a, 300b, 300c)

Epistemological constructivism (114)

Relating new concepts to prior knowledge (121)

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Ascertaining learner's prior knowledge (122)

Methodological individualism (137)

Concept structures (147); processes (e.g., subsumption differentiation (151 - 155)

Conceptual paths and endpoints (160, 927)

Transfer, isomorphic mapping and projection (150, 704, 708, 900.3b, 900.3c)

Learner's inability to express concepts they do not have (181)

Concept mapping (205)

Distinction between communication and transmission (301)

Acknowledgement of conduit metaphor error (313 and specific types)

Differentiation among concepts, linguistic expressions, and physical objects (402)

Apprehending is facilitated by preconception, readiness to learn (439, 187, 182)

The inquirer's cognitive question changes during inquiry (919)

Model of inquiry elements (900 series).

Table III.1 summarizes the analytic results by thematic group.

Only 23 (approximately 5.6%) of the 413 LIS texts examined were interpreted as consonant with Assimilation Theory overall. Approximately the same number of texts were scored as dissonant with Assimilation Theory. These texts overtly *teach against* some or many of the core criteria, most frequently by disclaiming epistemological constructivism (Criterion 114), disclaiming methodological individualism (Criterion 137), or embracing the metaphor of the human mind as a computer (Criterion 535).

The most conspicuous result, however, is that the remaining 89% of the LIS texts examined omit mention of, or take no position as to, all or most of the criteria, or even of the core criteria.

Analytic Results by Thematic Group.

		Total Texts	Consonant n	Consonant (%)	Dissonant n	Dissonant (%)	Mention or Silent n	Mention or Silent (%)
Theme 1	Philosophical	48	2	4	5	10	41	85
Theme 2	LIS as field	23	1	4	2	9	20	87
Theme 3	Foundations in LIS training	19	0	0	0	0	19	100
Theme 4	Library service	47	0	0	0	0	47	100
Theme 5	Bibliographic service	45	2	4	0	0	43	96
Theme 6	Digital libraries	27	1	4	3	11	23	85
Theme 7	Knowledge management	13	1	8	0	0	12	92
Theme 8	Cognitive	65	7	11	4	6	54	83
Theme 9	Needs assessment, usability	15	1	7	0	0	14	93
Theme 10	Communications, linguistics	26	1	4	2	8	23	88
Theme 11	Quantification	12	1	8	0	0	11	92
Theme 12	Information retrieval (IR)	63	5	8	5	8	53	84
Theme 13	Economics	10	1	10	2	20	7	70
	Total	413	23	5.6	23	5.6	367	88.8

Table III.1

Both dissonance and obliviousness with regard to the core <u>Stage Two</u> analytic criteria combine to underlie this result. Combining the 88.8% set of texts silent as to Assimilation Theory with the set of 5.6% that are dissonant, yields the primary analytical result:

> Approximately 94% of the LIS texts examined may be characterized as
> not consonant with the concept of *meaningful learning*.

The Primary Finding is derived from this result.

Primary Finding

An evaluation of 94% non-consonance is significant, whether by casual interpretation or formal measure. This datum is indicative of:

<u>Primary Finding vis-à-vis the Basis Relationship</u>

> A substantially inadequate LIS understanding of the Basic Relationship, the relationship between an inquirer and LIS intermediation, obtains, according to criteria derived from Assimilation Theory.

As alluded to below, validity of this Primary Finding is limited to the extent that the elements of Assimilation Theory, a theory of *meaningful learning*, cohere with the essential concern of LIS, assumed to be a concern for *inquirers becoming informed.*

This finding is reflected in LIS texts to *varying* degrees. The most apparent of these is the *absence* of LIS recognition of Ausubel's fundamental tenet, that *meaningful learning* requires the intermediary to ascertain the learner's conceptual structure prior to learning (Criterion 122), and then present materials that express concepts and relations that construct new knowledge connected to the learner's prior knowledge ("teach accordingly;" Criteria 124 and 125). LIS writings and practice, with few exceptions, do not call for ascertaining "what" the inquirer knows, nor for mapping the inquirer's cognitive question to an LIS reference structure or projecting concepts expressed by the reference structure to the reconstruction of the inquirer's cognitive question. Evidence of this omission is not found only IR literature, but is discernable across the LIS enterprise, in theoretical and experimental treatises and in descriptions of LIS operations.

The primary implication for the inquirer is that, once having "received service," they are on their own in regards constructing meaning, *becoming informed*. There is no feedback for ascertainment by the intermediary unless self-initiated by the inquirer.

The primary implication for LIS, both research and practice, is that LIS instruments are unable to achieve their potential because they do not incorporate or reflect the central concern of *an inquirer becoming informed*. Instead, intermediation is sub-optimized to focus on narrow objectives and thus its manifestations work not to the inquirer's construction of meaning, but at cross-purposes (e.g., circulation systems obstruct inquirer's access to physical volumes, data elements do not express attributes of texts of interest to an individual inquirer, computer interfaces concerned with presenting multitudes of features but not facilitating ascertainment of the inquirer's cognitive question, philosophical approaches expressive of tangential concerns that displace concern for an individual inquirer *becoming informed*). The result of inadequate concern for core Assimilation Theory concepts may contribute to poor retrieval precision, poor recall, failure to become informed, undiscovered expressions of explanatory paths remaining undiscovered, writer's block and other obstructions to writing and thinking, continuing potential ignorance and opportunity costs of such ignorance, and inquirers perceiving themselves to be overloaded with "information," ironically *without* becoming informed.

A corollary hypothesis is that removal of the constraint in the Primary Finding

> to the extent that the elements of Assimilation Theory . . . cohere with the essential concern of LIS

will result in improved LIS. With this hypothesis:

Application of Assimilation Theory elements will result in improved LIS

theory and intermediation. Conversely, their omission will work to the

detriment of both the inquirer and LIS as a scholarly field.

Such a hypothesis implies experimental work that might refute or confirm it. While

experimental work is beyond the scope of this report, Part IV takes some preliminary

steps in describing the elements of an Assimilation Theory-consonant framework for LIS.

Validity

Validity of this Primary Finding is limited to the extent that the elements of Assimilation

Theory, a theory of *meaningful learning*, cohere with the essential concern of LIS,

assumed to be a concern for *inquirers becoming informed.*

The Primary Finding is comprised of several concepts, any of which might be challenged:

(1) the claim that LIS' core concern is:

> Humans becoming informed (constructing meaning) via intermediation
>
> between inquirers and instrumented records (see: Part IV.4)

(2) the assumed relationship between meaningful learning and becoming informed,

> Assimilation Theory, a theory of meaningful learning, [and] . . . LIS,
>
> which is assumed to be a concern for *people becoming informed . . .*

(3) the interpretation of Assimilation Theory as extended in this report (Part II.2), or even with (4) the application of Assimilation Theory-based criteria to LIS texts as performed in this analysis. Indeed, a small number of writers overtly disclaim any form of "mentalisms" as essential to LIS concerns. Thus, from these various viewpoints, one might not expect recognition of a theory built upon foundations of educational psychology or cognitive linguistics to underlie LIS. The validity of these other approaches to understanding the Basic Relationship is not challenged here. Rather, I claim that, owing to the *human* nature of inquirers, an Assimilation Theory consonant approach is an indispensable element of an overall LIS understanding and its central concern, inquirers *becoming informed*.

In regards the application of Stage Two analytic criteria to LIS texts oriented to very specific topics, one might argue that discussion of an inquirer's conceptual processes might not to be expected to be expressed in texts deliberately focused on narrowly-defined technical domains such as classification research, cataloging practice, information retrieval, digital libraries, system architecture, or interface design, for example, and thus, one might not be surprised at the 94% statistic. Indeed, such texts reflect little such discussion. In counterargument, even a specific topic of a scholarly article or book should be connected to its field's central concerns either in a preface or an introductory chapter.

An argument might be made that LIS texts, especially those of a practical or operational nature, were conceived and written with the understanding that their subject matter, e.g., cataloging or IR system design, *relied on* the 'meaningful learning set' of the inquirer. The counterargument here is that the engineering and description of a bibliographic instrument is incomplete without examples of how it might be used. Its use necessarily entails engagement of an inquirer. However, such engagement is infrequently described

in most operational LIS texts, never mentioned in some, nor is the inquirer's evaluation of its impact upon their *becoming informed*.

Similarly, one could argue that specific bibliographic systems and instruments are not intended to stand alone, but are embedded as sub-systems in larger systematic enterprises, such as institutional libraries or online services that provide for engaging the inquirer to ascertain their cognitive question, and thus, to describe every nut and bolt as relating to an inquirer is unnecessary and inappropriate from the standpoint of the technical writing of an engineering document. However, if this were the case, descriptions of such instruments would allude to the larger context, including components that engaged inquirers. For example, if a treatise on indexing or cataloging assumed that a reference librarian is available, devoting little or no explanation to intellectual resources that an inquirer is expected to bring in order to use the catalog might be defended: An inquirer with such a deficiency would be expected to call upon the reference specialist. Indeed, this argument might be valid if catalogs and Readers' Guides were virtually always situated with such a specialist. Such is no longer the case, if it ever was. Catalogs, Readers' Guides, web search engines, and virtually all other bibliographic instruments are broadly understood as intended for independent self-service and the usage patterns, though not investigated here, likely bear that out. It is unlikely that, out of a hundred uses of a Readers' Guide or catalog, there is more than a handful of requests for reference specialist assistance. One may conclude, therefore, that descriptions of bibliographic instruments that do not account for how their users become informed are inadequate.

Nor does an argument that absence of such description in the technical texts analyzed is merely an *occasional* oversight, obtain. This omission is evident in the *majority* of LIS writings. From the perspective of a central concern for *inquirers becoming informed*, one might not expect such an omission, much less that it be prevalent. Nevertheless, it is

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there and it is rampant. Article after article does not express any relation of their specific

subject matter to a concern for an inquirer constructing understandings through use of

texts or for a model of inquiry.

Discussion

The Primary Finding, that a substantial majority of LIS texts do not express coherence

with Assimilation Theory, might be regarded as unremarkable. The thrust of this

discussion, however, is to explain why this finding *is* surprising, and why this surprise is

unlikely to be widely recognized *as* surprising.

This Primary Finding makes visible a paradox:

A body of work explanatory of *meaningful learning* is relevant to LIS' core concern of

becoming informed, yet

LIS seems (strangely) unconcerned with *meaningful learning*

On one hand, LIS texts provide ample evidence of its assumption that instruments and

services directly result in the inquirer successfully becoming informed.   On the other

hand, however, in the majority of LIS writings, virtually no account is taken of

conceptual operations that must be performed by an inquirer (assimilation, isomorphic

mapping, isomorphic projection) to construct meaning. The intellectual work performed

by inquirers themselves is transparent, virtually invisible, in the bulk of LIS theoretical

and practical writing.

Because the central concern of Assimilation Theory, *meaningful learning,* is comparable

to the concept of *becoming informed*, then elements of Assimilation Theory may be

expected to be imported or assimilated into LIS concepts and reflected in its writings. They are not, and this is surprising: two scholarly spheres with substantially similar concerns exhibit almost no overlap of core concepts. Why?

A factor potentially explanatory of why LIS has not embraced *meaningful learning* as a form of *becoming informed* is that LIS, and its conceptual cousin, *communication*, are both rooted in the physical domain as well as the intellectual. Communication, in the form of language, bridges these two domains. Since the Renaissance, Western society has been awed by technological achievements in the physical domain. Fascination with the technological has, however, (at least) one detrimental effect: it draws attention away from the other domain, the intellectual realm. LIS is no exception in its susceptibility to being mesmerized by technology. Consequently, LIS has become less interested in the essential nature of the intellectual domain to intermediation: Indeed, the analysis of more than 500 LIS texts shows that the bulk of LIS activity ignores the inquirer's conceptual structure and its inadequacies, and attends, instead, to objects that can be stored, retrieved, managed, and processed: information-as-thing.

This phenomenon is well-known. The most prominent factor in the hegemony of *pronuntiatio* over *dispositio* is the *conduit metaphor*. The conduit metaphor has been described in detail by Reddy [Reddy 1993] and summarized in Part II. It operates to discount the conceptual processes that a communicator must apply to received messages that, in turn, result in their construction of meaning. With concern for conceptual labor ignored, all that remains of the "communication" is the physical element. Thus, *becoming informed* morphs into *information*. *Information*-as-thing is born.

Evidence of conduit metaphor error (CME) in the examined texts was found. While only 3 of 47 (6.4%) of the LIS service texts (Theme 4) committed CME, 7 of 27 (26%) of the

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systems-oriented texts (Theme 6) manifested it. 36.8% of the Theme 3 texts (foundations of LIS training) revealed CME.

LIS has almost wholly acceded to the conduit metaphor. Concern for the inquirer's intellectual labor and constructs has been all but foregone in favor of interest in *pronuntiatio*, i.e., objects in the physical domain that are storable, retrievable, searchable, processable, and manageable. The conflation of *dispositio*, *elocutio*, and *pronuntiatio* into *information* has divested LIS of its inclination, even its capacity, to unpack the notion of *information* and to differentiate among its constituent elements. *Information* acquires, simultaneously, the properties of solid, liquid, and gas (One is *burdened* by too much information (solid), information *flows* from authors to publishers to readers (liquid), and information sometimes seems *difficult to grasp* even though one knows its there but cannot see it (gas)). The conduit metaphor conjures the illusion that ideas can slip out of human minds and *into* records so that once *having* a record, one has *become* informed.

Conventional treatment of the concept of *relevance* often reflects this displacement of concern for *dispositio* by interest in *pronuntiatio*. Just as concern for *dispositio* itself has been replaced by the tangible, the concept of *relevance* has been reinvented in several non-cognitive forms that characterize relationships between objects in the real world rather than the inquirer's mental realm, e.g., situational relevance (the relation between a text and a situation that the inquirer might inhabit), logical relevance (a relation between some attribute of a text and some other attribute, e.g., a match), and topical relevance (the relation between a text and a topic. These forms of relevance can be evaluated apart from the mental realm of the individual inquirer, and thus they can be operationalized, experimented upon, and exhibited, that is, confined to *pronuntiatio*.

Relevance is personal But, in *relevance*, as in LIS generally, conduit metaphor error removes the personal inquirer and their conceptual realm from our consciousness, and all that remains is the *pronuntiatio*, *information*-as-thing:

> . . . we thought we had been in the wine business, suddenly we realized
> that all along we've been in the bottling business.
> (John Perry Barlow, in [Nunberg 1996a 103])

Barlow's adage was expressed as a characterization of the library paradigm of the late Twentieth Century. Ironically, the "post-library" generation of technology enthusiasts is retracing this path. Enchantment with *pronuntiatio* and its technology (in the form of computer programs, interfaces, applets, etc.) results in the neglect of *dispositio*.

A notion of relevance absent a *particular* inquirer (that is, a "text" can be relevant to everyone), has become accepted as received wisdom. Similarly, the fallacy that a relevant *idea* and relevant *document* are one and the same, and that *relevance* can be self-contained within the document, and thus relevant to all in the same way is commonly found in operationalized IR. As well, relevance judgments are conceptualized as foreclosed from changing even for a particular inquirer during the course of inquiry despite broadly recognized contrary evidence.

In the case where a conventional retrieval system is not matching concept attributes (expressed as *elocutio*) to concept attributes, but only attributes of linguistic representations (also expressed as *elocutio*) to other linguistic objects, or physical objects, then it is entirely unsurprising that inquirer's relevance determinations, based on their conceptual structure, are at variance with those produced by an LIS service.

We are fortunate to have Ausubel's own words regarding relevance:

> First, at the very least, an implicit judgment of *relevance* is usually
> required in deciding under which existing concept or proposition to
> subsume new ideas in the instructional material.
> [ARK 51 (emphasis added)]

An Assimilation Theory view of *relevance* may be interpreted as meaning "on a conceptual explanatory path" and cannot be determined *without a particular inquirer* because the starting point, the inquirer's existing concept structure, differs from person to person. An assumed starting concept on an explanatory path might be one that the inquirer has not assimilated, i.e., "does not have" or recognize.

The dissonance vis-à-vis Assimilation Theory is not simply that other conceptualizations of relevance have been found useful, but that cognitive relevance, i.e. the relation of an explanatory path to the inquirer's cognitive question, is virtually *always* omitted in LIS characterizations of practice, systems, and instruments.

Assimilation Theory and psychological theory in LIS

Assimilation Theory is a body of work produced in educational psychology. It is distinct from 'cognitive viewpoint' work in LIS. Most LIS writings associated with the 'cognitive viewpoint' or 'cognitive turn' descend from, or at least acknowledge, a single paper presented at two conferences in 1977 by Michael DeMey. Though working with a background as a psychologist and with the endorsement of no less a figure than Jean Piaget who wrote the preface to the proceedings of the 1977 Ghent conference, DeMey's work was oriented primarily to artificial intelligence (AI).

LIS 'cognitive view' papers were unable to build upon the psychological theory in DeMey's paper for little was expressed. A one-sentence slogan is all that is generally quoted from DeMey paper by his LIS followers:

> The central point of the cognitive view is that any processing of information . . . is mediated by a system of categories or concepts which . . . are a model of his work. [DeMey 1977 xvi-xvii]

Instead, the LIS writers vectored off onto independent tangents. The most well-known of these is Belkin's "anomalous states of knowledge" (ASK) theme, comparable to only one of several hundred criteria upon which this report is built (Criterion 181). Some of these LIS papers have been eloquently criticized for projecting a grab bag of theories onto their expositions of LIS matters.

> [L]amentations of sterility co-exist happily with an extraordinary flowering of the speculative imagination. High-flying LIS researchers swoop indiscriminately down upon the theoretical terrain, colonizing Popperian worlds, or cannibalizing hermeneutics, phenomenology, general systems theory, symbolic interactionism, decision theory, existentialism, structural-functionalism, cognitive science, or philosophy of language, to name just a few of the theoretical models on current exhibit in LIS research literature.
> [Frohmann 1992a 366]

The so-called 'cognitive viewpoint' is no exception. Frohmann criticizes the cognitive viewpoint papers and mentalistic approaches to LIS as staking "imperialistic" claims that displace all the other understandings because they claim to be the *only* model explanatory of LIS phenomena:

> The cognitive viewpoint presents itself neither as one theory among many, nor as a local theory of specific problems, but as a *total* theory for LIS, and as its *only* theory. [Frohmann 1992a 371]

An Assimilation Theory approach to the Basic Understanding takes account of an important element of inquiry: It provides explanations as to the phenomenon of individual inquirers becoming informed and thus should take its place in the larger LIS theoretical context. It does not account for characteristics of whole societies, for technological aspects, legal aspects, or aspects of the field concerned with policy, social or otherwise, and thus does not purport to displace those that do.

Highlights of findings by theme group

Table III.1 above summarizes the analytic results by theme group and shows that only twenty-three (23) texts deemed substantially Assimilation Theory-consonant were found among the 413 analyzed. Nine of the thirteen groups had either one or two consonant texts.

Theme 1   Philosophical treatises

Consonant texts:

> [Brooks 1998] Brooks, Terrence A. Post-Modern Information Science and its "Journal". 1998.

> [Farradane 1980] Farradane, J. Knowledge, information, and information science. Journal of Information Science (2) 75-80. 1980.

Discussion

This thematic group exhibited the most diverse spectrum of subject matter. Brooks [Brooks 1998] overtly acknowledged that "users want to retrieve based on conceptual content." and alluded to the distinction between describing containers (*pronuntiatio*) in contrast to the ideas the express (*dispositio*). Farradane [Farradane 1980] acknowledged the importance of looking to communication, teaching, and learning, although he did not look to their theoretical underpinnings in educational psychology or cognitive linguistics. He embraced individualism and cognitive structures which is reflected in his work with relational indexes.

The majority of texts did not express views pertaining to Assimilation Theory. One of Brier's papers [Brier 1991] was close to consonance by addressing the inquirer's knowledge structures.

Several texts, particularly Brookes [Brookes 1980-1981], acknowledged a Popperian "World III" in which concepts exist in records, and thus knowledge is uniform and fixed from person to person. This view, grounded in conduit metaphor, stands in direct contrast to the constructivist approach upon which Assimilation Theory is based.

Wilson expresses consonance:

> Another person cannot give me knowledge; all he can do is tell me what he knows. [WilsonP 1977 40]

Consonant text:

> [Levy et al. 2003] Levy, Philippa. Ford, Nigel. Foster, Jonathon.
> Madden, Andrew. Miller, David. Nunes, Miguel Baptista. McPherson,
> Maggie. Webber, Sheila. Educational Informatics: An Emerging
> Research Agenda. Journal of Information Science 2003 29: 298-310.

Discussion

Levy, in conjunction with Ford (see below) and others consider LIS from the perspective of learning [Levy et al. 2003], an approach that only a few others (e.g., Kuhlthau, Dervin) have taken. They recognize the inquirer's prior knowledge and the intermediary's obligation to ascertain its characteristics.

One of the Theme 2 "texts" was a list produced for this report of all the course offerings for nineteen LIS schools or "i-Schools." Analysis of this list reflected even less consonance with Assimilation Theory (19 of 2263 courses were potentially consonant, (.84%), and 62 acknowledged cognition, psychology, conceptual structures, meaning, learning, or the nature of inquiry (2.70%)). This list evidences overall Assimilation Theory non-consonance. However, one course description merits mention: Indiana University School of Library and Information Science course L551 Information Inquiry for School Teachers was organized around an Assimilation Theory-oriented model of inquiry.

Theme 3   Foundations encountered in LIS training

Consonant texts:

No texts were evaluated as consonant although [Shera 1972] and [Buckland 1988] presented some of the core criteria in a consonant light: Buckland by virtue of an entire

chapter devoted to inquiry, and Shera for attempting to draw upon accepted principles from psychology, conceptual structures, and cognitive processes, and for attention to issues of intermediation and the individual inquirer.

Theme 4 <u>Collection development and maintenance, access (reference service), archiving and preservation</u>

<u>Consonant texts:</u>

None of the 47 library service texts analyzed expressed any consonance with Assimilation Theory.

<u>Discussion</u>

Personal, cognitively-engaged intermediation, in the form of professional reference service was one of the main subject matters encompassed in this thematic group. That the texts revealed no Assimilation Theory-consonant items, This is a surprise. Only one writer overtly acknowledged the importance of attending to the inquirer's cognitive realm:

> Despite evidence [citation omitted] that interest has shifted to one
> dimension of the complete paradigm (namely increased interest about the
> person on the other side of the [reference] desk), most of the reference
> textbooks ignore the substantial research into the psychological dimension
> of reference.
> [Richardson 1995 28 (reprinted from [Richardson 1992]) (annotation
> added)]

Even more surprising is the shallowness of conceptual theory and the debate, beginning with [Hernon McClure 1987], centering on the claim that reference service performs poorly, with only 55% of reference questions answered correctly.

In descriptions of both online catalog use and reference service, report after report acknowledge that inquirers were unsuccessful in becoming informed. Articles discuss, for example, the number of items retrieved, query term issues, inquirer's attitudes, librarian's attitudes, language barriers, availability of texts, format of texts, etc. Yet, *no* discussion of the nature of explanatory concepts and relations that might satisfy an inquirer's cognitive question is found.

In the small group of texts addressing the archival sub-theme, the unresolved problems in preserving digital files, both as *pronuntiatio* (physical files, machines, etc.) and as *elocutio* (program format, e.g., Adobe .pdf, MS Word) are the most frequent topics. From an Assimilation Theory perspective, these texts focus upon preserving the *pronuntiatio* and *elocutio* forms of digital texts, but ignore the *dispositio* forms, that is, the concepts and relations among them which could be expressed and archived separately. None of the texts considered the possibility of preserving or conserving the historical or conceptual context in which future readers of a document might require to construct meaning from either a paper or digital document.

The reconstruction of the inquirer's cognitive question, (Criterion 900.3a) is an often overlooked element in models of inquiry. Smith and Fitt [Smith Fitt 1982] emphasize an indispensable aspect of that cognitive process, *active listening*:

> [Smith Fitt 1982] Smith, N.M. Fitt, S.D. Active listening at the reference desk. Reference Quarterly, 21 (3), 247-249. 1982.

Jahoda and Braunagel instruct as to how to an intermediary performs *active listening* (Criteria 156 through 159):

> The first step in active listening is to stop talking.
> [Jahoda Braunagel 1980 134]

<u>Consonant texts:</u>

> [Green 1996] Green, R. Development of a relational thesaurus. In Knowledge Organization and Change: Proceedings of the 4th International ISKO Conference. Rebecca Green, ed. INDEKS Verlag, 72–79.

> [Green 1995a] Green, Rebecca Joyce. Syntagmatic relationships in index languages: A reassessment. Library Quarterly, 65(4), 365-385.

<u>Converging on consonance:</u>

> [Beghtol 2001] Beghtol, C. Relationships in Classificatory Structure and Meaning. Chapter 7 of [ISKM2 2001]. 99-114.

<u>Discussion</u>

Rebecca Green ([Green 1996] and [Green 1995a]) describes structural relations that transcend simplistic term matching, as well as elements essential to explanatory paths and endpoints. In [Green 1995a], she overtly calls for indexing structures that Lakoff associates with idealized cognitive models (ICMs) and, indeed, recites Lakoff's work on aspect and paths.

Beghtol [Beghtol 2001] deserves honorable mention for focus on the range of relation types among concepts, treated reductively or even simplistically by most others.

Some of the texts, even though not substantially expressive of Assimilation Theory, make notable observations.

Evidence of Assimilation Theory processes (subsumption, superordinate learning, isomorphic mapping and projection (transfer), and reconciliation, and differentiation) was found in descriptions of thesaurus building (concepts are subsumed, differentiated, reconciled by being situated under another term, etc.). Bean & Green's article on thesaurus construction and maintenance [Bean Green 2001], uses Assimilation Theory

vocabulary such as *subsume*, and *subsumption*, *integration* (integrative reconciliation), *meaningful*.

Foskett recognizes isomorphic mapping of concepts between the inquirer's knowledge and that expressed by a reference structure:

> This is in fact the crucial operation in library and information service:
> helping the reader to form a match between his own conceptual scheme
> (which is lacking something or he would not be making the inquiry) and
> those of the writers who may be able to supply what is lacking.
> (D.J. Foskett. The contribution of classification to a theory of
> librarianship. [Rawski 1973 175])

Shera is among the few who articulate the distinctions between the Divisions of Rhetoric and discusses implications of mistaking one for another:

> Our schools of [of information] are busily engaged in producing "control
> artists," technicians and mechanics who tinker with information systems
> but are unable to solve the problems of access and retrieval because they
> cannot control ideas. These control artists constantly mistake the symbol
> for reality and believe that counting or figuring with these symbols solves
> the bibliographic access problem. [citation omitted]
> . . .
> confused substance with instrumentation [and standards].
> [Shera 1983 383-384 (annotation added)]

> The confusion of ideas with data can be dispelled only by distinguishing
> between data systems and idea systems.
> [Shera 1983 383-384, 386]

Despite momentary lapses into conduit metaphor error, Wilson acknowledges that the understanding of the Basic Relationship between inquirers and LIS instruments is inadequate, and that the *dispositio* layer of the Divisions of Rhetoric model is where LIS intermediation is most in need of improvement:

Numerous novel indexing and classification schemes for displaying the results of that intuitive grasp of content have been devised, and many of them put into effect, but it is still true that the subject indexing and classification schemes most widely used by libraries are those proposed, and already well developed, a hundred years ago. It is commonly agreed that these old schemes do not work very well, but improving on them in practice would seem to require some improvement of, or substitute for, that intuitive grasp of intellectual content, and no one has good practical ideas about how that might be done.
[WilsonP 1983a 391-392].

Reinforcing the Basic Relationship's need for a better understanding of meaningful learning, Wilson continues (as quoted earlier):

What we would like, for its possible help in improving techniques for content representation, is deeper understanding of the phenomenon of understanding itself . . .. [WilsonP 1983a 397].

A portion of Theme 5 focused upon metadata. Assimilation theory calls not merely for (1) descriptions of conceptual components of concepts, but also (2) descriptions of the relations among them, and (3) descriptions of their use in conceptual operations such as isomorphic mapping and isomorphic projection. Specification of appropriate metadata elements describing concepts attributes, while an indispensable first step (if the attributes specified are adequate - see Part IV), does not address the latter two, nor does metadata account for the intermediating *process* of constructing both (4) concept structure expressions derived from concepts expressed by a collection and (5) concept structure expressions derived from the inquirer's cognitive question.

Theme 6   Digital libraries and infrastructure - Infrastructure

Consonant text:

>[Allen 1996] Allen, Bryce. Information Tasks: Towards a user-centered approach to Information systems. Academic Press. 1996.

Discussion

Some of the texts in this thematic group and in IR pursue an artificial intelligence (AI) or expert systems approach. Assimilation Theory, in contrast, is grounded in an inquirer's ability to (1) experience sensory stimuli, from which (2) basic concepts arise, and which are later projected onto (3) abstract concepts (see: Part II.2) Computing systems are not capable of sensory experience. Thus, they cannot conjure basic concepts. Assimilation Theory is not AI. Allen [Allen 1996] provides an extensive review of intermediation models and describes [Allen 1996 152-171] a model that can arguably be interpreted to include virtually all of the Assimilation Theory inquiry elements (900. series).

Theme 7   Knowledge management, information architecture

Consonant text:

>[Blair 2002] Blair, David C. Knowledge management: hype, hope or help? Journal of the American Society for Information Science and Technology, 53 (12), 1019-1028.

Discussion

Blair [Blair 2002] recognizes that knowledge management (KM) is in people, not in records or computing systems. Accordingly knowledge management is not a component of an LIS, which is regarded here as concerned with intermediation between inquirers and instrumented records (see: Part IV.4), unless records are maintained of concepts known by people in the organization. The Blair text's consonance rating was, perhaps, generous,

but is based upon his recognition of knowledge as *dispositio* rather than *pronuntiatio* as is the convention in the majority of other KM texts.

Theme 8   Cognitive orientation in LIS - "Cognitive Viewpoint" in LIS

Consonant texts:

> [Belkin 1980] Belkin, N. J. Anomalous states of knowledge as a basis for information retrieval. Canadian Journal of Information Science. Vol. 5 133-143. 1980.
>
> [Belkin 1984] Belkin, N. Cognitive models and information transfer. Social Science Information Studies. Vol. 4(2-3). 111-130. 1984.
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> [Belkin Oddy Brooks 1982] Belkin, N. J. Oddy, R. N. Brooks, H. M. ASK for information retrieval: Part I. Background and theory. Journal of Documentation. Vol. 38(2), 61-71. 1982.
>
> [Ford 2004] Ford, Nigel. Modeling cognitive processes in information seeking: From Popper to Pask. Journal of the American Society for Information Science and Technology. Vol. 55(9) July, 2004. 769-782.
>
> [Kuhlthau 1993] Kuhlthau, Carol Collier. Seeking meaning: A process approach to library and information services. Ablex. 1993.
>
> [Miller 1968] Miller, George. Psychology and information. American Documentation. Vol.19(3) 1968: 286-289.
>
> [Sutton 1994] Sutton, Stuart A. The Role of Attorney Mental Models of Law in Case Relevance Determinations: An Exploratory Analysis. Journal of the American Society for Information Science. Vol. 45(3) 186-200. 1994.

Discussion

Belkin's work in 'anomalous states of knowledge' (ASKs) is loosely tied to 'the cognitive viewpoint' . The notion of ASKs:

> compels one to recognize explicitly that representing users' needs is at least

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as important as representing texts. This means more than just user need surveys . . . user warrant ought to play a much stronger role ... than literary warrant. [Belkin 1980 136, 140]

Most LIS "cognitive viewpoint" writings cite a single quotation by DeMey:

> The central point of the cognitive view is that any processing of information . . . is mediated by a system of categories or concepts which . . . are a model of his work. [DeMey 1977 xvi-xvii]

Beyond the apparently obligatory reference to this quotation, LIS papers written from the "cognitive viewpoint" draw little from cognate fields. Adherents to this view subscribe to a shift of focus from system to individual and the notion of knowledge structure, but little overlap among authors beyond this minimal core is to be found. DeMey admitted that the AI program in the 1980's was unable to deliver upon inflated expectations and claims:

> In the original edition of this book, the cognitive paradigm has been introduced as it evolved with the developing field of AI. . . . In the recent history of AI, one can indeed witness how the search for a powerful general mechanism of intelligence weakened in favor of ad hoc local knowledge. . . . While presented as the ultimate AI achievement, the expert system is in a sense the expression of the inability to come to grips with intelligence at large and as such some indication of failure for AI.
> [DeMey 1982/1992 *xxi* (1992 edition)]

Recognition of ASKs has not led to drawing upon principles from cognitive linguistics or educational psychology, nor has a theory of *becoming informed* been developed based upon principles from these cognate fields. As alluded to earlier, the central ASK concept:

> 1. an information need arises from a perceived anomaly in the individual's state of knowledge concerning some topic . . .

> 2. in general, he/she is unable to specify precisely what is needed to resolve that anomaly.

> A consequence of this hypothesis for Information Retrieval (IR) systems

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design is that a system should try to describe the inquirer's ASK rather
than require him/her to specify the need as a search request.
[Oddy Palmquist Crawford 1986]

comparable to Stage Two criterion 181, is only one of 569 of Assimilation Theory

concepts that pertain to a concern for *meaningful learning* or *becoming informed*, and

thus, standing alone, is inadequate to mobilize substantial theoretical or empirical

improvement. Belkin does subsequently recognize Ingwersen's work [Ingwersen 1982]

in acknowledging the elements of an inquirer's knowledge structure, an LIS

intermediary's ascertaining it, and then recognizing relationships between the

reconstruction and concepts expressed by documents (presumably LIS instrumented):

> . . . [G]eneral characteristics of librarian and user searching behaviour,
> which they could relate explicitly to the choice of mediating knowledge
> structure on the part of the librarian, the initial model of the user and the
> subsequent construction of a new model of the user by the librarian, and
> the relationship of these models to the models held of the documents. The
> studies in a theoretical foundation for understanding the relationships
> between librarian, user and documents, in a methodology for studying
> these relationships and the knowledge structure on which they depend, and
> in results that give us valuable information about how librarians and users
> interact, and why. [Belkin 1990 13-14]

Miller [Miller 1968] considers the indispensability of spatial metaphor on memory (see

also: [Yates 1969]). The other major texts on memory "mnemotechnology," as Miller

calls it, post-date Miller's article ([Carruthers 1990], [Spence 1985]). Noteworthy is

Miller's observation:

> I doubt whether any retrieval system that does not have a spatial
> dimension is going to make any kind of adequate match to concepts that
> characterize my thinking. [Miller 1968 288].

Spatial imagery is a powerful mental model, employed for centuries in the West prior to

widespread writing and mechanical printing, through the idea of memory palaces and

other mental devices for recalling texts, [Carruthers 1990] , [Yates 1969], [Spence 1985], [Lanham 1993].

Perhaps the most Assimilation Theory-consonant text in this thematic group is Ford [Ford 2004] (with [Ford 2004a]) in which structures interact ("enmesh") as through isomorphic projection, and in which creativity is recognized:

> *Problem solving* may entail the identification of an integrating theme (synthesis) capable of achieving the resolution of connecting entities (thesis and antithesis). At appropriately high levels of abstraction and dissimilarity of context, such processes may lead to *creativity*. (Ford, 1999). So, for example, identifying a common problem-solution structure across two complex and apparently very dissimilar problems in very different fields is likely to be considered more creative than solving a relatively simple problem by analogy with another similar problem in the same or closely related field. However, Ford's model does not answer the question of how such integrating themes, capable of resolving an anomaly, bridging a gap, or reducing uncertainty, are generated.
> [Ford 2004 770-771]
>
> Description-building is supported in Pask's work by entailment meshes, conceptual maps showing the way in which topics are linked to each other in hierarchical and analogy-based relationships. An entailment mesh is essentially a map of topics linked via "coherences", each topic in a given coherence entailing, and being entailed by, the others. The meaning of any topic must be unambiguously derivable from the relationship between the other topics in the coherence. For example: the meaning of "thermometer" may be derived from the relationship between "heat" and "measurement". "Heat" may be understood as what a thermometer measures, whilst "measurement" may be understood as what a thermometer does in relation to heat.
> . . .
> However, it may increasingly be possible to map such different knowledge representation systems onto one another, and enable the user to switch seamlessly from an IR interaction to one in which pedagogic support is provided to facilitate more detailed study. Further research is needed to assess the extent to which such mapping could be achieved via machine

inferencing.
[Ford 2004 776]

[F]urther research is required for us to know better what might constitute
effective structural and content-related characteristics of such dialogues.
[Ford 2004 779]

Carol Kuhlthau's work [Kuhlthau 1993] stands out in several ways. It is one of only two
in the entire domain of 413 texts to cite Ausubel and Novak. As mentioned in more
detail below, it draws upon knowledge from cognate fields of psychology and
educational psychology rather than re-inventing bastardized LIS versions of them as is
commonly found. Her work treats information seeking as comparable to meaningful
learning and is concerned with the ideas the inquirer constructs rather than limiting
concern to provision of texts.

Stuart Sutton's work with attorney's mental models [Sutton 1994] illustrates specific
examples of interaction between concept structures that may be interpreted as projection
of elements of one structure upon another.

Other texts, although not expressing substantial consonance, made noteworthy
observations.

Don Swanson's work in using bibliographic means to discover explanatory paths not
known to any human is discussed in detail in Part IV. Weeber *et al.* [Weeber *et al*. 2001]
replicate some of Swanson's work and is thus interesting, but still without the use of
concepts as comprising relations to other concepts and relations among them.

Dervin's sense-making work (sometimes regarded as theory) is important in
characterizing the inquirer's challenge through the metaphor of a *path* in which gaps and
blocks are encountered. However, she does not describe the elements comprising the
path or gaps or blockages in terms of concepts, relations among concepts, nor conceptual

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structures. She does not describe processes in which concept structures are modified, e.g., mapping, projection, transfer, superordinate learning, subsumption, differentiation, reconciliation, etc., that amount to construction of meaning or *becoming informed*.

Earlier, Brookes characterized *becoming informed* based upon an additive volumetric metaphor that acknowledged the inquirer's prior knowledge, new concepts assimilated, and resulting new knowledge expressed as an equation:

$$K(S) + \Delta I = K(S + \Delta S)$$

which, roughly translated, may be read as: one's prior knowledge, supplemented by newly added information is equal to the amount of new knowledge.

As with ASKs, recognition of just one Assimilation Theory criterion, in this case acknowledgement of the learner's prior knowledge (Criterion 122) is insufficient to stand alone as a theory of *becoming informed*. It does not account for the conceptual processes that result in $K(S + \Delta S)$, nor the partitioning of responsibilities among inquirer and intermediary. Moreover, "prior knowledge + new ideas" does not necessarily *equal* new knowledge as subsumption and other processes integrate, condense, modify, and expand conceptual structures. Ausubel devotes a substantial portion of his text to the notion of *forgetting* and its role in the construction of new meaning.

For this thematic group, as for Theme 12 (IR), a significant number employ terminology that implies a cognitive, psychological, or linguistic approach to intermediation. The tendency in some of these papers to profess or even re-invent cognitive, psychological, or linguistic theory, rather than draw upon the published writings of those fields, is troubling A survey was taken from among these papers of LIS that discuss cognitive aspects of the field but cite no cognitive, psychological, nor linguistics theory from those cognate literatures. A subset of

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these that overtly include cognitive or psychological terms in their titles and those items were analyzed (Criterion 300) to identify references to papers or books written by researchers in those fields.

Of 65 papers, 22 employed terminology in their title implicating the cognate fields listed and were still available for re-analysis. Twelve of these 22 drew wholly upon LIS and artificial intelligence (AI) texts, ignoring the entire body of knowledge expressed in the relevant cognitive linguistics, educational psychology, communications and rhetoric literatures.

Willful disregard of cognate fields on a scale as broad as found in LIS, may be regarded as an arrogant act and exhibiting gross ignorance. Implications can only be adverse to the field.

Theme 9   Needs assessment, usability, human-computer interaction (HCI)

Consonant text:

> [Dervin Nilan 1986] Dervin, B. and Nilan, M. Information needs and uses: a conceptual and methodological review. Annual Review of Information Science and Technology. 21: 3-33. Elsevier. 1986.

Discussion

[Dervin Nilan 1986] is an oft-cited turning point in the refocusing away from positivistic concern with systems and instead, taking the inquirer's "needs" into account. As with the Blair text (Thematic Group 7), the consonance rating for [Dervin Nilan 1986] might be regarded as generous but is deserved for its grounding in theories of communication, and its recognition of conceptual phenomena (gaps, obstructions) on an explanatory path toward understanding.

Although texts in this thematic group are predominantly "user-centered" rather than interested only in external systems, "needs assessment" and usability studies in LIS attend to a broader array of phenomena than cognitive conceptual objects and processes. These include heuristic evaluation, surveys and focus groups, ethnographic methods, likes and dislikes, profiles, community memberships, behavior, interviewing, demographic facts, ergonomic observation and evaluation, policy compliance, etc. With the exception of "cognitive walk-throughs," virtually all of the texts in this group appear to overlook cognitive or psychological issues. These interests generally reflect a behavioristic approach that is disclaimed in Assimilation Theory (see: Part II.1). These texts do not attempt an account of an inquirer's cognitive question, conceptual processes, nor a model of inquiry that accounts for construction of meaning. Consequently, Assimilation Theory criteria shed little light on understanding of the Basic Relationship as expressed in these texts.

Consonant text:

> [Green 1991] Green, Rebecca. The profession's models of information: a cognitive linguistic analysis. Journal of Documentation. Vol. 47(2). June, 1991. 130-148.

Discussion

One of the most germane observations regarding LIS' refocusing on "the user" comes from Green:

> disturbing findings . . . even though the information seeking model presents the information user's perspective, the data emphasize the role of the information system. The findings suggest respectively that the field lacks a coherent model of information transfer *per se* and that our model of information retrieval is mechanistic, oblivious to the cognitive models of end users. [Green 1991 130]

Green's finding is telling and parallels those made in the course of the present project. There is little evidence of any model of the conceptual resources or processes at work in the course of inquiry. There is no evidence that such models are commonly surveyed in LIS education nor its newer reincarnations. Inquiry and the inquirer's intellectual resources are not generally the focal point of research in the field. Accordingly, LIS understandings of the Basic Relationship are not grounded upon available knowledge expressed in nearby literatures in the fields of education, psychology, or cognitive studies.

Bronshteyn and Baladad's piece [Bronshteyn Baladad 2006] on writing deserves honorable mention as Assimilation Theory consonant despite addressing only a narrow topic.

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Consonant text:

> [Ellis 1996] Ellis, David. The dilemma of measurement in information
> retrieval research. Journal of the American Society for Information
> Science. Vol. 47(1): 23-36. 1996.

Discussion

Measurement and quantification are notions mechanically and easily applied in the

natural sciences and the social sciences as applied to external observable objects and

behavior. Cognitive science attempts to find characteristics of mental phenomena that

can be isolated, described, and quantified. To achieve these with respect to intellectual

phenomena, instruments are constructed to produce visible or audible derivations of

them. The question facing psychologists, educational psychologists, and others interested

in people becoming informed, is, What to measure? Novak warns of programs that

wrongly bestow cognitive authority by virtue of performing measurements rather than

considering which phenomena should be measured:

> . . . the mental measurements crowd . . . the psychometric gang . . .
> unwarranted reverence for precise numbers.   [Novak 1998 76]

Novak has made significant contributions in showing (Part II.1) how concept maps and

other instruments are useful in deriving expressions of concepts and conceptual

processes. With the exception of Ellis [Ellis 1996], the objects quantified by writers

represented in this thematic group are bibliometric citations and references which are, in

some cases, interpreted by investigators as subject matter themes. None of the writings

analyzed called for measuring the number of concepts in an explanatory path relevant to

an inquirer's cognitive question. Little consonance with Assimilation Theory is found

expressed by texts in this thematic group. To this extent, the LIS understanding of the

Basic Relationship is inadequate in that little work has been done in quantitative

characterizations of inquirers' cognitive questions, explanatory conceptual paths, reference structures, or the cognitive labor in performing conceptual processing as in isomorphic mapping and isomorphic projection.

Moreover, because most LIS practice does not engage the inquirer in satisfying Ausubel's ascertainment requirement (Criterion 122), an essential task of LIS intermediation remains inadequately characterized, quantitatively or qualitatively. Indeed, in the conventional model of LIS service, the inquirer has disengaged from LIS intermediation by the time they invoke intellectual processes involved in construction of meaning.

Theme 12 Information retrieval (IR), filtering and selective dissemination of information
(SDI), information overload, and data mining

Consonant texts:

[WilsonP 1996] Wilson, Patrick. Some Consequences of Information Overload and Rapid Conceptual Change. In Information Science: From the Development of the Discipline to Social Interaction. Johan Olaisen, Erland Munch-Petersen, and Patrick Wilson (eds.) Scandinavian University Press, 1996, 21-34.

[Blair 2002a] Blair, David C. Some thoughts on the reported results of TREC. Information Processing and Management 38:445-451. 2002.

[Doyle 1961] Doyle, Lauren. Semantic road maps for literature searchers. Journal of the ACM. Vol. 8(4). 1961. ACM Press.

[Dunlop 2000] Dunlop, Mark. Reflection on Mira: Interactive evaluation in information retrieval. Journal of the American Society for Information Science. Vol. 51(14):1269-1274. 2000.

[Todd 1999] Todd, Ross J. Back to our beginnings: information utilization, Bertram Brookes and the fundamental equation of information science. Information Processing & Management. Vol. 35(6). Nov. 1999. 851-870.

<u>Discussion</u>

Although five texts were scored as Assimilation Theory-consonant, four were minimally so, with only [WilsonP 1979] suggesting that *texts* are not *meanings* and that an inquirer may be overloaded by both:

> Overload is more than the existence of very large amounts of information, enormous accumulations of publications, larger and larger data bases. Rather, it is a gap between what one can do and what one wants to do, a gap between what one can do and what one thinks one should do with existing information. [WilsonP 1979 22]

Blair expressed consonance [Blair 2002a] through his challenges to the assumptions that underlay much of the TREC experimentation. Although the roots of concept mapping might be traced back to daVinci, Lauren Doyle, a prominent figure in the early days of electronic computing, was among the first to apply both automation and mapping techniques to literature searching [Doyle 1961]. Dunlop [Dunlop 2000] was among the few who took the distinctions between concepts, linguistic expressions, and physical objects seriously. Todd's paper [Todd 1999] stood out as the only LIS text that actually cited Ausubel and Novak. He reviewed various attempts to use semantic nets, mental models, concept maps, and conceptual graphs to ascertain an individual's prior knowledge, although unfortunately, none of these attempts were expressed graphically in the paper.

Three items [Baziz Boughanem Aussenac-Gilles 2005], [Ingwersen 1992], and [Rajapakse Denham 2006] in the neutral category were annotated as "promising," the first for recognition of the notion of indexing concepts although they do not contrast an inquirer's concept structure with an LIS reference structure, Ingwersen for recognizing many of the elements of the Model of Inquiry (in his Chapter 8)

although not fitting them together into a coherent model, and Rajapakse and Denham for their clarity in regards mistreating "keywords as the sole representation of a concept."

For this thematic group, as for Theme 8 (cognitive approach papers), a significant number employ terminology that implies a cognitive, psychological, or linguistic approach to intermediation. One of the bothersome characteristics of this thrust in LIS is the willingness to profess or even re-invent knowledge in these fields rather than draw upon the published writings of those fields. A survey was taken from among these papers of LIS that discuss cognitive aspects of the field but cite no cognitive, psychological, nor linguistics theory from those cognate literatures. Of the 63 texts in this group, 10 employed terminology in their title implicating the cognate fields listed. Eight of these drew wholly upon LIS and artificial intelligence (AI) texts, ignoring the entire body of knowledge expressed in relevant adjacent literatures. Willful ignorance of cognitive, psychological, and communications theory by LIS writers in the Twentieth Century must be considered as a potential contributing factor to inadequate theoretical progress.

Only one text ([Todd 1999]) cited Ausubel and Novak.

Theme 13 Economics of becoming informed (how value is ascribed to texts)

Consonant text:

> [Buckland 1988] Buckland, Michael K. Library services in theory and context. 2nd ed. Pergamon Press, 1988. Chapter 13 Demand. Chapter 15, Access. Chapter 16, Measurement and Quantification.
> http://sunsite.berkeley.edu/Literature/Library/Services/.

<u>Discussion</u>

Michael Buckland's well-known book [Buckland 1988] suggests and emphasis on applied use of LIS principles, which, indeed, are explored. However, it is the only text that devotes serious discussion (a full chapter) to the notion of an inquirer *becoming informed*. Much of the conceptual discussion remain apt even as technological ongoing progress presents an opportunity to revise the chapters oriented to library operations.

A small number of texts were analyzed on grounds that economics of information is taken to be a core concern of the field according to conventional viewpoints. However, very few of the ideas expressed in these texts intersect with the <u>Stage Two</u> criteria nor do they have significant bearing on inquirers becoming informed through engagement with instrumented records other than acknowledgement that *value* may be regarded as a cognitive notion and thus influence individual constructions of meaning.

Highlights of findings by criteria group

All 569 <u>Stage Two</u> analytic criteria were applied to the 413 selected LIS texts. There is high likelihood that some instances of criteria evidence were overlooked. No estimate has been produced of the extent of such errors. As well, application of the criteria was an interpretative task. Other reviewers likely will obtain results with (presumably insignificant) variation.

Generally, a sparse matrix found. That is, of the 569 criteria, more than half were not encountered in the texts analyzed. This coheres with the finding that virtually none of the LIS texts cited Ausubel nor Assimilation Theory by name (Criteria 101-112). Indeed, despite the endless din of claims to the effect that LIS is interdisciplinary, only a handful of texts could be interpreted as seriously engaged with, or drawing upon, ideas from cognate fields such as educational psychology, cognitive linguistics, or communication theory (Criteria 300 series). Apparently projecting ideas such as these onto LIS theory and practice is non-obvious.

The criteria characterized (above) as core criteria were among the most frequently cited, although other criteria of lesser significance were detected sporadically.

Ausubel's point of departure for meaningful learning, ascertaining the concepts that comprise the learner's prior knowledge (Criterion 121) is a key element in the Assimilation Theory model of inquiry (900 series Criteria) and has been addressed frequently in this report. In lieu of ascertaining the inquirer's prior knowledge, LIS agents have always made assumptions regarding the inquirer's cognitive question and contextual knowledge, often taking account only of surface phenomena:

An indexer must learn to anticipate the searcher.
[Bellardo 1991 10]

1. *The reader as focus*. [T]he heading, in wording and structure, should be that which the reader will seek in the catalog, if we know or can presume what [term] the reader will look under . . . . [In] the face of lack of sufficient objective, experimental data, we must rely for guidance in the choice of terms upon the experience of librarians and such objective findings as are available.

In choosing subject terms, librarians try to consider both the author's usage and the patron's needs and preferences; but authors and patrons are likely to use different terms for the same subject. [Taylor 2000 345-346]

Of course, the instrument makers (catalogers, system designers, indexers, HCI designers, etc.) cannot know a specific inquirer's cognitive question as their work pre-dates the inquiry. The best they can do is configure their instruments to accommodate the elements of inquiry, including means to achieve recognition of the inquirer's cognitive question.

The trend of increasing disintermediation appears to exacerbate rather than mitigate this deficiency. None of the recent texts analyzed called for use of HCI nor communications bandwidth to be utilized for engagement of the inquirer. Transmission between inquirer and LIS system is asymmetric, comprised of transmissions *from* system to inquirer routinely in the megabyte range, yet extremely low-byte-count specifications by the inquirer (assumed to be mostly keywords) transmitted *to* online systems. Thus, in the automated portion of the LIS service domain, because ascertainment (Criterion 300.3a) is not performed, network bandwidth capacity between inquirer (local client) and automated LIS intermediary (server) that might have been utilized to ascertain the inquirer's cognitive question by identifying concepts in his or her knowledge structure, is, in fact, not utilized efficiently.

Rather than ascertaining the concepts known by the inquirer, LIS continues to demand that the inquirer express the very concepts he or she does not possess (Criterion 181). To the extent that this is a contributing factor of inquirers failing to become informed, it reflects an inadequate understanding of the Basic Relationship according to Assimilation Theory. From the inquirer perspective, the bottom line is that it is *their* responsibility not only to assimilate explanations, but to recognize expression of them. Ausubel views this situation as discovery learning, as distinct from reception learning, and regards it as non-conducive to meaningful learning in most cases (see: Part II.1).

Absent consonance with the ascertainment obligation (Criterion 121), little surprise can be expected in finding virtually complete silence as to the "teach accordingly" criteria (Criterion 124 series).

Acceptance of the notion of methodological individualism (Criterion 137 series) was not overtly expressed in most texts where the context implied it. In contrast, IR texts tended to assume that a search result deemed relevant for one inquirer is relevant for all (as discussed above) and thus may be found dissonant with this criterion.

By and large, the granularity-of-text criterion (Criterion 142) as found in less modern LIS texts is dissonant:

> Consider: in all the years of their activity (easily reckoned as centuries),
> librarians have never developed substantive theories for eliminating,
> abridging, summarizing, synthesizing anything. Their editing, such as it
> is, consists of selecting and rejecting publications in their *entirety*.
> [White Bates Wilson 1992 76-77 (emphasis added)]

Perritt [Perritt 1993] proposed substantially increased intra-text instrumentation though his suggestions appear to be confined to *pronuntiatio* and *elocutio* registers, rarely achieving derivations of *dispositio*. Wilson [WilsonP 1989] recognized the problem of

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granularity in observing that Cutter's [Cutter 1876] second object of the catalog, to say "what" the library has, is not met because catalogs generally do not instrument subjects expressed in chapters or articles in a particular volume of a journal. Indices such as the Reader's Guide provide greater granularity, as do abstracts and descriptive bibliographies. Nevertheless, none of these instruments express conceptual explanatory paths as succinctly as concept maps or shorter encyclopedia articles.

While this criterion (Criterion 142) generally pertains more to the LIS reference structure (Criterion 900.0) than the inquirer, it is the case that isomorphic mapping cannot be accomplished unless both structures, target and domain, are expressed at appropriately fine degrees of granularity.

The pervasiveness of conduit metaphor error (Criteria 313 series and 402 series) has been addressed earlier in this report, as have been the adverse implications for LIS. LIS understanding of the Basic Relationship, so far as reflected by this criterion, ranges from frequently oblivious to occasionally conscious. Ones expectations, even in light of the central concern of LIS, that LIS writers and practitioners are particularly careful to differentiate among *pronuntiatio*, *elocutio*, and *dispositio-inventio*, will be emphatically disappointed. LIS writers and practitioners habitually confuse and conflate (Criterion 447) ideas, texts that express them, and their inscriptions in books and online documents. Suffice it to say that the operative assumption in our field remains that when an inquirer has received *information*, then he has *become informed*. In IR, a string of characters is still misunderstood as "a word" absent all the other properties of words (e.g., pronunciation, sense definition, syllabification, verbal, adverbial, and adjectival forms, context of use, etymology, etc.) (Criterion 420). Retrieval operations based exclusively on character strings are misunderstood as matching terms or even concepts. Knowledge is "stored in databases." Researchers embark upon projects to discover "how much

information there is" independently of any extent to which inquirers have become informed.

On these criteria (communications, conduit metaphor, Divisions of Rhetoric) a conclusion that our understanding of the Basic Relationship is inadequate is easily reached.

The evidence as viewed through criteria relating to reading, writing, and thinking (Criteria 600-821) is materially different: rather than massive misunderstanding, there is massive absence of evidence of these among the analyzed texts.

Finally, the model of inquiry criteria may be reviewed (Criteria 900-936). Although a longitudinal study was neither intended nor conducted, some observations can be made in regards older texts in contrast to newer texts. While there is no surprise in finding that human LIS intermediation is now substantially less than in the prior decades, the criteria also reveal that present LIS theory and practice, exhibiting a trend toward disintermediation, no longer assumes an LIS reconstruction of the inquirer's cognitive question. A communicative reference specialist generally constructs an understanding of the inquirer's question and context. Automated system do not. Instead they are provided a negligible specification of a query, often merely character strings. This change over time became apparent in acquiring data (in the Criteria 900-series) of Stage Two criteria.

Indeed, the majority of LIS texts did not reflect most of the 900 series criteria:

> Ascertaining the concepts and relations that comprise the inquirer's prior knowledge;
>
> Identifying the concepts that comprise the inquirer's cognitive question;

A reconstruction of the inquirer's conceptual structure by the LIS instrument;

An isomorphic mapping by the LIS instrument from the reconstruction of the inquirer's conceptual structure to a conceptual structure derived from an LIS domain;

An isomorphic projection by the LIS instrument from the conceptual structure derived from the LIS domain to the reconstruction of the inquirer's conceptual structure;

A recognition of conceptual explanatory paths revealed from the isomorphic projection above.

A recognition of, and listing of, texts expressive of the conceptual explanatory path is performed.

Only two texts out of 413, [Allen 1996], [Ford 2004] reflect substantially the elements of the model of inquiry (Criteria 900. series).

III.3 Implications

   Implications for theory
   Implications for practice
   Implications for retrieval
   Terminological implications
   Implications for systems, instruments, collections
   Implications for evaluation
   Implications for research
   Implications for LIS-as-profession
   Implications for inquirers

LIS convention has been shown to be dissonant with respect to essential elements of Assimilation Theory (as extended by the ideas described in Part II.2). The foremost implication of this dissonance is adverse effects across the conventionally-configured LIS enterprises, upon the inquirer in failure to become informed, upon LIS intermediation for evaluation of services below its potential, and for LIS research which will be misguided in selection of its questions, its methods, its criteria for drawing conclusions, and ultimately, for inadequate progress.

The massive extent of non-consonance found implies that models underlying current conventions are inadequate. In response, Part IV is devoted to sketching an Assimilation Theory-consonant model of inquiry and of the field. In this Part, specific implied changes from current LIS conventions are presented, as are their anticipated impacts on the LIS enterprise. Of course, changing models and paradigms result in different practices, instruments, research programs, effects on inquirers and service providers, etc. The descriptions that follow are selected highlights.

Implications for theory

In recent decades, concern in LIS epistemology, like a pendulum, has moved away from its traditional position of emphasis on the individual to focus on systems and technology, and back again. Over the last fifteen years, LIS concern has again reversed direction, moving away from individualistic positions, but now reflects diverse interests in social systems, learning, culture, approaches centered on material, actions, gender, and political interests, and, in Shera's terms, social epistemology. These efforts likely will continue to contribute to understandings of the field, perhaps even the Basic Relationship. The constructivist Assimilation Theory view presented in this report does not attempt to invalidate or obviate them. Instead, it attempts to draw attention to elements, a few of which can be found in earlier LIS paradigms, some that are known but overlooked, but most that are projected from outside the LIS literature. Indeed, to some extent, concern for the individual inquirer has itself been displaced by trendy viewpoints and programs motivated by technological progress seemingly for technology's sake.

Individualistic elements of Assimilation Theory are not unique to it, and are generally known. Thus, positions of epistemological constructivism, methodological individualism, and meaningful learning, and the ways in which they stand in contrast to LIS convention, will be left to stand on the descriptions provided above without further ado except to recapitulate the grounds on which these positions are taken. Inquirers are born individually. They experience sensory events individually. From these, they construct basic concepts whose properties are subsequently projected into abstract concepts on an individual basis. In our system of education, students are tested individually, evaluated individually, provided advanced learning opportunities on an individual basis, obtain employment individually, and are generally compensated for their labor individually. Eventually, they depart life as individuals. Most of these events and

activities are essential to life, and importantly, cannot be delegated. Though people are massively influenced by their social and cultural context, people are ordinarily held accountable *as individuals*. These positions contrast, sometimes markedly, with the array of theories and positions advocated in LIS. Thus, an important implication of the findings is a call not simply to concern for or about "the user" but, specifically, each user as an individual and a concern for that individual's concepts, the relations among them, and the processes that account for creation of new knowledge and modification of existing knowledge.

A model of inquiry, generally as outlined in Part II.2, serves as *ground* upon which most of the research implications, service implications , and professional implications stand. It differs from LIS convention in the following way: Conventional LIS is configured to provide documents. An Assimilation Theory framework aims to construct and express to the inquirer an explanatory conceptual path in conjunction with texts toward satisfaction of the inquirer's cognitive question.

Implied in this new model are new kinds of coordination. Inquirers are not in a position to describe concepts they do not possess, and thus cannot formulate questions well or determine what relations to seek among concepts. An inquirer's concepts must be coordinated with a reference structure to identify gaps and obstructions. The reconstruction of the inquirer's concepts, i.e., their cognitive question, is coordinated with concepts expressed by texts under bibliographic control (a reference structure) through isomorphic mapping. Explanatory concepts from the reference structure are projected onto the reconstruction of the inquirer's cognitive question, forming an explanatory path. This conceptual path, and texts that express it, are communicated to the inquirer. Such a model contrasts with LIS convention in nearly every one of the elements and process steps recited in the 900-series of analytic criteria and as reconceptualized in Part IV.

This model of inquiry, substantially different from LIS convention, implies that bibliographic instruments, services, methods, research programs, and education might be reconceptualized accordingly. This Assimilation Theory-consonant LIS is not about merely providing documents, but oriented to *providing texts expressive of ascertained explanatory paths*. This implies attaining an approximate recognition of the inquirer's cognitive question, and relevant subject matters expressed by the instrumented texts that comprise the "collection." Provision of texts expressive of explanatory paths implies that texts provided to an inquirer are relevant to their cognitive question.

As well, the new model of inquiry takes account of, rather than ignores, the inquirer's individual cognitive processes and conceptual domain. This stands in contrast to LIS convention that accepts character strings as adequate expressions of an inquirer's cognitive question.

In the current state of the art, only text (or recommendations) are reported. The inquirer is not presented with an explanation for why particular records are presented in a retrieval result or why they were assigned a particular relevance ranking. Most modern IR systems are "black boxes," that is, non-transparent to inquirers in how they recognize the inquirer's question and how they select relevant texts. Assimilation Theory implies that conceptual explanatory paths provided to inquirers constitute an explanation as to why particular texts are included in search results.

In conventional LIS, the intellectual labor of construction of an explanatory path is wholly borne by the inquirer through reading texts provided. Assimilation Theory implies that the inquirer's construction of an explanation derived from instrumented texts, constitutes *reception* learning because an expression of an explanatory path is received by the inquirer.

Other fundamental implications are foregone here, for example as to how derivations of concepts expressed by texts in a collection might be produced and different forms of writing or indexing languages those might entail.

Implications for practice

An Assimilation Theory-consonant model of inquiry implies that the event of deeming a *text* to be relevant occurs *prior* to document delivery because the concepts expressed by any given text are judged relevant or not before specific results are reported to the inquirer. It further implies that the rationale for recommending specific texts or records in a search result is revealed to the inquirer (in the form of explanatory paths) rather than hidden. It further implies that a finer granularity of text, e.g., paragraphs or sections, may be expressed in an LIS reference structure and utilized for retrieval in the isomorphic processes described earlier. Taken together, these imply reduced "overload" and "noise" burdens upon the inquirer.

Other practical implications are numerous. Deriving benefit from finer granularity of text requires indexing particular senses of terms (*elocutio*) rather than merely the sequence of characters (*pronuntiatio*). That is, indexing of, and mapping to terms, based upon *all* their characteristics (spelling, etymology, pronunciation, senses, synonyms, antonyms, etc.) has the potential to reduce assimilation of undesired texts.

Labor, cost, and other economic implications of the conceptual indexing implied here are addressed in Part IV.

Implications for retrieval

In the current online retrieval paradigm, query strings (rarely *terms*) are provided by the inquirer, matched to character strings derived from collected texts (according to a range of simple to sophisticated algorithms), then results are returned that either refer to documents or comprise the whole texts. This conventional search, mistakenly regarded as a search on the *concept* of, say, `bank`, or (also mistakenly) on the *term* `bank`, is actually based on attributes of *pronuntiatio*, the character string `b a n k`, will retrieve *pronuntiatio* having the character string `b a n k`. It will *not* necessarily retrieve documents expressive of the idea *bank* if, for example, the character string `financial institution` was used. An implication according to Assimilation Theory is that if the inquirer understands his inquiry to be based on a concept, as distinct from a term or a string of physical markings on a catalog records or in a database, then the retrieval should be conducted according to attributes of *dispositio*, not merely *elocutio* nor *pronuntiatio* attributes.

In contrast, Assimilation Theory implies that an inquirer searches, not for or upon texts nor for or upon records representing texts, but for *concepts* upon records derived *from* concepts. From this can be recognized important distinctions between (1) searching *for* a text by searching *upon* texts, *elocutio*, and (2) searching for a text by searching *upon dispositio* by searching *upon elocutio* derivations of *dispositio*.

These implications may be seen as shifting from the Information Retrieval (IR) paradigm to one of Constructive Retrieval (CR), that is, concept-based retrieval based upon a model of inquiry as conceptualized above and sketched in Part IV.

Terminological implications

Adherence to the Divisions of Rhetoric reference model, an Assimilation Theory element, implies adjustments in terminological practice.

Following Furner [Furner 2004], refer to *ideas* or *concepts* as *ideas*, *concepts*, *dispositio*, or *inventio* rather than *information*.

Refer to texts, data, or linguistic expressions as *texts*, *data*, *expressions*, or *elocutio* rather than *information*.

Refer to physical objects, visible or perceptible writings or audible speech as *codex*, *inscriptions*, *sounds*, *signal*, or *pronuntiatio* rather than *information*. One might be tempted to use nouns such as *writings* or *documents*, however these might be mistaken for *elocutio*, e.g., the idea of a particular book rather than a physical instantiation of it.

Refer to an event of comprehending as *comprehension*, *recognition*, or *understanding* rather than *information*.

Use *searching for records* or *pronuntiatio* rather than *searching for information* in circumstances where physical objects are intended.

Use *searching for concepts*, or *searching for explanations*, rather than *searching for information* where ideas or concepts are intended.

Organizing implies *establishing relations among* objects, whether concepts or physical books.

Avoid use of the verb *inform* transitively applying to a non-human, as in "The principle of first come-first served informs the policy of course registration in our department."

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Instead use a specific verb, such as *governs* or *requires*, and overtly mention the object to which it applies, e.g., "The principle of first come-first served necessitates approval of the earliest-received course requests first."

Avoid use of the verb *inform* transitively in a passive voice, as in "I was informed of his plan" Instead use appropriate forms of *explain*, or *communicate* as in "He explained his plan to me." This issue is that *was informed* erroneously implies both receipt *and grasp* of a message, and without cognitive effort. To paraphrase Wilson:

> Another person cannot inform me; all he can do is tell me what he knows.
> (cf. [WilsonP 1977 40])

Use of the pronoun *what* in place of a term that provokes *only inventio-dispositio* tends to make conceptual structure invisible, undefined, ignored, discounted. Rather than using the pronoun *what* for knowledge, as in "I want him to tell me what he knows" or "What do you mean?" use *idea*, *concept*, or *dispositio*, as in "What idea are you referring to?" Replace anaphora with an appropriate noun rather than a pronoun. For example, "What did you find out from the book?" is better expressed as "What ideas were activated in your mind by the expressions in the book?"

In referring to meaning expressed by a text or interpreted from a text, use *expressed **by*** or *interpreted **from***, rather than *in*, e.g., "The idea is expressed and explained in the book" is preferable to "I found the idea in the book" See [Reddy 1993] for a more comprehensive itemization.

Avoid use of pronouns for *inventio-dispositio*, for example, "*The idea* I was looking for was expressed in the article" is preferable to "I found *what* I was looking for in the article."

Differentiate between *transmission* and *communication*. Only physical objects, *pronuntiatio*, are *transmitted*. Concepts, ideas, opinions, *dispositio* are *communicated*. *Transmission* is a logistical exercise in the physical world, and implies transmission, receipt, and possession, all with no cognitive labor expended by the recipient. *Communication*, on the other hand, implies constructive effort by a reader-listener-learner to construct and comprehend a meaning of a message received.

Implications for systems, instruments, collections

Humans cannot hear sounds below 80 hertz or above 20,000 hertz, and cannot see in the ultraviolet or infrared range. To understand such phenomena, instruments are required that derive perceptible expressions of the imperceptible phenomena themselves. Similarly, people cannot perceive some cognitive objects easily, including recognizing concepts, recognizing relations among concepts. To aid in performing such tasks, instruments are required that render conceptual objects accessible to consciousness. Such instruments might also be utilized in forming relations among concepts, forming concepts, deriving abstractions (concepts) from sensed experience, and the complex set of tasks of isomorphic mapping and isomorphic projection -- that is, thinking.

Many LIS writings do not depict the inquirer as part of the "retrieval system" despite the fact that retrieval is incomplete until judgment is made by a human inquirer as to satisfactoriness of the results provided to them by the LIS system. In contrast, in an Assimilation Theory-consonant model of inquiry, the inquirer is regarded as an essential element of the domain that conventional LIS refers to as "system."

In that an Assimilation Theory-consonant LIS theory and practice differ from convention, little surprise will be found in comparable implications for adjustments in LIS machinery.

To adhere to Assimilation Theory, LIS instruments must reflect derivations of concepts, concept structures, relations among them, and conceptual processes, both of the inquirer's intellectual realm, and of the domain of concepts expressed by texts in LIS-instrumented collections. Technical details of these are sketched in Part IV. In many respects, conventional LIS systems substantially meet these criteria, but in others they do not. Differently-purposed bibliographic instruments are called for. These include, at a minimum, (1) instrumentation for producing and indexing concept derivations, (2) interfaces devoted to facilitating reconstructions of inquirers' cognitive questions (i.e., meeting Ausubel's ascertainment obligation), (3) instrumentation of associations between conceptual level structures or paths and texts.

Even if ascertainment of an inquirer's cognitive question and its reconstruction by an LIS intermediary are achieved, concepts expressed by texts in collections are not indexed in a substantially similar form. Thus, an inquirer's concepts cannot be isomorphically matched with those expressed in a collection. Nor can an inquirer's missing concepts, incorrect concepts, and wrong relationships among concepts ("alternative understandings"), currently be exposed through isomorphic projection of concepts from the reference structure.

This implies the need, first for recognition of this form of operational impotence, and second for an indexing language, perhaps new, that expresses the structure of *dispositio* (*inventio* and the relations among them) as distinct from the properties of terms (*elocutio*), and as distinct from the attributes of physical objects (*pronuntiatio*). An attempt to outline specifications for such an indexing language is made in Part IV.

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Current LIS instruments express many kinds of relations. But few express concepts and their *relations* or paths among concepts as expressed in specific texts. Virtually none capture concepts and their relations as expressed by inquirers, from which a cognitive question can be delineated.

Arrangement of derivations of concepts can render the inquirer's task of constructing meaning from them less difficult. *Organizing* is *establishing relations*. To arrange expressions of explanatory paths and project them onto an expression of a cognitive question implies a sort of bibliographic instrument that is not currently in the LIS inventory. Nor are any that present concept context such that the inquirer can easily recognize a conceptual path as an explanation.

Critical thinking is supported by an Assimilation Theory-consonant system by additionally projecting, recognizing, or highlighting expressions of superordinate concepts that pertain to particular sorts of explanatory paths. In this way, assumptions that might have been implicit within the inquirer's cognitive question can be expressed overtly.

One of the few Assimilation Theory-consonant texts found in the course of this project, and the only one identified in Thematic Group 6, enumerates design implications for systems, instruments, and collections:

> Specific Design Implications
>
> I. Information systems should facilitate the efficient scanning of presented materials
>
> A. Materials should be presented in a way that is consistent with the knowledge that users have of the topic.
>
> B. Knowledge of the topic that will assist users in scanning should be

presented to the user as preparation for scanning.

C. Materials should be presented in a way that is consistent with the knowledge that users have of the structure of the information sources.

D. Knowledge of information-source structures should accompany the presentation of those sources.

E. Materials should be presented in a way that is consistent with the task being accomplished by the user.

F. Materials should be presented in a way that allows users to make best use of their cognitive abilities, particularly perceptual speed and spatial orientation.

II. Information systems should facilitate the effective evaluation of materials presented

A. Presentation of materials should highlight data particularly useful in evaluation.

B. Materials should be presented in a way that allows users to make best use of their cognitive abilities, particularly logical reasoning.

III. Information systems should facilitate learning from materials presented

A. Materials that enhance dual coding should be presented.

B. Materials should be presented in a way that is consistent with the task being accomplished by the user and with the domain being studied.

C. Materials should be organized to emphasize associative links that facilitate elaboration.

D. Materials should be presented in a way that allows users to make best use of their creativity.

E. Materials should be accompanied by organizing materials that will

facilitate learning.

F. Knowledge of information-source structures should accompany the presentation of those sources.

G. Information from people and the media should be linked to recorded messages.

IV. Information systems should facilitate planning for information seeking.
[Allen 1996 219-220]

Among the system components identified as susceptible to reconfiguration to achieve Assimilation Theory-consonant intermediation is the network-based human-computer interface. Computing and networking technology have been touted as providing exponentially greater bandwidth. Most of this bandwidth has been directed *at* the inquirer, i.e., for *delivery*. In finding that bandwidth capacity in the opposite direction is underutilized, an implication for improvement arises for making better use of bandwidth *from* inquirer *to* LIS system: (1) to engage the inquirer so as to stimulate *active* cognitive inquiry processes in contrast to mere receipt of database records, and (2) to better address the ascertainment obligation whereby, over the course of the inquirer's use of an LIS system, the system constructs a continuously *improving* representation of an inquirer's knowledge and capacity for process. This coheres with the systems notion of *feedback*.

Present bibliographic instruments appear to assume that reader has sufficient context for their inquiry. This is evident in an inquirer having to have either sufficient knowledge of a structure of subject headings or keywords to retrieve texts indexed according to those headings and terms or the benefit (and risk) of using additional terms.   An implication of this is that not only must the inquirer's cognitive question be circumscribed but also their immediate and mid-range context. Ausubel's notion of Advance Organizers and Novak's

concept maps are attempts to instrument the context that circumscribes a cognitive question.

Implications for evaluation

LIS service is occasionally evaluated according to whether an inquirer has become informed, or is satisfied that they have become as informed as well as they can. The likelihood of an inquirer's recognition of a conceptual explanatory path improves because it is expressed by an LIS intermediary.

The Assimilation Theory model of inquiry has implications for evaluation and even measurement of the extent to which meaningful learning takes place. Novak has described these in detail [Novak 1998 192-195] as concept maps. These methods offer potential efficacy in the context of inquiry. Consider the following scenario:

> An inquirer specifies to an LIS intermediary a target concept in which he is interested, and concepts with which he is currently familiar, to the best of his ability.

> Through iterative communication, the LIS intermediary identifies the inquirer's target concepts and concepts reflective of his existing knowledge. Presumably, a path between existing knowledge and target concept is desired. This is the inquirer's cognitive question.

> The LIS intermediary has at its disposal an inventory of records expressing concepts and relations among them. Through appropriate processing, the intermediary is able to construct an explanatory path of

concepts, either beginning with the inquirer's present knowledge and leading to the target concept, or vice versa.

The number of concepts expressed on this explanatory path is countable.

Upon receiving messages expressing the explanatory path, the inquirer is provided texts or citations expressive of the segments on the path.

In such a scenario, several types of measurement are possible. (1) To what extent was the intermediary able to identify a progression of concepts that reached both ends of the inquirer's cognitive question? To a first approximation, this metric is binary. A path was identified or it was not. At greater granularity, partial explanatory paths may be recognized. (2) If an end-to-end path was identified, of how many concept manifestations did it consist? And (3), upon receipt and assimilation of the explanatory path and accompanying texts, did the inquirer become satisfactorily informed?

Coherence [e.g., continuous conceptual path] of a text can be assessed by converting a text into its propositions and then calculating the number of arguments that overlap from one proposition to the next [mapping] A greater amount of propositional overlap corresponds to a greater amount of coherence. [Rouet *et al*. 1996 116 (annotation added)]

Mere counting of relevant concepts that comprise a concept path is elementary. Cicero teaches:

For when I collect arguments for my cases, I make it a practice not to count them but to weigh them. (Cicero *De partitione oratoria*, II.1 xxvi.309) [Clark 1957 78]

Yet such simple counting of concepts on a path is merely a point of departure for investigation into more sophisticated means of evaluation, e.g., criteria for determining the best of *alternate* explanatory paths.

Perhaps most fundamental is to ascertain whether the LIS intermediary's reconstruction of the inquirer's cognitive question reached a *dispositio* level (concepts and relations among them), only an *elocutio* level (matching all the properties of *terms* with corresponding properties of other *terms*), or, as is conventionally the case, only a *pronuntiatio* level (matching bytes against bytes, character strings with character strings).

Similarly, if one Division of Rhetoric layer is being mistaken for another, e.g., an inquirer believes she is "searching on concepts" but has not supplied structural specifications of concepts, has not supplied specifications for linguistic terms, but has supplied only character strings, an evaluation instrument must be devised to sound the alarm, and perhaps engage the inquirer to obtain specifications at the *dispositio* layer so that the appropriate concept expressions in the reference structure can be identified.

As mentioned (Part II.1), Novak and others have written extensively on the use of concept maps as evaluation instruments. The potential impact on the problems of quantifying relevance and characterizing it qualitatively through the use of concept maps depicting explanatory paths merits further research.

Finally, the tension between the inquirer's exclusive capacity for their own construction of meaning and the fact that LIS intermediation is held accountable for the inquirer's success must be acknowledged. Consequently, intermediation must be engaged in that construction of meaning, rather than assume that its responsibility is satisfied merely with provision of texts for the inquirer to sort through and assimilate.

Implications for research

Even in the brief review of implications presented above, opportunities for more careful investigation are apparent. How can concept-oriented derivations of concepts expressed by texts be produced? How can the extent of *meaningful learning* or *becoming informed* be measured? How might bibliographic instruments and systems be reconfigured to achieve ascertainment of the inquirer's cognitive question, perform isomorphic mapping and projection, and associate the results with recommended texts?

Research on more fundamental questions might draw upon ongoing work in cognate fields including cognitive linguistics, educational and cognitive psychology, and communications studies. For example, a better understanding of the extent to which searching, as part of inquiring, is analogous to writing might be revealing. A better understanding of the structure of texts and the role they play in readers constructing meaning will be valuable. What makes an idea or argument "clear"? How can it be determined when an inquirer is *ready* to assimilate a particular new concept or proposition? The results reported above (Primary Finding) reveal far too much LIS isolation from, and ignorance of, knowledge accumulated in fields concerned with aspects of *becoming informed*. The obvious implication is that the urgency exhibited by LIS over the last fifteen years to establish interdisciplinary affiliations with business management, law, economics, and particular computer technology, none of which are *centrally* concerned with *people becoming informed*, should be coupled with interreading in, and building upon knowledge from, cognitive and educational psychology, linguistics, communication, rhetoric, and the interpretative disciplines, the humanities, *all* of which are centrally concerned with aspects of *people becoming informed*.

Implications for LIS-as-profession

To date, there has been little agreement among the various precincts of LIS as to core concepts that practitioners, researchers, and educators hold in common. An Assimilation Theory-consonant LIS, as a reconceptualized field, implies the possibility of recognizing concepts to which most might subscribe. A reconceptualized LIS is sketched in Part IV showing that the intellectual core of LIS differentiates the field from others in the academy. Here some highlights of implications of such a field are surveyed.

Assimilation Theory implies a particular set of skills that were not appreciated as essential in the context of conventional LIS. The skill sets required to organize (i.e., recognize relations among) concepts and to organize physical objects are distinct. Separate still are linguistic skills. Conceptual and linguistic skills are implicated in an Assimilation Theory-consonant LIS as its focus shifts from retrieving records and books and facts to recognizing ideas, mapping them, projecting them, and expressing them as explanatory paths. For those concerned about the future of LIS-as-profession, these implications should be taken to heart.

> [T]he broader view of information education goes beyond location of materials to the interpretation and use of information. It centers on thinking about the ideas in information resources rather than merely locating sources in an organized collection. . . . It is concerned with seeking meaning and gaining understanding. [Kuhlthau 1993 153]

> When the user's process of learning from information access and use is recognized as an important element in information provision, we become aware of a critical gap in the theoretical foundations of library and information science. Theory for explaining users' experience in the process of seeking meaning from information is . . . in need of a more extensive research base. [Kuhlthau 1993 168]

The case has presumably been argued above that conduit metaphor error is detrimental to inquirers becoming informed. To confront it, LIS intermediaries must be competent at unpacking *inventio* into their constituent concepts, relations, and linguistic labels, and treating each appropriately (e.g., not mistaking key terms for concepts).

LIS intermediaries must learn to ascertain and reconstruct the inquirer's cognitive question. The skill of deriving concept expressions from massive collections of text must be learned, as well as how to perform mapping among concept expressions, and how to perform projections of complex concepts onto inquirer's cognitive questions. Critical thinking must be applied to recognize where superordinate concepts are projecting themselves onto an inquirer's cognitive question, unseen.

Perhaps a significant implication of an Assimilation Theory-consonant LIS is the expansion of the LIS enterprise to offer a scholarly home to the currently unincorporated enclave of practice and research that attends to reading theory, writing theory, and inquiry theory, including the sector of research methods that addresses writing papers and dissertations, and expressing, structuring, and accessorizing texts to improve the lot of the inquirer endeavoring to become informed. An inquirer's understanding of these is indispensable to effective intermediation. Some departments of English might address some of these, but they are not central to the study of English literature *per se*. Nor is there any immutable justification for ascribing responsibility for these concerns to a department whose portfolio is confined to one particular natural language. The argument is made in Part IV that constructing meaning through instrumented records, through reading, writing, and thinking, is a core concern of LIS

Implications for inquirers

The paradigm of "searching for documents" is replaced by that of finding beginning and ending terminal points of potentially explanatory concept paths. The intermediary can then project a concept path onto, i.e., fill in, the gap or block expressed by the inquirer.

> The first step in moving toward user-centered evaluation of information systems is surely to replace artificial relevance judgments with those of real people with real information needs. [Allen 1996 292-293]

Only then are documents that express those paths presented to the inquirer. The consequence may be: (1) precision (a conventional measure) will increase, (2) the cognitive labor of reading massive amounts of text and constructing meaning from them is avoided by establishing higher likelihood that the texts provided will be relevant to the inquirer's expressed interests; and (3) recall will improve because texts are instrumented for the concepts they potentially express (*dispositio*), rather than the character strings of which they consist (*pronuntiatio*); (4) the inquirer will be presented with the conceptual context of his or her question and the explanation provided; and (5) as the inquirer's cognitive question evolves during the course of the inquiry, the LIS intermediary's reconstruction of it tracks those changes rather than remaining static as under conventional search models. The first two of these are claimed to be progress in reducing the cognitive burden that has come to be known as "information overload."

In current LIS convention, the rationale for why specific records are reported by IR systems to inquirers is hidden, as if in a black box. In Constructive Retrieval, the conceptual relations associated with texts that are selected and reported to inquirers are best revealed visually as explanatory paths and in record presentation form.

III.4 Epilogue

To come full circle, the ideas that Ausubel regarded as the primary implications of his work in meaningful learning are revisited:

> One major implication of the cognitive position is that . . . new ideas and information can be meaningfully learned . . . when appropriately relevant and typically more inclusive concepts or propositions are already available to play a subsuming role. . . . Subsumption thus, largely accounts for the acquisition of new meanings. [ARK 41]

Progressive differentiation, *subsumption*, and *integrative reconciliation* can each be shown to play important roles in the process of inquiry. Ausubel also acknowledges *transfer* as an essential cognitive process in learning, distinct from the others only in that it had been widely recognized prior to Ausubel's work. The processes that underlie transfer, isomorphic mapping and particularly isomorphic projection are grounded in, but extend Ausubel's Assimilation Theory.

The present research cannot draw *comprehensive* conclusions as to LIS' present self-understanding of the Basic Relationship, for this was not the question at hand. This report is confined to observations as to LIS' conceptualization of the Basic Relationship *only to the extent* that it is made perceptible by the tenets of Assimilation Theory. This Part has attempted to characterize that understanding.

This report is directed toward uncovering elements essential to LIS but which might be overlooked. The Primary Finding is that several core elements of Assimilation Theory are essential to the Basic Relationship but not generally recognized as such. To this extent, LIS understanding of the Basic Relationship between the inquirer and LIS intermediation is found to be inadequate.

One significant finding, though already well-known, is the detrimental effect of the conduit metaphor. If LIS understood itself to be concerned with *inquirers becoming informed*, one might expect that research programs would be undertaken to better understand the conditions under which inquirers construct meaning from engagement with records. But such is not the case, and thus, such is not LIS' self-understanding. Instead, the field appears to be hypnotized by *information*. In most senses, *information* exists outside the mental realm. Consequently, the field directs the bulk of its research, not to inquirers and their cognitive tasks, but to systems, processing, standards, interfaces, and so forth.

Problems of physical access have mostly been solved. Now the primary challenge is intellectual access. It is true that preservation of digital materials remains a concern for physical access in the future. Perhaps the last significant advance in intellectual access, within the domain of LIS intermediation, was the invention of the reference librarian. The paradigm of real-time human assistance to inquirers is now in decline with the ongoing trend toward automation of every aspect of intermediation.

LIS is distinguishable from neighboring fields, in part, by the nature of its unique core concepts. As these differentiating characteristics become invisible, forgotten, or taken for granted, the enterprise deteriorates to the detriment of inquirers through foregone improvement in LIS theory and practice. Nowadays, graduates of LIS and information graduate programs find careers beyond traditional LIS occupations and for which their education serves as much for breadth as for technical training. A sound understanding of foundations of Assimilation Theory-based intermediation is all the more indispensable to their capacity to intermediate effectively on behalf of their chosen community of inquirers.

Because a theory about the details of the processes of an inquirer becoming informed is available, experiments can be constructed and directed to intervention in those processes, to detect where anomalies occur, and to suggest adjustments. Part IV describes how this might work.

Part IV

An Assimilation Theory-consonant Model of Inquiry

The Primary Finding presented in the previous Part reveals an inadequate understanding of the Basic Relationship across virtually all sectors of LIS (according to Assimilation Theory as extended by the ideas described in Part II.2), and implies that an improved understanding may have favorable consequences for LIS systems, instruments, practices, services, theories, and education. This Part offers a speculative profile of an Assimilation Theory-consonant LIS and ponders, in particular, the resources that might be required for an LIS intermediation that takes into account an inquirer's prior knowledge and is thus able to "teach accordingly" and how such intermediation might appear to the inquirer.

The Model of Inquiry, outlined at the end of Part II.2, is taken as the point of departure for the LIS-specific model conjured here, Constructive Retrieval (CR). CR is differentiated from its conventional LIS counterpart, information retrieval (IR) both in principle and in operation.

Given this Model of Inquiry, one may ask, What objects, processes, and other resources are required to provide LIS intermediation?

The answer is twofold. Needed are (at least):

> A concept indexing language that differentiates the attributes of *dispositio-inventio*, *elocutio*, and *pronuntiatio*; and

> An appropriate intermediary

LIS is concerned with *intermediation*. CR intermediates between (1) an inquirer and (2) a domain of texts. Operational characteristics are sketched for each: an *indexing language* to instrument intellectual access to a domain of texts is outlined (with examples), and *intervention* from the vantage point of the inquirer is portrayed. The potential impact upon inquirer and field is assessed.

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An Assimilation Theory perspective of the field illuminates core concepts and skills implied by the Model of Inquiry. Finally, a brief survey of appropriate follow-on work is presented.

IV.1 An indexing language for conceptual indexing

> Of one thing I am certain, namely that neither any form of vocabulary
> control nor an increase in computing power will overcome the imprecision
> and diversity of language which, as I have argued elsewhere, makes
> retrieval a random process.
> (Cleverdon 1987 154-155) [Rorvig 1988 158]

The communication between inquirer and LIS intermediation implies record structures

derived from *inventio-dispositio*, *elocutio*, and *pronuntiatio* that are susceptible to the

Assimilation Theory operations of isomorphic mapping, isomorphic projection, transfer,

subsumption, progressive differentiation, and integrative reconciliation.   An indexing

language is required to operationalize the rendering of texts in such record form.

What attributes of texts, of documents, and of concepts must be expressed in such a

record structure? If an attribute desired by the inquirer is not rendered in the instrument,

either by being stored or constructed on-the-fly, then it is not available to the inquirer.

For example, if the structure of a record in a database consisting of records describing

kinds of trees does not include elements to record *specific instances* of trees, then a query

as to the kind of tree located at 4th and Main will be unlikely to return a satisfactory

result. The omission of *dispositio* renderings, comprised of all the essential attributes of

dispositio, is the norm in conventional LIS. Thesaurus entries and subject headings

express one or a few relations between concepts (and in many cases, not between

concepts but between *terms*), but they do not reflect the full composition of *dispositio* as

expressed by the *dispositio* record structures next described.

Several writers, generally identifying with the field of artificial intelligence rather than

LIS (e.g., Woods [Woods 1997]), have put forth proposals for conceptual indexing, some

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of which allude to some of the elements as described below. The AI literature might offer some complementary ideas to the proposals expressed in this Part.

Record structures

Constructive Retrieval (CR) captures the attributes of *inventio-dispositio*, *elocutio*, and *pronuntiatio* in separate record structures. Their record structures each express different attributes, described below with the caveat that detailed discussion and rationale is left as future work. *Memoria* is momentarily set aside.

<div style="border:1px solid">

Mental or intellectual realm:

   inventio-dispositio ideas, concepts

Bridge reaching into both intellectual and physical realms:

   elocutio   linguistic expressions

Physical realm:

   pronuntiatio

</div>

Aspects of record structure notation

Values of Key are arbitrary and unique. All data elements at record level, except Key, are multiply-occurring.

Structures bind the elements under them. For example, in

  Intra-*dispositio*
    inventio L34343 (cherry)
    Relation type source of

the concept of *cherry* (concept L34343) is bound to a relation type, *source of*. This

provides for browsing, mapping, and projecting on relations among them (see: IV.2

Constructive Retrieval: Intermediation between inquirer and a domain of texts).

Inventio-dispositio record structure

Inventio-dispositio record structure for describing concepts expressed by texts in a

collection is outlined. All elements are multiply occurring in the record structure unless

designated as singly-occurring.

Dispositio-Inventio

Required

    Key (singly occurring, unique to the *inventio* record)

Optional

    Sensory experience that gives rise to *dispositio* (if the *dispositio* is a basic
    concept. See Part II.2)

    Epistemic standing: extent, conditions under which regarded as *true*
        (see: [WilsonP 1979])

    Intra-*dispositio* (that comprise this *inventio*)
               Dispositio (pointers to records)
               Relation type to the *dispositio*

    Inter-*dispositio* (not subsumed into this concept, but related to other
    concepts)
               Dispositio (pointers to records)
               Relation type to the *dispositio*

    Elocutio expressive of the concept, whole texts, quotations, etc. (pointers
    to records)

    Pronuntiatio objects associated with the concept (pointers to records, e.g.,

    ISBN)

Further development of Constructive Retrieval theory will likely result in modification of the record structures described here. Other attributes that might be incorporated into the record structure include biographies of the concept, topical (as distinct from semantic) relations [Buckland 1999 (email)], its reflection in well-known instruments such as Roget's, WordNet, or CYC, provenance, belief, trust indicators, genres in which it is prominent such as law or theater, or other *dispositio* to which it is not merely related, but onto which it *projects* its own attributes, that is, acts as a superordinate concept, ICM, or plot.

How might a concept be rendered in record form? The concept of a *cherry tree* might be expressed (in part) as:

Dispositio-Inventio

Key   A12345

Intra-*dispositio*
   inventio L34343   (cherry)
   Relation type   source of
Intra-*dispositio*
   inventio R83838 (tree)
   Relation type   type of
Inter-*dispositio*
   Related *dispositio* C77838
   Relation type source of an ingredient to pie
Elocutio Z77840 (cherry sense 2)
Elocutio Z77841 (cherry tree)
Pronuntiatio   ISBN 0813917468
Pronuntiatio   Y92940
Pronuntiatio   http://en.wikipedia.org/wiki/Cherry

An *elocutio* record structure is comprised of attributes clearly distinct from *dispositio*:

<div style="text-align: center">***Elocutio***</div>

Required
Key (singly occurring, unique to the *elocutio* record)
Spelling
Plural spelling
Optional
English part of speech
English syllabification
English pronunciation
Etymology
Parent to (Sense) (Singly occurring for sense disambiguation - each sense has its own *elocutio* record, associated both with a parent *elocutio* record and each is associated with a distinct *dispositio* record)
Instances of use
German
French
etc.

An *elocutio* of *cherry* might be rendered (in part) as:

<div style="text-align: center">***Elocutio***</div>

Key   Z77840
Spelling cherry
Plural cherries
English part of speech   noun
English syllabification cher-ry
English pronunciation CHER ee
Etymology ME. *cheri* < Anglo-Fr. *cherise* (taken as pl.) < OFr. cerise < VL. *ceresia* < Gr. *kerasion*, cherry < *kerasos*, cherry tree, prob. < IE. base *ker- , whence CORNEL; derived by the ancients from *Cerasus*, city on the Black Sea: the city's name is itself from the cherries grown in the area
Sense   A small, fleshy fruit containing a smooth, hard pit and ranging from yellow to very dark red

> Spanish cereza
> German Kirsche
> Instances of use recipe for cherry pie
> Instances of use Myth about George Washington, the cherry tree, "I cannot tell a lie."

Thus, *inventio-dispositio* record A12345 (example above) is related to *elocutio* record Z77840. Consequently, a term search on the character string `spelling = cherry` or on the `sense having 'fleshy fruit' and 'hard pit'` not only identifies the linguistic term described by Z77840, but differentiates it from other senses of the term *cherry*. The inquirer can be assured that they are engaged with fruit objects and not other senses of cherry, e.g., color (red) or favorable quality (that hotrod is *cherry*). Note that this *elocutio* record is distinct from an *inventio-dispositio* record for the concept of cherry that might appear:

Dispositio-Inventio

> Key L34343
> *Elocutio* Z77840 (cherry sense 2)
> Intra-*dispositio*
>   *inventio* L34343 fruit
>   Relation type type of
> Intra-*dispositio*
>   *inventio* R83838   tree
>   Relation type type of
> Intra-*dispositio*
>   Related *dispositio* C77838
>   Relation type source of an ingredient to pie
> *Pronuntiatio*   ISBN 0813917468
> *Pronuntiatio*   Y92940
> *Pronuntiatio*   http://en.wikipedia.org/wiki/Cherry

A *pronuntiatio* record structure might comprise elements similar to a catalog record for a specific item in a specific collection, including a hyperlink to a server from which the document may be obtained, e.g., as linked to by an example above:

Key Y92940
Type report
Author   University of California Cooperative Extension
Title   Guidelines to evaluate cherries for commercial planting in the
    Sierra Nevada Foothills
Publisher   University Press of Virginia
Publication date 1998
URL http://homeorchard.ucdavis.edu/Guideline-cherries.pdf
etc.

Pronuntiatio corresponds both to conventional catalog records descriptive of specific objects in a collection and to the objects (whole texts) themselves.

Discussion

Several features are evident. First, *dispositio* records **are not** *dispositio*, concepts, ideas or thoughts. They are records. As such, they are in *pronuntiatio* form. Frequently below, references to *dispositio records* are found. They should not be mistaken for *dispositio* itself, but only as *expressions* and *reconstructions* of it.

Second, *dispositio* records, even for "simple" ideas, can be lengthy and complex.

Third, the attributes of *inventio-dispositio* records are wholly differentiable from *elocutio* and from *pronuntiatio* records based on their *attributes*. Thus, there is little justification for mistaking descriptions of concepts for descriptions of linguistic expressions or descriptions of physical document objects. This is intended to mitigate confusion as to whether one is searching for ideas, for texts, or for copies of documents.   A search for the *concept* of *cherry* are less likely to be confused with a search for the linguistic *term* *cherry* because the attribute sets of concepts and linguistic terms are overtly dissimilar.

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Fourth, concepts (described by *inventio-dispositio*) records are clearly distinguishable from one another because the attribute values for any concept are different from the attribute values for any other concept. If they are not, then there are two records for the same concept. For example, a search for the concept *cherry*, the fruit, cannot reasonably be confused for *cherry* the color or *cherry* the adjective.

Fifth, granularity of the concepts indexed is crucial. The internal structure of a document must be instrumented with higher resolution than current LIS convention applies to classification, cataloging, indexing, and abstracting. That is, individual concepts and their relations to other concepts must be described rather than merely describing a document as a whole. Conceptual indexing can be performed at the granularity of the section or chapter, and even to the paragraph and sentence level if the concepts expressed so merit. All these *dispositio-inventio* records are of identical structure as those above. They differ only in the concepts they express.

Inventio-dispositio records can express frames, models, ICMs, metaphors, and other figures based on isomorphic projection. For example, the conventional presentation of a commercial event frame often appears:

Commercial Event Frame

actor: willing buyer
actor: willing seller
initial state: seller has goods or services
initial state: buyer has consideration (money)
      event: offer to sell by seller
      event: acceptance by buyer
      or
      event: offer to buy by buyer
      event: acceptance by seller
event: buyer give consideration to seller
event: seller conveys goods or services to buyer

---
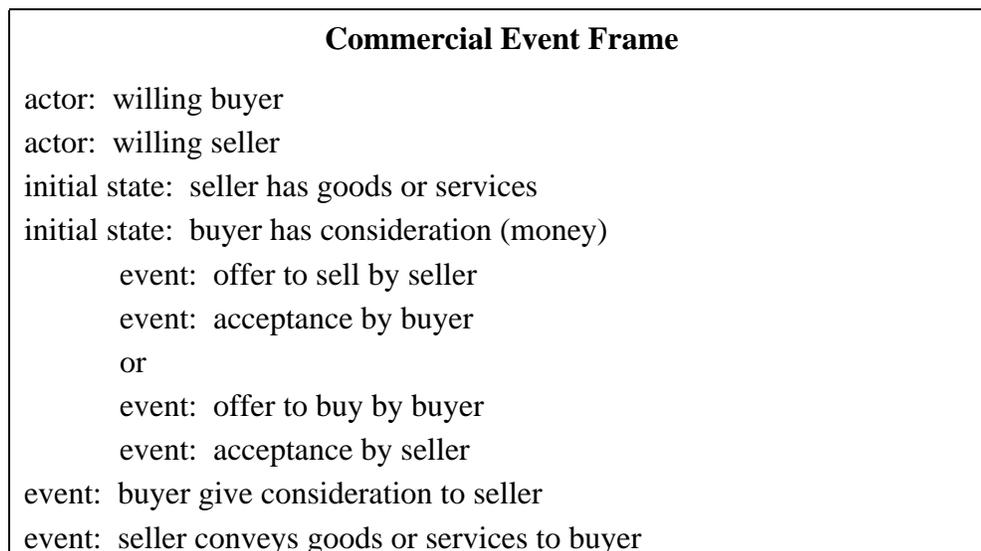
final state: buyer has goods or services
final state: seller has consideration

Multiple occurrences of Intra-*dispositio* in a *dispositio* record can express these attributes.

For example, to express the often-cited commercial event frame as a *dispositio* record:

Dispositio-Inventio

Key K12344
Elocutio commercial event
Intra-*dispositio*
> *inventio* K12380 (willing buyer)
> Relation type is type actor

Intra-*dispositio*
> *inventio* K12381 (willing seller)
> Relation type is type actor

Intra-*dispositio*
> *inventio* K12382 (seller has goods or services)
> Relation type initial state

Intra-*dispositio*
> *inventio* K12383 (buyer has consideration, money)
> Relation type initial state

Intra-*dispositio*
> *inventio* K12390 (offer to sell by seller)
> Relation type event

Intra-*dispositio*
> *inventio* K12391 (acceptance by buyer)
> Relation type event

Intra-*dispositio*
> *inventio* K12392 (offer to buy by buyer)
> Relation type event

Intra-*dispositio*
> *inventio* K12393 (event: acceptance by seller)
> Relation type event

Intra-*dispositio*
> *inventio* K12410 (buyer conveys consideration to seller)
> Relation type event

Intra-*dispositio*
> *inventio* K12411 (seller conveys goods or services to buyer)

```
                Relation type  event
Intra-dispositio
        inventio  K12420  (buyer possesses good or service)
        Relation type  final state
Intra-dispositio
        inventio K12421  (seller possesses consideration)
        Relation type  final state


Inter-dispositio
        inventio L53537  (purchasing a house)
        Relation type  projection upon instance of target dispositio
Inter-dispositio
        inventio   L53538  (purchasing a car)
        Relation type  projection upon instance of target dispositio
Inter-dispositio
        inventio L53538  (proposing marriage)
        Relation type  projection upon instance of target dispositio
```

Records describing *inventio* are one and the same as those derived from *dispositio*. Only their presentation differs: *inventio* is shown as unitary objects, *dispositio* are shown as composed of concepts, relations, labels, etc.

Although the *goal* record types illustrated above step beyond LIS convention (based on their attributes), the corresponding *index* record types (which index the values in the goal record record-type, to adopt SPIRES™ DBMS terminology), are conventional and not shown here. The reader may assume that all data elements shown, including relations among *dispositio*, are indexed and therefore available for use in intermediation (following section) for identifying and displaying explanatory concept paths.

Do concept derivation records have to be in a structured form?

A structured form of expressing concept attributes is used to show clearly the binding between component *dispositio* (Intra- and Inter-*dispositio*) and their relation types, and to differentiate these from the other attributes of *dispositio* records and *dispositio* themselves. Undeniably, this is also the form of presentation commonly found in record schematics intended to be susceptible to automation as in a database management system. However, there is no reason in principle that the attributes of concepts could not be expressed in *dispositio* records as prose, poetry, or whatever form chosen by the author of the text from which the dispositio records are derived, so long as the distinguishing structured attributes are expressed. These attributes must, however, be structured as *records* to achieve the efficiencies that fragmented texts possess over monolithic texts.

Performing the indexing process

How is construction of an *inventio-dispositio* record initiated? One might be concerned that production of *inventio-dispositio* records is "out of thin air." While generation of *dispositio* records is no more nor less interpretative than other LIS description, some guidelines might bring continuity to the process.

The first step, perhaps a difficult one, is to recognize and identify the attributes of the concept to be indexed. Concepts expressed by existing *dispositio* records in the *reference structure* to which records are being added may serve as a guide.

The first decision may be whether to create a new *dispositio* record or not. If even one attribute of a concept as understood by the indexer is different, a new concept record may be created. However, rather than redundantly copying all the elements of the existing

record, the new record and the old record may simply point to one another, and the new record be comprised of that pointer and the attribute that is different.

As mentioned in Part II, occasionally the only attribute of a concept an inquirer or an indexer evokes is a linguistic term or label associated with the concept, as when one hears a new term in an introductory foreign language or biology class. As time goes on, one builds the concept by adding attributes and instances of its use. Indexing concepts will work in the same way, as does thesaurus maintenance which, in fact, is concerned with the maintenance of structured descriptions of concepts and terms.

Indexing skills

What skills might be required to perform conceptual indexing? Attending to providing values for each of the *inventio-dispositio* attributes involves, of course, personal interpretation as to which specific concepts are expressed. As well, all of the types of labor in specific derivations in the task of reading and writing, e.g., *dispositio* ➤ *elocutio* and *elocutio* ➤ *dispositio*, obtain. For example, as Foucault observed, *dispositio* is web-like or may be conceptualized as having a network form of structure whereas most *elocutio* is linear (Part II.2). Certainly, this question is worthy of further study as well as attention in the practical portion of the LIS curriculum. Recognizing concepts, performing operations with and upon them, including mapping, projection, and indexing, are basic LIS skills (see: Part IV.4 below).

Indexing skills might be developed, in part, by working with concept maps. Concept maps compel the reader-learner-writer-indexer to identify anchor and target concepts, identify their attributes, and particularly identify relations among concepts, explanatory

paths, and superordinate *dispositio* that project their properties onto ideas at hand. LIS is centrally concerned with aiding the inquirer in the recognition of metaphors, idealized cognitive models (ICM), warrants, assumptions, and evidence expressed in texts if such texts are to be of greatest service to the inquirer, and thus, the indexer or other LIS instrumentalist must recognize and record them.

> One way to aid students . . . may be explicitly to teach them multiple
> analogies ... explain when analogy is appropriate.
> [Holyoak and Thagard 1995 203]

As in Part II, one may draw upon cognate fields for relevant principles:

> Part of what therapists need to do to understand their clients' problems is
> to appreciate the metaphors with which the clients understand their own
> lives. [Holyoak and Thagard 1995 228]

Methodologies for recognition and indexing must be articulated and assimilated into the curriculum. Concept mapping may be regarded as an adjacent LIS skill whereby indexing is expressed visually as distinct from record form. Similarly, writing forces one to think and to recognize ideas and relationships and is thus, arguably, an indispensable indexing skill. Whether better writers and those who devote time to daily writing can also be regarded as better-skilled indexers is left as a future investigative endeavor.

Indexing labor

Given the granularity (in the sense of structural level of text, e.g., paragraph or section, as distinct from granularity of detail of a given concept) of conceptual indexing called for above, the issue of indexing labor arises. There is no question but that the indexing described is labor intensive. But consider the following scenario. Suppose that in 1988,

a year before Tim Berners-Lee published his original conceptual paper describing a world wide web, one attempted to estimate how much labor might be required, and how much would be the cost, by 2007, of making all the texts, images, audio and video, and other materials currently available during the next twenty years. Without doubt, any reasonably accurate estimates of the labor would have yielded cost estimates that would have caused any sane manager to forego the entire program. The decision, of course, turns on the key assumptions as to who performs the labor and by what motivation. In 1988, likely no one foresaw a magazine-like presentation of Mosaic that would motivate tens of thousands of people to learn to write in a new language, hypertext markup language (html). Even Berners-Lee did not believe that computer users would learn, want to learn, or need to learn html. One can imagine that authors, accustomed to expressing ideas in text and markup languages such as html, TeX, XML, etc., might accompany their text with a set of *dispositio* records to reduce ambiguity regarding the ideas and explanations they wish to communicate. Such *dispositio* records might be in a program-ready markup that facilitates their presentation in concept map form. These likely would be at a general level, LIS conceptual indexing specialists might then receive those *dispositio* records and extend them by projecting from their reference structure other *dispositio* records at finer levels of granularity. At the same time, indexers might identify and record relations to the new structure in the existing set of reference structure records.

How does this bear on the question at hand? Substantial labor is implied in producing the concept and linguistic indexing proposed here. However, just as the World Wide Web as created largely by hand by people motivated not by professional compensation, but by intellectual and personal interest, so might Constructive Retrieval provide motivation. Ordinary people have direct access to the concepts evocable by their own conscious

concept systems, i.e., minds. They can identify concepts and relations among concepts.
Missing is a model that does not have the shortcomings of current conventions.
Professional web programmers and designers continue to be highly paid, highly valued,
and rarely disadvantaged in the job market. The same can be true for professional LIS
intermediaries, including indexers, in a world where inquirers gain substantial benefit
though engagement with systems at a conceptual level rather than at the more primitive
query term level.

Constructive Retrieval implies constructive indexing

Constructive Retrieval implies constructive indexing: the indexer must recognize
concepts, and thus, impart expression of their own knowledge into *dispositio* records.

Indexers, as well as reader-inquirers, are confronted with the task of recognizing not only
surface-level concepts but also plots, plans, themes, models, superordinate *dispositio*, and
frames. These are nothing more than additional *dispositio* although they are not generally
derivable from the linguistic terms in a text (*elocutio*). Instead, they must be projected
from "what the learner already knows," or, in Constructive Retrieval, from "what the
indexer already knows," and expressed as *dispositio* records deliberately constructed to
characterize such concepts.   Once constructed, of course, they may be used by the
indexer by being added to the elements describing any particular surface level concept.

The commercial event frame (above) might be considered an example of a "simple"
superordinate or plot concept. How might it be used in indexing? Here one of the "grand
challenges" described by Buckland is encountered:

What a book is about tends to be viewed in literal and limited terms. At a literal level, Aesop's fables are about animals: the fox, the stork, frogs, and other creatures. But we read the fables because they are allegorical. They are really about the foibles of human beings, not zoology, and can be enjoyed at that level. . . . Already in the European middle ages, these multiple levels of meaning were recognized. If meaning matters and if it is at multiple levels, how can modern library services catch up with the European middle ages? [Buckland 2003 678-679]

Consider the text of one of the better known of Aesop's fables, The Ant and the Grasshopper, which provokes conceptual operations inherent in metaphor:

The Ant and the Grasshopper

In a field one summer's day a Grasshopper was hopping about, chirping and singing to its heart's content. An Ant passed by, bearing along with great toil an kernel of corn he was taking to the nest.

"Why not come and chat with me," said the Grasshopper, "instead of toiling and moiling in that way?"

"I am helping to lay up food for the winter," said the Ant, "and recommend you to do the same."

"Why bother about winter?" said the Grasshopper; we have got plenty of food at present." But the Ant went on its way and continued its toil. When the winter came the Grasshopper had no food and found itself dying of hunger, while it saw the ants distributing every day corn and grain from the stores they had collected in the summer.
[Aesop's fables Ant-Grasshopper]

The moral of the fable is an ICM that may be described by the words "It is best to prepare for the days of necessity," "Idleness brings want" or "no work - no eat." None of the significant terms in these phrases occur in the fable.

Conventional LIS might retreat to searching on genre, present day IR indexing of this text likely operationalizes only searching on *terms* such as *ant*, *grasshopper*, *food*, etc., if not only on character strings such as a n t and g r a s s h o p p e r. Thus, if

the inquirer were searching for texts pertaining to contributing factors associated with the labor and social policy, they are unlikely to find this story included in the result. Nevertheless, from the perspective of a hypothetical lawmaker, this story might be interpreted as explanatory of, or relevant in some other way to, labor policies. How might this text be indexed to reflect the superordinate concepts of "no work - no eat" expressed by the fable, and how might an appropriate inquiry identify it as part of a search result? Neither LIS nor IR is likely to facilitate such an inquiry directly.

A possible *dispositio* indexing of the Ant and the Grasshopper might appear:

Dispositio-Inventio

Key   A40005
Intra-*dispositio*
    inventio A40117   (personal labor for hire is compensated with money)
    Relation type   positive expression of
Intra-*dispositio*
    inventio A40115   (best to prepare for the days of necessity)
    Relation type   positive expression of
Intra-*dispositio*
    inventio A40114   (thrift)
    Relation type   positive expression of
Intra-*dispositio*
    inventio A40117 (commercial event frame)
    Relation type   expresses negative relation between inadequate funds and
          activation of the commercial event frame (failure to provide money to
          seller results in failure to receive goods or services)
Inter-*dispositio*
    Related *dispositio* J40902 (labor policy legislation)
    Relation type A40005 expressed policy element of J40902
Elocutio A03040 (ant)
Elocutio A03041 (grasshopper)
    etc.
Pronuntiatio http://www.aesopfables.com/. . .

Here, the fact that indexing is interpretative is most apparent. *Interpretation* is expressing ideas evoked by one set of terms (the text) using a different set of terms (the indexing language).

Thus, the *dispositio* record A40005 is expressive not only of ants, grasshoppers, labor, and rewards, but of, among others, the consequences of failure to accrue compensation, i.e., the ability or inability to activate a commercial event frame to successful conclusion. The manner in which this *dispositio* structure can be used to provide appropriate intermediation to the inquirer is described in the next section (IV.2 Constructive Retrieval).

A first step in recognition of an overall plot structure is the recognition of any of its elements that already are instantiated as *dispositio* records in the *reference structure*. Superordinate *dispositio* (including frames, models, ICMs, metaphors, and other figures based on isomorphic projection) are no different: if any *dispositio* or relation type that essentially characterizes the nature of the new concept is expressed in another *dispositio* record, an instance of Intra-*dispositio* is entered into the new record. Where the structure of the new record projects onto more specific ideas, as a superordinate idea, model, metaphor, or ICM projects onto an idea at hand, an Inter-*dispositio* may be entered.

The simulations in the section below (Part IV.2 Constructive Retrieval: Intermediation between inquirer and a domain of texts) demonstrate how record structures such as these can be used to perform Assimilation Theory processes on behalf on the inquirer, including Constructive Retrieval (CR), metaphor recognition, recognition of subtext themes, and deconstruction of humorous texts, among others.

Indexing relation types

The generic *dispositio* record structure and examples presented in this Part illustrate that concepts are defined, in part, by their relationships to other concepts. A relationship to another concept is comprised of a binding between the other concept and a *relation*, e.g.,

Dispositio-Inventio

```
Key   A12345
Elocutio Z77841 (cherry tree)
Intra-dispositio
      inventio L34343   (cherry)
      Relation type   source of
etc.
```

This concept, *cherry tree*, is related to the concept of *cherry*. One of the relations between *cherry* and *cherry tree* is source of, that is *cherry tree* is *source of cherry*,

The relation type *source of,* is, of course, one of a virtually unlimited number of possible relations. This, however, is no reason to forego bibliographic or conceptual control over relation types. Indeed, relation types are, themselves, concepts. As CR underlies a program to identify and index concepts, recognition and indexing of relation types is but a subset of that enterprise.

In the examples in the Part, the inquirer's initial term-based searching for *dispositio* records and subsequent browsing has focused only on entity-type concepts. There is no reason in principle why relation type concepts cannot also be search-and-browse criteria. Indeed, in searching for a metaphor or ICM *dispositio*, the relation types rather than the entities they connect are likely the root element of the sought *dispositio*. For example, consider the metaphor, "His article was music to my ears." A mixed metaphor to be sure, nevertheless, an inquirer needing to find examples of this metaphor could not achieve adequate recall by searching on concept entities of *ears*, *music*, *articles*, or other entities

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unless the particular concept *music to my ears* existed in the reference structure and texts expressive of it had been appropriately indexed.

How, then, might instances of such a construct be found? This metaphor (metaphor is a figure of thought rather than a figure of speech) depends upon projecting a relation of *correspondence* between a concept entity expressed in the reference structure to a corresponding external entity (i.e., an Inter-*dispositio* binding), and a relation of *consonance* between the same reference structure entity and a second entity in the reference structure (i.e., a Intra-*dispositio* binding). The metaphor is operationalized when the relation type consonance is projected to a corresponding second entity outside the reference structure based upon the first correspondence relation described (see, for example, Part II.2, What steps occur in isomorphic projection?, and the metaphor "Anger is Heat" in Part II.2, Metaphor is a figure of thought, not a figure of language).

The *correspondence* and *consonance* relations are both, themselves, concepts. Instances of structures comprising these two relations, if indexed in the context of their Inter-*dispositio* and Inter-*dispositio* bindings, should, in principle, be identifiable as instances of the "is music to my ears" metaphor.

Further exploration of treatment of relation type concepts, particularly the potential value of seeking *reverse* relations for any given instance of a relation, is left as future work.

Indexing superordinate concepts, models, ICMs, plots, etc.

This section earlier noted that *inventio-dispositio* records can express frames, models, ICMs, metaphors, and other figures based on isomorphic projection. Structurally, they are no different than any other *dispositio*, consisting of the same Intra- and Inter-

dispositio, *elocutio*, and *pronuntiatio* elements. The commercial event frame model was rendered as a *dispositio* record. Similarly, metaphoric concepts were identified and indexed despite their expression only as surface terms (subtext).

If these concepts can be recognized and indexed, then they can be used as the target of inquiry. Because of their important role in human construction of meaning, attention to instrumenting them is likely to have favorable impact upon inquiry generally.

As with themes and ICMs, a first step in recognition of an overall *plot* structure is the recognition of any of its elements, its *inventio* that comprise the plot. Once a plot *dispositio* is identified in the reference structure, its projection onto a text can be attempted to determine whether there is sufficient mapping to justify treating the superordinate *dispositio* as an element of the text, in particular, whether the model has predictive ability with respect to subsequent concepts expressed by the text.

Ideally, intermediation detects and reveals to the inquirer the existence of hidden premises, ICMs, plots, themes, and then illuminates their projection onto the particular inquiry at hand, especially reporting potentially conflicting elements among them.

Counterfactuals might be among the easier model *dispositio* to recognize: they are often expressed in subjunctive terms such as would, could, should, if, might, etc. For example, a text that describes a particular existing economic situation, then describes a counterfactual that does not presently obtain, but might if particular conditions were met, should be recognized as distinct by LIS intermediation, and rendered to include the attribute that the structure is a counterfactual.

Finally, ICM *dispositio* recognition should be investigated for its potential in recognizing and even posing *predictions*.

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Political bias in indexing

Indexing is interpretation. Interpretation is never neutral, politically, conceptually, stylistically, in terms of values, or in virtually any other sense. There is no "neutral cataloging." Similarly, reference structures cannot be created by a neutral evoker of concepts but only by people, and people are neither neutral or disinterested.

Exercises

1. Select a short (no longer than two pages) factual text such as a report. Attempt to identify each subtext, superordinate concept, theme, model, genre, plot, and metaphor. Identify counterfactuals.

2. Draw a concept map to express the document as interrelated concepts.

3. Select one of the *dispositio* (#1) and index the concept in CR form. Conjure any related *dispositio* records to which your selected concept relates.

4. Attempt to perform a projection of your concept onto a fact pattern or set of target-and-anchor concepts suggested by a friend as an inquiry pertaining to the subject of the concept.

5. Select a term from the dictionary. How many *elocutio* records will be used to describe the term? Why?

6. Construct *elocutio* records for the term selected above.

7. Construct an *elocutio* record for the phrase *throw your hat into the ring*. How many *elocutio* records will be associated with it? What *dispositio* records will be associated with it?

8. Construct a full set of *dispositio*, *elocutio*, and *pronuntiatio* records for the phrase *swept under the rug*.

IV.2 Constructive Retrieval: Intermediation between inquirer and a domain of texts

The purpose of LIS intermediation is to facilitate an inquirer's recognition of explanatory conceptual paths expressed by texts, and then the identity of the texts that express those concepts. Though conventional LIS instruments might be (mis-)understood to provide exactly this, an implication of the Primary Finding is that, generally, they do not. This section describes Constructive Retrieval from the inquirer's perspective and according to the Model of Inquiry (Part II.2) with examples or simulations of hypothetical operation.

An inquirer, after having recognized distressing ignorance and considered other means of mitigation such as communicating with human experts and teachers, friends, or examining texts directly, might engage LIS intermediation [Step 3]. LIS may perform triage as described in [Step 3.0] ("Step" designations refer to the LIS-Specific Model of Inquiry depicted immediately below).

The early stage of an inquiry is devoted to the intermediary's task of reconstructing the inquirer's cognitive question, Steps [3] through [4], a stage virtually always omitted in conventional automated IR. In providing reference service, a reference specialist might subconsciously perform these tasks. Strangely, these steps are not taught by LIS in cognitive or psychological terms and are treated in a cursory way by many textbooks about reference service.

In CR during this stage, the inquirer actively searches and browses the *reference structure* to identify and select *dispositio* expressions that comport with their own, especially initial and terminal endpoint concepts (Steps [3] through [4]). The inquirer does so by searching for *dispositio* concept records using their own entry vocabulary. Then, by browsing the results, the inquirer identifies and selects concepts that reflect their

cognitive question (prior knowledge and target concept(s)). This mapping process potentially results in the satisfaction of Ausubel's ascertainment criterion.

McGriff provides an adequate starting point for considering approaches to quantification of meaningful learning based on concept mapping.

> A concept in the learner's network could be linked to the same concept in the experts' networks indicating understanding of the concept or could be linked to different concepts indicating misunderstanding of the concept. [McGriff 2001. 10]

Once the inquirer's cognitive question has been reproduced to their satisfaction, the task of *discovering* explanatory paths between prior knowledge (anchor concepts) and target concept as expressed by the instrumented texts is borne by the intermediator rather than the inquirer. This contrasts with conventional LIS where the inquirer is provided texts (based on search results) but with little explanation as to the concepts they express that might be relevant. The inquirer must undertake to *discover* explanatory concepts on their own. In an Assimilation Theory-consonant model of inquiry, the inquirer, of course, may read and assimilate concepts expressed by the text. However, the explanatory concepts expressed by the texts, are *presented* to the inquirer, as prescribed by Ausubel (*reception learning*), rather than leaving the inquirer to *discover* them by reading the recommended texts then construct them anew (*discovery learning*).

The Model of Inquiry below is a protocol for communication between inquirer and intermediary. The inquirer's actions are described in the right-hand column. LIS intermediation, or following Kuhlthau's terminology [Kuhlthau 1996], the *zone of intervention*, is described on the left. Steps in the model are in chronological order, although reiteration of steps or sequences of steps is expected at particular points.

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An LIS-Specific Model of Inquiry

LIS Intermediary   Inquirer:

[1.1] A <u>domain of texts is established</u>

e.g., a collection.

[1.2] The <u>collection is instrumented as</u>

<u>above (Indexing Language)</u>. The

combination of the texts themselves and

their *dispositio* instrumentation is the

reference structure.

[1.1] and [1.2] are maintained *ad infinitum*.

> <u>A specific inquiry begins:</u>
>
> "I thought the government created money by printing it and raising the debt limit.
>
> If the government controls these two factors, then why is inflation,
>
> which is based on the money supply, such a worry?
>
> Doesn't the government control inflation by controlling the factors that cause inflation?"

[2.1] <u>Distressing ignorance</u>. Inquirer

experiences inadequacy of knowledge,

perceived as feeling or thought.

[2.2] <u>Recognition of cognitive question</u>.

Inquirer become conscious of the cognitive

question and decides to *become informed*.

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Reconstructing the inquirer's knowledge structure

(often overlooked in conventional IR)

Inquirer's knowledge structure

isomorphic mapping
from Inquirer's *dispositio*
onto *reference structure*

LIS Reference Structure
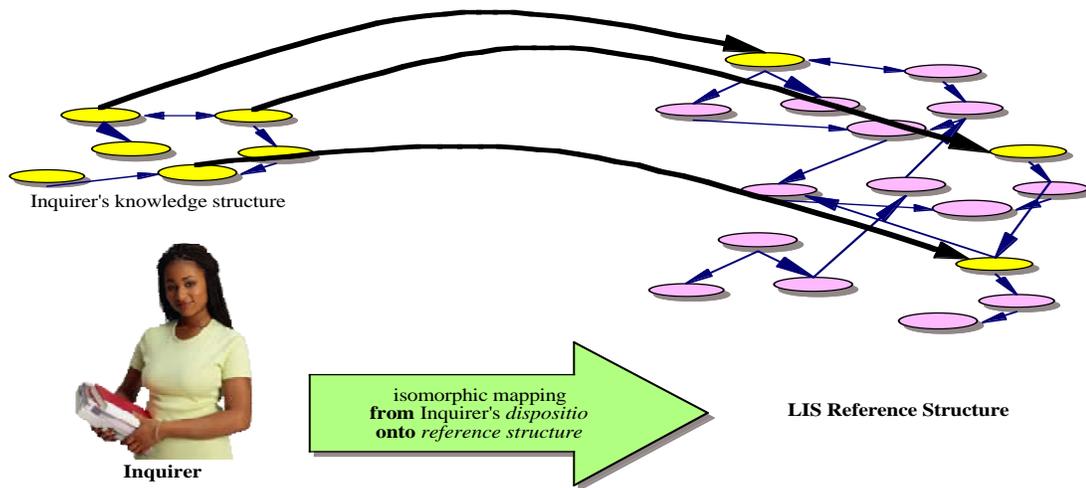
Inquirer

Figure IV.1

Isomorphic mapping inquirer's question to reference structure (Step [3])

[3] Inquirer engages LIS intermediation

with expressed question.

[3.0] Triage of inquiries by type. Prior to

providing *dispositio*-level service, the

intermediator might conduct a triage process

to redirect certain types of questions to

appropriate resources that do not require

conceptual-level intermediation, e.g., "How

is the name of the third U.S. President

spelled?", known-item requests, e.g.,

"Where is the almanac? "or "Has the book I

ordered come in yet?", and infrastructure

questions, e.g., "What time does the library

close?"

[3.1] Inquirer searches for *target* concept(s)

in *reference structure* using linguistic terms.

Identify Target Idea

all of the concepts	inflation, 'money supply'	**Search**
at least one concept		
exact concept		
without the concept		

Figure IV.2

[3.2] *Dispositio* records retrieved. Initial

results are presented along with adjacent

concepts and the relations that differentiate

them from one another.

To perform mapping and projection, attributes must be in a form that is common from

dispositio record to *dispositio* record. Linguistic terms are not appropriate because of

polysemy, synonymy, different spellings, etc. Instead, unique keys are adopted as the

common unit among *dispositio* records.

Suppose the query in [3.1] resulted in retrieval of three (3) *dispositio* records:

Dispositio-Inventio

Key   L43834
Elocutio B30258 (inflation)
Intra-*dispositio*
inventio Z21663   (pressure)
Relation type   Z21663 applied to confined volume causes L43834
Intra-*dispositio*
inventio S92624   (air)
Relation type   S92624 gas used for L43834
Inter-*dispositio*
Related *dispositio* J04038 (tires)
Relation type L43834 required condition for operation of J04038

(Values in parentheses are for illustration only, not part of the record.)

Relation types themselves might be rendered wholly as keys to *dispositio* records, e.g.,

H544020 R045 R49884 R022 M44698 , but are expressed in English here for readability.

For example,

"deposits (H544020) less (R045) reserves (R49884) equal (R022) loans (M44698)")

Key   D92934
Elocutio B30247 (inflation)
Intra-*dispositio*
   inventio B10258   (rising prices)
   Relation type   D92934 is excessive B10258
Intra-*dispositio*
   inventio B10243   (money supply)
   Relation type   B10243 a factor in causing D92934
Intra-*dispositio*
   inventio B10244   (economics)
   Relation type   D92934 a phenomenon of B10244
Intra-*dispositio*
   inventio B10258   (detriments of)
   Relation type   D92934 causes B10258
Inter-*dispositio*
   Related *dispositio* C90338 (Federal Reserve)
   Relation type C90338 attempts to control D92934

and,

Key   B10243
Elocutio I5673 (money supply)
Intra-*dispositio*
   inventio D92934 (inflation)
   Relation type   B10243 a factor in causing D92934
Intra-*dispositio*
   inventio T95413 (money)
   Relation type   B10243 is total amount of T95413
Intra-*dispositio*
   inventio R45463 (M1)
   Relation type   R45463 is a measure of B10243
Inter-*dispositio*
   inventio B10244   (economics)
   Relation type   B10244 is, in part, the study of B10243

The inquirer is presented with:

**Please Select Target Ideas that
best reflect your question**

inflation
(pressure on
volume)

inflation
(prices rising
excessively)

money
supply
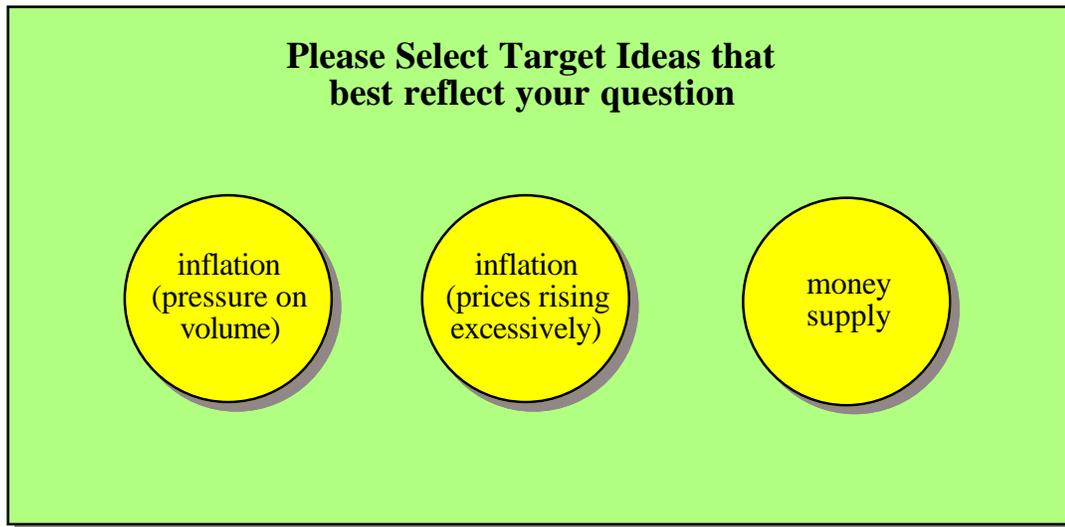
Figure IV.3

If the inquirer wishes to "zoom in" on, or *unpack* any of the *inventio* displayed to reveal

their detail their internal structure, the intermediation system so provides.

LIS Intermediary   Inquirer:

[3.3] Inquirer selects *target* concept(s).

Through *browsing* the concepts reported in

the search result [3.2], inquirer *selects* those

that best reflect the **target** (terminal

endpoint) concepts of their inquiry.

Reconstructing your question

inflation
(prices rising
excessively)

money
supply
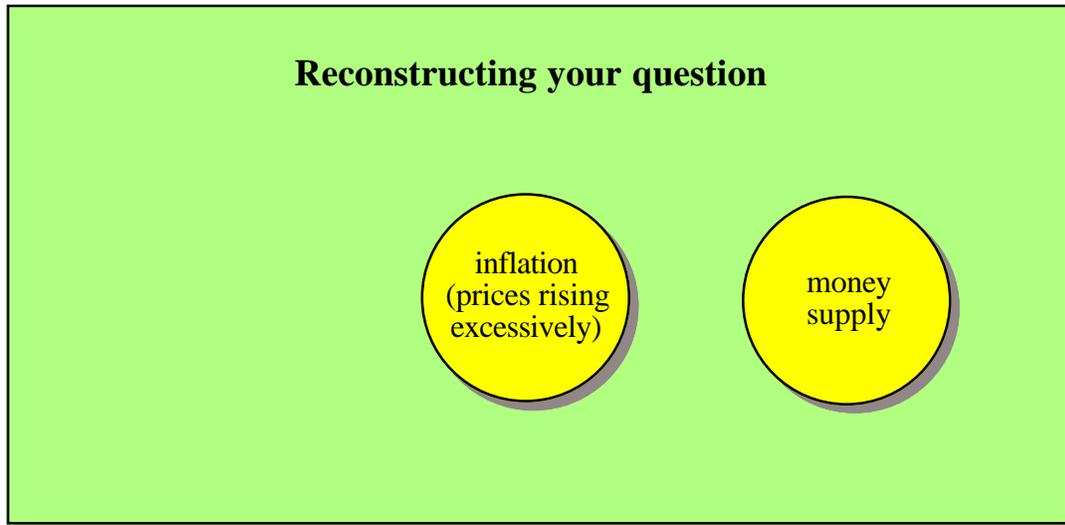
Figure IV.4

<u>LIS Intermediary</u>   <u>Inquirer:</u>

[3.1] through [3.3] may iterate.

[3.4] <u>Selected target concepts recorded in</u>

<u>temporary memory.</u> Intermediator begins

production of a reconstruction of the

inquirer's cognitive question by recording

the selected concepts and the relations

among them as *target* concepts.

LIS Reference Structure

Target concept(s) rendered in temporary memory

Temporary Memory
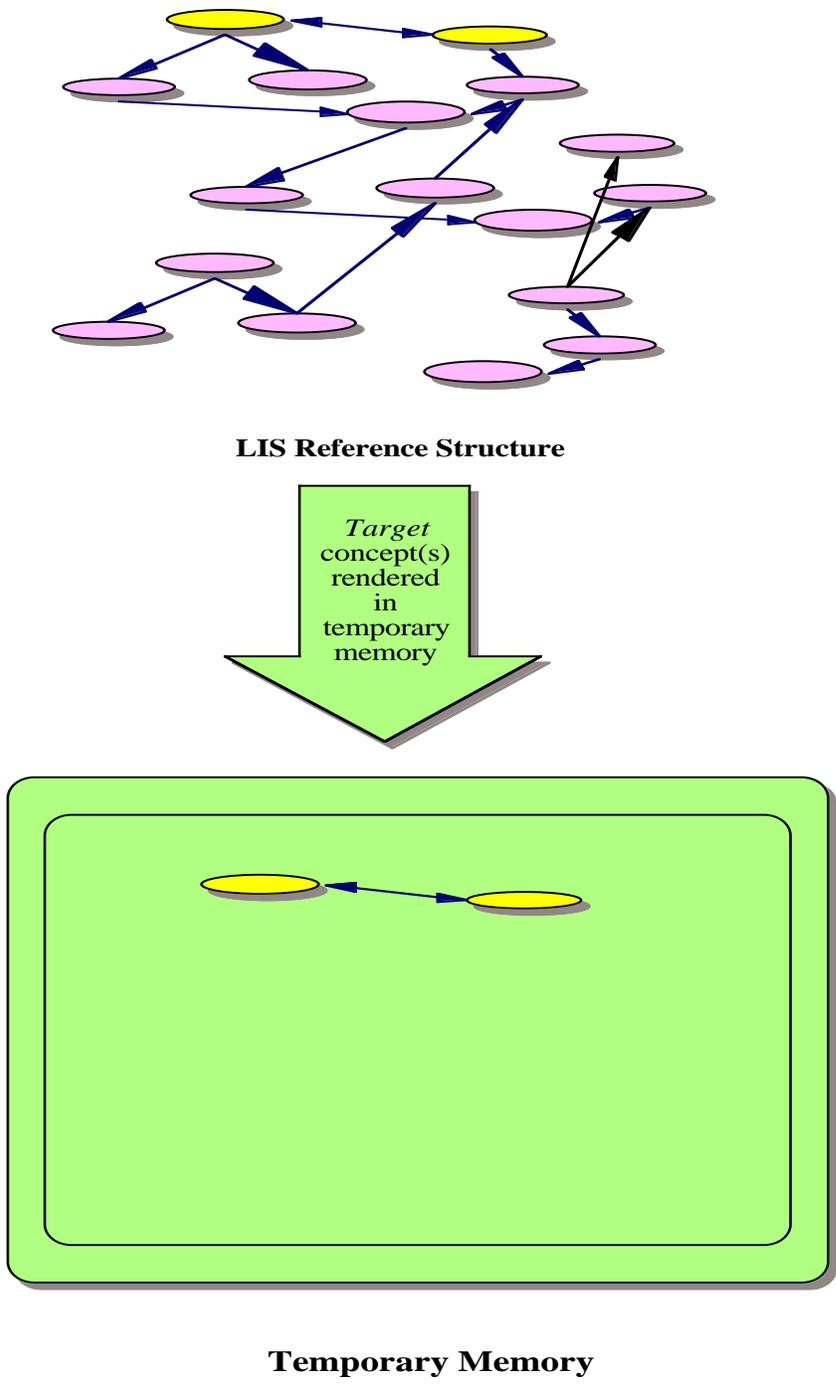
Figure IV.5

[3.1] through [3.4] iterate until inquirer is satisfied with intermediator's presentation of the structured *target* concept(s). This constitutes the inquirer's *isomorphic mapping from* their cognitive question *to* the *reference structure* of their *target* concept.

[4.1] Inquirer searches for *anchor*

concept(s). Inquirer searches *reference*

structure for *anchor* concept(s) that reflect

their relevant existing knowledge.

**Describe what you know about
your question thus far**

Single concept	government creates money	**Search**
Single concept	printing money	
Single concept	government controls inflation	
Single concept		

Figure IV.6

[4.2] Concept records retrieved. As in

[3.2], initial results are presented along with

adjacent concepts and the relations that

differentiate them from one another.

Suppose the query in [4.1] resulted in retrieval of two (3) *dispositio* records. The

dispositio record structures retrieved might appear:

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Key   G78702

Elocutio F35347 (printing money)

Intra-*dispositio*

   inventio B24243   (mint)

   Relation type G78702 located at B24243

Intra-*dispositio*

   inventio G84323   (government)

   Relation type   G84323 performs task of G78702

Intra-*dispositio*

   inventio T95413 (money)

   Relation type G78702 creates T95413

Key   G84323

Elocutio D63634 (government)

Intra-*dispositio*

   inventio G78702 (printing money)

   Relation type   G84323 performs task of G78702

Intra-*dispositio*

   inventio T95413   (money)

   Relation type G84323 controls amount of T95413

Inter-*dispositio*

   inventio R49112 (banking industry)

   Relation type G84323 regulates R49112

etc.

Of course, many others are possible.

As above, the inquirer does not see these database records unless they request to do so.

Instead, they are presented with:

Please select Anchor ideas that best
reflect your current knowledge

printing
money

government
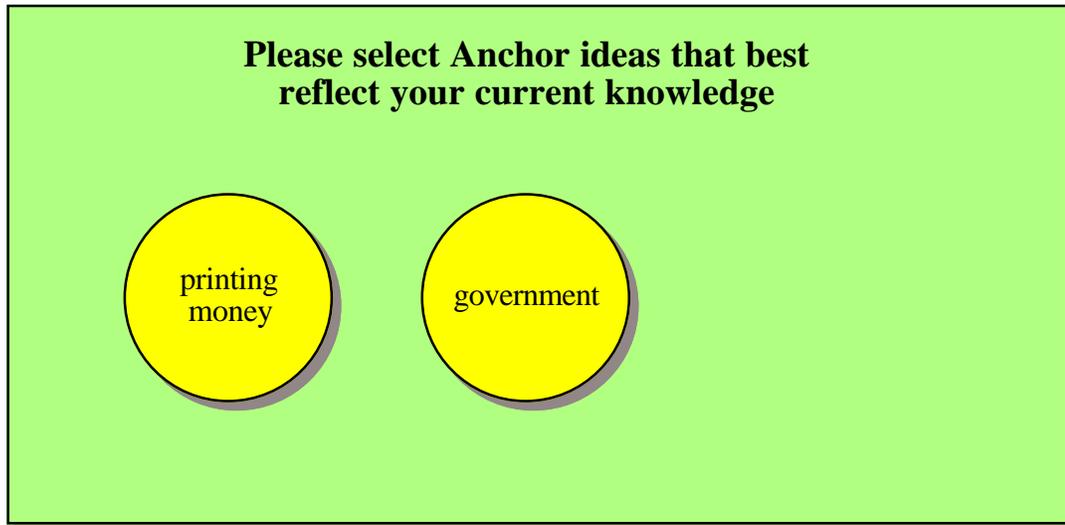
Figure IV.7

LIS Intermediary	Inquirer:
	[4.3] Inquirer selects *anchor* (initial endpoint) concept(s). As in [3.3], through *browsing* the concepts reported in the search result [4.2], inquirer *selects* those that best reflect their prior knowledge relative to the question

In this example (Figure IV.7), suppose that the inquirer selects both of the two *inventio* records displayed. The inquirer might also choose to "zoom in" on any one to reveal its *dispositio* form, i.e., its internal structure, or return to the previous step to enter more or different search terms.

Alternatively, the intermediary might display more than exclusively the concepts identified by key term. Display of *inventio* records immediately adjacent to them in the reference structure (not illustrated) might provide the inquirer the opportunity to browse for more or better matches between the reference structure and their own knowledge.

Upon final selection, the intermediator presents a concept map of the inquirer's question:

Reconstructing your question
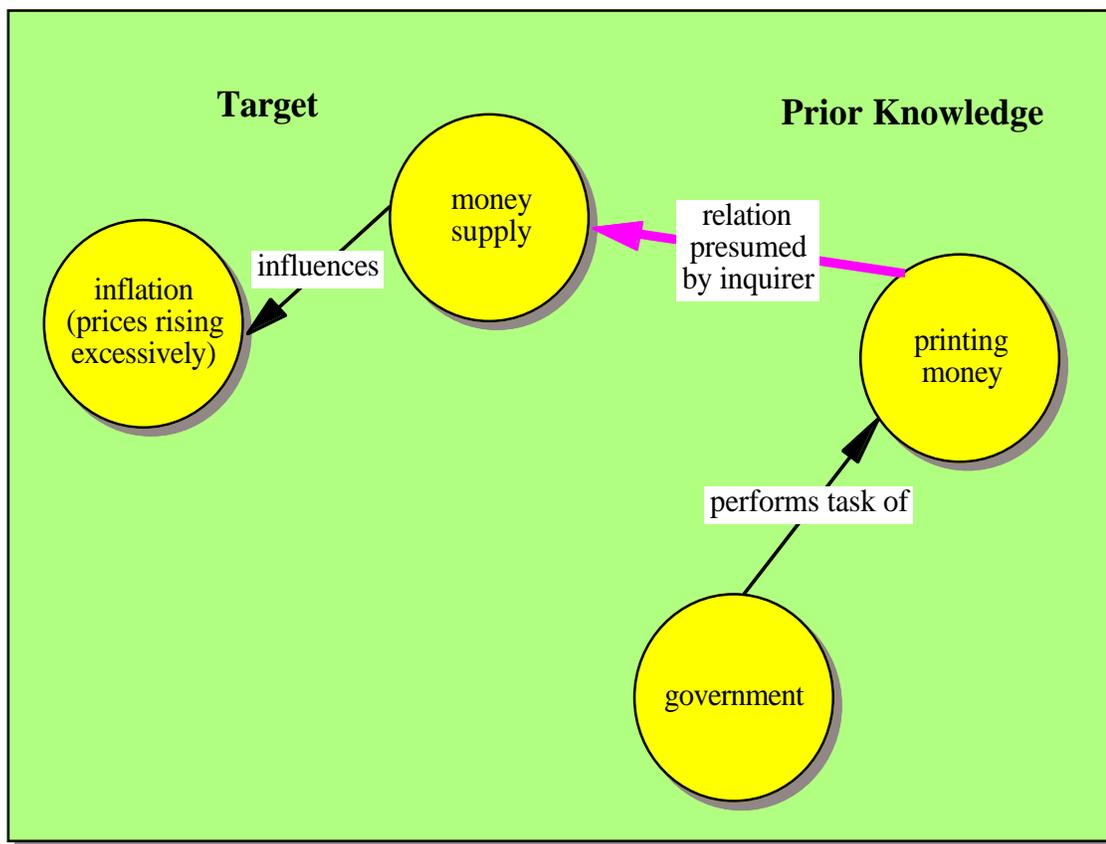
Figure IV.8

LIS Intermediary	Inquirer:
	[4.1] through [4.3] may iterate.

[4.4] <u>Selected anchor concepts recorded in</u>

<u>temporary memory.</u> Intermediator continues

production of a reconstruction of the

inquirer's cognitive question by recording

the selected concepts and the relations

among them as *target* concepts.

[4.1] through [4.4] iterate until inquirer is satisfied with intermediator's presentation of

the structured *anchor* concepts. This **completes** the inquirer's *isomorphic mapping **from***

their cognitive question ***to*** the *reference structure* of their prior knowledge.

[4.5] <u>Reconstructing the inquirer's prior</u>

<u>knowledge.</u> Step [4.4] constitutes reconstruction of

the inquirer's cognitive question. Intermediator

presents this reconstruction to the inquirer to solicit

their confirmation that it accurately represents their

understanding, or if not, return to Step 3 or Step 4

as appropriate.
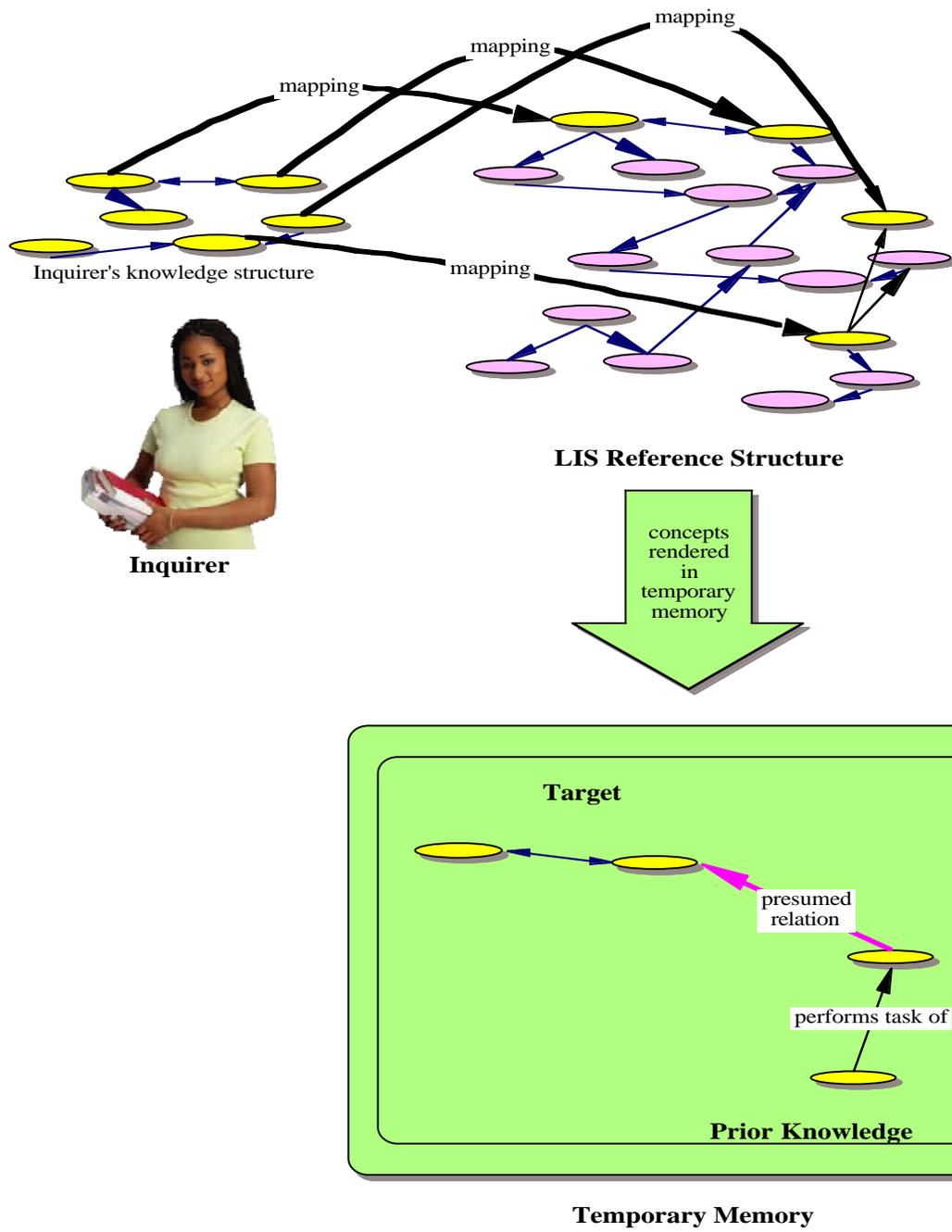
mapping

mapping

mapping

Inquirer's knowledge structure

mapping

LIS Reference Structure

Inquirer

concepts
rendered
in
temporary
memory

Target

presumed
relation

performs task of

Prior Knowledge

Temporary Memory

Figure IV.9

The state of temporary memory, comprising anchor and target concepts, and inherently comprising gaps or obstructions in the inquirer's understanding, may be regarded as the intermediary's reconstruction of the inquirer's *cognitive question*. With this milestone in the inquiry process, Ausubel's ascertainment obligation is satisfied, and the inquiry becomes the responsibility of the intermediary.

LIS Intermediary   Inquirer:

[5.1] Intermediator *contrasts* its reconstruction of

the inquirer's cognitive question (yellow, Figure

IV.10) against relevant portions of its full *reference*

structure. The portion of the inquirer's cognitive

question (yellow) that differs from the reference
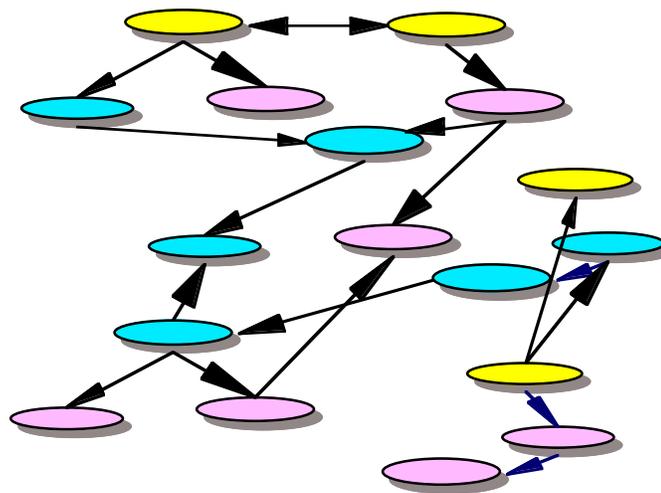
LIS Reference Structure

Figure IV.10

structure (light red) but form a continuous

connection are identified (light blue). These are

explanatory path(s) as described above.

The two target concepts appear (in yellow) as above, as do the two anchor concepts (also

in yellow). However, the reference structure is not expressing the inquirer's presumed

relationship between the anchor and target (shown in light red in Figure IV.9). The

reference structure is interpreting this relation, a meaning, as a preconception that is not

on the explanatory path, highlighted in light blue (Figure IV.10). A different

intermediation interface might display the preconception but highlight it as "unsupported

by the reference structure" for example by coloring it bright red.

How are the concepts that form the explanatory path (light blue) identified?

A pair of *dispositio* keys is formed from the key values mentioned in the Relation Type

elements of Intra-*dispositio* and Inter-*dispositio* structures. For example, in the B10243

(money supply) record (see above), the first key pair is: B10243 - B30247, a relation

between money supply and inflation.

The goal of the process is to find sequences of pairs of keys that lead from *target*

dispositio to the inquirer's *anchor dispositio*. Airline reservation systems perform exactly

this type of search among database records that consist of location-destination pairs. In

many cases, it may be necessary for particular Intra-*dispositio* records themselves to be

scanned for relations. In a sense, airline databases do this also in discovering multi-

segment paths when direct flights or routes with only a single stop cannot be found.

The intermediary begins by listing all combinations in the *target* records, e.g., beginning with the *dispositio* record B10243 (money supply), and terminates when any of the following are reached: G78702 (printing money) or G84323 (government).

We begin with *dispositio* record B10243 (money supply)

First Pass:

B10243 - D92934

B10243 - T95413

B10243 - R45463

B10243 - R49112

B10243 - B10244

and D92934 (inflation)

D92934 - B10258

D92934 - B10243

D92934 - B10244

D92934 - B10258

D92934 - C90338

None of these pairs terminate with G78702 (printing money) or G84323 (government). So, each of the records for each of the key values in this first pass are inspected and their key values listed:

Second Pass:

D92934 already processed

T95413 (money)

```
        T95413- X40586 (medium of exchange)

        T95413- Y73374 (as compensation)

        T95413- W13223 (serviced by banks)

and B10244 (economics)

        B10244 - P49334 (the study of wealth)

        B10244 - P52234 (production)

        B10244 - P52235 (consumption)

        B10244 - P52245 (microeconomics)

        B10244 - P52246 (macroeconomics)

etc.
```

Eventually, pairs will be found that terminate in G78702 (printing money) or G84323 (government). For illustration and simulation, the following records are conjured:

A text, *pronuntiatio* record R018202970 (below) is indexed for its concepts.

Pronuntiatio

```
Key  R018202970
Type  monograph
Author   Heimann, John G.
Title    The philosophy of regulation of the banking system
Publisher   The Association of the Bar of the City of New York
Publication date 1979
CallNumber   KF974.A2 H45
etc.
```

The document is interpreted to express the notion that the government regulates the banking industry. Among the *dispositio* records derived might be:

Key   R49112
Elocutio I54364 (banking)
Intra-*dispositio*
   inventio H544020 (deposits)
   Relation type   R49112 receives H544020
Intra-*dispositio*
   inventio H544020 (deposits)
   Relation type   R49112 returns H544020
Intra-*dispositio*
   inventio M44698 (loans)
   Relation type   R49112 derives income by making M44698
Intra-*dispositio*
   inventio H544021 (interest)
   Relation type   R49112 charges H544021
Intra-*dispositio*
   inventio H544021 (interest)
   Relation type   R49112 pays H544021
Intra-*dispositio*
   inventio H544021 (interest)
   Relation type   R49112 retains as income H544021
Inter-*dispositio*
   inventio R49112 (banking industry)
   Relation type R49112 regulated by G84323
Inter-*dispositio*
   inventio R49884 (reserve requirement)
   Relation type R49112 must retain by R49884
etc.

and

Key   R49884
Elocutio J63451 (reserve requirement)
Intra-*dispositio*
   inventio H544020 (deposits)
   Relation type   H544020 calculated based on R49884
Intra-*dispositio*
   inventio M44021 (5% must be retained)

Relation type   M44021 is R49884

Intra-*dispositio*

   inventio M44022 (95% may be lent)

   Relation type   100% - M44022 may be lent M44698 (loans)

etc.

and

Key   C95859

Elocutio F90211 (total debits)

Intra-*dispositio*

   inventio H544020 (deposits)

   Relation type   H544020 are part of C95859

Intra-*dispositio*

   inventio M44698 (loan)

   Relation type   M44698 is part of C95859

Intra-*dispositio*

   inventio M44029 (total debits)

   Relation type   H544020 + M44698 = C95859

etc.

A different document reports that M1 is calculated from the sum of all deposits reported by all banking institutions. Its *dispositio* records include:

Dispositio-Inventio

Key   R45463

Elocutio N67721 (M1 money supply)

Intra-*dispositio*

   inventio B10243 (money supply)

   Relation type   R45463 is one measure of B10243

Intra-*dispositio*

   inventio B10243 (money supply)

   Relation type   A change R45463 is a change in B10243

Intra-*dispositio*

   inventio C95859 (debits of individual banks)

   Relation type   C95859 are part of R45463

Intra-*dispositio*

> *inventio* C95859 (debits of individual banks)
>
> Relation type   R45463 is sum of all C95859
>
> etc.

Expressed in the reference structure, in an encyclopedia, is a concept that:

Dispositio-Inventio

> Key   M44698
>
> *Elocutio* K4721 (loan)
>
> Intra-*dispositio*
>
> > *inventio* C87641 (commercial event frame)
> >
> > Relation type   M44698 is an instance of C87641
>
> Intra-*dispositio*
>
> > *inventio* R49112 (banking)
> >
> > Relation type   R49112 derives income by making M44698
>
> Intra-*dispositio*
>
> > *inventio* H544020 (deposits)
> >
> > *inventio* R49884 (reserve requirement)
> >
> > Relation type   H544020 - R49884 = M44698
> >
> > > (deposits - reserve = loans)
>
> etc.

From these, an *explanatory path* may be constructed:

Initiation endpoint of explanatory path: B10243 (money supply)

A change R45463 is a change in B10243

(Increase in debits is increase the money supply)

R45463 is sum of all C95859 (M1 money supply is sum of bank debits)

H544020 + M44698 = C95859 (loans increase Debits)

H544020 - R49884 = M44698 (deposits - reserve = loans)

R49112 must retain by R49884 (banks must retain reserve requirement)

G84323 regulates R49112 (government regulates banks)

Terminal endpoint of explanatory path: G84323 (government)

This path in the reference structure is isomorphically projected onto the inquirer's cognitive question, shown via concept mapping:

B10243
(money supply)

D92934
(inflation)

R45463
(M1)

preconception

C95859
(sum of all bank debits)

G78702
(printing money)

M44698
(deposits - reserve = loans)

R49884
(bank reserve)

R49112
(banks)

G84323
(government)

R49884
(reserve requirement)
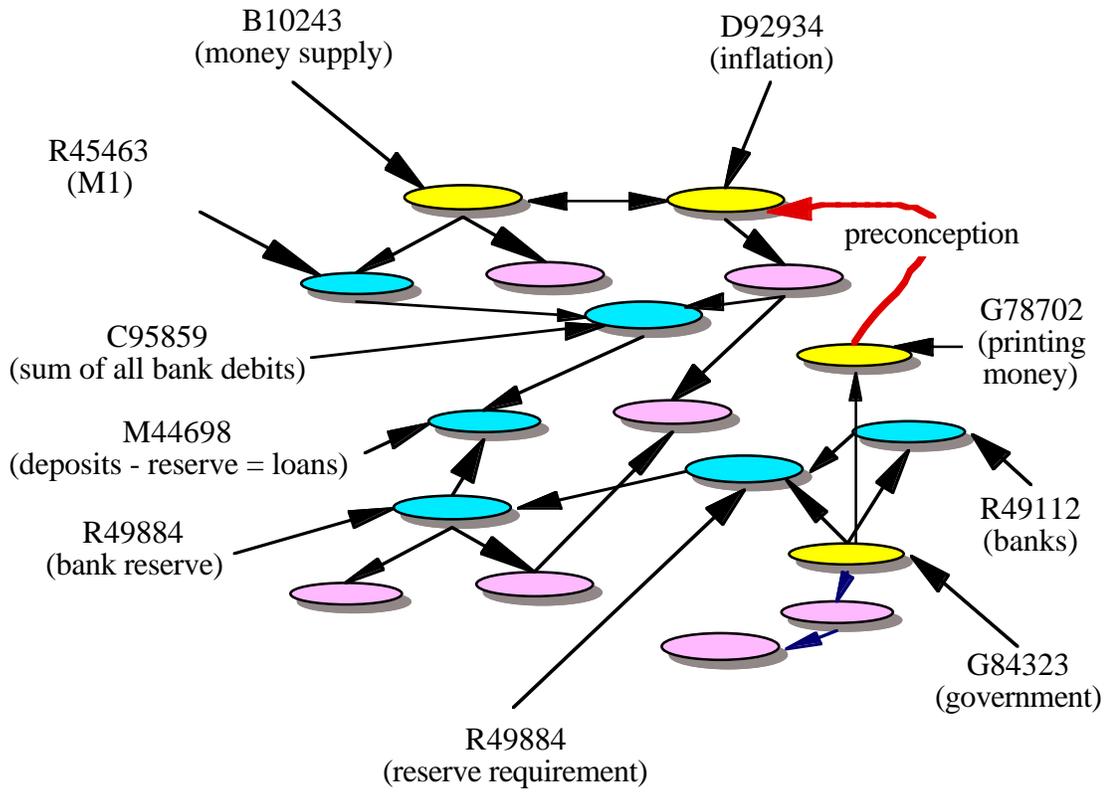
LIS Reference Structure with

Explanatory path labeled

Figure IV.11

LIS Intermediary	Inquirer:

[5.2] Intermediator performs *isomorphic projection* of the identified differences (in light blue, [5a] above] *from* the *reference structure* *to* the temporary memory comprising the reconstruction of the inquirer's cognitive question (Figure IV.11).

[6] Intermediator presents these explanatory paths to the inquirer (Figure IV.11).

[7] Inquirer examines the alternative explanatory paths, and selects those they deem relevant to their cognitive question.

Selection, identification, location, and fetching of documents

---

[8] For those explanatory paths selected by the inquirer as conceptually relevant to their cognitive question, documents in the domain or collection, or surrogate records describing those texts, and associated with those bibliographic items because they are expressive of segments of the concepts in the selected explanatory path, are reported to the inquirer, and subsequently transmitted if requested.

B10243
(money supply)

D92934
(inflation)

R45463
(M1)

preconception

G78702
(printing
money)

C95859
(sum of all bank debits)

M44698
(deposits - reserve = loans)

R49112
(banks)

R49884
(bank reserve)

G84323
(government)

pronuntiatio record
R018202970

R49884
(reserve requirement)
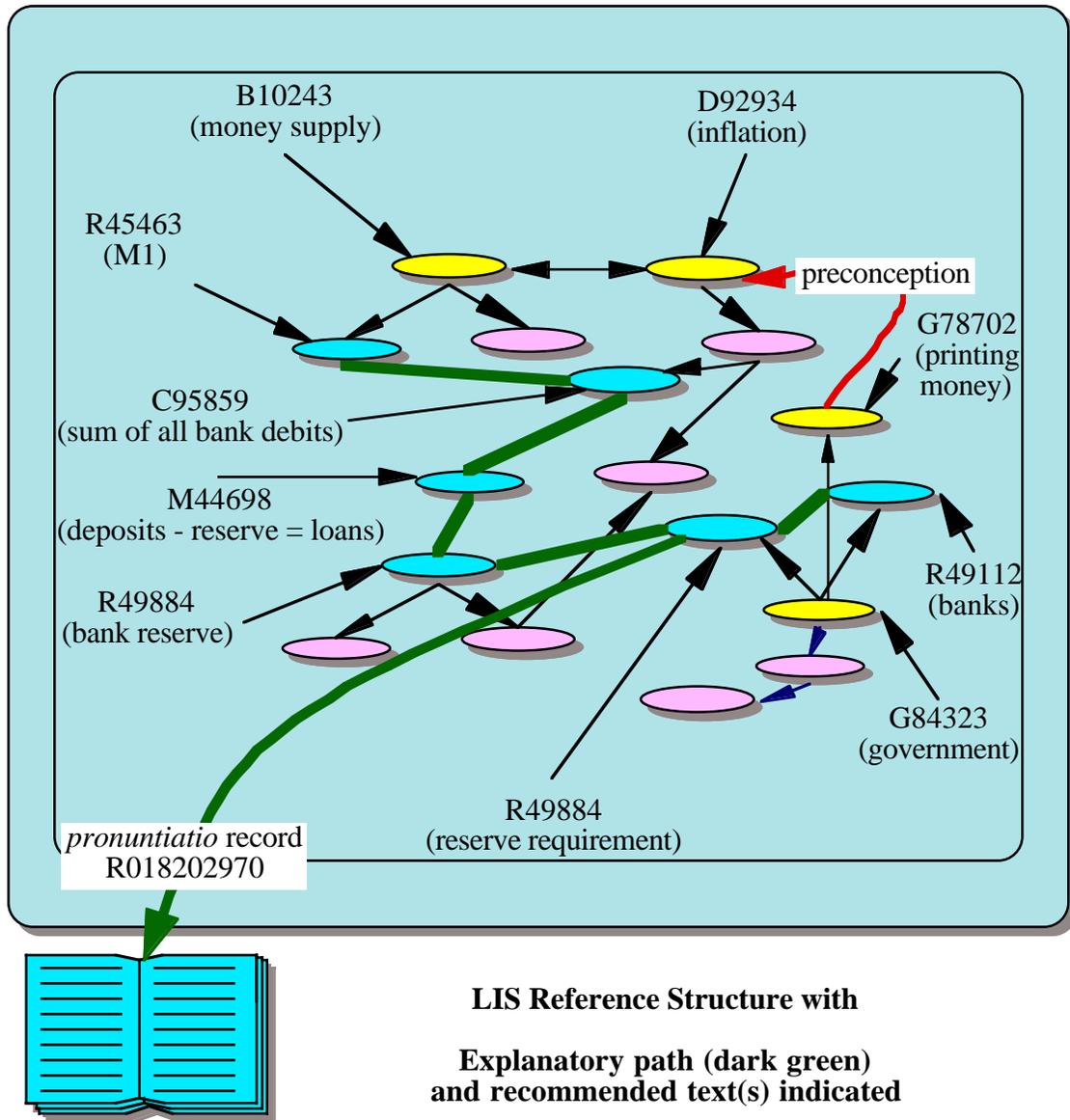
LIS Reference Structure with

**Explanatory path (dark green)
and recommended text(s) indicated**

Figure IV.12

Figure IV.12 illustrates the concepts (bright blue) comprising explanatory path (green)

isomorphically projected from the reference structure onto the intermediary's

reconstruction of the inquirer's cognitive question (yellow), as well as the recommended

texts or "search result" in IR terminology.

While the inquirer must still assimilate the concepts and relations on the explanatory path, the likelihood of failure to recognize them *as explanatio*n is substantially less than in conventional IR.

The red line indicates a *preconception*, that is, a conceptual path between target(s) and anchors(s) that is *different* than that expressed in the reference structure. The gist of the display presented in Figure IV.12 is that the LIS intermediary has **expressed to the inquirer a new *explanation***, that is, an explanation that either the inquirer apparently did not know or did not regard as primary.

In this example, government action to raise the debt limit and "print more money" might indeed influence the money supply and thus inflation. However, texts in the collection did not describe the Federal Reserve as controlling government spending or the Federal debt ceiling, but only overseeing the banking industry. This fact might explain why a second conceptual path toward the terminal concept of "inflation" that traverses the concepts of "federal debt ceiling" and "government spending" was not displayed.

Some concepts come to be regarded as *wrong*, e.g., the phlogiston theory and cold fusion. The intermediary might include indicators of apparent or adjudged epistemic standing, i.e., validity and provenance of ideas presented in conceptual paths, subject to future CR research.

Relations among concepts are, themselves concepts

In the examples above, relations among intra-*dispositio* and inter-*dispositio* were presented in syntax suggesting that, although the concepts on either end of the relation were expressed as dispositio records, the relations themselves were merely loosely described, e.g.:

> Intra-*dispositio*
>
>> *inventio* R49112 (banking)
>>
>> Relation type   R49112 derives income by making M44698

In fact, the relation is a relation type, and is also thus, a concept. Therefore, this path segment might be better expressed as:

> Intra-*dispositio*
>
>> *inventio* R49112 (banking)
>>
>> Relation type   R49112 J02203 M44698

Where J02203 is a concept record derived from "derives income by making"

Conceptual Relevance

> [A]n information retrieval system should deliver evidence that can support
> an argument or a theory even if not prove it.
> [Swanson 1986b 395]

Following Swanson, the notion of Conceptual Relevance is proposed:

> Conceptual relevance is a relationship between (1) *ideas* expressed by text
>
> (as distinct from the text, *elocutio*, itself), and (2) *ideas* comprising

inquirer's cognitive question. The former do not *match* the latter, but *complement* the inquirer's cognitive question to form explanatory conceptual paths.

In response to an inquiry, intermediation thus provides:

A visual presentation of conceptual explanatory path(s) between inquirer's prior knowledge (anchor concepts) and target goal concept; and

Recommended texts expressing segments of that path.

The nodes that comprise an explanatory path are regarded as *relevant* to the particular inquirer's cognitive question at the moment of the query. The inquirer must assimilate the explanatory path and independently ascertain relevance. Based upon that judgment, the inquirer might decide to obtain and read the texts or not.

Constructive Retrieval, automation, and the human element

Early conventional IR was often conceptualized as comprising no human whatsoever, indeed, not even an inquirer! In CR, several human elements obtain. The human inquirer is assumed to be a member of the overall inquiry apparatus.

As well, pre-coordination of texts to *dispositio* is presumed to be best performed by humans. This pre-coordination has two manifestations: derivation of *dispositio*-level records from texts, and, in the reverse direction, instantiation of pointers to texts that are explanatory of a concept path segment from those *dispositio*-level records. To this writer's knowledge, no generally accepted means of performing either derivation purely through automation is currently available.

As described above, other elements of this Model are appropriate for automated processing as Novak anticipated:

> The advantage of using computer search engines based on information stored in concept maps is that knowledge is highly organized in a concept map and each proposition in the map is set in a context. ... selecting and clicking on a concept on a global map can bring up on the screen a subordinate or more explicit concept map with greater detail.
> . . .
> [A] searcher can easily scroll across and up and down a concept map to see other related concepts and propositions, some of which might never have been known or considered if only keywords were used to guide the search. Thus, information stored as concept maps is contextualized, not random bits . . . (Canas & Ford, 1992; Canas, Ford, & deBessonet, 1993; Ford, Stahl, 1991.) [Novak 1998. 218]

The notion of automating the instrumentation concept relations can be traced back to the 1960's ([Doyle 1961] and [Farradane 1967]), and, with imaginative license, to the early Twentieth Century, e.g., H.G. Wells' "world brain" ([Wells 1937] and [Rayward 1999]), and the chemist Ostwald, with his "monographic principle" ([Hapke 1998] and [Buckland ponto]), and Otlet ([Rieusset-Lemarié 1998]) who adopted and attempted to operationalize the monographic principle as the "universal book." Otlet's application of contemporary technology was an innovative precursor to database technology in implementing *a process means* of recording relationships among records.

Records are generally susceptible to machine processing. However, the intellectual work of both the inquirer and indexer in *constructing meaning* based upon basic concepts (see: Part II) is not performable by a machine, but at best, simulatable. Even more to the point, success in LIS is perceived where a *human* inquirer *becomes informed*.

Automation has had an agonistic relationship with the indexing, cataloging, and classification enterprise generally. Machine systems obviously relieve much of the clerical work from human technical processing staff. Prior to the 1990's, author and title indexing and cataloging were weapons of first choice in the inquirer's arsenal in the battle against the tidal wave of texts they faced. Database developers built separate indexes depending on the data elements their users required, e.g., author, title, or subject. A directory database might be indexed on telephone number, zip code, and keywords in the street address. Nowadays, such coordination between data element and index is much less frequent. Indeed, data records themselves may not have internal element structure. Web-based search engines perform sophisticated queries against records as text strings without any demarcations among data elements. The result is that a search for McGillicutty as an author, and only as an author, will be likely be processed by generalized online facilities as a search for the character string MCGILLICUTTY regardless of context. McGillicutty Hardware is as likely to be found as a book or article by McGillicutty, moreso if McGillicutty Hardware has purchased priority with the search engine company. Customized LIS systems still retain data element distinctions, however generalized systems are frequently applied to bibliographic applications. CR retains the context specificity of distinguishable data elements through the attributes of concept representation. For example, an author concept will have different attributes than the concept of a hardware store.

Constructive Retrieval and concept mapping

Maps, generally, provide several functions:

> to show *how to get* from A to B

> to show relations among A and B

> to show context of A with respect to B

Concept maps, described as cognitive cartography [Mintzes Wandersee Novak 1998 xix], have been used in this presentation of Constructive Retrieval for several reasons. They depict clearly (though incompletely) relations among *dispositio* records, and lend themselves to rudimentary forms of quantitative evaluation, e.g., counting the concepts on an explanatory concept path.

From the inquirer's point of view, the purpose of concept mapping serves to enable them to visualize where their knowledge lies in relation to a reference structure of knowledge, and the territory through which an explanatory path might lie.

The inquirer is presented not merely with recommendations of texts, but also with a clear progression of concepts that lead to the recommended texts. The nodes which comprise the explanatory path (e.g., bright blue in Figure IV.12), and the documentary evidence from which they were derived and recorded as part of the *reference structure*, are reported to the inquirer as part of the search result so that inquirers can understand why particular documents are recommended. These cues are provided visually, through concept mapping, so that the inquirers has "You are here - this is where you want to go" context. This differs from the IR "black box" paradigm where inquirers are provided little or no explanation as to why documents are deemed "relevant."

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"Before and after" concept map renderings might also be helpful to the inquirer during the course of their inquiry as reflective of ongoing changes to their knowledge and cognitive question.

Browsing via concept maps reduces the burden on the inquirer of identifying entry vocabulary. While the inquirer must still identify terms for initial concept identification, subsequent concept browsing in the vicinity of concepts associated with those terms obviates the need for entry vocabulary to the extent needed in conventional IR.

> [I]nstead of depending on his imagination to think up a search request, he is depending on his recognition of semantic relationships.
> Here is a case illustrating the advantage of recognition over search request formation. [Doyle 1961 577]

Swanson's *Undiscovered Public Knowledge*: an Assimilation Theory view

The Holy Grail of mediation between inquirers and instrumented records is to be able to provide recommendations of texts (and explanations justifying those recommendations) that enable the inquirer to understand and solve difficult problems. One of the fascinating, if miniscule, niche literatures in LIS are papers by and about Swanson's discovery of a potential treatment for Raynaud's disease from articles published in a separate domain of journals from those with which Raynaud's experts were familiar.

Swanson described his work in terms of specific diseases, specific treatments, specific effects and symptoms. Thus, he was left to speculate how other such discoveries might be accomplished through use of conventional bibliographic instruments, such as a "thesaurus built in advance" and conventional retrieval paradigms having "no formal method of identifying searchable attributes" [Swanson 1986 114]. Unfortunately,

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Swanson did not have (or did not use) the conceptual apparatuses of the Divisions of Rhetoric Reference Model, of isomorphic projection and isomorphic mapping, of Assimilation Theory, and of an adequate Model of Inquiry in his quiver. With these, Swanson's accomplishment can be operationalized according to the Model of Inquiry described in this report.

This procedure begins, as it does above, with conceptual indexing. The salient ideas from Swanson's description [Swanson 1986] are rendered as *dispositio* records.

Swanson begins by describing a report, here labeled " Clinical Test A" that describes the favorable effects of dietary fish oil on blood. These concepts may be rendered thus:

<div align="right">

Dispositio-Inventio

</div>

Key   S111111

Elocutio S300001 (fish oil)
Inter-*dispositio*
   inventio S20002   (blood)
   Relation type S111111 favorable effect on S20002
Pronuntiatio   Clinical Test A

<div align="right">

Dispositio-Inventio

</div>

Key   S20002

Elocutio S302221 (blood)
Inter-*dispositio*
   inventio S111111 (fish oil)
   Relation type S111111 favorable effect on S20002
Pronuntiatio   Clinical Test A

Key   S31133

Elocutio S304421 (eicosapentaenoic acid)
Inter-*dispositio*
   inventio S111111 (fish oil)
   Relation type S31133 component of S111111
Inter-*dispositio*
   inventio S20002   (blood)
   Relation type S31133 favorable effect on S20002
Inter-*dispositio*
   inventio S20017   (blood platelet clumping)
   Relation type S31133 reduces S20017
Inter-*dispositio*
   inventio S20018   (low-density lipoprotein)
   Relation type S31133 reduces S20018
Inter-*dispositio*
   inventio S20019   (blood viscosity)
   Relation type S31133 reduces S20019
Pronuntiatio   Clinical Test A

Key   S20017

Elocutio S302222 (blood platelet clumping)
Inter-*dispositio*
   inventio S31133   (eicosapentaenoic acid)
   Relation type S31133 reduces S20017
Inter-*dispositio*
   inventio S20444   (heart disease)
   Relation type S20017 abnormally high is associated with S20444
Pronuntiatio   Clinical Test A

Key   S20018
Elocutio S302223 (low-density lipoprotein)
Inter-*dispositio*
   inventio S31133   (eicosapentaenoic acid)
   Relation type S31133 reduces S20018
Inter-*dispositio*
   inventio S20444   (heart disease)
   Relation type S20018 out-of-range adverse effect on S20444
Pronuntiatio   Clinical Test A

Key   S20019
Elocutio S302224 (blood viscosity)
Inter-*dispositio*
   inventio S31133   (eicosapentaenoic acid)
   Relation type S31133 reduces S20019
Inter-*dispositio*
   inventio S20444   (heart disease)
   Relation type S20019 out-of-range adverse effect on S20444
Pronuntiatio   Clinical Test A

Key   S20444
Elocutio S30477 (heart disease)
Intra-*dispositio*
   inventio R66601 (death)
   Relation type S20444 cause of R66601
Inter-*dispositio*
   inventio S20017 (blood platelet clumping)
   Relation type S20019 out-of-range adverse effect on S20444
Inter-*dispositio*
   inventio S20018 (low-density lipoprotein)
   Relation type S20018 out-of-range adverse effect on S20444
Inter-*dispositio*
   inventio S20019 (blood viscosity)
   Relation type S20019 out-of-range adverse effect on S20444
Pronuntiatio   Clinical Test A
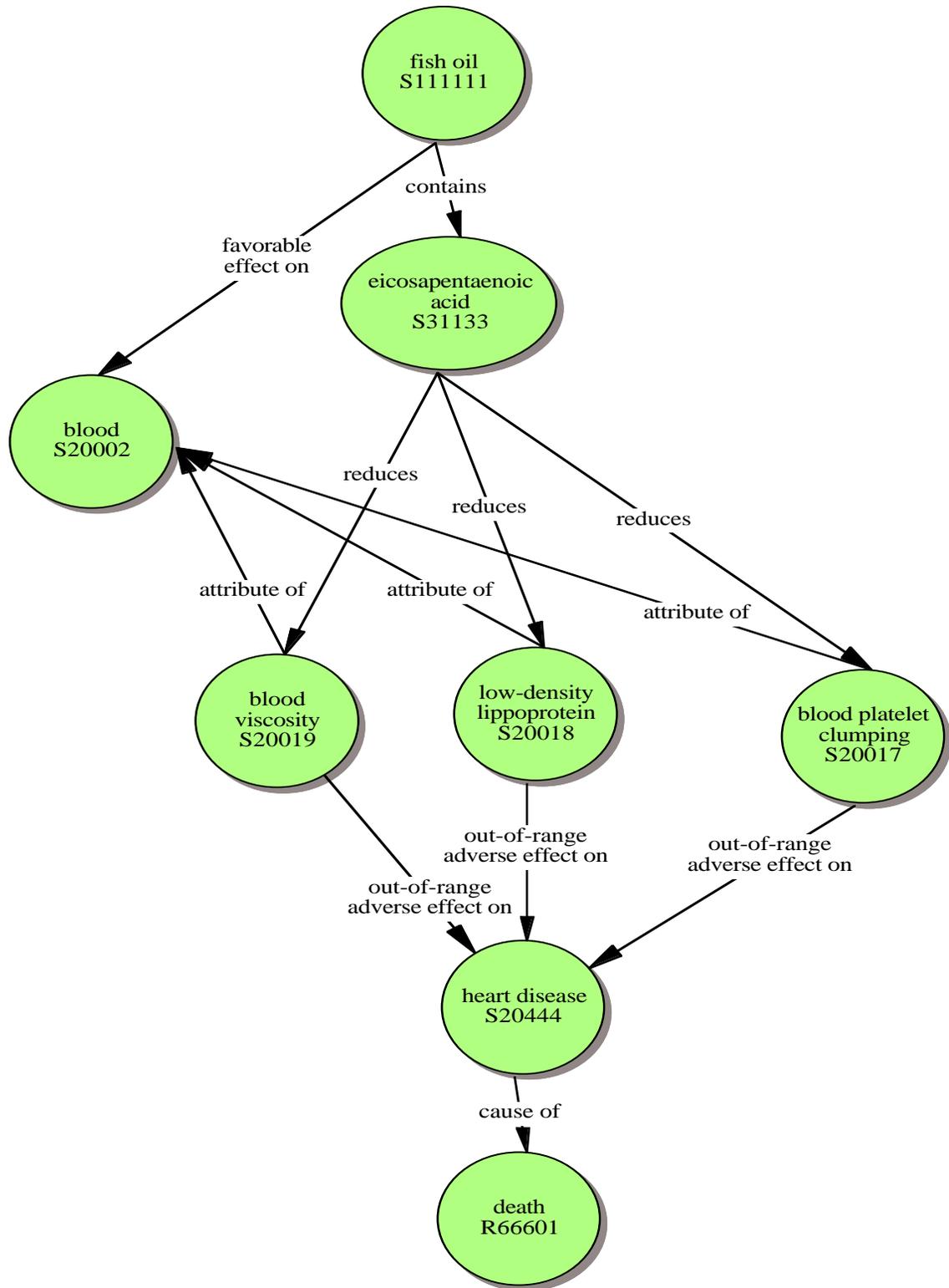
Figure IV.13

```
Key   R66601
Elocutio R666012 (death)
Inter-dispositio
    inventio R66601 (heart disease)
    Relation type R66601 caused by  S20444
Pronuntiatio   Clinical Test A


etc.
```

These may be diagramed as in Figure IV.13:

Separately, Swanson analyzes a second document (Raynaud paper 1) from a different

scholarly field concerned with Raynaud's disease. It expressed concepts, as reported by

Swanson, that may be rendered in *dispositio* records as follows:

```
Key   R92006
Elocutio L28582 (Raynaud's disease)
Inter-dispositio
    inventio R85921  (episodic blanching of fingertips)
    Relation type R85921 symptom of R92006
Pronuntiatio   Raynaud paper 1


etc.
```

```
Key   R85921
Elocutio L296972 (episodic blanching of fingertips)
Inter-dispositio
    inventio R92006  (Raynaud's disease)
    Relation type R85921 symptom of R92006
Pronuntiatio   Raynaud paper 1


etc.
```

Key   S20019
Elocutio S302224 (blood viscosity)
Inter-*dispositio*
   inventio S31133   (eicosapentaenoic acid)
   Relation type S31133 reduces S20019
Inter-*dispositio*
   inventio S20444   (heart disease)
   Relation type S20019 out-of-range adverse effect on S20444
Inter-*dispositio*
   inventio R92006 (Raynaud's disease)
   Relation type S20019 symptom of R92006
Pronuntiatio   Raynaud paper 1
Pronuntiatio   Clinical Test A

Key   S20017
Elocutio S302222 (blood platelet clumping)
Inter-*dispositio*
   inventio S31133   (eicosapentaenoic acid)
   Relation type S31133 reduces S20017
Inter-*dispositio*
   inventio S20444   (heart disease)
   Relation type S20017 out-of-range adverse effect on S20444
Inter-*dispositio*
   inventio R92006 (Raynaud's disease)
   Relation type S20017 symptom of R92006
Inter-*dispositio*
   inventio S31773   (prostacyclin)
   Relation type S31133 inhibits S20017
Pronuntiatio   Raynaud paper 1
Pronuntiatio   Clinical Test A
Pronuntiatio   Clinical Test B

Key   S31773
Elocutio S304827 (prostacyclin)
Inter-*dispositio*
    inventio S20017   (blood platelet clumping)
    Relation type S31773   inhibits S20017
Pronuntiatio   Clinical Test B

These may be diagramed:
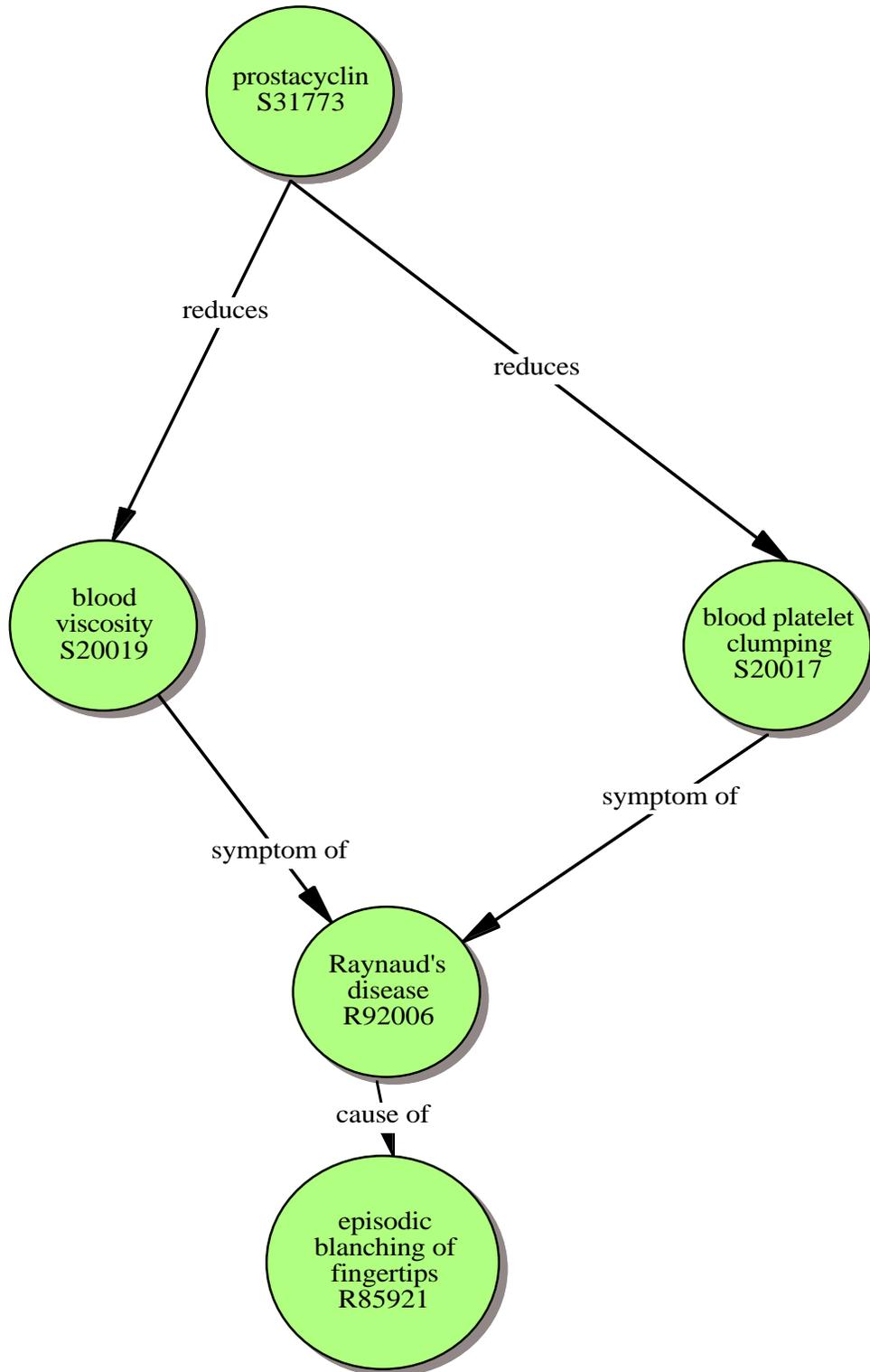
Figure IV.14

According to the Assimilation Theory Model of Inquiry, these may be regarded as an inquiry and a reference structure. Inquiry proceeds (Figure IV.15) with Steps [3] and [4] of the model (Part IV.2) by isomorphic mapping of the concepts in common,

S20017 (blood platelet clumping)

S20019 (blood viscosity)
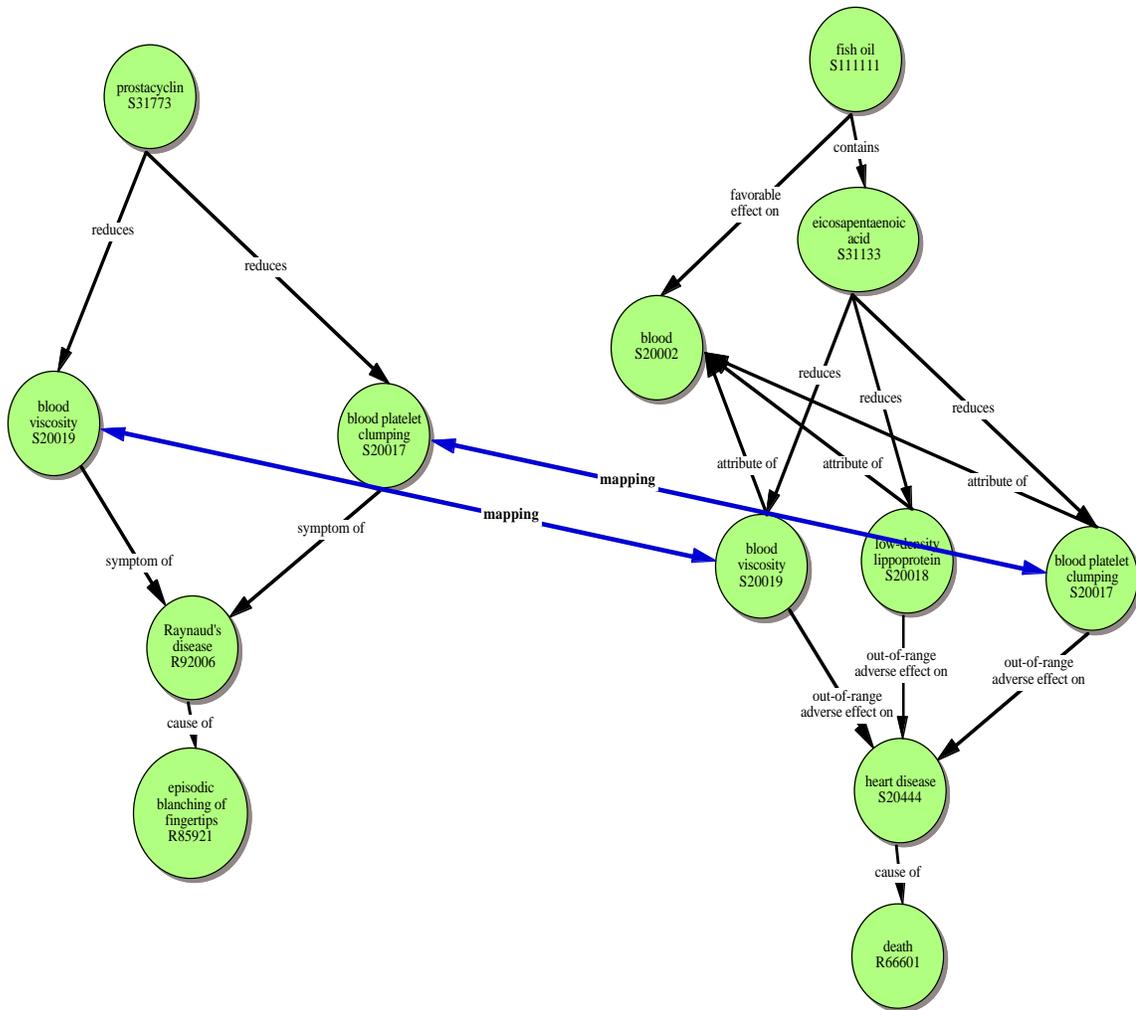
Figure IV.15
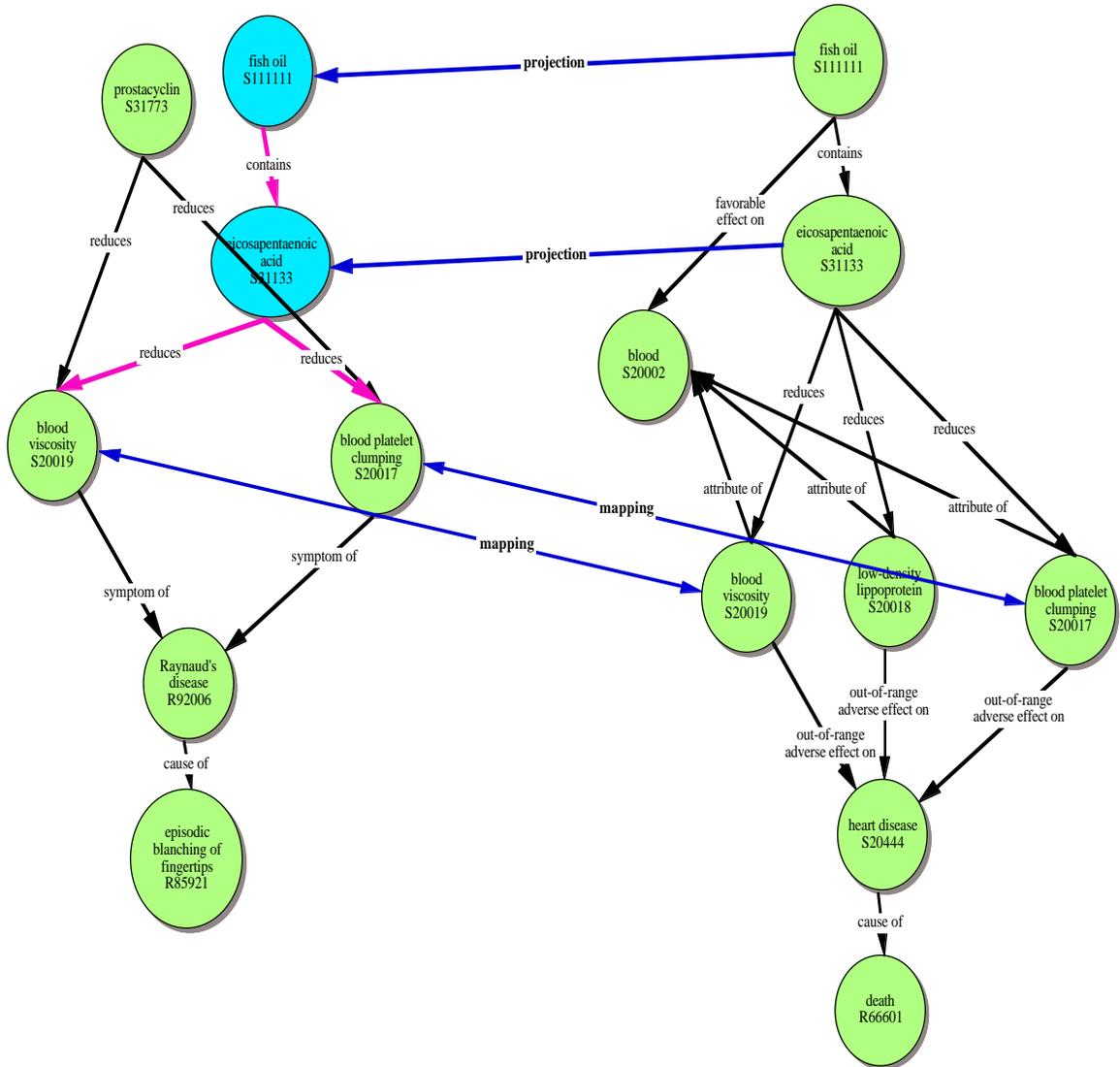
Figure IV.16

Isomorphic projections may then be performed to apply the favorable effects of dietary

fish oil on symptoms suffered by Raynaud's patients (Figure IV.16, projected *dispositio*

in light blue, relations in hot pink):
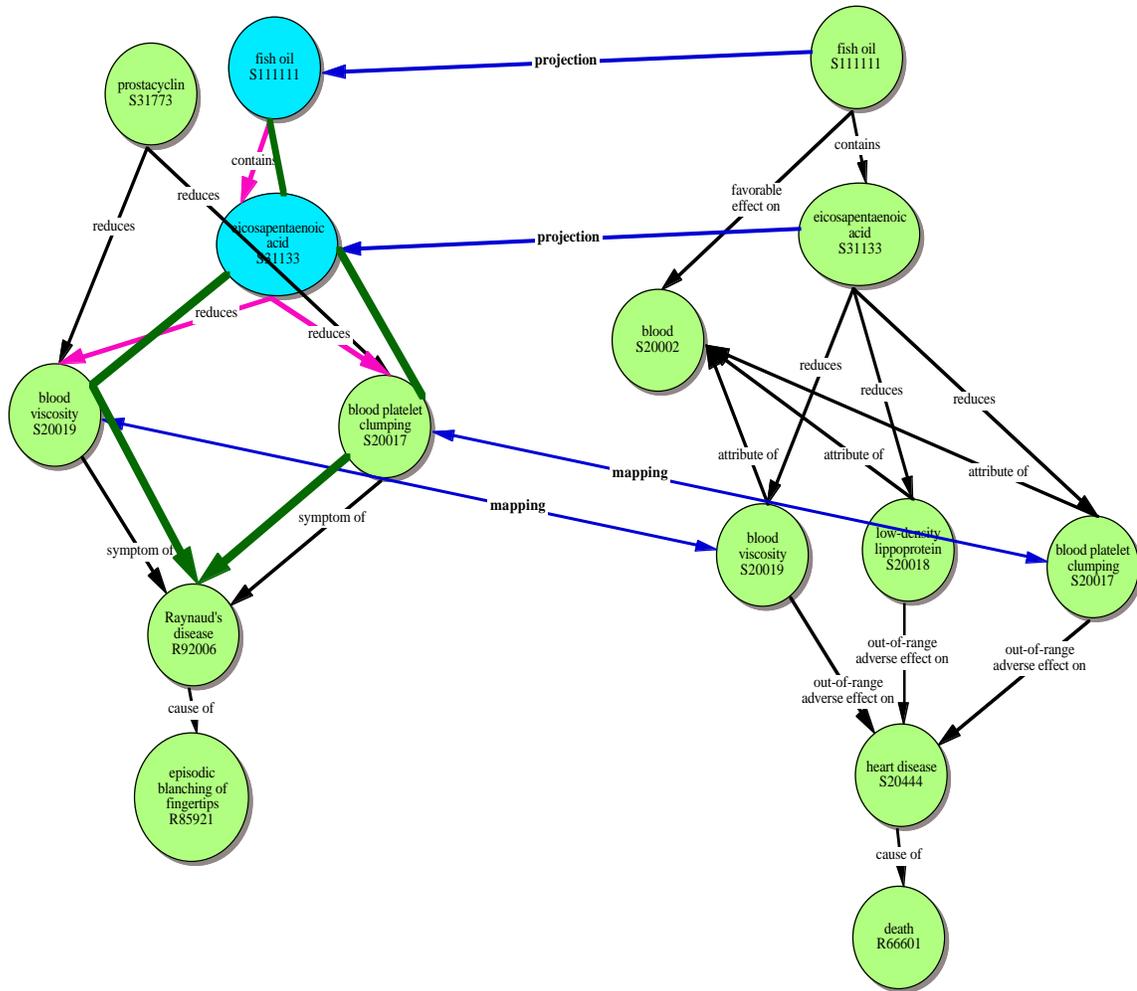
Figure IV.17

Figure IV.17 illustrates the entire explanatory path (forest green) with initial endpoint at fish oil and terminal endpoint at Raynaud's disease of the cognitive question, with interior relations of "reduces," i.e., that mitigation of Raynaud's disease might be explained by concepts from fish oil.

Figure IV.18

The next step in the inquiry is provision to the inquirer of text recommendations (light green to blue book) associated with the explanatory path (Figure IV.18).

Swanson noted that discovering explanatory concepts from instrumented texts that inhabit unconnected literatures:

> may be inherently and peculiarly difficult because there are virtually no references in either literature to the other, nor are there any clues from cocitation, bibliographic coupling, or statistical association of descriptors that the two literatures are logically related. . . .
> Regrettably, I cannot describe any systematic process for discovering these connections.
> [Swanson 1987 228, 233]

As recently as 2006 [Swanson Smalheiser Torvik 2006], Swanson and his colleague's efforts to use conventional bibliographic and probabilistic methods on lexical (*elocutio*) texts continues to resist the ultimate goal of identifying specific "hypotheses" (i.e., conceptual paths):

> [This approach] is implemented by finding all key B-terms (words and phrases) in titles that are common to two disjoint sets of articles, A and C, and then displaying each B-term in the context of its use within A-titles and within C-titles. The user then can assess whether the titles displayed suggest a possibly interesting A–C connection that is worth pursuing further. [Swanson Smalheiser Torvik 2006]

However, as observed at the beginning of this section, Swanson did not have the benefit of the conceptual apparatuses of the Divisions of Rhetoric Reference Model, of isomorphic projection and isomorphic mapping, of Assimilation Theory, and of an adequate Model of Inquiry available to him.

I claim that the methods of (1) conceptual indexing applied to domains of texts and (2) Constructive Retrieval, can routinely operate to recognize and report potential explanatory paths that no human had known or published.

Constructive Retrieval an oxymoron?

The term *retrieval* implies that the object wanted is contained *in* what is fetched.

Constructive Retrieval assumes that the inquirer's desire or need is not merely for tools to search for records, nor even pointers to specific documents, nor even for documents themselves, nor even to become informed. CR presumes that, ultimately, the inquirer seeks the *benefit* of becoming informed, that is, *impact* on a cognitive question. Intermediation is presumed to have substantial responsibility through the stage where expressions are delivered to and received by the inquirer who, ultimately, must construct meaning themselves. Accordingly, Assimilation Theory is averse to conduit metaphor models where ideas reside in external objects such as books, documents, computer displays, etc., and where the learner need only *extract* or retrieve the ideas from the external container and insert them into their mind. The term *retrieve* may thus be regarded as dissonant with a constructivist approach to meaningful learning and becoming informed unless it is confined to retrieval of external objects, *pronuntiatio*.

From this standpoint, is the term *Constructive Retrieval* an oxymoron?

Constructive Retrieval, as a linguistic term, expresses an idea that is distinct from *retrieval*. It is, of course, related to the common understanding of *retrieval*, and thus, the suggestion of the contradictory figure. However, CR also has a relation to another term besides *retrieval*, the term *information retrieval*. *Information retrieval* implies much more than *retrieval:* collections of texts, record structures, derivations of texts expressed as record structures, search processes, indexing, selecting, identifying, locating, fetching, sorting, and presenting, all components of intermediation. *Information retrieval* and *retrieval* are distinct terms.

While *Constructive Retrieval* is antithetical to *retrieval*, it parallels *information retrieval* in evoking the related ideas itemized above, but differing primarily in the *type* of objects indexed, searched, and processed. The parallel thus aligns CR with the context of IR, and thus serves its intended purpose in this report.

CR does retrieve *pronuntiatio*, records expressive of *dispositio*, and presents them as depicting explanatory conceptual paths connecting an inquirer's anchor concepts to their target concepts. It is still the task of the inquirer to assimilate that explanatory path, that is, to relate the concepts the display provokes to their prior knowledge. The concepts sought by the inquirer *are not contained in* either the concept records isomorphically projected and displayed, nor the bibliographic records fetched and reported. Thus, CR may be regarded as a form of *reception learning* rather than *discovery learning*, but it is *learning* nevertheless. There still remains the possibility that an inquirer might fail to comprehend either a presented explanatory path, recommended texts expressing that path, or both. Different individual inquirers, even having substantially the same *target* concept(s) in the inquiry, will bring different sets of *anchor* concepts (prior knowledge), and thus, inquiry might or might not result in any particular individual inquirer becoming informed.

IV.3 Impact of Constructive Retrieval

Having operationalized no real world trials, but only the *gedenken* experiments reported in this Part, full review of the impact of the benefits of an Assimilation Theory-consonant LIS is premature. At this point, however, impacts can be anticipated and evaluation criteria considered.

Perhaps most fundamental is that, in the Assimilation Theory Model of Inquiry described here, an inquirer's cognitive question is *not* reduced to linguistic terms or character strings, but quite the opposite: Matching (mapping and projection) is elevated from *elocutio* (terms) and *pronuntiatio* (character strings) to *dispositio*, that is, matching the ideas comprising the inquirer's cognitive question with ideas expressed by instrumented texts. The distinction is verifiable by considering the *attributes* of objects matched: the attributes of *dispositio* are *different* than the attributes of *elocutio* or *pronuntiatio*.

No texts are retrieved or recommended until relevant concepts have been identified. Constructive Retrieval (CR) is differentiated from information retrieval (IR) by virtue of performing conceptual relevance determinations *prior* to provision of texts to the inquirer rather than after. The intended benefit is that texts recommended or provided express concepts already deemed relevant.

Relevance changes as does the inquirer's cognitive question as the process of inquiry proceeds, and pertains only to the individual inquirer at the moment they express their cognitive question to LIS intermediation. In conventional IR, a query generally returns identical results to a query to all inquirers.

This Model of Inquiry embraces, rather than overlooks, indispensable elements of intermediation: reconstructing the inquirer's cognitive question, isomorphic mapping of

concepts in the cognitive question to the reference structure, isomorphic projection of concepts expressed by texts in the reference structure to the reconstructed cognitive question, and the notion of *reception* learning as distinct from *discovery* learning as obtains in conventional IR and the present do-it-yourself mode of modern online services. These will result in both improved relevance of recommended texts and more efficient assimilation of recommended texts by the inquirer with minimal cognitive labor.

Mistaking objects or labor associated with one layer for a different layer will be minimized. The impact will be that focus of intermediation will be directed to inquirers and their *becoming informed* rather than technological gimmickry and other red herrings.

Granularity of indexing at the sub-document level can localize recommended texts to specific cognitive questions. This will favorably impact the burden of the inquirer in determining which portions of a text are relevant to their cognitive question. Increased relevance of concepts expressed by recommended texts and reduced labor on the part of the inquirer in assimilating ideas expressed by texts will have a favorable impact on "information overload" in two ways: (1) The volume of *pronuntiatio* ➜ *elocutio* ➜ *dispositio*, and the cognitive labor inherent in deriving meaning from texts, is reduced because the inquirer can filter away texts that do not express ideas on their explanatory path, and (2) the labor inherent in *elocutio* ➜ *dispositio* is reduced because the inquirer is reading a concept map rather than prose.

One of the strategies humans employ to mitigate "overload," both cognitive and physical, is *specialization* [WilsonP 1996]. LIS encounters specialization in the form of *fragmentation* of the record. Saracevic has explained the benefits and detriments (Part II.2 and [Saracevic 1975 323]). The significant detriment is that the inquirer is burdened not only with constructing meaning from the fragmented record, but must collect and

organize the records. Conceptual indexing performs this function on behalf of the inquirer.

Sense-disambiguation of *elocutio* is accomplished through separate *dispositio* records for separate term senses, although linked to an *elocutio* record that binds them. This binding *elocutio* record might be used as part of a sense-disambiguation tool.

Intermediation based on this Model of Inquiry has the potential to recommend explanatory paths independent of natural language of the texts upon which indexing was performed.

Browsing via concept maps reduces the burden on the inquirer of identifying entry vocabulary. While the inquirer must still identify terms for initial concept identification, subsequent concept browsing in the vicinity of concepts associated with those terms obviates the need for entry vocabulary to the extent needed in conventional IR.

> [I]nstead of depending on his imagination to think up a search request, he
> is depending on his recognition of semantic relationships.
> Here is a case illustrating the advantage of recognition over search request
> formation. [Doyle 1961 577]

Additionally, concept mapping of explanatory paths offers potential for evaluation, perhaps even measurement, of intermediation performance at the concept level. Asking "how much information" a system provides, or even "how much relevant information" are the wrong questions because they focus on objects and texts transmitted, not concepts expressed and assimilated as explanatory paths. A better evaluative question, according to Assimilation Theory, is: To what extent does the intermediation provide an explanatory path between the inquirer's existing knowledge and their question that mitigates conceptual gaps an obstructive ideas, and if so, are texts expressive of that explanatory path recommended to the inquirer?

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In this model of inquiry, dependence on alphabetic order of search results, publication date, or even on estimated relevance is replaced by presentation based on association with adjacent concepts expressed as records. As well, the possibility of access to a "before-and-after" view of a graphic presentation of their cognitive question, and access to a graphic presentation of explanatory paths will favorably impact the overall process from the inquirer's vantage point. Indeed, presentation of an explanatory path might, for some inquiries, obviate the need to receive and read relevant texts at all.

IV.4 LIS as an Assimilation Theory-consonant scholarly field

Context

The Primary Finding (Part III) reveals that an opportunity is at hand for a better understanding of the Basic Relationship between inquirers and instrumented texts than that which underlies conventional LIS intermediation. This section speculates as to an Assimilation Theory-consonant reconceptualization of the field, its core concepts, and its curricula for education and training that can result in improvement for inquirers and those concerned with intermediation.

The question, "What is library and information science?" does not elicit responses of the same internal conceptual coherence as similar inquiries as to the nature of other fields, e.g., "What is chemistry?", "What is economics?", "What is medicine?" Each of those fields, though broad in scope, has clear ties to *basic concerns* of their field (chemistry is the study of the composition and properties of physical substances, and their interactions; economics is the study of motivating factors explanatory of production, consumption, wealth, and attribution of financial value; and medicine is the study of causes and cures of physiological conditions of animals). Neither LIS theory nor practice is perceived to

be monolithic nor unified by a common literature or set of professional skills. Occasionally, LIS scholars (many of whom do not self-identify as members of an inter-reading LIS community, or prefer names other than LIS), attempt, but are unable, to find core concepts in common. Some believe that computing and internetworking concepts and skills underlie virtually every important aspect of LIS, indeed see LIS as a sub-field of computer science! [Footnote III.1] Others claim that LIS is principally a social science accompanied by practical skills such as ethnography and interviewing. Historically, traditions of public service, bibliography, documentalism, and information science have viewed their mission, their philosophical toolsets, and their domain of research differently. Still others deny the existence of a greater metropolitan LIS, viewing LIS instead as a loosely organized collection of specialized interests often unified by nothing more than their shared (and fought-over) use of the descriptor *information*. Indeed, claims occasionally arise to the effect that the field even has no theory of its own. These debates frequently segue into characterizations of LIS, by whatever name, as interdisciplinary, comprised merely of a loose assemblage of ideas and practices originated from other fields such as computing and internetworking, social policy, entrepreneurship, etc. At an extreme, LIS has been regarded by some as a field so new that it serves as a privileged corner of the academy where there are no disciplinary constraints, where scholars native to any scholarly field come to investigate virtually any subject matter.

In contrast to these myths, core concerns uniquely central to LIS as a scholarly field *can* be identified, as shown below. That a conceptual core has become invisible to many, even within the LIS community may be attributed to several causes:

- LIS practices and instruments have become ubiquitous, assimilated into everyday use by inquirers-at-large;

- New technologies grounded in computing and internetworking have overtaken previously established practices and instruments;

- The glamour and economic potential of applying digital technology lured competitors from other fields willing to stake out territory LIS assumed was its own [Van House Sutton 1996];

- Perception of LIS as gatekeepers, access-preventers, and matronly police who enforce circulation and "quiet" policies;

- Perception of LIS as a service workforce populated primarily by women;

- A tendency of LIS schools to neglect theory development, and emphasize only the training of practitioners.

Recognizing the unique *concern* of Library and Information Science

Wilson [WilsonP 1973 461] distinguishes *concerns* from *interests*. A *concern*, to paraphrase Wilson, is a state or condition that makes a difference. An *interest* refers to subject matter that one might desire to know about, but does not make a difference. What states, conditions, or concepts are of central *concern* to LIS? Are any of these *unique* to LIS?

Although consensus about mission and subject matter of the field might seem minimal in comparison to other fields, one notion appears relatively uncontroversial:

> The field derives from *concern* around the term *information*.

Thus one may ask,

> Who or what can *become informed*?

Setting aside the question of whether machines can *become informed* or can *know*, one may observe that:

<p style="text-align:center;">*People* become informed</p>

Such people shall be called *inquirers*.

A scholarly field that does not manifest concern for *inquirers* and their means and conditions of their *becoming informed*, cannot credibly be a field centrally concerned with the nature of *information*. Thus, LIS, a scholarly field concerned with the nature of *information*, must have, as its central concern, *people becoming informed*.

Concern for *people becoming informed* is not unique to LIS, and thus is insufficient to differentiate LIS from other fields. LIS are a part of a larger enterprise.

Education (pedagogy) is a field interested in how people, particularly students, become informed through teaching, often, though not always, in formal classroom settings. Education is distinct from LIS in many ways. Its practitioners are licensed to practice. They have warrant to *originate* explanations and to formulate lesson plans, i.e., select and organize concepts and skills to be learned. LIS has neither the cognitive authority nor juridical warrant to do so. When an inquirer is separated from educators (human or agent) by space, time, or both, educators may express their labor in the form of recorded texts that they either have authored or recommend. In Assimilation Theory terms, such separation is important because the educator may no longer be in a position to ascertain the learner's prior knowledge, and thus not be in a position to recommend an explanatory path.

The field of psychology studies mind, mental objects, processes, and behaviors, including how people become informed through learning.

The intersection between teaching and learning has achieved an identity of its own, educational psychology, by exploiting synergy among the two.

Cognitive science approaches understanding how people become informed by synthesizing concepts from neurophysiology, computer science, and linguistics, among others.

Linguistics, particularly cognitive linguistics, is concerned, in part, with how people derive meaning, become informed, through use of linguistic systems such as ordinary ("natural") languages, mathematics, cultural practices, etc.

As evident from Part II, ancient rhetoric was concerned with how people can be influenced such that they become informed for purposes such as seeking truth, drawing conclusions, persuasion, education, and presentation of arguments in judicial forums.

Communication, media studies, and advertising are concerned with how people can be influenced such that they become informed for commercial, political, entertainment, and other purposes.

Figure IV.19 illustrates these each as "a slice of the pie," of the domain *concerned* with *how people become informed*. The diagram is no doubt incomplete. Virtually any scholarly field might claim an interest in *how inquirers become informed* as relevant to their particular subject matter.
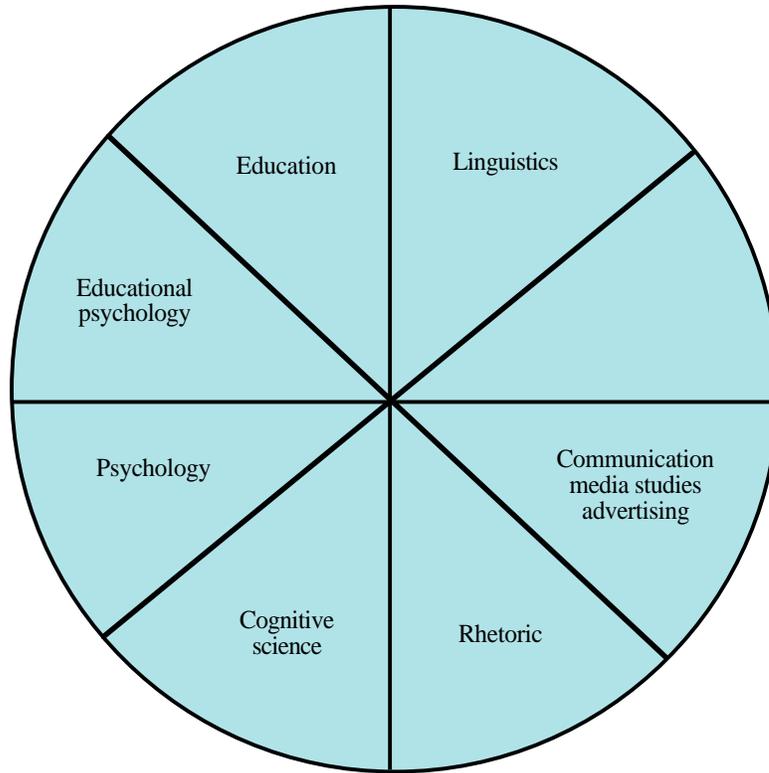
Examples of fields with a stake in

How inquirers become informed

Figure IV.19

Indeed, the very possibility of becoming informed, of *knowing* and the selection of criteria for constructing knowledge, are central concerns of philosophy, particularly epistemology, the branch of philosophy concerned with *criteria for knowing*.
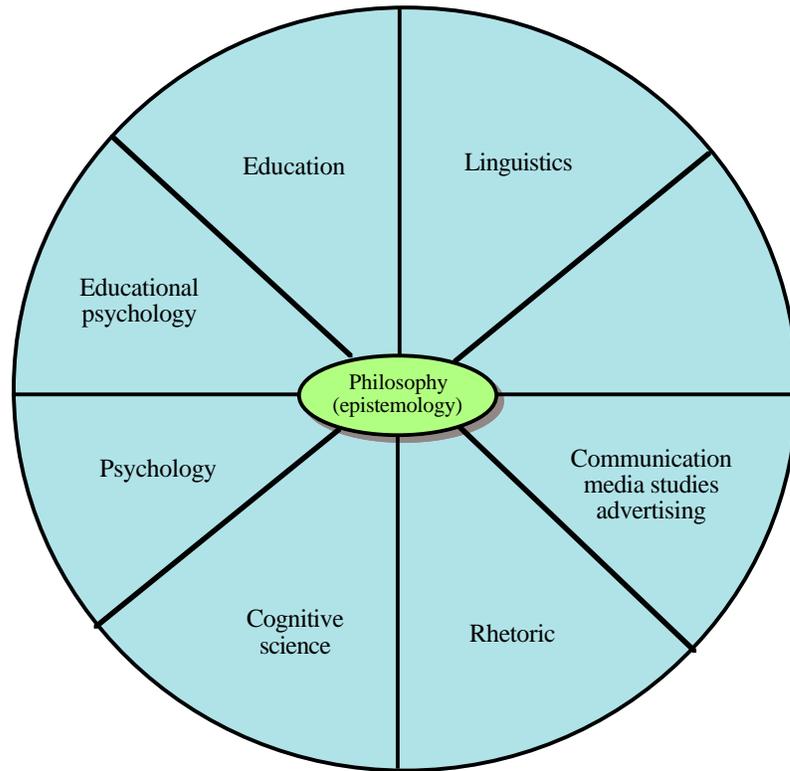
Figure IV.20

In this context, it is clear that a concern for *inquirers becoming informed* is, by itself, not sufficient to differentiate LIS from others. Indeed, each of the fields shown can make the same basic claim.

Are LIS' concerns distinguishable from these? Where does LIS work fit? Does LIS have well-grounded claim to a separate piece of this pie, or is the field merely infrastructure to the others? On what unique *concern* might such a claim for autonomy be based?

Figure IV.21

These fields are distinct from LIS in an important way: none are *centrally* concerned with inquirers becoming informed *through engagement with records*.

Indeed, none are centrally concerned with *instrumenting* records for the purpose of constructing meaning.

The unique *concern* of LIS is recognized as:

Statement of the core concern of LIS

Humans becoming informed (constructing meaning)

via intermediation between

inquirers and instrumented records

No other field has this as its *concern*.

Education

Linguistics

LIS
Library and
Information Science

Humans becoming informed
(i.e., constructing meaning) via
intermediation between inquirers
and instrumented records

Educational
psychology

Philosophy
(epistemology)

Communication,
media studies,
advertising

Psychology

Cognitive
science

Rhetoric
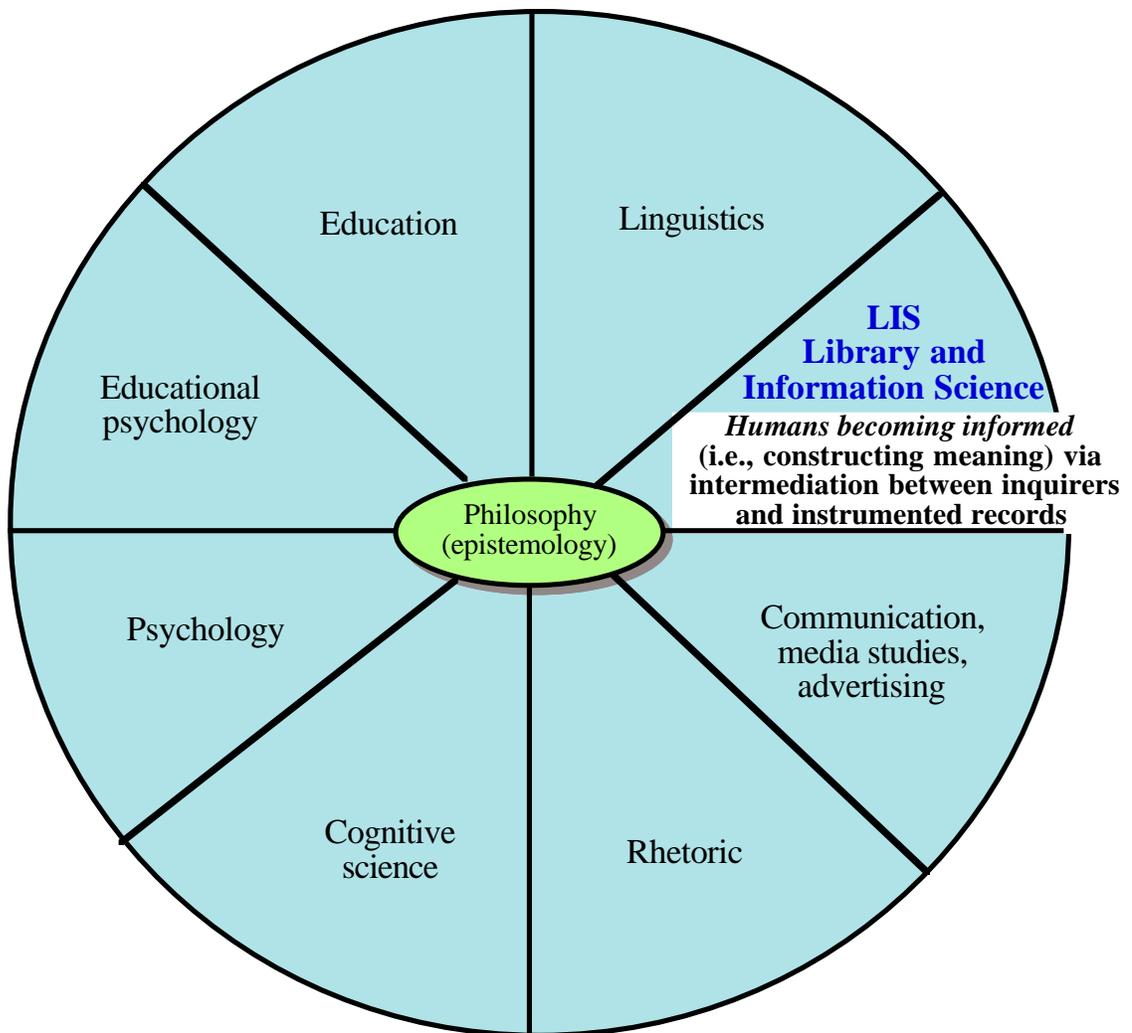
Figure IV.22

What are library and information science's core concepts?

Virtually all of the fields depicted in Figure IV.20 produce and utilize records. Their interest in their records is, of course, ardent. Even instrumentation of their records can be the focus of passionate interest within their field. For example, during the 1990's, physicists at Los Alamos National Laboratory established access to preprints of journal articles in the high energy physics community. However, such is only an *interest* of the field of high energy physics, not its *concern*. All these fields characterized above are concerned with *humans becoming informed*, but none have, as their *concern*, the study of the nature and development of *instruments* through which records are instrumented for *becoming informed*. Concern for instrumented records (i.e., collections) is thus claimed as an element of the *concern* of LIS. Conversely, instrumenting (designing, collecting, organizing, maintaining, and providing access to) collections and domains is *not* the *concern* of any other field. Moreover, inquiry has also been shown to be an element of the *concern* of LIS. With these, the statement of the core concern of LIS can be offered as alluded to earlier:

<div align="center">

Humans becoming informed (constructing meaning)

via intermediation between

inquirers and instrumented records

</div>

Note that the promiscuous term *information* does *not* appear in the above statement circumscribing the field's central concerns: The detrimental effects of the ambiguity this term provokes are discussed above (Part III). Furner [Furner 2004, 427] has shown that discourse in the field is improved where specific terms are utilized in place of the *i*-word for specific senses of that term.

Two principle *tasks* are expressed by this Statement of concern, both described in IV.3:

<div align="center">

instrumenting

intermediating

</div>

They are discussed briefly as they relate to LIS' core concepts.

Records, instruments, and instrumented records

What are *records*? *Records* are *pronuntiatio*, tangible objects. They manifest *elocutio*. A record, or document, is an organized set of *elocutio* expressions intended to *pro*voke cognitive processes of the reader to *e*voke concepts and conceptual structures, i.e., to construct meaning. Records are objects constructed to *preserve* expressions rendered using terms (usually) selected from some established language or linguistic system (e.g., English, French, Aleut, various dialects of so-called "natural languages," mathematics, music, body language, images). Forms of records, *pronuntiatio*, include the codex, printed documents, entries in databases, web pages, entries in blog systems, audio disk recordings, and printed or engraved images on paper, and other material such that expressions are materially rendered and stored in a manner susceptible to human senses.

What are *instruments*? Instruments are tools for performing tasks. One such task is representing imperceptible phenomena in sensory-susceptible (e.g., visible) form. In this context, *instruments* of various types are man-made systems for *facilitating access to records*, e.g., classification schemes, abstracts, indices, tables of contents, union catalogs, author-title-subject catalogs, dictionaries, thesauri, glossaries, bibliographies, syndetic components of documents (titles, chapters, pagination, colophons, internal and external hyperlinks), human-computer interfaces, web servers, blogs, policies, museums, archives.

Why is the limitation of *instrumented* records essential in the above statement? Why not simply *records* or *texts*? The reason is that LIS is purposive: concerned with *understanding, designing, and constructing the instruments* used to instrument records. This concern differentiates LIS from all other fields. For example, a primary concern of teachers is their intermediation between students and concepts regardless of whether concepts are expressed in recorded form. Psychologists are concerned with how people construct meaning regardless of stimulus. Linguists are concerned with which meanings are constructed from texts as well as live speech. All are concerned with their records. However, none of these have as their *concern* the *organizing and instrumenting* of records. The concern of education is teaching and learning. The concern of psychology is the mental realm. The concern of linguistics is the relationship between expressions and construction of meaning. None of these are comparable to concern with *organizing and instrumenting* records. (*Organizing* refers to *projecting* relations among conceptual objects. It is intellectual labor as distinct from clerical work.)

Intermediation

The tasks and resources associated with intermediation have been described above (Part IV.3). Conventional characterizations of LIS view the intermediary's core work as acquisitions and collection development, cataloging, classification, reference service, and archival and preservation work. None of these are granted the cognitive authority of scholarly fields but are generally seen as clerical. However, concern for intermediation according to the Model of Inquiry described above, specifically, the nature of derivation and expression of concepts, rises to the intellectual level of scholarly field.

Intermediation is the physical and intellectual labor expended in course of engagement with inquirers. This intervention is organized around the elements of the Model of Inquiry [see Part II.2], especially ascertaining the inquirer's prior knowledge, mapping their question to the intermediary's own domain (*reference structure*), projecting their *reference structure* upon the inquirer's question, and expressing those explanatory paths to the inquirer. Intermediating also includes instrumenting texts in preparation for engagement by inquirers. These tasks and the Model of Inquiry underlying them differentiates LIS from all other scholarly fields: no other field is concerned with the cognitive and conceptual operations of instrumenting the reconstruction an inquirer's cognitive question and connecting that conceptual object to concepts expressed in texts.
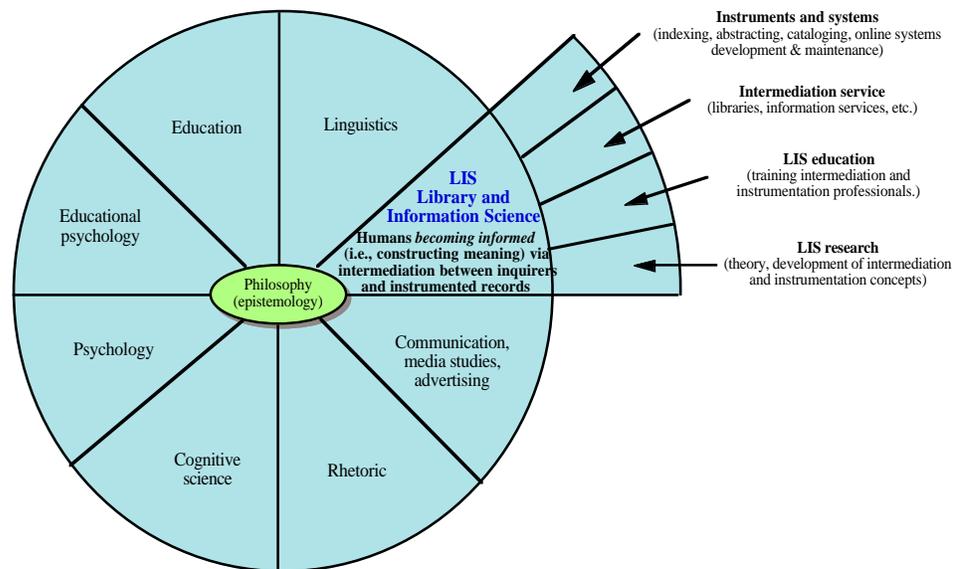
Figure IV.23

Intermediation thus encompasses the understanding of, and *intervention* in, the inquirer's evocational processes whereby ideas arise from engagement with, and provocation by, texts (i.e., reading) inscribed as physical records.

Accordingly, Figure IV.23 illustrates the functional composition of the field:

No others have intermediation and instrumentation of records as their central or even peripheral concerns. LIS originates theory about inquiries, the psychological concepts of becoming informed, conceptual objects and processes, the nature of records, the nature of instruments, the interaction between instrumented records and inquirers that constitutes intermediation. Not only is this a substantive intellectual core, but it is distinguishable from other intellectual fields. No other field is *primarily* concerned with people becoming informed via *intermediation between inquirers and instrumented records.*

Importance of core concepts

Why is having a *unique* concern imperative? The academy is no less competitive than the workaday world. To survive and succeed, scholarly fields and their investigators, practitioners, and educators must select with care the niches in which they choose to compete.

In recent decades, LIS has found itself competing in the domains where others make legitimate claim, have greater resources, and thus displace traditional LIS activity, e.g., automation, database design and operation, "networked information," social and governmental policy, economics of information, legal aspects of information.

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One competes with others on their native conceptual turf to one's detriment. A better strategy is to compete where one is regarded as "the best there is."

The core concepts and activities described here are claimed to be those in which LIS may be regarded as preeminent: intermediation to, and instrumentation of, texts.

Structure of the field

Figure IV.23 shows LIS as comprised of four specializations: instrumentation and intermediation (as described in Part IV.3), and education and research, elements of every scholarly field.

This conceptualization of the field accommodates HCI developers, IR specialists, web designers, and librarians. For example, reference intermediation is provided, in part, in the form of web resources navigable by inquirers, invisibly assisted by clever machine-based algorithms. These new elements take their place alongside library service traditions, but do not displace them. This coexistence is reflected in real world academic libraries.

This four-pillar model reflects core concepts derived from Assimilation Theory that are not taken into account in two-column models founded upon technology and social science (particularly the cognitive aspects of intermediation (Part IV.3)), nor in a chain-link model comprised of computer science, management science, social science, information science (undefined), economics and policy, design and architecture, human-computer interaction, and social studies. None of these focus on concepts that differentiate LIS from all others (see itemization in next section, Interdisciplinary vs. a unique conceptual core).

An Assimilation Theory-Model of Inquiry approach implies a different model of the field: one of instrumenting records for intermediation (intervention) for the purpose of an inquirer's *becoming informed*.

Interdisciplinary vs. a unique conceptual core

LIS is often characterized as interdisciplinary.   This can be interpreted in two ways:

> LIS is founded upon unique core concepts, and additionally inter-reads
> with other disciplines

> There are no unique core concepts that differentiate LIS;
> Instead, LIS is nothing more than a combination of other fields.

With sporadic attempts within and among i-schools and LIS schools to define core concepts, accompanied by wholesale failure to acknowledge any such ideas, the latter conceptualization has prevailed over the former.

To the contrary, this section, indeed this entire investigation, shows that concepts unique to LIS are recognizable.

> Intermediation between inquirers and instrumented records
> Reconstructing the conceptual structure of an inquirer
> Conceptual indexing of texts
> Constructing reference structures
> Isomorphically mapping elements of an inquirer's cognitive question to the
> reference structure
> Isomorphically projecting concepts expressing in the reference structure to
> the inquirer's cognitive question

> Identifying explanatory conceptual paths, and recommending texts accordingly.

Figure IV.23 reinforces the notion that LIS is *not* merely an interdisciplinary combination of the concerns of others. Each of the others in the pie, though concerned with inquirers becoming informed, has its own particular approach.

Fields other than those depicted in Figure IV.23 are frequently regarded as *comprising* (not merely *contributing to*) an interdisciplinary LIS. These include computer science, law, management, social science and policy to name the most familiar. However, each of these is distinct from LIS and from the other fields shown in the Figure: they are *not* primarily about *people becoming informed*, and are thus ancillary. Computer science is primarily concerned with understanding digital devices and algorithms. Economics is concerned principally with matters of production, distribution, consumption, and value of goods and services, not with people becoming informed. Law is a theoretical and practical field that centers on rules and procedures for ascertaining compliance and enforcing rule sets, not with people becoming informed.

The Assimilation Theory viewpoint refutes the notion that LIS is *essentially* interdisciplinary, and instead reveals core concepts and skills unique to library and information science.

Which scholarly fields are LIS' next-of-kin?

The notion that indexing is an interpretative act has been acknowledged above. Indeed, instrumentation, rendering the imperceptible perceptible, is an interpretive act. Similarly, the LIS counterpart to instrumentation, intermediation, is overtly interpretative:

intervention requires expressing the entities encountered in different terms. *Organizing* is selecting and instantiating relations among entities, and *selection* is an interpretative act.

There are many scholarly endeavors whose *concern* is *interpretation*. These cognate fields include the arts, architecture, music, dance, literature, theater, and others. They may employ quite different linguistic systems (ballet, atonal music, a romantic genre, Bauhaus, baroque, or impressionistic), but procedurally, they are the same as ordinary writing: They begin with conceptions and arrangements of ideas and a desire to express them. Terms are carefully selected to express those ideas, and they are rendered in physical form, exposed to the physical world. That is, they are *inventio* ➜ *dispositio* ➜ *elocutio* ➜ *pronuntiatio*

(i.e., expressing, as in writing, speaking, and performing). The fundamental work of these, interpretation, corresponds to LIS' essential subject matter interest in interpretation.

A chorus of i-writers and thinkers continuously proclaim that LIS is an interdisciplinary field comprised of information technology, computer science, law, management, economics, and other social sciences who are LIS' intellectual next-of-kin. But they cannot be, for none of these are *concerned* with *interpretation*, nor in *inquirers becoming informed*.

Rather, it is those whose central interest is *interpretation* who are LIS' closest kin,

<div align="center">the humanities</div>

The humanities encompass the branches of learning concerned with human thought and its expression through communication, cultural practice, and artifacts. Communication and culture are certainly shaped, in part, by technological context. Yet, clearly, technology alone does not equate to *inquirers becoming informed*. Nor have

technological advances been accompanied by theoretical advances in understanding the Basic Relationship.

The claim made here is not that technical or social science endeavors are not relevant to the field, but that LIS has failed to build relationships with fields closer to its core concern -- those concerned with *people becoming informed*.

Some may challenge this view on the grounds that funding and prestige are less likely to find their way to projects wearing the mantle of the humanities. However, no suggestion has been made that LIS should forsake its *interest* in technology nor the other disciplines with whom LIS has partnered. The view taken her holds only that it is incumbent upon LIS to assimilate the knowledge that kindred scholarly fields have accumulated to gain a better understanding of intermediation between inquirers and instrumented records.

Research processes as part of LIS' domain of concern

With its core concern of *inquiry*, LIS professionals require knowledge of research writing processes. Indeed, a sizable literature concerned with reading, writing, and methodologies for conducting inquiries that result in writing research *reports* (not to be confused with quantitative and qualitative research methods) has no apparent scholarly home. LIS research and teaching in the conceptual skills of inquiry has declined. What remains is "information literacy," how to use databases, and training as to where reference materials in the library may be found. This sort of sub-intellectual training attracts very few students.

Plagiarism analyses are administered using isomorphic mapping of concepts and expressions of concepts. Research in text analysis clearly falls within the LIS skill set.

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Topics such as reading and writing methodologies, and conceptual tools for thinking and expressing ideas, the nature of writer's block and conceptual remedies, and understanding plagiarism, are presently dispersed throughout the academy and even wholly outside. These communities of interest might benefit from assimilation into LIS as a scholarly home. Conversely, LIS might benefit from the attention these subjects can bring to LIS' core concern with *inquiry* research, practice, and education.

A significant implication of an Assimilation Theory-consonant LIS (Part III, above) is the expansion of the LIS enterprise to annex practice and research that attends to reading theory, writing theory, and inquiry theory including the sector of research methods that addresses expressing, structuring, and accessorizing texts to improve the lot of the inquirer endeavoring to become informed.

If LIS is a field concerned with inquirers *becoming informed*, and thus teaching students preparing for professional practice, certainly the field may be expected to be concerned with, among others, theories of *reading*. At present, LIS is not.

As the mission of a scholarly field is not confined to teaching, but also encompasses formulating and conducting research programs to advance what is known about its *concern*, in LIS' case, how people become informed through engagement with instrumented documents, LIS may be expected to participate in setting the research agenda in *reading theory*. At present, LIS does not.

"Scientific" research in reading was an active, if small part of library science from 1900 to the 1930's. Waples and other researchers failed to achieve meaningful advances in understanding the effects of reading upon people, cognitively or in other dimensions. Although selection issues in collection development still receive attention in LIS curricula, research into reading and writing and their impact upon *becoming informed* has

all but disappeared from LIS. In psychology, educational psychology, communications and rhetoric (specifically regarding acting and storytelling), cognitive science, and the humanities (regarding expression in the form of literature, art practice, music, drama), attention to reading and writing is sporadic and is generally uncited by LIS writers.

If LIS is a field concerned with inquirers *becoming informed*, and thus teaching students preparing for professional practice, and if *writing* is one of the means by which people become informed (either as a writer oneself or as a reader of someone else's writing), certainly the field may be expected to be concerned with, among others, theories of *writing*. At present, LIS is not.

As with research in the construction of meaning from reading, LIS may be expected to participate in setting the research agenda in *writing theory*. At present, LIS does not.

Of course, producing *pronuntiatio* is not the difficult aspect of writing unless one is confronted with a faulty printer. Organizing (i.e., *projecting* relations onto a set of objects) one's thoughts into a coherent arrangement, *dispositio*, is nearly always the most challenging. It is intellectual rather than clerical work and encompasses the inability to organize, search for, recognize, and establish relations among concepts. Once having identified concepts and relations, finding the right words to express one's ideas, then re-editing because it still doesn't quite "say what one wants it to say" is not merely a thesaural task of selecting terms, but usually includes revising, reconstructing, one's *dispositio*. This is what makes writing difficult.

Nor is improvement in a writer's writing *per se* the field's concern. This concern generally falls to departments of English composition. LIS' concern is for the effect of writing on the inquirer, becoming informed through writing.

Conceptual skills and implications for LIS curricula

What skills might be required for instrumenting texts and performing intermediation as described above (Part IV.1 and .2)? Which skills may be regarded as *core* skills, for which mastery might be expected of all in the field, and which are specialized skills that need not be mastered by everyone? How might an LIS graduate curriculum accommodate development of both core and specialized skills?

From a perspective of the LIS enterprise as a whole, acquisition of a working knowledge of elements of the Model of Inquiry will be an indispensable framework for operationalizing an Assimilation Theory-consonant LIS. To recapitulate from a skill orientation (from Interdisciplinary vs. a unique conceptual core, Part IV.4), it entails:

<div style="border:1px solid">

<u>Elements of Intermediation between inquirers and instrumented records</u>

<u>Instrumentation</u>

    Recognizing concepts and differentiating them according to their attributes

    Conceptual indexing of texts

    Constructing reference structures

<u>Intermediation between inquirers and instrumented records</u>

    Reconstructing the conceptual structure of an inquirer

    Isomorphically mapping elements of an inquirer's cognitive question to the reference structure

    Isomorphically projecting concepts expressed in the reference structure to the inquirer's cognitive question

    Constructing and expressing explanatory paths

    Identifying and associating texts with explanatory paths

</div>

<u>Conceptualizing, generally</u>. The basic skill of recognizing concepts is a core skill and includes the ability to differentiate among a concept's Divisions of Rhetoric manifestations, that is concepts and relations, as distinct from linguistic expressions, as

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distinct from presentation or performance of those expressions in physical media. Secondly, it entails the ability to perform the derivations *inventio* ➔ *dispositio* and *dispositio* ➔ *inventio*. *Inventio* ➔ *dispositio* is the ability to unpack a concept into its component concepts, relations, and labels (Part II.2).

Conceptualizing about the field. A *core* skill. Anyone considered to be a member of a scholarly community is expected to be able to:

> identify its core concepts and

> articulate them and explain how they differentiate the field from others.

Comparative conceptualization. A *core* skill, anyone considered to be a member of a scholarly community is expected to be able to receive an article or a claim about some work, identify the concepts it evokes, and then identify how those concepts relate to one's conception of the field's core concepts. Critical thinking regarding one's field is a *core* skill.

First steps in characterizing skills required to perform conceptual indexing are suggested above (Part IV.1). Facility with conceptual manipulation entails several skills:

> Recognize when a concept is identical to another except in linguistic labels, and recognize when a concept possesses a property different from another concept.

> Recognize specific types of *dispositio* such as metaphors, idealized cognitive models (ICM), warrants, assumptions, and evidence, for indexing purposes.

> Characterize a concept's attributes (Inter-*dispositio*, Intra-*dispositio*, *elocutio*, and *pronuntiatio*) in the form of a *dispositio* record.

Interviewing skills as used by a skilled reference specialist are relevant to instrument designers that must facilitate the reconstruction of an inquirer's cognitive question.

Intermediation between inquirers and instrumented records. Intermediation requires several core skills. An LIS professional is able to perform the intermediative tasks (above) regardless of medium, e.g., inquiry in person in real-time, or instantiated as an automated instrument.

LIS is a producer of derivations, and even of derivation-producing systems (e.g., indexing languages) covering vast rather than narrow subject matters. Consequently, confusion is especially detrimental where, in LIS, surrogates are mistaken for objects from which they are derived. To the extent that LIS differentiates its core concerns from others based upon the fundamental notions of *dispositio*, *elocutio*, and *dispositio-inventio*, LIS has a greater obligation than other fields to recognize the conflation of objects of these distinct types when encountered, to confront conduit metaphor, and to construct its systems and instruments mindful of these distinctions. Intermediators, like indexers, must be adept in differentiating among objects of the Divisions of Rhetoric reference model. That is, as mastery of conceptual instrumentation is a core skill, and both indexers and intermediation specialists (researchers, designers, and service practitioners) may be expected to be held to a higher standard than others in recognizing and avoiding conduit metaphor error.

The basic tasks of the intermediator are (1) designing and constructing instruments for accessing texts, and (2) assisting inquirers in using them. In the latter, the intermediator is expected to be able to recognize the elements of an inquirer's cognitive question, including incomplete paths and obstructed paths, to perform an initial search for *dispositio* based upon *elocutio* (terms, labels), and then perform browsing and construction of *dispositio* records that comprise the reference structure, not confusing them with texts or text retrieval.

Essential skills for intermediation encompass those for conceptual indexing, particularly the ability to perform isomorphic projection from a conceptual reference structure onto a reconstruction of an inquirer's cognitive question, and recognize incomplete relation paths and obstructed paths.

LIS professionals, presumed to be experts in inquiry, conceptual structure, and its manipulation, may be expected to be expert at recognizing flawed claims, fallacies, epistemological contradictions, and internal inconsistencies when expressed by texts.

In summary, recognizing concepts, performing isomorphic mapping, isomorphic projection, and indexing, are regarded as *basic* LIS skills from an Assimilation Theory perspective. Concept mapping techniques are likely to be helpful in depicting relationships among *dispositio*.

LIS Curriculum. Because consideration of this or comparable Models of Inquiry is not presently reflected in i-school curricula, there is an opportunity for leadership: to produce graduates who have acquired mastery of the skills itemized in this section. Such skills are not about technology, not particularly quantitative, nor about social, economic, or legal policy, but rather, of a very specific qualitative type: basic conceptualizing skills. These skills, as practiced in relation to instrumenting records (texts), differentiate LIS from the rest of the scholarly enterprise.

The dissertation was prepared using only word processors, a spreadsheet program, standard web clients, and a concept-mapping software package. Of all the tasks and skills required in the conduct of this investigation (conceptualization of the study, assimilation of principles from educational psychology, cognitive linguistics, rhetoric, and communications studies, the selection and interpretation of texts, and speculating as to an improved understanding of the Basic Relationship), all of which adhere to the

guidance of the University of California at Berkeley Information Planning Group document that formed the mandate for the School of Information Management and Systems (subsequently i-School), *none* required applet programming, C programming, or computer programming of any kind. The implication for LIS education is that matriculating graduate students who are capable of conducting the sorts of research envisioned by the founders of the School should regard programming and engineering skills as specialized rather than as core skills for admission purposes. The pendulum might have swung from the systems-centered end of the system-inquirer continuum in many respects, but graduate admissions requirements appear to be lagging.

The reputation of LIS schools and the field, even as a professional field, depends, as does any scholarly field, upon achieving better fundamental understandings of phenomena in the field through teaching and research, not exclusively by building gizmos. Thus emphasis on *both* understanding of the Basic Relationship that underlies the technological component of the field, as well as the engineering itself, is appropriate. Presently, the LIS curriculum is, for the most part, silent as to inquiry, intermediation, and the Basic Relationship.

Specialized (non-core) skills

Should every LIS professional be a competent database developer or programmer? For those in some sectors (Figure IV.23), technical skills are indispensable. For those in the other sectors, it is unlikely that requiring extensive technical skills is justified.

The Primary Finding implies a shift from one paradigm to another, from conventional thinking about LIS to an Assimilation Theory perspective. Accordingly, little surprise may be expected in finding that some skills regarded as indispensable according to LIS

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convention are regarded as peripheral or specialized from the perspective of the Assimilation Theory Model of Inquiry.

Admission to modern i-schools generally emphasizes technical savvy over subject matter knowledge. While technology has, for centuries, played a role in design, construction, and maintenance of LIS intermediation, an Assimilation Theory perspective of the field acknowledges the essentially *human* aspects of intermediation: assimilation and cognitive manipulation of concepts, expression, interpretation, isomorphic projection for the creation of new ideas, and particularly, the intermediary's reconstruction of the inquirer's prior knowledge as a foundation to constructing a conceptual explanatory path that leads to appropriate texts. These tasks might be simulated by computing systems, but they are not *about* computing. Nor are they essentially quantitative.

Indeed, had technical requirements for Java applet writing and gizmo development been in place, the present report would never have been written, nor would philosophers such as Patrick Wilson have been among our number to illuminate the Two Kinds of Power, the nature of Second Hand Knowledge, or Public Knowledge Private Ignorance.

Value of inquiry-related skills

Despite the structural changes both inside and outside the library and information domains, inquirers still generate cognitive questions. One may speculate that inquirers collectively conjure more cognitive questions today than ever before. There is a demand, a market, for explanations. Some of those explanations will be derived from instrumented records, and thus there is a demand for LIS professionals.

Fragmentation of the record began, according to some accounts (see: Part II.2, and [Saracevic 1975 323]), with the inception of the scientific article displacing comprehensive texts. Fragmentation implies that connections and relations among texts and among concepts are not provided to inquirers except through citation and references, and must be constructed by the reader. In the Assimilation View, to ascertain and exhibit relations among fragments is native LIS work.

IV.5   A program for ongoing research

Various projects have been suggested throughout Parts III and IV as follow-on research work. The highlights are summarized here.

Experimental work on conceptual indexing of texts is an obvious point of departure for follow-on work. The notion of indexing concepts has arisen in several venues historically and more recently since the 1980's in the field of artificial intelligence. However, the approaches taken in AI and expert systems have been rule-oriented, do not take account of the *inventio-dispositio* attributes as described above, and do not reflect psychological theory, rhetoric or communications theory, in any appreciable way. Constructing ontologies has been fashionable for more than a decade but has contributed only minimally to LIS theory, and been largely unable to reach beyond experimental efforts to have impact on service and systems.

Within LIS, the idea of concept indexing is occasionally mentioned but the approaches are inconsistent and more *ad hoc* than reflective of a core skill. Future research toward more detailed review of the indexing and classification literatures is, however, likely to be fruitful.

Serious attention to concept indexing might begin with indexing concepts expressed by encyclopedia articles because they are generally succinctly written. Conceptual indexing of authors' works might be derived from biographical dictionaries. Following these, small collections should be analyzed and indexed according to all three layers of the Divisions of Rhetoric reference model. The utility of adding *dispositio* record elements that accumulate the frequency of use of the particular concept should be investigated.

One place *not* to start is with development of standards for *dispositio*-, *elocutio*-, and *pronuntiatio*- record structures.

Linguistics research should instead be drawn upon. For example, a *dispositio* record for the concept

<div align="center">

The lady saw a cat.

</div>

likely would differ from

<div align="center">

The lady saw a *cat***.**

</div>

Obviously, reliance on terms alone is insufficient to derive different meanings from the text. The *relations* between "The lady" and "cat" might differ in each. Investigation into characterizing relation concepts might be another facet of the near term stage of an overall ongoing research program. Better characterizations of types of relations among concepts would yield a richer reference structure. Historical paradigms for expressing relations among concepts and texts including Otlet, H.G. Wells, and Ostwald, among others should be revisited for their ideas regarding *explanatory paths*, as should the literature of *memory palaces* and the art of memory in ancient rhetoric.

Anyone who has prepared to teach or write knows they have become informed in the process. Further work in reading theory and writing theory is needed to illuminate several Model of Inquiry elements, notably reconstructing the inquirer's cognitive question and their ability to assimilate explanatory paths. Annexation of these aspects of inquiry theory into the LIS curriculum and research program, alluded to above, offers the potential for a better understanding of how inquirers construct meaning and improved intermediation practice.

Ongoing developments in cognate fields of educational psychology and cognitive psychology, communications and rhetoric, cognitive science, and perhaps even findings in journalism, should be taken into account. For example, theories of inquiry might benefit from a better understanding of which cognitive and conceptual tasks are better performed by humans and which are better performed by machines.

Ongoing research in the use of *concept maps* for evaluation of meaningful learning and its LIS counterpart, *relevance*, should be taken into account for evaluation of Constructive Retrieval (CR) prototypes. Criteria for recommending the best of *alternate* explanatory paths should be investigated. The potential of concept mapping for quantitative and qualitative characterization of relevance through the use of concept maps depicting explanatory paths merits research.

Conceptual aspects of *interpretation* in other language systems such as music, fine arts, film, theater and body language, fiction, have not yet been adequately taken into account for their implications for an Assimilation Theory-consonant indexing language and Constructive Retrieval.

A great deal of unfinished work remains regarding understanding the processes of curiosity, planning, judgment-making and conclusion-drawing, expecting, and believing in Assimilation Theory terms.

Improved methods should be investigated for recognizing and indexing of plots, themes, and superordinate *dispositio* that project onto ideas expressed in both current events and scholarly discourse.

What role might existing bibliographic and semantic instruments (e.g., as Roget's, WordNet ([Baziz Boughanem Aussenac-Gilles 2005] [Hearst 1998]), or CYC) play in facilitating conceptual indexing and construction of a reference structure?

The possibility of finding better metaphors than *construction* for understanding *inquiry* should be investigated. The concept of *construction* has several attributes that usefully project onto the concept of inquiry, however others might be overlooked. For example, *construction* generally implies an object that is *fixed* in place, whereas an inquirer's concept structure may be regarded as flexible and growing continuously.

Throughout the findings reported here (Part III) is a troubling thread: that conceptual confusion among LIS writers and service providers is attributable, in part, to poor terminological hygiene. Among the terms for which specific senses have been found in the course of this report, beyond the obvious terms having the prefix *inform*, are: *believe* and *belief*, *browse*, *concept*, *conscious* and *consciousness*, *construe*, *context*, *coordinate* (and *control*), *derive* (and *representation* and *transformation*), *document*, *explain* and *explanation*, *implicit* and *explicit* (and *tacit*), *interpretation*, *know* (and *knowing*, *knowledge*, and *knowledge structure*), "public knowledge," *layer* (*reference model*), *meaning* and *meaningful* (and *relation*, *relationship*, and *relation type*), *mind*, *organize*, *process*, *system*, *think* and *thinking*, *understanding* (and *meaning*), *unpack*, *value* (and *benefit* and *impact*). Unfortunately exegesis of these and others is beyond the scope of this project. Nevertheless, the road to an Assimilation Theory-consonant LIS would, no doubt, pass through a site where senses of these terms were carefully constructed.

A final rabbit trail chased

In a more abstract vein, writers in many fields, including the main adherents of Assimilation Theory, Ausubel and Novak, have differentiated *thinking* from *feeling*:

> Throughout this book, I emphasize the interplay between thinking (cognition), feeling (affect), and acting (motor or psychomotor). [Novak 1998 51]

> Human beings do three things: they think, feel, and act. [Novak 1998 12]

Thus, there is understood to be a gap between *thinking* and *feeling*, between mind and matter, with *feeling* associated with sensory, autonomic, and emotional phenomena that are somewhat susceptible to investigation in medical science, and *thinking* relegated to a separate mental realm from which science-at-large distances itself. Bridging this mind-matter gap has attracted the investment of countless careers in conjuring mappings from theories of neural networks and spreading activation onto neurological phenomena, and mapping the structure of neural synapses to concept structures. As with AI, there is little success to be reported.

Suppose, however, that there was no gap between mind and matter, between *thinking* and *feeling*, but instead that *thinking* and *feeling* were one and the same, or that *thinking* is merely one category of *feeling*. Specifically, consider the possibility that *thinking* is "merely" physical *feeling* but stimulated by nerve endings in the brain rather than by those that report a poke on the arm or sense coffee aroma in the nose. Many cognitive phenomena appear to have both sensory (felt) and intellectual consequences that seem to be inextricably linked. Indeed, even everyday terminology suggests that thinking and feeling are one and the same: One may "*feel* that they understand the lesson" and if an idea makes sense, one *feels* better about it. Perhaps the same isomorphic projection that accounts for transfer, metaphor, etc. is at work here.

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What might be the consequences of *thinking*-as-*feeling*? First, the mind-body gap disappears and with it, a philosophical conundrum that has bothered philosophers for thousands of years. Second, emotions, previously conceptualized as having physical and mental origins, become more easily accounted for. Third, the pending question shifts from "How does matter manage to think?" to "How does matter manage to feel?" which, in turn, is immediately recognized as a topic reasonably well understood through medical science. Fourth, the heretofore indispensable observation that *the mind is embodied* becomes obvious, if not redundant. Abstract concepts might no longer arise as separately classified entities from basic concepts (which result from direct sensory experience), but instead, all concepts become derived from feelings derived through material sensory experience. Carried to a radical conclusion, thought might be transferred from one person to another with the transfer of physical tissue, cognitive transplants, if you will. An uncomfortable prospect indeed. (This possibility is not advocated, but merely acknowledged as a consequence of concepts-as-feelings arising from human neural material.)

Why does this question arise here? In conceptual indexing, one is faced with a question as to what the essence of the objects indexed is. For *pronuntiatio* objects, i.e., physical objects, indexers are accustomed to describing its properties. *Elocutio* objects, texts, are routinely described by well-understood attributes distinct from concepts and physical objects.

But what *are* concepts? Of what do they consist? The best that could be done in this report was to characterize them as mental objects comprised of nothing but links to other objects, intra-*dispositio* links, inter-*dispositio* links, labels, etc. But there is no "there" there. If, however, they arose from stimuli inherent in neural matter, as indeed they must,

just as do other feelings like itches, pains, and sneezes, a better understanding for where concepts might they reside is available.

As the scope of the present inquiry does not extend to brains and their associated neural accessories, this line of inquiry terminates here, hopefully to be taken up by others in a way that sheds light on *meaningful learning* and *becoming informed.*

IV.6 Conclusion

Let us step back now from the trees and consider the forest. What can be said of LIS's understanding of the Basic Relationship? Can meaningful responses be provided to the tripartite Research Question?

> (1) How has the relationship between *how inquirers become informed* and *how LIS systems intermediate to serve that inquirer* (the Basic Relationship) been understood in LIS theory and practice?
>
> (2) How might this Basic Relationship be interpreted according to Assimilation Theory?
>
> (3) How might the contrast between these two understandings suggest an improved LIS theoretical framework and better practice?

As to the first part, on one hand, the texts analyzed indicate ample evidence that LIS writers *assume* that its instruments and services result in inquirers successfully constructing meaning through engagement with LIS-instrumented texts. On the other hand, however, the majority of LIS writings provide virtually no account of resources that might be required for that very construction of meaning (e.g., assimilation, isomorphic mapping, isomorphic projection). The intellectual work performed by inquirers themselves is transparent, virtually invisible in the bulk of LIS theoretical and practical writing.

In this, there is the most fundamental of disconnects. Becoming informed is essential, but how people do it is little-studied. A gap of this significance should attract substantial attention. Indeed, graduate students and faculty have been invited:

to explore . . . the nature and properties of information . . . information and meaning . . . conditions of reception: information and comprehension, understanding . . . information and conceptual frameworks . . . drawing on expertise from cognitive psychology.
[UCB IPG 1993]

In addressing the second, and particularly the third, portions of the Research Question, the report has been responsive to the Information Planning Group's invitation.

Similarly, this study has attempted to illuminate aspects of becoming informed, particularly the *dispositio*, that are responsive to Patrick Wilson's call:

What we would like, for its possible help in improving techniques for content representation, is deeper understanding of the phenomenon of understanding itself . . .. [WilsonP 1983a 397]

Some ideas emphasized in this study have been known since antiquity but forgotten in modern practice (For example, rhetoricians were taught to attain empathy with their audience by understanding their concerns and interests as a point of departure on leading them to the subject matter of their speech). Other ideas expressed above were genuinely unknown (e.g., the stages of the Model of inquiry and its applicability to revealing undiscovered public knowledge).

A prominent theme in LIS is concern with the nature of relevance. Saracevic observed, in 1996:

. . . psychological relevance, as conceived, is a most limiting framework for relevance in information science. It has a similar, and even larger, blind side as situational relevance. While it is developed in reaction to IR, no attempt is made to connect it in any way to IR.
[Saracevic 1996]

This report has attempted to explicate exactly that connection by showing that the concepts forming an explanatory path mitigate the obstruction or gap that constitutes an

inquirer's cognitive question, and are thus *relevant* to it. The explanatory path is one of two results of Constructive Retrieval (CR) (the other being recommendations of texts). CR is distinguished from IR in this way.

With inspiration from the review of Swanson (above), this report draws to a conclusion by asking, as Michael Buckland suggests,

> What might be the impact of taking the Basic Relationship seriously?

I claim:

> There is no reason, in principle, why the methods of (1) conceptual indexing applied to domains of texts and (2) Constructive Retrieval, cannot be brought into routine operation to recognize and report explanatory paths expressive of potential solutions to problems, the explanatory paths and solutions being ones that no human had previously discovered or knew.

More specifically, I claim:

There is no reason, in principle, that conceptual indexing cannot be performed upon a text to derive *dispositio* records, *elocutio* records, and *pronuntiatio* records, appropriately linked;

There is no reason, in principle, that *dispositio* records cannot express relations to one another;

There is no reason, in principle, that an inquirer cannot search textual descriptions of *dispositio* records to identify approximate concept expressions that reflect both their target idea and their existing knowledge structure;

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There is no reason, in principle, that an inquirer cannot browse concepts depicted as adjacent to *dispositio* records selected as reflective of their target idea and prior knowledge;

There is no reason, in principle, that the *dispositio* records finally selected by the inquirer cannot be isomorphically mapped onto an LIS reference structure comprised of *dispositio* records;

There is no reason, in principle, that the reference structure cannot isomorphically project the sum of its structured *dispositio* records upon the inquirer's specified concepts to identify and present (as concept maps) sequences of *dispositio* records, i.e., explanatory paths, that link the target and prior knowledge records specified by the inquirer;

There is no reason, in principle, that inquirers cannot select, from alternative explanatory conceptual paths presented to them, those conceptual paths they deem most relevant to their inquiry;

And finally, there is no reason, in principle, that such an LIS intermediation instrument cannot report to the inquirer those texts associated with the explanatory path(s) finally selected by the inquirer.

The texts reported to the inquirer are claimed to be likely highly relevant to their inquiry, relevance having been ascertained by the inquirer prior to identification of specific texts.

Beyond the confines of intermediation with the individual inquirer,

There is no reason, in principle, that collections or domains of texts, instrumented according to the conceptual indexing described above, cannot express never-before-known-to humans explanatory paths responsive to questions and problems.

There is no reason, in principle, that discovered explanatory paths cannot operate to overturn or refute scientific or political claims.

There is no reason, in principle, that discovered explanatory paths cannot be used to originate patent claims or to evaluate existing patent claims.

An apotropaic postscript

As LIS overcomes its hypnotic fascination with digital technology and regains its focus upon the human cognitive aspect of intermediation, improved understandings of LIS instruments can then arise, and creative labor in developing new instruments that engage inquirer's intellects become possible. At present, this fertile territory is still a frontier, mostly unexplored, ripe for progress.

Sooner or later, if the ideas expressed here are embraced, some will be tempted to automate the intermediation in a way that omits the human intermediary, perhaps even the human inquirer. The price to be paid for that program is the loss of the skills that computers cannot have and thus, functions they cannot perform: Automata cannot, at least presently do not, possess central nervous systems with feelings from which concepts arise. Such a program will never be human and thus never be capable of the essence of the field, *becoming meaningfully informed*.

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Footnotes

[Footnote II.1]

The title page of [ARK] describes David P. Ausubel as a Distinguished Professor Emeritus of The City University of New York. He also held an appointment at the University Center for Private Practice in Psychiatry (CUNY). The Directory of the American Psychological Association (1997 edition) include the following entry:

> Ausubel, Dr. David P. b Oct 25, 1918. MD Dev Psychol 1943
> Middlesex U.,   MF- Psychiat. SP child & Adol Psychiat; drug abuse.
> Psychiat Self-Empl;
> Distinguished Prof emer, PhD. Prgm, Ed Psycholo 75- CUNY Grad Scho and
> Univ Ctr Priv Prac of Psychiat.

[Footnote II.2]

> Education Full Text indexes articles from English-language periodicals and yearbooks published in the United States and elsewhere on all topics related to education, 1994 - present. A search on "Ausubel" in returned only 13 citations. A similar search in ERIC retrieved 139 items.

[Footnote II.3]

> For example:
>
> Art: http://oregonstate.edu/~vanlondp/courses/art300/resources.htm
>
> Regional Planning: instruct1.cit.cornell.edu/courses/crp637/bibliography-F02.html
>
> Law: www.law.stetson.edu/lawlib/nettitles.htm
>
> Music: http://www.sci.sdsu.edu/CRMSE/Fisher_aaas2000.html

[Footnote II.4]

> Ausubel dismisses Miller's notion of *chunking* as "rote capacity for apprehending and retaining information" [ARK 79].

[Footnote II.5]

Elementary and high school students from the 1950's and 1960's may recall the arrival of new styles of "teaching." One personal recollection is the daily meeting of a high school English class where the instructor would configure the seating into a circle, indicate the topic, and simply command, "Discuss!" I don't recall whether the concepts for the topic ever arose in conversation or were learned. I recall that they were not *presented* as such, and the sensation of wondering whether we were spending our time wisely. Possibly the concepts did arise and we assimilated them without being aware.

[Footnote II.6]

On 14 December 2005, a search on Ausubel as used in reference entries of articles in the PsycINFO database returned 455 results (with unknown precision) of a database of "Over 2,167,174 records as of October 2005. " (http://oh1.csa.com/factsheets/psycinfo-set-c.php) and 78 records in PsychArticles, a database of "More than 40,900 articles as of August 2004. " (http://oh1.csa.com/factsheets/psycarticles-set-c.php)

[Footnote II.7]

The term document has also been used in the sense of an object in a collection where the object might not have the properties of a *record* produced by humans.

[Footnote II.8]

Columbia Encyclopedia. *Scholasticism.*

Much knowledge of ancient philosophy came to the early scholastics through the writings of Boethius. John Scotus Erigena continued the tradition of Neoplatonism in the 9th cent., adding to it certain mystical notions of his own.
. . .
The beginning of scholasticism can be identified in the methods used by civil

and canon lawyers of the 11th and 12th cent. to reconcile seemingly contradictory statements. St. Anselm in the late 11th cent. took as his life's motto "fides quaerens intelligentiam" [faith seeking understanding], and sought to use reason to illuminate the content of belief.

. . .

The 13th cent. is generally regarded as the golden age of medieval philosophy. It was marked by two important developments: the growth of universities, especially at Paris and Oxford (see colleges and universities), and the introduction of Aristotle into the West.

. . .

In the late 15th cent. the Dominicans began a Thomistic revival; its brilliant leader was the reformer Cajetan. There was also a living Scotist tradition, and every Catholic university had Thomists and Scotists in its theological faculty. After the 18th cent. the secularization of the universities resulted in the suppression of the theological faculties, and the old tradition was broken. [Columbia Encyclopedia *Scholasticism*]

[Footnote II.9]

I anticipated the opposite, i.e., that the secondary subject, the new ideas, would be regarded as an individual thing, *inventio*, and the primary subject, i.e., that the learner's existing knowledge complex be regarded as a system [*dispositio*], or that both be regarded as *dispositio*.

[Footnote II.10]

See also [Gentner Gentner 1983].

[Footnote II.11]

John Seely Brown and Richard Burton developed a computer model called Buggy that attends to debugging misconceptions.

[Footnote III.1]

> The subfield of computer science that deals with the automated storage and
> retrieval of documents is called information retrieval (IR).
> [Frakes Baeza-Yates 1992 vii]

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Appendix I

<u>Stage Two</u> Analytic Criteria

<u>Criteria range</u>   <u>Source</u>

[Crit.001] (for reference)   Research Question

[Crit.101] - [Crit.220]   Assimilation Theory

[Crit.301] - [Crit.342]   Communication; the Conduit Metaphor

[Crit.401] - [Crit.541]   The Five Divisions of Rhetoric

[Crit.600] - [Crit.682]   What are reading and writing?

[Crit.690] - [Crit.696]   What is interpretation?

[Crit.700] - [Crit.821]   What is thinking?

[Crit.901] - [Crit.936]   What is inquiry?

The following pages enumerate the questions derived in the examination of Assimilation Theory and complementary texts in Part II.

I.3   The Research Question

[Crit.001] Is the relationship between *how inquirers become informed* and *how LIS systems intermediate to serve that inquirer* (the Basic Relationship) acknowledged in the text directly?

[Crit.002] Is *how* that topic engages the inquirer toward construction of meaning explained?

[Crit.003] (structure) What are LIS understandings of the changes in the structure of an inquirer's mind during and following engagement with LIS resources?

[Crit.004] (process) Are the LIS understandings of cognitive processes that become active prior to, and during the course of engagement with LIS resources described?

[Crit.005] (superordinate ideas) Are overarching concepts, metaphors, models, or paradigms expressed by the text that might bear upon LIS understandings of the Basic Relationship?

II.1 What is Assimilation Theory?

[Crit.101] Is "Assimilation Theory" cited?

[Crit.102] Is David Ausubel cited?

[Crit.103] Is the term "meaningful learning" cited?

Sources

[Crit.104] Is [Ausubel 1963] cited?

[Crit.105] Is [Ausubel 2000 ([ARK])] cited?

[Crit.106] Is [Ausubel 1968] cited?

[Crit.107] Is [Ausubel Novak Hanesian 1978] cited?

[Crit.108] Is Joseph D. Novak cited?

[Crit.109] Is [Novak 1998] cited?

[Crit.110] Is [Novak and Gowin, 1984] cited?

[Crit.111] Is [Mintzes 1998] cited?

[Crit.112] Is [Mintzes 2000] cited?

Disciplinary and epistemological contexts

[Crit.113] Is educational psychology embraced as relevant to LIS?

See [Crit.300] Do theory and principles of inquirer's conceptual objects and process ability take account of, rather than disregard, concepts established in other relevant fields?

See [Crit.300a]   Are communication theory or principles of rhetoric embraced as relevant to LIS?

See [Crit.300b] Are principles of cognitive linguistics embraced as relevant to LIS?

See [Crit.300c]   Are principles of cognitive science embraced as relevant to LIS?

[Crit.114] Is the epistemological position of constructivism, that is, that one constructs ones own knowledge, embraced?

[Crit.115] Does the text disclaim that *ideas* can be *outside* of people, during transmission or otherwise?

[Crit.116] Is a cognitive approach to inquiry embraced by the text?

[Crit.117] Is the notion that "concepts, thoughts, ideas (i.e., mental entities) *are real to inquirers*" embraced?

[Crit.117a] Is the notion of phenomenalism, i.e., if reality or truth exists, people cannot know them with certainty, but only through objects of their own consciousness, embraced?

See [Crit.416] Does the text acknowledge the notion that an attribute of a concept is that it can be, but need not be, *believed* (fact, e.g., who, what, where, when, why), *trusted*, or considered to be *truth*?

Themes and principles of Assimilation Theory

Presupposition: Learner's primary goal is to acquire new *meaning*

[Crit.118] Is "inquirer's goal is to (acquire) *meaning*" embraced?

See [Crit.326] Does the text disclaim that meaning can be *received from a person*?

[Crit.119] Is the proposition "people are meaning-makers" embraced?

[Crit.120] Is the proposition "knowledge *is* meaning" embraced? See [Crit.144]

See [Crit.116] Is a cognitive approach to inquiry embraced by the text?

Interpretation of *acquire* and *acquisition*

See [Crit.326] Does the text disclaim that meaning can be *received from a person*?

Assimilation Theory emphasizes cognitive knowledge

See [Crit.116] Is a cognitive approach to inquiry the focus of the text?

Meaningful learning: a learner relating new ideas to prior knowledge

[Crit.121] Is the proposition that meaningful learning is the product of a process involving the interaction between meaningful ideas, relevant

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background ("anchoring") ideas in the <u>particular</u> learner's cognitive structure, and his mental set embraced?

See [Crit.120] Is the proposition "knowledge *is* meaning" embraced?

See [Crit.144] Is the proposition that "relations among concepts *are meaning*" embraced?

Prerequisite for relating new ideas to learner's prior knowledge: ascertain the learner's prior knowledge

[Crit.122] Is the proposition "ascertain the inquirer's prior knowledge" embraced?

[Crit.123] Is the question of whether ascertainment of the inquirer's prior knowledge is possible discussed?

See [Crit.302] Are nature and purpose of communication, sharing for use, discussed?

See [Crit.308] Is a distinction between public and private knowledge discussed?

See [Crit.201] Is the proposition that "instruments can be used by teachers and students to *identify* a inquirer's concepts, relations, and processes, that is, to ascertain a inquirer's prior knowledge" embraced?

Mandate to teacher: "teach accordingly"

[Crit.124] Is "teach accordingly" embraced?

[Crit.125] Is the notion *teach accordingly* explained as teacher's presentation of continuously connected concepts embraced?

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See [Crit.540] Does the text acknowledge that derivation sequences can iterate continuously?).

See [Crit.927] Does the text acknowledge that an *explanation* is a conceptual *path* of connected concepts leading from the learner's existing knowledge to the *dispositio* to be assimilated and that displaces a cognitive question?

[Crit.126] Are the following elements implied by *teach accordingly* discussed?:

Inquirer's prior knowledge structure;

An external-to-the-student subject matter structure ("conceptual reference structure");

Teacher-constructed image of differences between inquirer and reference (*gap* or inadequate preconception);

Task of identifying structure to bridge gap or replace inadequate preconception;

Task of expressing structure to bridge gap or replace inadequate preconception;

Task of presenting structure to bridge gap or replace inadequate preconception

Meaningful learning is distinct from rote learning

[Crit.127] Is roteness of learning recognized, characterized as ideas insubstantially related to prior knowledge?

[Crit.128] Is roteness of learning differentiated from meaningful learning?

Meaningful learning requires *deliberate* cognitive effort

[Crit.129] Is the proposition that "learning requires (cognitive) *work*" embraced?

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[Crit.130] Is the proposition that "the *inquirer* is required to expend cognitive effort" embraced?

[Crit.130a] Is the proposition that "the intellectual effort the inquirer expends is a cognitive component of the price or cost of meaningful learning" embraced?

See [Crit.138] Is the proposition that "the labor of learning is an activity that cannot be delegated to others if the inquirer himself is to learn" embraced?

[Crit.131] Is the proposition that "the effort by inquirer must be *deliberate*, engaged, intentional" embraced?

[Crit.132] Is the proposition that "the nature of the effort is the *relating* of new ideas to existing knowledge" embraced?

[Crit.133] Is the proposition that "part of the intellectual work of learning includes *searching* one's mental realm for concepts" embraced?

[Crit.134] Is the proposition that "part of the intellectual work includes *recognizing* concepts" embraced?

[Crit.135] Is the proposition that "part of the intellectual work includes *establishing relations* among concepts" embraced?

[Crit.136] Is the proposition that "part of the intellectual work includes associating linguistic labels with concepts" embraced?

Meaningful learning and methodological individualism

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[Crit.137] Is the epistemological position of methodological individualism embraced?

See [Crit.303] Is "each person constructs their own idiosyncratic meanings as a result of reading, writing, communication" embraced?

[Crit.138] Is the proposition that "the labor of learning is an activity that cannot be delegated to others if the inquirer himself is to learn" embraced?

Meaningful learning elements

Cognitive objects in meaningful learning: Concepts

[Crit.139] Is the proposition that "concepts (cognitive structures) are comprised of concepts, relations, and optionally a linguistic label" embraced?

Anchor concepts

[Crit.140] Are *anchor concepts*, existing ideas to which new ideas become connected, embraced?

[Crit.141] Is conceptual *scaffolding* (as differentiated from instructional scaffolding) embraced?

Granularity of concepts

[Crit.142] Is *granularity*, the notion that ideas can be presented at various levels of sophistication or structural detail, embraced?

Relationships among concepts: *meaning*

[Crit.143] Is the proposition that "relations are, themselves, concepts" embraced?

[Crit.144] Is the proposition that "relations among concepts *are meaning*"

embraced?

[Crit.144a] Is the proposition that "relations among objects in the tangible world,

or expressions of relations among tangible objects *are* not *meaning*"

embraced?

[Crit.145] Is the proposition that "*relationships* among concepts may be

comprised of *more* than one *relation*" embraced?

See [Crit.119] Is the proposition that "humans are meaning-makers" embraced?

[Crit.146] Is the proposition that "the degree of meaningfulness is a function of

the type and relevance, strength, and number of relations" embraced?

See [Crit.162] Is the proposition that "making (and assimilating) meaning is often

a terminal endpoint to an inquiry" embraced?

Cognitive structures

[Crit.147] Are "cognitive structures are concepts" embraced?

See [Crit.139] Is the proposition that "concepts (cognitive structures) are

comprised of concepts, relations, and optionally a linguistic label"

embraced?

[Crit.148] Is the proposition that "the function of structures is to connect or relate

objects" embraced?

See [Crit.541] Does the text acknowledge that new meanings, relations among *inventio*, can be stimulated (1) directly by a *dispositio* (ideas beget other ideas), (2) by a term (*elocutio*), or (3) by perceptual stimuli from receipt of *pronuntiatio*?

[Crit.149] Is the proposition that "cognitive structures can be incomplete relative to some external conceptual reference structure, or have internal inconsistencies (i.e., be wrong, untruthful, misinformed)" embraced?

See [Crit.117a] Is the notion of phenomenalism, i.e., if reality or truth exists, people cannot know them with certainty, but only through objects of their own consciousness, embraced?

Cognitive processes in meaningful learning: Transfer

[Crit.150] Are cognitive processes acknowledged?

[Crit.150a] Is a transfer-like process acknowledged?

See [Crit.704] Does the text acknowledge that *isomorphic mapping* is a comparative operation between two structures whereby relation among corresponding elements of both structures are identified?

See [Crit.708] Does the text acknowledge that *isomorphic projection* is a separate process that fills in a portion of the target *dispositio* by deriving replica *inventio* from the source structure?

Subsumption

[Crit.151] Is a subsumption-like process, whereby new ideas are related to relevant preexisting superordinate anchor concepts embraced?

Progressive differentiation

[Crit.152] Is a progressive differentiation-like, i.e., a successive disambiguation process embraced?

Superordinate learning

[Crit.153] Is a superordinate-like process embraced, whereby a new proposition is relatable to specific subordinate ideas in existing cognitive structure?

[Crit.154] Is "superordinate learning is difficult for two reasons: (1) more labor is required and (2) *recognition* that an idea *is* a superordinate idea is an imaginative act, relying on recognition of similarity of very little conceptual structure" embraced?

Integrative reconciliation

[Crit.155] Is an integrative reconciliation-like process, whereby restructuring or recombination of existing elements of cognitive structure resolves inconsistencies between concepts, embraced?

Process characteristics

Motivation and attention

[Crit.156] Is "intensification, focusing, and mobilization of attention and effort" embraced?

See [Crit.637] Does the text acknowledge that "reading" and "listening" without paying attention are both less detectable than "writing" or "speaking" without paying attention?

See [Crit.641] Does the text acknowledge criteria for recognizing attention: a cognitive event, *comprehension*, or a felt sensation, *Eureka!*?

[Crit.157] Is the question of "can inadequate attention be mitigated?" embraced?

[Crit.158] Is the benchmark of "Nintendo-level attention" embraced?

[Crit.159] Is the notion that to learn an idea, the learner must *attend* to the idea, embraced?

Endpoints

[Crit.160] Is the notion of process endpoints embraced?

See [Crit.927] Does the text acknowledge that an *explanation* is a conceptual *path* of connected concepts leading from the learner's existing knowledge to the *dispositio* to be assimilated and that displaces a cognitive question?

[Crit.161] Is the notion that "process endpoints are temporal" embraced?

[Crit.162] Is the proposition that "making (and assimilating) meaning is often a terminal endpoint to an inquiry" embraced?

[Crit.163] Is the notion that "a terminal endpoint may occur upon completion (and assimilation) of a continuous explanatory concept *path* from prior knowledge to goal concept" embraced?

[Crit.164] Is the notion that "a terminal endpoint might also occur at the time of the inquirer's concluding that meaning is *satisfactory*, that lack of meaning is insurmountable, or expenditure of effort exhausts available amount" embraced?

[Crit.165] Is "recognition of initial and terminal endpoints as a step toward better understanding of conditions that initiate and terminate mental processes" embraced?

See also [Crit.540]   Does the text acknowledge that derivation sequences can iterate continuously?

[Crit.166] Is "inquirer's recognition of a conflicting relation, question, or other dissonance may be a process trigger (initiating endpoint)" embraced?

[Crit.167] [See 164].

Feedback

[Crit.168] Is the proposition that "feedback can confirm that the inquirer's
meanings align with a conceptual reference structure or assessor's
understanding - why was a particular concept, relation or path
activated, or why a document corresponds to these" embraced?

[Crit.169] Is the proposition that "feedback can reflect recognition of ambiguities
and thus potentially lead to clarification" embraced?

[Crit.170] Is the proposition that "feedback can reflect recognition of
misconceptions (preconceptions) and thus potentially lead to changes
in the inquirer's knowledge structure " embraced?
(See also [Crit.182] Preconceptions).

Learning set

[Crit.171] Are the nature of "mental abilities that relate aspects of new concepts
to relevant components of existing cognitive structure" described?

Cognitive variables in meaningful learning

[Crit.172] Is a "cognitive availability" variable embraced?

[Crit.173] Is a "cognitive specificity" variable embraced?

[Crit.174] Is a "cognitive clarity" variable embraced?

See [Crit.500] Does the text acknowledge meaning cannot be objectively *explicit*
or *implicit* as derived from terms, but is, instead, specific to the

individual inquirer (varies from person to person) depending on whether meaning is both (1) conscious, and (2) unambiguous to *them*?

[Crit.175] Is a "cognitive stability" variable embraced?

[Crit.176] Is a "cognitive discriminability" variable embraced?

[Crit.177] Is "optimal level of inclusiveness, generality, and abstraction" embraced?

Cognitive capacity

[Crit.178] Is Miller's theoretical *seven plus or minus 2* limitation on cognitive processing capacity, number of ideas, number of processes, number of relations embraced?

See [Crit.311] Is "bandwidth disparity in physical *transmission* can influence *communication*: (people can read or listen to a physical object faster than they can inscribe, copy, speak it, or perform it)" embraced?

See [Crit.433] Does the text acknowledge that memory is the feed stock upon which isomorphic mapping and isomorphic projection calls upon for source and target concepts?

See [Crit.524] Does the text acknowledge that attention capacity might be limited?

See [Crit.638] Does the text acknowledge that learners have conscious control over attention?

See [Crit.640] Does the text acknowledge the 100-millisecond threshold as the boundary between conscious and subconscious (or automatic) control of cognition?

See [Crit.740] Does the text acknowledge that the function of isomorphic mapping and isomorphic projection is to conserve cognitive labor*?*

See [Crit.744] Does the text acknowledge that an inquirer's cognitive velocity is limited*?*

Concepts missing (relative to a conceptual reference structure); Gaps

See [Crit.913] Does the text acknowledge that inadequate *dispositio* may be of at least two kinds:
a *gap* is a missing relation between *inventio*, preventing one from activating the other;
a *block* is an existing relation, a preconception, that prevents establishment of a new idea or relation from one *inventio* to another?

See [Crit.911a]   Is the proposition that a conceptual reference structure is *dispositio*, not *elocutio* or *pronuntiatio* (e.g., expressions of a classification system or a concept map) acknowledged?

[Crit.179] Is the proposition that "concepts existing in a conceptual reference structure but not in the inquirer's knowledge structure may be deemed *missing* on the part of the inquirer, and that these lacunae may be termed *gaps* in the inquirer's knowledge" embraced?

[Crit.180] Is the proposition that "a teacher may be expected to construct an understanding of gaps in a inquirer's knowledge structure" embraced?

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See [Crit.927] Does the text acknowledge that an *explanation* is a conceptual *path* of connected concepts leading from the learner's existing knowledge to the *dispositio* to be assimilated and that displaces a cognitive question?

[Crit.181] Is the proposition that "inquirer's inability to express their gap is a dilemma: they are unable to express requests for expressions of the very concepts and relations they do not possess and thus cannot describe in their inquiry" embraced?

See [Crit.912] Does the text acknowledge that *cognitive questions* are differentiated from their expression in natural language terms, an *expressed question*?

Preconceptions

See [Crit.913] Does the text acknowledge that inadequate *dispositio* may be of at least two kinds:
a *gap* is a missing relation between *inventio*, preventing one from activating the other;
a *block* is an existing relation, a preconception, that prevents establishment of a new idea or relation from one *inventio* to another?

[Crit.182] Is the proposition that "learning is inherently biased to leave prior knowledge intact because more labor is required to mitigate an existing meaning and establish a new one, than merely to establish a new meaning" embraced?

[Crit.183] Is the proposition that "preconceptions are potent, tenacious limiting factors to meaningful learning" embraced?

[Crit.184] Is the proposition that "the first step in mitigating preconceptions is recognizing them" embraced?

[Crit.185] Is the proposition that "mitigating inadequate preconceptions can be as valuable as forming new concepts" embraced?

[Crit.186] Is the proposition that "overcoming prior misconceptions requires both (1) evaluation of prior ideas using the new concept as a baseline for evaluation, and (2) assimilation of new ideas by relating them to the baseline of prior knowledge" embraced?

Readiness to learn

[Crit.187] Is the proposition that "learners learn an idea best at the moment that idea is important to them" embraced?

Meaningful *reception* learning

What is meaningful *reception* learning?

[Crit.188] Is the proposition that "the inquirer's derivation of new meanings from expository instructional materials (*reception learning*) requires cognitive analysis necessary for *ascertaining* which aspects of existing cognitive structure are most relevant to the new potentially meaningful material" embraced?

[Crit.189] Is the proposition that "without direct communication with the inquirer, the assumptions about their prior knowledge might be faulty" embraced?

[Crit.190] Is the proposition that "local teacher, in direct communication with the inquirer, may attempt to render the author's assumptions valid by communicating the author's assumed concepts to the inquirer" embraced?

[Crit.191] Does the text acknowledge reading and listening as forms of meaningful reception learning?

[Crit.192] Does the text acknowledge that meaningful reception learning is inherently an *active* process, not passive?

[Crit.193] (Not used)

[Crit.194] Does the text acknowledge that meaningful reception learning requires reconciliation with existing ideas in cognitive structure?

[Crit.195] Does the text acknowledge that meaningful reception learning requires reformulation of the learning material in terms of the idiosyncratic intellectual background and vocabulary of the particular learner?

Material presented to learner is only *potentially* meaningful

[Crit.196] Is the proposition that "expressions presented to inquirer from expository instructional materials are only *potentially* meaningful; they only become meaningful when the inquirer is able to assimilate the conceptual structure they express" embraced?

Meaningful reception learning distinct from discovery learning

[Crit.197] Is the proposition that "meaningful learning is distinct from discovery learning" embraced?

Reception learning is distinct from problem solving

[Crit.198] Is the proposition that "meaningful reception learning is distinct from problem solving" embraced?

Instruments associated with Assimilation Theory

[Crit.199] Is the proposition that "instruments can be used to reflect objects from the mental realm in the physical, transmittable, realm" embraced?

[Crit.200] Is the proposition that "instruments can be used to *recognize* concepts, relations, and processes" embraced?

[Crit.201] Is the proposition that "instruments can be used by teachers and students to *identify* a inquirer's concepts, relations, and processes, that is, to ascertain a inquirer's prior knowledge" embraced?

[Crit.202] Is the proposition that "instruments can be used by teachers to assess an inquirer's knowledge over the course of instruction" embraced?

[Crit.203] Is the proposition that "instruments can be used by *writers* to *stimulate* concepts, relations, and processes" embraced?

Advance organizers

[Crit.204] Is notion of "expression of subject matter context based on the inquirer's prior knowledge" embraced?

Vee-diagrams

Concept maps

[Crit.205] Is notion of "concept maps" embraced?

[Crit.206] Is the notion that "concept maps depict inquirer's existing knowledge, and can show both well-connected concept paths and gaps" embraced?

See [Crit.927] Does the text acknowledge that an *explanation* is a conceptual *path* of connected concepts leading from the learner's existing knowledge to the *dispositio* to be assimilated and that displaces a cognitive question?

See [Crit.927a]   Does the text acknowledge that an *explanation* may be comprised of multiple or alternate conceptual *paths* of connected concepts?

[Crit.207] Is notion that "concept maps depict inquirer's existing knowledge, both concepts and relations, *concisely*" embraced?

[Crit.208] Is the proposition that "concept maps depicting the inquirer's existing knowledge may be used in conjunction with concept maps depicting the conceptual structure of a subject matter (conceptual reference structure)" embraced?

[Crit.209] Is the proposition that "a inquirer's concept map may be contrasted to a reference map to reveal gaps and misconceptions" embraced?

[Crit.210] Is the proposition that "the gaps and misconceptions revealed in contrasting an inquirer's concept and a reference map may be used to formulate instructional plans" embraced?

[Crit.211] Is the proposition that "concept maps assist the reader of a text by partially alleviating the cognitive labor of constructing a web structure from linear text" embraced?

[Crit.212] Is the proposition that "concept maps can motivate questions by revealing explicitly undefined relations" embraced?

K-W-L charts

[Crit.213] Is the notion that K-W-L charts "express the inquirer's existing knowledge, concepts the inquirer wants to know, and the knowledge the student has learned" embraced?

Personal interviews

[Crit.214] Is the proposition that "personal interviews should be characterized not as a test or assessment, but as a venue to converse, with the various psychological phenomena that implies" embraced?

Role of instruments in assessment and evaluation

See also [Crit.202]   Is the proposition that "instruments can be used by teachers to assess an inquirer's knowledge over the course of instruction" embraced?

[Crit.215] Is the proposition that "instruments can be used to recognize inadequate *dispositio*: gaps and preconceptions" embraced? (See also [Crit.209]).

[Crit.216]   Is the proposition that "assessment requires the inquirer's knowledge structure to be compared and contrasted to a conceptual reference structure" embraced?

[Crit.217]   Is Ausubel's dissent with "unwarranted reverence for precise numbers" heeded?

[Crit.218]   Is the proposition that "central concern in evaluation of cognitive learning should be with ability of test instrument to assess conceptual and propositional frameworks held by the subject" embraced?

[Crit.219]   Is the proposition that "assessment of an inquirer should give greater weight to the most important concepts and relations, not simply count the number of concepts or the number of relations on their map" embraced?

[Crit.220]   Is the proposition that "iterative, before-and-after concept maps can facilitate the inquirer's understanding of their learning progress" embraced?

II.2 Complements to Assimilation Theory

[Crit.300] Do theory and principles of inquirer's conceptual objects and process ability take account of, rather than disregard or worse, reinvent, concepts established in other relevant fields?

[Crit.300a] Are communication theory or principles of rhetoric embraced as relevant to LIS?

[Crit.300b] Are principles of cognitive linguistics embraced as relevant to LIS?

[Crit.300c] Are principles of cognitive science embraced as relevant to LIS?

[Crit.300d] Are principles of cognitive psychology embraced as relevant to LIS?

See [Crit.113] Is educational psychology embraced as relevant to LIS?

What is Communication

Communication not only physical *transmission*, but requires cognitive *sharing for use* for constructing *meaning*

[Crit.301] Is "*communication* is distinct from *transmission, delivery, and conveyance*" acknowledged?

[Crit.302] Is "*communication* understood as *sharing for use*"?

[Crit.303] Is "each person constructs their own idiosyncratic meanings as a result of reading, writing, communication" embraced?

See [Crit.137] Is the epistemological position of methodological individualism embraced?

Negotiation of meaning

[Crit.304] Is the notion of *negotiation of meaning* embraced?

[Crit.305] Is the communicative notion of negotiation of meaning, that "people draw conclusions that others have constructed meanings of expressions substantially similar to those they have conjured, and usually continue conversing at least until such conclusion is drawn" embraced?

[Crit.306] Is the notion that "negotiation results in ascribing concepts or meaning to terms and disambiguating linguistic expressions, that is, creating or arriving at at least one, but no more than a small number of meanings for an expression" embraced?

See [Crit.500] Does the text acknowledge meaning cannot be objectively *explicit* or *implicit* as derived from terms, but is, instead, specific to the individual inquirer (varies from person to person) depending on whether meaning is both (1) conscious, and (2) unambiguous to *them*?

[Crit.307] Is the notion and benefit of feedback (required for *negotiation of meaning*) embraced?

See [Crit.486] Does the text acknowledge that *elocutio* ➜ *dispositio* continues with *selecting* from among the constructed meanings?

See [Crit.486a] Does the text acknowledge that *elocutio* ➜ *dispositio* continues with *construction* of first order grammatical meanings?

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See [Crit.168] Is the proposition that "feedback can confirm that the inquirer's meanings align with a conceptual reference structure or assessor's understanding" embraced?

Private knowledge vs. public knowledge

[Crit.308] Is a distinction between public and private knowledge embraced?

[Crit.309] Is "in communication, the thought in the writer-speaker's mind loses its status as private" embraced?

[Crit.310] Is "a speaker-writer can never express and communicate *all* aspects of their ideas, communication is always incomplete" embraced?

Sensory-perceptual capacity limits communication

[Crit.311] Is "bandwidth disparity in physical *transmission* can influence *communication*: (people can read or listen to a physical object faster than they can inscribe, copy, speak it, or perform it)" embraced?

Loss of meaning is inherent in communication and reception learning

[Crit.312] Is "sources of loss of meaning in communication include (1) terms are only indirectly correlated to meaning, (2) terms can never express a writer-speaker's complete meaning, (3) meaning is grounded in personal experience that one's interlocutors do not have" embraced?

See [Crit.310] Is "a speaker-writer can never express and communicate *all* aspects of their ideas, communication is always incomplete" embraced?

See [Crit.489] Does the text acknowledge that *elocutio* only indirectly correlates to meaning, *dispositio*?

See [Crit.497] Does the text acknowledge that *elocutio* always *under*specifies *dispositio*? That terms can never wholly express concepts?

What are implications of the conduit metaphor to meaningful learning?

[Crit.313] Is the concept of conduit metaphor as a phenomenon adverse to an individual's constructing meaning embraced, even if by another name?

See [Crit.114] Is the epistemological position of constructivism embraced?

[Crit.314] In the LIS text, are ideas expressed in constructive rather than conduit terms?

[Crit.315] Is characterization of the learner's mind as *passive*, as an empty vessel, as a *tabula rasa*, or bank account waiting to be filled, disclaimed?

[Crit.315a] Is there a characterization of the learner's mind as having an essential role or is the text's discussion wholly about externals, with the assumption that the inquirer will become informed upon receipt of "information" disclaimed?

[Crit.315b] Does the text disclaim that production, transmission, or receipt of external objects alone are sufficient for people becoming informed?

[Crit.315c] Does the text disclaim the characterization of the labor the inquirer performs as passive or merely as 'having capacity' that results in becoming informed?

[Crit.316] Does the LIS source acknowledge instances of conduit metaphor error within its own text?

Manifestations and adverse consequences of the conduit metaphor

[Crit.317] Does the text explicitly disclaim the notion that ideas, meaning, are *inside* words?

[Crit.318] Does the text disclaim the position that *people put* or *insert* their thoughts *into* words?

[Crit.319] Does the text disclaim the position that words have insides and outsides?

[Crit.320] Does the text disclaim the position that words, linguistic expressions, and visual images are therefore *containers* of ideas, of meaning?

[Crit.321] Does the text disclaim the position that words (containers) are conveyed from person to person, and thus *carry* ideas?

See [Crit.432a]   Does the text acknowledge the non-standard sense of the verb "to give" as applied to communication: when a sender *gives* "information" by conveying *pronuntiatio*, they retain their *dispositio*?

[Crit.322] Does the text disclaim the position that words, as containers, *flow* through a conduit, *language*, from person to person, and thus words are flow outside of people, as through a conduit (language)?

See [Crit.115] Does the text disclaim that *ideas* can be *outside* of people, during transmission or otherwise?

[Crit.323] Does the text disclaim the position that meanings can be acquired by acquiring objects outside of people, rather than constructed intellectually?

[Crit.324] Does the text disclaim that, during transit, if *ideas* can be *outside* of people, encapsulated in *words*, which are physical objects, then ideas are susceptible to operations in the physical world, e.g., storage, retrieval, processing, managing?

[Crit.325] Does the text disclaim that, in listening or reading, people *extract* meaning from the words? Or, construct meaning with the use of their prior conceptual resources (knowledge and abilities)?

[Crit.326] Does the text disclaim that meaning can be *received from a person*, without any contribution from the inquirer's prior knowledge?

See [Crit.301] Is "*communication* is distinct from *transmission, delivery, and conveyance*" acknowledged?

[Crit.327] In the LIS text, is the inquirer actively evoking ideas or interpreted as doing so, rather than merely receiving them passively?

[Crit.328] Are texts characterized as provoking the reader to evoke existing ideas or construct new meanings? (Rather than characterized as containing knowledge or meaning that is *transmitted to* a reader-listener)

[Crit.329] Does the text disclaim that constructing meaning from an interaction with someone else merely requires transmission of words or images, but is otherwise virtually labor-free, automatic, or passive?

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[Crit.330] Does the text disclaim that, if learning does not result from a communication event, that it must be the reader/listener's fault or incompetence because, since the meaning is in the words, all the reader or listener need to is 'take the meaning out of the text'?

[Crit.331] Does the text disclaim that if the meaning was not properly inserted into the text, and thus the meaning could not be extracted, communication failure can be the speaker's or writer's fault?

[Crit.332] Does the text disclaim that, in the event of communication failure, whether the speaker-writer was at fault or the reader-listener was at fault can be determined by a third party who can simply inspect the text to ascertain whether the meaning was, indeed, in the text, i.e., that meaning is objectively in the world, whether its presence is detected or not?

[Crit.333] Are adverse *effects* of conduit metaphor acknowledged generally?

[Crit.334] Does the text acknowledge the major adverse effect of the conduit metaphor, *viz.* that people extract meaning from words *easily*, obtain "success without effort," or imply that learning is passive, or simply happens once having been provided external stimuli?

[Crit.335] Does the text disclaim that receipt or possession of *words* is virtually equivalent to possessing their *meaning*, of *knowing* them? *Having* information is *knowing*?

[Crit.336] Does the text disclaim that, if one possesses a book or document, one *possesses* the knowledge it expresses.

[Crit.337] Does the text disclaim that a community's knowledge resides *in* books, databases, libraries? And if one has a large library of books, one has a correspondingly large storehouse of knowledge?

[Crit.338] Does the text disclaim that, if one is responsible for managing books, databases, or libraries, one is a *gatekeeper of knowledge.*

[Crit.339] Does the text disclaim that meaning can be *mined from* texts as if it were solid mineral material?

See [Crit.446] Does the text acknowledge reasons for retaining distinctions among the Divisions: to avoid blurring objects of one and of another into *information*?

[Crit.340] Does the text acknowledge Reddy's finding that effects of the conduit metaphor often cannot be overcome even by conscious critical effort to refer to intellectual objects literally rather than metaphorically?

Mitigation of conduit metaphor effect: communications reference models

[Crit.341] Does the LIS text suggest methods to overcome adverse effects of the conduit metaphor?

[Crit.342] Does the text disclaim, by its *absence* of emphasis on cognitive labor of reader or listener, that cognitive labor is not essential in communication?

See [Crit.401] Does the LIS text acknowledge differentiation among intellectual objects (concepts, relations), physical objects, and linguistic objects?

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Five divisions of rhetoric: communications reference model

[Crit.401] Does the text differentiate among

concepts ("arguments" or ideas);

arrangement of concepts;

linguistic expressions;

memory; and

physical derivations ?

[Crit.402] Does the text use terminology that differentiates among

concepts ("arguments" or ideas) (*inventio*);

arrangement of concepts (*dispositio*);

linguistic expressions (*elocutio*);

memory (*memoria*); and

delivery of the expressions (*pronuntiatio*)?

See [Crit.432a]   Does the text acknowledge the non-standard sense of the verb

"to give" as applied to communication: when a sender *gives*

"information" by conveying *pronuntiatio*, they retain their *dispositio*?

Properties of objects of each Division of Rhetoric

Inventio

[Crit.403] Does the text acknowledge the notion of concept as intellectual objects

comprised of attributes and relations among them?

Basic *inventio* and abstract *inventio*

[Crit.404] Does the text (1) differentiate between basic concepts and abstract

concepts, where basic concepts are derived from sensory experience,

(2) acknowledge that abstract concepts are grounded in basic concepts,

and therefore (3) that avoidance of abstract thought, e.g., metaphor, is

virtually impossible because avoidance of sensory experience is

impossible?

See [Crit.721] Does the text acknowledge that *metaphor* is a figure of thought

(*dispositio* from isomorphic projection), not a figure of speech

(*elocutio*)?

[Crit.404a] Does the text acknowledge that the function of metaphor aligns with

the function of isomorphic projection? (See [Crit.740] Does the text

acknowledge that the function of isomorphic mapping and isomorphic

projection is to avoid expenditure of cognitive labor*?*)

See [Crit.722] Does the text acknowledge that *metaphorical expression* is the

elocutio derivation of metaphor?

Basic *inventio* and epistemological individualism

[Crit.405] Does the text acknowledge the concept that abstract thought arising

from sensory experience reinforces the epistemological position of

individualism? See [Crit.137]

Basic *inventio* and categories

> [Crit.405a] Does the text acknowledge the concept that an instance of *inventio* may be regarded as a *category*?

> See [Crit.411] Does the text acknowledge the mechanism upon which categorization works, whereby a *single* component *dispositio* is a sub-element in common in two different *dispositio*?

Dispositio

> [Crit.406] Does the text acknowledge that *inventio* is a unitary view of *dispositio*?

> See [Crit.144] Is the proposition that "relations among concepts *are meaning*" embraced?

> See [Crit.480] Does the text acknowledge that occasionally, the only attribute of an *inventio* known to a person, or of which they are conscious or can evoke, is its linguistic label?

Dispositio **reveals the relations among component** *inventio*

> [Crit.407] Does the text acknowledge that *dispositio* differs from *inventio* in that *dispositio* reveals the inner structure (relations) and component sub-concepts of a concept?

> See [Crit.480] Does the text acknowledge that occasionally, the only attribute of an *inventio* known to a person, or of which they are conscious or can evoke, is its linguistic label?

[Crit.408]   Does the text acknowledge that nearly any *inventio* can be a relation type?

[Crit.409]   Does the text acknowledge that the constructive purpose of structure is to bind elements together?

[Crit.410]   Does the text acknowledge that, because structures (and thus *dispositio*) are the objects manipulated in Assimilation Theory, *dispositio* is an element of Assimilation Theory?

How *dispositio* explains contemporary category theory

[Crit.411]   Does the text acknowledge the mechanism upon which categorization works, whereby a *single* component *dispositio* is a sub-element in common in two different *dispositio*?

Species of *dispositio*: Idealized cognitive models

[Crit.412]   Does the text acknowledge idealized cognitive models as comparable to *dispositio* that operate as superordinate organizing ideas?

Species of *dispositio*: Frames

[Crit.413]   Does the text acknowledge frames as comparable to *dispositio* that bind together properties into a structure?

Species of *dispositio*: Image schemas

[Crit.414]   Does the text acknowledge image schemas as comparable to *dispositio* that are basic concepts derived from visual sensory experience and that are often applied as superordinate organizing ideas?

Intervention

[Crit.415] Does the text acknowledge that superordinate forms of *dispositio* are important in teacher intervention because they can provide the inquirer with ideas that can structure or organize their inadequate understandings?

***Dispositio* attributes: belief, trust, truth**

[Crit.416] Does the text acknowledge the notion that an optional attribute of a concept is that it can be *believed* (fact, e.g., who, what, where, when, why), *trusted*, or considered to be *truth*?

See [Crit.738] Does the text acknowledge that isomorphic mapping and isomorphic projection underlie the notions of *constructing beliefs, branding, advertising, granting academic degrees, vouching for someone, endorsements, testimonials, licenses, identification documents,* and *cognitive authority*?

Elocutio

[Crit.417] Does the text acknowledge that *elocutio* is a linguistic system for (1) specification of meanings and (2) specification of physical manifestations?

[Crit.418] Does the text acknowledge that *elocutio*, e.g., words, terms, expressions, are comprised of definition, part of speech, usage, etymology, synonyms and antonyms, etymology, spelling, syllabification, pronunciation, and *not* only one or some of these?

[Crit.419] Does the text acknowledge that language is *distinct from* meaning, only a *specification for* an invocation of meaning?

[Crit.420] Does the text acknowledge that a spelling, a sequence of letters, is *not* a word, but only one type of manifestation of it (*elocutio* (graphic))?

[Crit.421] Does the text acknowledge that *elocutio* is not confined to so-called natural languages?

[Crit.422] Does the text acknowledge that *elocutio* is an imperfect and indirect mechanism for provoking others to evoke particular concepts?

Unique property of Language, *elocutio*:

[Crit.423] Does the text acknowledge that *elocutio*, language, has a special status, it reaches into *both* mental and physical realms, bridging the two?

[Crit.424] Does the text acknowledge the conceptual function of language to *bridge* the mental and physical realms by facilitating derivations of each from the other?

Fixity

[Crit.425] Does the text acknowledge that the act of associating a term, *elocutio*, with an idea, projects fixity to the idea?

Pronuntiatio

[Crit.426] Does the text acknowledge that *pronuntiatio* inhabits *only* the physical realm and thus cannot *carry* meaning because meaning exists only in the intellectual realm?

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[Crit.427]   Does the text acknowledge that receipt of *pronuntiatio* does not

constitute receipt of *dispositio*, i.e., construction of meaning?

[Crit.428]   Does the text acknowledge that construction of meaning by deriving

dispositio from *elocutio* and *pronuntiatio* is not a trivial task once

pronuntiatio has been received?

[Crit.429]   Does the text acknowledge that *pronuntiatio* operates by provoking a

reader-listener's perceptual resources such that they evoke ideas?

[Crit.430]   Does the text acknowledge that *pronuntiatio* includes the property of

materiality and durability, i.e., *material fixity*?

[Crit.431]   Does the text acknowledge that *pronuntiatio* includes the property of

materiality, which gives rise to the possibility of *transmission*?

[Crit.432]   [Not used]

Differentiating *pronuntiatio* from *dispositio* explains the *giving* anomaly

[Crit.432a] Does the text acknowledge the non-standard sense of the verb "to

give" as applied to communication: when a sender *gives* "information"

by conveying *pronuntiatio*, they retain their *dispositio*?

Memoria

Role of memory in extended Assimilation Theory

[Crit.433]   Does the text acknowledge that memory is the feed stock upon which isomorphic mapping and isomorphic projection calls upon for source and target concepts?

[Crit.434]   Does the text acknowledge that, because human thought relies upon isomorphic projection and isomorphic projection relies upon memory, no abstract thought is possible without memory?

[Crit.435]   Does the text acknowledge that computer systems, computer disks, and databases are inadequate analogs for human memory?

Differentiating *recall* and *recognition*

[Crit.436]   Does the text acknowledge that *recall* is the sheer ability to *evoke inventio* or *dispositio. Recognition* requires both recall and mapping or even projection?

[Crit.437]   Does the text acknowledge that one type of recognition, to ascertain identity, requires simply a mapping?

[Crit.438]   Does the text acknowledge that a second type of recognition, an explanation, requires a projection to complete a conceptual explanatory path?

[Crit.439]   Does the text acknowledge that *explanation* is facilitated where the inquirer anticipates, "knows what to look for," that is, has a skeletal *dispositio* that serves as a model or set of criteria by which evaluation

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of a new idea can be made to determine whether an explanation has been "found" (that is, is able to be *constructed*)?

[Crit.440] Does the text acknowledge that a inquirer's recall is never complete, and thus, there is always the potential for projection?

Historical role of memory

[Crit.441] Does the text acknowledge that memory palace techniques from oral culture operated on two metaphors: `a place is an idea` and `a path through a place is a sequence of thoughts`?

[Crit.441a] Does the text acknowledge that variant paths were possible from one retelling of a text (story, poem) to another using memory palace techniques?

See [Crit.206]   Is the notion that "concept maps depict inquirer's existing knowledge, and can show both well-connected concept paths and gaps" embraced?

See [Crit.927] Does the text acknowledge that an *explanation* is a conceptual *path* of connected concepts leading from the learner's existing knowledge to the *dispositio* to be assimilated and that displaces a cognitive question?

See [Crit.927a]   Does the text acknowledge that an *explanation* may be comprised of multiple or alternate conceptual *paths* of connected concepts]?

Impact of *memoria* on thought and language

[Crit.442] Does the text acknowledge that memory is not static, but can project attributes of belief, truth, or reliability onto *dispositio*?

[Crit.443] Does the text acknowledge that *forgetting* plays a role in construction of new meaning?

[Crit.444] Does the text acknowledge that physiological and even obliterative subsumption aspects of memory contribute to difficulties in thinking and language use?

[Crit.445] Does the text acknowledge the distinction between constructive forgetting and undesirable forms of forgetting: sheer inability to recall, and faulty recall?

Differentiating objects derived in any Division from those of the others

See [Crit.402] Does the text use terminology that differentiates:

concepts ("arguments" or ideas) (*inventio*);

arrangements of concepts (*dispositio*);

linguistic *expressions* (*elocutio*);

memory (*memoria*); and

delivery of the expressions (*pronuntiatio*)?

See [Crit.426] Does the text acknowledge that *pronuntiatio* inhabits *only* the physical realm and thus cannot *carry* meaning because meaning exists only in the intellectual realm?

See [Crit.427] Does the text acknowledge that receipt of *pronuntiatio* does not constitute receipt of *dispositio*, i.e., construction of meaning?

See [Crit.428] Does the text acknowledge that construction of meaning is not a trivial task once *pronuntiatio* has been received?

See [Crit.432a] Does the text acknowledge the non-standard sense of the verb "to give" as applied to communication: when a sender *gives* "information" by conveying *pronuntiatio*, they retain their *dispositio*?

[Crit.446] Does the text acknowledge reasons for retaining distinctions among the Divisions: to avoid blurring objects of one and of another into *information*?

Mistaking objects of one Division of Rhetoric for objects of another

[Crit.447] Does the text acknowledge that mistaking an object of one Division for an object of another Division, can lead to dysfunction in constructing meaning?

[Crit.448] Does the text acknowledge reasons for coordinating like objects: to avoid mistaking objects of the *inventio* and *dispositio* for linguistic terms (*elocutio*), and vice versa?

[Crit.449] Does the text acknowledge reasons for coordinating like objects: to avoid mistaking objects of the intellectual realm for physical objects (*pronuntiatio*), and vice versa?

[Crit.450] Does the text acknowledge reasons for coordinating like objects: to avoid mistaking linguistic objects for physical objects (*pronuntiatio*), and vice versa?

[Crit.451] Does the text acknowledge that constructive malfunction occurs if the speaker-writer's *dispositio* and the learner-reader's *dispositio* are not coordinated with one another?

[Crit.452] Does the text acknowledge that constructive malfunction occurs if the speaker-writer's *elocutio* and the learner-reader's *elocutio* are not coordinated with one another?

[Crit.453] Does the text acknowledge that objects of any given layer transmitted by a teacher-speaker-writer must be treated as objects *of that layer* by the learner-reader-listener?

[Crit.454] Does the text acknowledge that the learner-reader-listener's task is not complete until *dispositio*, *meaning*, is constructed?

Derivation of objects of one Division from objects of another Division

Objects are *derivations,* not *transformations*, not *representations*, not encapsulations, and not *codes*

[Crit.455] Does the text acknowledge that objects of any Division generally are *derivations* of intellectual objects?

[Crit.456] Does the text acknowledge that objects of any Division generally are *not transformations* of intellectual objects?

[Crit.457] Does the text acknowledge that objects of any Division generally are *not representations* of intellectual objects?

[Crit.458] Does the text acknowledge that objects of any Division generally are *not encapsulations* of intellectual objects?

[Crit.459] Does the text acknowledge that objects of any Division generally are *not encodings* of intellectual objects?

[Crit.460] Does the text acknowledge that objects of the physical world, *pronuntiatio*, are *derivations* of intellectual objects?

[Crit.461] Does the text acknowledge that objects of the physical world, *pronuntiatio*, are *not transformations* of intellectual objects?

[Crit.462] Does the text acknowledge that objects of the physical world, *pronuntiatio*, are *not representations* of intellectual objects?

[Crit.463] Does the text acknowledge that objects of the physical world, *pronuntiatio*, are *not encapsulations* of intellectual objects?

[Crit.464] Does the text acknowledge that objects of the physical world, *pronuntiatio*, are *not encodings* of intellectual objects?

[Crit.465] Does the text acknowledge that objects of *elocutio* can be *derivations* of *pronuntiatio*?

[Crit.466] Does the text acknowledge that objects of *elocutio* can *not* be *transformations* of *pronuntiatio*?

[Crit.467] Does the text acknowledge that objects of *elocutio* can *not* be *representations* of *pronuntiatio*?

[Crit.468] Does the text acknowledge that objects of *elocutio* can *not* be *encapsulations* of *pronuntiatio*?

[Crit.469] Does the text acknowledge that objects of *elocutio cannot be encodings* of *pronuntiatio*?

[Crit.470] Does the text acknowledge that objects of *dispositio-inventio* are *derivations* of *elocutio*?

[Crit.471] Does the text acknowledge that objects of *dispositio-inventio* are *not transformations* of *elocutio*?

[Crit.472] Does the text acknowledge that objects of *dispositio-inventio* are *not representations* of *elocutio*?

[Crit.473] Does the text acknowledge that objects of *dispositio-inventio* are *not encapsulations* of *elocutio*?

[Crit.474] Does the text acknowledge that objects of *dispositio-inventio* world, are *not encodings* of *elocutio*?

Loss, change, or addition of meaning may be a consequence of any derivation

[Crit.475] Does the text acknowledge that loss, change, or addition of meaning may be a consequence of any derivation?

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Specific derivations

Inventio ➤ *dispositio* **and** *dispositio* ➤ *inventio*

> [Crit.476] Does the text acknowledge that derivation *inventio* ➤ *dispositio* is *analytic*, revealing its component concepts and the structure among them? Is *unpacking* used in this sense?

> [Crit.477] Does the text acknowledge that derivation *dispositio* ➤ *inventio* is reduction to salient theme, endpoints, and perhaps a linguistic term?

Dispositio ➤ *elocutio* **and** *elocutio* ➤ *dispositio*

> [Crit.478] Does the text acknowledge that an *optional* component of *inventio* is association with a linguistic label?

> [Crit.479] Does the text acknowledge that occasionally, a person evokes a concept but cannot associate any linguistic label with it?

> [Crit.480] Does the text acknowledge that occasionally, the only attribute of an *inventio* known to a person, or of which they are conscious or can evoke, is its linguistic label?

The derivation *dispositio* ➤ *elocutio* is selection of linguistic system and terms

> [Crit.481] Does the text acknowledge that from *dispositio*, a writer-speaker derives *elocutio* by *selecting terms* to express his ideas, "to clothe his thoughts with language"?

> [Crit.482] Does the text acknowledge that the writer-speaker decision to render the expressions in tangible (physical) form is separate from selection

of *elocutio* (semantic), that these are separate acts, even if below the
threshold of consciousness?

[Crit.483] Does the text acknowledge the writer-speaker is confronted with two
questions:(1) which linguistic system expresses the concepts in a
manner most likely to be grasped by the learner-reader, and (2) which
terms within that system are best suited to the learner?

**The derivation *elocutio* ➔ *dispositio* is specification for evoking and selecting
meaning**

[Crit.484] Does the text acknowledge that *elocutio* ➔ *dispositio* begins with
recognition of terms?

[Crit.485] Does the text acknowledge that *elocutio* ➔ *dispositio* continues with
activation of existing ideas by tracing relation from term to ideas
associated with that term?

[Crit.486] Does the text acknowledge that *elocutio* ➔ *dispositio* continues with
selecting from among the constructed meanings?

[Crit.486a] Does the text acknowledge that *elocutio* ➔ *dispositio* continues with
construction of first order grammatical meanings?

Dispositio* ➔ *elocutio* compels speaker-writer to (re-)organize *dispositio

[Crit.487] Does the text acknowledge that *dispositio* ➔ *elocutio* compels
speaker-writer to (re-) organize thoughts?

[Crit.488] Does the text acknowledge that the speaker-writer's effort to
reorganize thoughts may be cyclic (*dispositio* ➔ *elocutio* ➔ *dispositio*

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→ *elocutio*, etc.) as in the cycle of markup/edit, print, read, markup/edit?

Elocutio only indirectly correlates to meaning, *dispositio*

[Crit.489] Does the text acknowledge that *elocutio* only indirectly correlates to meaning, *dispositio*?

[Crit.490] Does the text acknowledge that the correlation between expression and meaning is imperfect and uncertain?

[Crit.491] Does the text acknowledge that the meaning imputed to a term or text by a specific inquirer may be influenced by polysemous use of the term by the inquirer?

[Crit.492] Does the text acknowledge that the meaning imputed to a term or text by an inquirer may be influenced by the inquirer's private experience?

[Crit.493] Does the text acknowledge that the meaning imputed to a term or text by an inquirer may be influenced by the effect of cognitive?

[Crit.494] Does the text acknowledge that meaning is *derived from* terms by the reader-listener rather than inherent *in* the terms?

[Crit.495] Does the text acknowledge that terms are *derived from* meaning (selected) by the inquirer-listener rather imputed with meaning by an authority, despite the dictionary-makers, author's, and advertiser's best efforts to do so?

[Crit.496] Does the text acknowledge that meaning expected to be expressed by an author-writer might not be the meaning evoked by the learner-listener-reader?

Elocutio **always** *under***specifies** *dispositio*

[Crit.497] Does the text acknowledge that *elocutio* always *under*specifies *dispositio*? That terms can never wholly express concepts?

[Crit.498] Does the text acknowledge that composition of most concepts is complex beyond human comprehension?

[Crit.499] Does the text acknowledge that people compensate for the underspecification of meaning expressed by linguistic terms, in part, by a mental process of "filling in," i.e., isomorphic projection?

See [Crit.312] Does the text acknowledge that loss of meaning inevitable is inevitable in derivation?

Can *elocutio* **specify meaning** *explicitly***?**

[Crit.500] Does the text acknowledge meaning cannot be objectively *explicit* or *implicit* as derived from terms, but is, instead, specific to the individual inquirer (varies from person to person) depending on whether meaning is both (1) conscious, and (2) unambiguous to *them*?

See [Crit.174] Is a "cognitive clarity" variable embraced?

[Crit.500a] Does the text acknowledge that several sources of indeterminacy are at work in *elocutio* ➔ *dispositio*: (1) any particular object of *elocutio*, as understood by the majority of speakers, only imperfectly specifies a

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particular concept; (2) a particular *elocutio* object might not evoke a

particular *dispositio* in the mind of a particular person; not to mention

that regardless of the looseness of the relation between *elocutio* and

dispositio, *dispositio* objects are inherently imperfectly specifiable, (3)

on account of their complexity and (4) because any specific persons

dispositio arises from their own experience, which differs from person

to person?

Dispositio is not linear, natural language elocutio usually is

[Crit.501] Does the text acknowledge *dispositio* is not linear, natural language

elocutio usually is?

Elocutio (graphic) ➜ elocutio (semantic) and vice versa

[Crit.502] Does the text acknowledge that the correlations between semantic and

graphic-phonic properties are the associations one learns in the study

of vocabulary?

[Crit.503] Does the text acknowledge that these correlations associate the

specification of a meaning with *the idea of* a physical rendering, not

the physical rendering itself?

[Crit.504] Does the text acknowledge that familiarity with one form of *elocutio*

does not always indicate mastery of the other?

Elocutio ➜ pronuntiatio and pronuntiatio ➜ elocutio

[Crit.505] Does the text acknowledge that how artists, writers, and speakers

produce (derive) *pronuntiatio* from *elocutio* (graphic-phonic) is a

process of rendering tangible (including digital) objects according to specifications?

[Crit.506] Does the text acknowledge that, in *pronuntiatio* ➜ *elocutio,* a reader-listener is provoked, through their physical senses, to perceive and recognizes expressions from tangible objects according to graphic-phonic specifications. Perceptions are then mapped to corresponding *elocutio* (semantic) from which *dispositio* are evoked or constructed?

[Crit.507] Does the text acknowledge that *elocutio* need not be confined to so-called natural languages, but may be any system of culturally recognized behavior that is meaningful to individuals?

Pronuntiatio ➜ *dispositio*

Principles that bear upon *pronuntiatio* ➜ *dispositio*

[Crit.508] Does the text acknowledge concern for the effect of specific genres of *pronuntiatio* upon comprehension?

[Crit.509] Does the text acknowledge concern for the effect of specific genres of *pronuntiatio* upon how concepts are expressed?

[Crit.510] Does the text acknowledge that a *pronuntiatio's* appearance can influence how potential readers impute credibility to the ideas it was intended to express?

[Crit.511] Does the text acknowledge that learner-listener-readers might project different idealized cognitive models (ICMs) to a document depending on *pronuntiatio* type?

[Crit.512] Does the text acknowledge concern for the effect of specific genres of *pronuntiatio* upon organization of the text, and thus upon comprehension?

[Crit.513] Does the text acknowledge concern for the effect of specific genres of *pronuntiatio* upon selection of a linguistic system for expression of *dispositio*?

Interaction with paper

[Crit.514] Does the text acknowledge paper as a medium providing for annotation of texts?

[Crit.515] Does the text acknowledge paper as a medium providing for recordation of texts?

[Crit.516] Does the text acknowledge paper as a medium providing for personal cognitive use of texts?

[Crit.517] Does the text acknowledge paper as a medium providing for freedom from monitoring of speech and thought by others inherent in a medium compatible with personal cognitive use?

[Crit.518] Does the text acknowledge cognitive skills required of users of paper-based texts?

See [Crit.652] Does the text acknowledge the notions of *granularity* and *partitioning* granules to facilitate arrangement within, and organization of, texts?

See [Crit.653] Does the text acknowledge paper as a medium providing for

fragmentation and granularity which facilitate reorganization of texts?

Human-computer interaction (HCI)

[Crit.519] Does the text acknowledge multidisciplinary sources of HCI

convention and theory?

[Crit.520] Does the text acknowledge that HCI is about what people want to do

rather than what the technology can do?

[Crit.521] Does the text acknowledge that HCI must use human cognition as a

point of departure for theory, on the logic that if one intends to design

and build usable interactive systems, one must understand something

about the capabilities of people?

[Crit.522] Does the text acknowledge the importance of (a) memory; (b)

attention; (c) visual perception; and (d) mental models?

[Crit.523] Does the text acknowledge that attention can be focused or divided?

[Crit.524] Does the text acknowledge that attention capacity might be limited?

[Crit.525] Does the text acknowledge that attention may be partitioned into that

which is conscious and that which is sub-conscious?

See [Crit.640] Does the text acknowledge the 100-millisecond threshold as the

boundary between conscious and subconscious (or automatic) control

of cognition?

[Crit.526] Does the text acknowledge that stress might affect attention positively, negatively, or both?

[Crit.527] Does the text acknowledge that mental workload can be evaluated based on mental demand, physical demand, temporal demand (time pressure), performance (degree success achieved), effort (how "hard did you have to work mentally"), and frustration level ?

[Crit.528] Does the text acknowledge that [an instructional] system includes the learner-inquirer, not merely for HCI, but in all engagement with intermediation?

[Crit.529] Does the text acknowledge (a) that the inquirer's mental model is developed through interaction *with* the system? (b) that designers often expect the inquirer's model to be identical to the design model?, but (c) that if the designer does not communicate directly with the inquirer, the inquirer will end up with the wrong mental model?

[Crit.530] Does the text acknowledge that mental models are incomplete?

See [Crit.497] Does the text acknowledge that *elocutio* always *under*specifies *dispositio*? That terms can never wholly express concepts?

[Crit.531] Does the text acknowledge that mental models are difficult to test mentally?

[Crit.532] Does the text acknowledge that mental models are unstable?

[Crit.533] Does the text acknowledge that mental models do not have firm boundaries?

[Crit.534] Does the text acknowledge that mental models are parsimonious?

[Crit.535] Does the text disclaim the so-called 'human information processing paradigm' whereby the human mind is modeled as a computer system?

See [Crit.435] Does the text acknowledge that computer systems, computer disks, and databases are not adequate analogs for human memory?

[Crit.536] Does the text acknowledge an HCI model consisting of

(1) the inquirer's mental model of the subject matter

(1(a)) the inquirer's mental model of the intermediation system

(2) the intermediation system's model of the inquirer's mental model of the subject matter

(3) a conceptual reference structure model sufficiently rich to perform as a source model to isomorphically project concepts and relations to inquirer's target mental model (this reference set model can only be within the inquirer)

(3(a)) an external derivation of (3)

is *the designer's model of the user's model* which is basically constructed before the system exists by looking at similar systems or prototype or by cognitive models or task analysis?

See [Crit.900] What is inquiry?

Evidence that a learner has constructed meaning

[Crit.537] Does the text acknowledge, as evidence of an inquirer's successful construction of meaning, a *cognitive* change occurs (a relation established, a gap filled, a path completed)?

[Crit.538] Does the text acknowledge, as evidence of an inquirer's successful construction of meaning, a felt *sensation* that displaces the distress of inadequate *dispositio*, occurs?

[Crit.539] Does the text acknowledge that detection of cognitive change and felt sensation can be accomplished through the instrumentation described in Part II.1, e.g., using concept mapping techniques? (See [Crit.205 - 212]).

Continuous derivations

[Crit.540] Does the text acknowledge that derivation sequences can iterate continuously?

[Crit.541] Does the text acknowledge that new meanings, relations among *inventio*, can be stimulated (1) directly by a *dispositio* (ideas beget other ideas), (2) by a term (*elocutio*), or (3) by perceptual stimuli from receipt of *pronuntiatio*?

See [Crit.148] Is the proposition that "the function of structures is to connect or relate objects" embraced?

See [Crit.541] Does the text acknowledge that new meanings, relations among *inventio*, can be stimulated (1) directly by a *dispositio* (ideas beget other ideas), (2) by a term (*elocutio*), or (3) by perceptual stimuli from receipt of *pronuntiatio*?

See [Crit.164] Is the proposition that "concept formation continues iteratively until condition of satisfaction or exhaustion is reached, even if

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comprehension is not reached or if *dispositio* is still inadequate"
embraced?

See [Crit.187] Is the proposition that "learners learn an idea best at the moment
that idea is important to them" embraced?

What are reading and writing?

[Crit.600] Does the text acknowledge that *pronuntiatio* ➡ *elocutio* ➡ *inventio*
➡ *dispositio* is assimilating, as in reading and listening?

[Crit.601] Does the text acknowledge that *inventio* ➡ *dispositio* ➡ *elocutio* ➡
pronuntiatio is expressing, as in writing, speaking, and performing?

Reading and writing are *personal*

See [Crit.516] Does the text acknowledge paper as a medium providing for
personal cognitive use of texts?

What is a *text*?

[Crit.602] Does the text acknowledge the term *text* is polysemous, referring
potentially to objects of any of the Divisions of Rhetoric?

[Crit.603] Does the text acknowledge that a document is a *recorded* text?

What is the purpose of a *text*?

[Crit.604] Does the text acknowledge the notion that the text should organize
presentation of ideas in a sequence such that the learner is ready to
learn those ideas?

[Crit.605] Does the text avoid venturing, with undue certainty, into whether a text expresses authorial intent?

What is reading?

[Crit.606] Does the text acknowledge that *reading* is

pronuntiatio ➜ *elocutio* ➜ *inventio* ➜ *dispositio*?

[Crit.606a] Does the text acknowledge that the process of reading is a continuous isomorphic mapping and projection between the new ideas derived from the text and the reader's ICMs which organize the newly encountered concepts, that is, sense-making?

[Crit.607] Does the text acknowledge provocation by written *pronuntiatio*, through perception of external visual manifestation of natural language expressions (*elocutio* graphic), of internal evocation of meaning, is *reading*?

[Crit.608] Does the text acknowledge a taxonomy of *reading* including (1) meaningful reading (reader constructs meaning) as in private reading, and (2) recognizing graphic *elocutio* and then producing audible sounds, i.e., "reading aloud" which might or might not include constructing meaning as one produces oral sounds?

[Crit.609] Does the text acknowledge that reading is not merely conjuring meanings from individual words or terms, but sentence and whole text meaning as well, which required the reader to integrate new ideas provoked by written objects with prior knowledge?

[Crit.610] Does the text acknowledge that the reader must apply syntactic, grammatical, and semantic systems to the individual terms and expressions perceived from a document?

[Crit.611] Does the text echo Miller in claiming the reader understands a sentence if s(he) knows the conditions under which a person would use it?

[Crit.612] Does the text echo Miller further in claiming that the reader must discover a model that is compatible with those sentences -- a model that includes the author's model [or not] .. . .   Then his task becomes just the reverse of the author's: a reader uses the true descriptive sentence to select a model?

Why is reading difficult?

[Crit.613] Does the text acknowledge that meaningful reading can be obstructed if the reader's perceptual (physical sensory) resources are impaired, especially vision, i.e., the reader may be unable to perform derivation of *pronuntiatio* ➡ *elocutio*?

[Crit.614] Does the text acknowledge that reading can be obstructed if the reader cannot recognize the inscribed shapes?

[Crit.615] Does the text acknowledge that successful reading might require a reader to process a character-based text, which, though *linear*, might nevertheless demand that the reader's *eye follow a non-linear* path?

[Crit.616] Does the text acknowledge that reading can be obstructed if terms are composites of finer-grained elements, (e.g., letters comprise letter

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sequences associated with words in English) but the reader does not recognize the finer-grained elements or does not recognize the character sequences associated with terms in the language?

[Crit.617] Does the text acknowledge that reading can be obstructed if the reader does not recognize the terms that comprise the language set?

[Crit.618] Does the text acknowledge that reading can be obstructed if the reader does not have working knowledge of the syntactic, grammatical, or semantic functions, forms, or patterns of the language?

[Crit.619] Does the text acknowledge that reading can be obstructed if the reader does not have working knowledge of the vocabulary of the language?

[Crit.619a] Does the text acknowledge that reading can be obstructed if the reader does not have intellectual access to the meaning of *elocutio* in use by writer and readers at the time the text was written?

[Crit.620] Does the text acknowledge that reading can be obstructed if the reader does not have working knowledge of the pronunciation of the language?

[Crit.621] Does the text acknowledge that reading can be obstructed if the reader does not have working knowledge of the syllabification of the language?

[Crit.622] Does the text acknowledge that reading can be obstructed if the reader does not have working knowledge of the etymology of terms in the language?

[Crit.623] Does the text acknowledge that reading can be obstructed because negotiation of meaning impossible with an inert text?

[Crit.624] Does the text acknowledge that reading can be obstructed if the reader has inadequate capacity to survey their own *dispositio* to ascertain where opportunities lie to relate the surface meanings to one's existing *dispositio*?

[Crit.625] Does the text acknowledge that reading can be obstructed if the reader has inadequate capacity to recognize central thematic concepts (ICMs)?

[Crit.626] (not used)

[Crit.627] Does the text acknowledge that overcoming obstacles to reading consumes cognitive energy and time?

Innovations that mitigate obstacles to meaningful reading

[Crit.628] Does the text acknowledge the cognitive function of syndetic reference?

[Crit.628a] Does the text acknowledge that syndetic references expressed by bibliographic references, and guides to periodical literature conserve cognitive labor by providing an alternative to sequential assimilation of texts?

[Crit.629] Does the text acknowledge that syndetic function requires three elements, the indexical to a referent, the referent, and the intellectual capacity to evoke the referent from the indexical?

[Crit.630] Does the text acknowledge that the form of *pronuntiatio* and the extent to which it facilitates re-arrangement, facilitates construction of *dispositio*?

[Crit.631] Does the text acknowledge that white space, graphic emphasis, and punctuation facilitate differentiation between inscriptions, and thus facilitate construction of *dispositio*?

[Crit.632] Does the text acknowledge that intradocument boundary markers, e.g., chapters, sections, and headings, facilitate construction of *dispositio*?

[Crit.633] Does the text acknowledge that summaries, abstracts, and titles reduce the quantitative amount of *elocutio* the reader need process to comprehend a text, and thus facilitate construction of *dispositio*?

[Crit.634] Does the text acknowledge that expressions from which cognitive authority are derived facilitate construction of *dispositio*?

[Crit.635] Does the text acknowledge that syndetic devices facilitate finding texts or portions of texts, and thus construction of *dispositio*?

[Crit.636] Does the text acknowledge re-reading to facilitate construction of *dispositio*?

What is *paying attention*?

[Crit.637] Does the text acknowledge that "reading" and "listening" without paying attention are both less detectable than "writing" or "speaking" without paying attention?

[Crit.638] Does the text acknowledge that learners can have conscious control over attention?

[Crit.639] Does the text acknowledge, as does Ausubel, that *inattention* is comparable to rote learning because surface concepts derived from a text are not then related into the reader's existing knowledge?

See [Crit.523] Does the text acknowledge that attention can be focused or divided?

See [Crit.524] Does the text acknowledge that attention capacity might be limited?

[Crit.640] Does the text acknowledge the 100-millisecond threshold as the boundary between conscious and subconscious (or automatic) control of cognition?

See [Crit.525] Does the text acknowledge that attention may be partitioned into that which is conscious and that which is sub-conscious.

What criteria might be used to determine if one is paying attention?

[Crit.641] Does the text acknowledge criteria for recognizing attention: a cognitive event, *comprehension*, or a felt sensation, *Eureka!*?

What is listening?

[Crit.642] Does the text acknowledge that *listening is meaningful hearing*, that is, hearing, deriving concepts expressed, and assimilating them with existing knowledge?

[Crit.643] Does the text acknowledge that *listening* demands *attention*, *anticipating*, *recognizing,* and *applying* concepts expressed aurally to existing knowledge (*interpreting*)?

What is writing?

[Crit.650] Does the text acknowledge that *writing* encompasses *inventio* ➜ *dispositio* ➜ *elocutio* ➜ *pronuntiatio*?

Senses of *writing*

[Crit.651] Does the text acknowledge that *writing* can alternatively refer to a process of inscribing only, or to deriving expressions from ideas and then deriving inscriptions from linguistic expressions?

Fragmentation facilitates arranging

[Crit.652] Does the text acknowledge the notions of *granularity* and *partitioning* granules to facilitate arrangement within, and organization of, texts?

[Crit.653] Does the text acknowledge paper as a medium providing for fragmentation and granularity which facilitate reorganization of texts?

Value of writing to meaningful learning

[Crit.654] Does the text acknowledge that one value of writing to meaningful learning, according to Ausubel, is in successive expositions of progressively differentiated *dispositio* with increasing specificity?

[Crit.655] Does the text acknowledge that one value of writing to meaningful learning is in expressing *relations among ideas* that the reader might not otherwise have been able to make?

[Crit.656] Does the text acknowledge that one value of writing to meaningful learning is in revision which encompasses reevaluating and reorganizing a text?

See [Crit.487] Does the text acknowledge that *dispositio* ➔ *elocutio* compels speaker-writer to (re-) organize thoughts?

How does a writer decide which ideas to express next? Arrangements, models, plots, themes, plans

[Crit.657] Does the text acknowledge that concepts are organized by writers according to models, plots and themes?

[Crit.658] Does the text acknowledge that isomorphic projection and isomorphic mapping of ICMs onto skeletal texts are the fundamental method by which writers organize new *dispositio*?

[Crit.659] Does the text acknowledge the distinction between text (e.g., story) and structure (plot, theme, or superordinate ICM)?

[Crit.660] Does the text acknowledge that teachers can guide writing students in several ways: if the writer does not have a clear model or plan from which to project, she can be encouraged to evoke or select one?

[Crit.661] Does the text acknowledge that teachers can guide writing students in several ways: where the writer's text appears to stray from the plan or

include expressions that conflict with or are not relevant to the plan, the teacher may offer such observations?

[Crit.662] Does the text acknowledge that teachers can guide writing students in several ways: if the writer has arranged expressions in a different order than a path, or if steps in a path are missing, the student may be advised to revise accordingly?

[Crit.663] Does the text acknowledge that teachers can guide writing students in several ways: if assumptions are made in the writer's model, the teacher may constructively challenge them?

[Crit.664] Does the text acknowledge that teachers can guide writing students in several ways: if a writer fails to express a thematic element or believe he has expressed it but the reader-teacher finds that such element is not, for him, evoked as a result of reading the text, the writer may be advised accordingly?

[Crit.665] Does the text acknowledge that teachers can guide writing students in several ways: if the writer has activated a theme, and is unaware of it, the teacher may call the writer's attention to it?

Anticipating and satisfying the reader's expectations

[Crit.666] Does the text acknowledge that readers generally bring particular expectations to their engagement with a text?

[Crit.667] Does the text acknowledge that readers generally bring particular expectations to their engagement with a text: they expect expressions of *dispositio* that are significant for them?

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[Crit.668] Does the text acknowledge that readers generally bring particular expectations to their engagement with a text: they expect expressions of *dispositio* that are new, interesting, or both?

[Crit.669] Does the text acknowledge that readers generally bring particular expectations to their engagement with a text: they expect expressions of *dispositio* that follow some theme, model, plot, superordinate ICM, with initial and terminal endpoints with which they are familiar?

[Crit.670] Does the text acknowledge that readers generally bring particular expectations to their engagement with a text: they expect expressions of belief structures and linguistic expressions that are familiar to them?

[Crit.671] Does the text acknowledge that readers generally bring particular expectations to their engagement with a text: in scholarly writing, they expect claims to be supported by expressed warrants and evidence?

[Crit.672] Does the text acknowledge that the writer's task is an imaginative one, and encompasses not only expressing the concepts they wish to communicate, but anticipating the reader's ideas and those they might conjure, and what relations the writer must express between what the reader's prior knowledge and the ideas the writer desires to communicate?

Why is writing difficult?

[Crit.673] Does the text acknowledge that writing consumes cognitive and physical energy and requires labor?

[Crit.674] Does the text acknowledge that writing requires labor of several types: evoking *inventio*, organizing *dispositio*, selecting *elocutio*, and in many cases, inscribing and delivering *pronuntiatio*, not to mention revising, illustrating, indexing, or publishing?

[Crit.675] Does the text acknowledge that evoking and selecting ideas about which to write can be barriers to writers?

[Crit.676] Does the text acknowledge that the writer must identify the underlying models (ICMs) that communicate intended ideas to the reader?

[Crit.677] (Not used)

[Crit.678] Does the text acknowledge that taking into account the conditions under which those readers would reach the intended constructions, all without interacting iteratively with his readers in real time, is difficult?

[Crit.679] Does the text acknowledge that a formidable difficulty for the writer is viewing his own draft text from the perspective of the reader?

[Crit.680] Does the text acknowledge that ambiguity of *elocutio* to unknown readers adds to the difficulty of writing?

[Crit.681] Does the text acknowledge that the cognitive velocity of *pronuntiatio* ➡ *elocutio* reading is slow relative to velocity of thinking?

[Crit.682] Does the text acknowledge that writing, even more than reading, is (most often) private?

What is interpretation?

[Crit.690] Does the text acknowledge that interpretation is both assimilating and expressing?

[Crit.691] Does the text acknowledge that the *objects* produced in *expressing*, *pronuntiatio*, e.g., documents, musical or stage performances, paintings, etc., are also referred to as *interpretations*?

[Crit.692] Does the text acknowledge that the *objects* produced in *assimilating*, i.e., ideas, *dispositio*, are also *interpretations*?

[Crit.693] Does the text acknowledge that hermeneutics, codified interpretation for specific purposes, strictly controls meanings allowed and conclusions drawn?

[Crit.694] Does the text acknowledge that *explicit* is synonymous with *derivation of meaning by the inquirer that is unambiguous*?

[Crit.695] Does the text acknowledge that subtexts rely on situation and context for drawing interpretative conclusions?

[Crit.695a] Does the text acknowledge that *subtexts* provoke evocation of concepts via a mental model the reader is expected to have, by first mapping concepts provoked by the text to some of the elements of the mental model, then, by projecting remaining concepts not provoked by the text?

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[Crit.696] Does the text acknowledge that interpretation is the central concern of the arts, architecture, music, dance, poetry and literature, theater, the humanities?

What is thinking?

What is mind?

[Crit.700] Does the text acknowledge the term mind as the totality of processes of thinking and the resulting objects, thought (*inventio*, *dispositio*)?

What do learners do when they think?

[Crit.701] Does the text acknowledge that thinking consists of cognitive capabilities of *abstraction, categorization, and generalization*?

[Crit.702] Does the text acknowledge that *abstraction, categorization, and generalization* are each a direct product of isomorphic mapping and isomorphic projection?

Why does one thought lead to another?

[Crit.703] Does the text acknowledge that isomorphic mapping and isomorphic projection cause a thought to evoke a subsequent thought?

See also: [Crit.315a-c]

[Crit.703a] Does the text acknowledge an inquirer cannot become informed without isomorphic mapping and isomorphic projection?

Isomorphic mapping and isomorphic projection

What is isomorphic mapping?

[Crit.704]   Does the text acknowledge that *isomorphic mapping* is a comparative operation between two structures whereby relation among corresponding elements of both structures are identified?

[Crit.705]   Does the text acknowledge that the purpose of *isomorphic mapping* is to find and identify commonalties among the two structures?

What steps occur in isomorphic mapping?

[Crit.706]   Does the text acknowledge that the isomorphic mapping process comprises:

(1) (optionally) *becoming motivated* consciously or subconsciously, to perform a mapping,

(2) *searching* for *inventio* or relations in the target domain that match the element of interest in the source domain,

(3) *recognition* of substantially similar elements (concepts and relations),

(4) *identification* of the substantially similar elements,

(5) optionally, *recognition of differences* of *inventio* and relation, or degree (duration, intensity) of relations in the two structures, and

(6) recognition of "unknown" concepts or where the target manifests a gap?

Determining whether two concepts are "the same"

[Crit.707] Does the text acknowledge that differentiating among concepts is best performed by contrasting their elemental *inventio* and relations?

What is isomorphic projection?

[Crit.708] Does the text acknowledge that *isomorphic projection* is a separate process that fills in a portion of the target *dispositio* by deriving replica *inventio* from the source structure?

[Crit.709] Does the text acknowledge that isomorphic projection is not accomplished though mapping or recognition of similarities alone, but incorporates the *construction* of a *new* portion of *dispositio* derived from another concept?

[Crit.710] Does the text acknowledge that isomorphic projection's creation of new structure may be regarded as *creative* or *imaginative*?

What steps occur in isomorphic projection?

[Crit.711] Does the text acknowledge that isomorphic projection consists of isomorphic mapping followed by determining which *inventio* of the source will project to the target, which relations of the new *inventio* will project and to which existing *inventio* in the target they appropriately connect?

Blends

[Crit.712] Does the text acknowledge Fauconnier's conceptualization of projection, the operation upon the target does not result in a modified target, but the creation of a new third object, a blend?

Counterfactual blends

[Crit.713] Does the text acknowledge that a learner can *know* a hypothetical concept, a counterfactual, for the purpose of testing it against other ideas?

[Crit.714] Does the text acknowledge that subjunctive terms such as *if*, *should*, *would*, or *could*, indicate creation of a counterfactual *dispositio*?

What motivates isomorphic mapping and isomorphic projection?

[Crit.715] Does the text acknowledge that cognitive and linguistic questions, curiosity, and felt sensations of distressing ignorance or constructive discontent, motivate isomorphic projection?

Isomorphic projection underlies *transfer*

[Crit.716] Does the text acknowledge that isomorphic mapping and isomorphic projection underlie the process of *transfer*?

[Crit.716a] Does the text acknowledge that isomorphic mapping and isomorphic projection underlie the process of *inference*?

Isomorphic projection underlies *abstraction*

[Crit.717] Does the text acknowledge that isomorphic mapping and isomorphic projection underlie the process of *abstraction*?

Isomorphic projection underlies *categorizing*

[Crit.718] Does the text acknowledge that isomorphic mapping, by virtue of recognizing *inventio*-in-common in multiple *dispositio*, underlie the process of *categorizing*?

Isomorphic projection underlies *generalization*

[Crit.719] Does the text acknowledge that isomorphic mapping and isomorphic projection underlie the process of *generalization*?

Isomorphic projection underlies many other cognitive activities

Isomorphic projection underlies *metaphor*

[Crit.720] Does the text acknowledge that isomorphic mapping and isomorphic projection underlie the process of *metaphor*?

[Crit.720a] Does the text acknowledge that the mechanism of metaphor, as a type of projection, creates new knowledge?

Metaphor is a figure of thought, not a figure of language

[Crit.721] Does the text acknowledge that the process of *metaphor* is a figure of thought (*dispositio* from isomorphic projection), not a figure of speech (*elocutio*)?

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[Crit.722] Does the text acknowledge that *metaphorical expression* is the *elocutio* derivation of metaphor?

Metaphoric operation is a *partial* isomorphic projection

[Crit.723] Does the text acknowledge that *metaphoric operation* is a *partial* isomorphic projection?

[Crit.724] Does the text acknowledge that multiple metaphors might conflict with one another with respect to some attributes?

Impact of metaphor, as isomorphic operation, on learning

[Crit.725] Does the text acknowledge that partial isomorphic projection, as distinct from total projection, enables learners to differentiate between metaphor and literal interpretation?

[Crit.726] Does the text acknowledge the notion of a shift from a mode of cognition in which ideas are being fitted to an existing knowledge structure (mapping), to a metaphorical process resulting in construction of a third knowledge structure consisting of concepts and relations projected from the first two domains (a *blend*)?

Isomorphic projection also underlies . . .

[Crit.727] Does the text acknowledge that isomorphic mapping and isomorphic projection underlie the processes of *analysis* and *synthesis*?

[Crit.728] Does the text acknowledge that isomorphic mapping and isomorphic projection underlie the notions of *models* and *schema*?

[Crit.729] Does the text acknowledge that isomorphic mapping and isomorphic projection underlie the notions of *theory*, *prediction*, and *consistency*?

[Crit.730] Does the text acknowledge that isomorphic mapping and isomorphic projection underlie the notions of *drawing conclusions*, *estimating*, and *making assumptions*?

[Crit.731] Does the text acknowledge that isomorphic mapping and isomorphic projection underlie the notions of *reason*, *certainty*, *mathematics*, and *logic*?

[Crit.732] Does the text acknowledge that isomorphic mapping and isomorphic projection underlie the notions of *tropes, analogies,* and *memory palaces*, and *photographs*?

[Crit.733] Does the text acknowledge that isomorphic mapping and isomorphic projection underlie the notions of *humor?*

[Crit.734] Does the text acknowledge that isomorphic mapping and isomorphic projection underlie the notions of *fables, morality plays, fairy tales, parables,* and *allegories?*

[Crit.735] Does the text acknowledge that isomorphic mapping and isomorphic projection underlie the notions of *conversation, becoming acquainted,* and *reunions?*

[Crit.736] Does the text acknowledge that isomorphic mapping and isomorphic projection underlie the notions of *precedent, example, and reason in judicial analysis?*

[Crit.737] Does the text acknowledge that isomorphic mapping and isomorphic projection underlie the notions of *classification?*

[Crit.737a] Does the text acknowledge that isomorphic mapping and isomorphic projection underlie the notions of *organizing?*

[Crit.738] Does the text acknowledge that isomorphic mapping and isomorphic projection underlie the notions of *constructing beliefs, branding, advertising, granting academic degrees, vouching for someone, endorsements, testimonials, licenses, identification documents*, and *cognitive authority*?

[Crit.739] Does the text acknowledge that a purpose of promoting a learner-reader's projection of concepts is to exercise intellectual control over the learner-reader, influencing what they know or believe*?*

Function of isomorphic mapping and projection: labor-saving

[Crit.740] Does the text acknowledge that the function of isomorphic mapping and isomorphic projection is to avoid expenditure of cognitive labor*?*

[Crit.741] Does the text acknowledge that without isomorphic mapping and isomorphic projection, construction of new knowledge would be impossible -- knowledge would have to be re-learned in every instance*?*

Most isomorphic operation is sub-conscious

[Crit.742] (Not used)

See [Crit.640] Does the text acknowledge the 100-millisecond threshold as the boundary between conscious and subconscious (or automatic) control of cognition?

[Crit.743] Does the text acknowledge that intervention in inadequate cognitive process requires the learner or intermediary to bring to the learner's consciousness the objects resulting from isomorphic mapping and isomorphic projection*?*

See [Crit.757] Does the text acknowledge that ongoing subconscious activity for a prolonged period (i.e., hours or days, rather than seconds), upon which people occasionally rely in lieu of overt cognitive effort, is referred to as *incubation?*

Why is thinking difficult?

Cognitive velocity

[Crit.744] Does the text acknowledge that an inquirer's cognitive velocity is limited*?*

See [Crit.523] Does the text acknowledge that attention can be focused or divided?

See [Crit.524] Does the text acknowledge that attention capacity might be limited?

Mental workload

See [Crit.178] Is Miller's theoretical *seven plus or minus 2* limitation on cognitive processing capacity, number of ideas, number of processes, number of relations embraced?

See [Crit.527] Does the text acknowledge that mental workload can be evaluated based on mental demand . . . ?

Thinking strategy

[Crit.745] Does the text acknowledge that an inquirer may have difficulty recognizing an applicable superordinate model that organizes disparate *dispositio?*

Memory dysfunction

[Crit.746] Does the text acknowledge that an inquirer's memory can be dysfunctional*?*

Innovations that mitigate obstacles to thinking

[Crit.747] Does the text acknowledge that *analysis* is a human innovation that mitigates obstructions to thought*?*

[Crit.748] Does the text acknowledge that one facet of analysis is partitioning a "problem" into components (e.g., conceptual sub-structures of inadequate *dispositio)?*

[Crit.748a] Does the text acknowledge that facets partitioning a "problem" can include setting "a boundary around the problem," that is, a conceptual scope discriminating those concepts that the problem encompasses and those that it does not?

[Crit.749] Does the text acknowledge that one facet of analysis is differentiating the concepts and relations of a "problem"*?*

[Crit.750] Does the text acknowledge that synthesis is a human innovation that can mitigate obstructions to thought*?*

[Crit.751] Does the text acknowledge that mathematics is a human innovation that can mitigate obstructions to thought*?*

[Crit.752] Does the text acknowledge that logic is a human innovation that can mitigate obstructions to thought*?*

[Crit.753] Does the text acknowledge that scientific method is a human innovation that can mitigate obstructions to thought*?*

[Crit.754] Does the text acknowledge that literary analysis is a human innovation that can mitigate obstructions to thought*?*

[Crit.755] Does the text acknowledge that political analysis, i.e., ascertaining a party's *interests*, is a human innovation that can mitigate obstructions to thought*?*

[Crit.756] Does the text acknowledge that religious analysis is a human innovation that can mitigate obstructions to thought*?*

What is *incubation*?

[Crit.757] Does the text acknowledge that ongoing subconscious activity for a prolonged period (i.e., hours or days, rather than seconds), upon which people occasionally rely in lieu of overt cognitive effort, is referred to as *incubation?*

[Crit.758] Does the text acknowledge that inability to incubate is a barrier to meaningful learning?

What is critical thinking?

[Crit.760] Does the text acknowledge that *critical thinking* is probing ideas that do *not* manifest apparent inadequacies?

[Crit.761] Does the text acknowledge that *critical thinking* encompasses the tasks of probing for, recognizing, identifying, and examining *assumptions* underlying an idea?

How can assumptions be recognized?

[Crit.762] Does the text acknowledge that assumptions can be recognized through detection of contradictions?

[Crit.763] Does the text acknowledge that assumptions can be recognized through detection of claims of truth, belief, or trust?

[Crit.764] Does the text acknowledge that assumptions can be recognized through detection of warrants (as criteria for accepting claims)?

[Crit.765] Does the text acknowledge that assumptions are *inventio-dispositio*, like any other, but that they gain the status of an *assumption* when they:

(1) become related to *another* idea, a *claim*,

(2) operate as a criterion for imputing *truth*, *belief*, *trust* to that claim?

[Crit.766] Does the text acknowledge that ideas often become recognized as assumptions (or warrants) when the attribute of *reliability* is, or

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becomes, *absent* from the *claim*, i.e., when the claim is contradicted by evidence?

[Crit.767] Does the text acknowledge that in critical thinking, *warrants* are regarded as *assumptions at inception*, rather than awaiting contradiction?

[Crit.768] Does the text acknowledge that in critical thinking, assumptions must be probed?

[Crit.769] Does the text acknowledge that critical thinking intervenes in a subconscious thought process to insert, at the conscious level, the task of probing the warrant?

How does warrant probing operate in critical thinking?

[Crit.770] Does the text acknowledge that probative critical thinking is not strictly a cold, logical operation, but implies a human drawing conclusions as to belief and validity?

[Crit.771] Does the text acknowledge that two evaluations must occur: evaluation of the *warrant* to determine whether it is sufficient, and then evaluation of the *evidence* according to the *warrant*?

[Crit.772] Does the text acknowledge that, to carry out these evaluations, the critical thinker must construct counterfactual probes, then isomorphically project them onto the idea to be evaluated?

[Crit.773] Does the text acknowledge that critical thinking can be regarded as directed to *overcoming* preconceptions, that is, relations such as trust, and cognitive authority *already* imputed?

[Crit.774] Does the text acknowledge that probing warrants and overcoming assumptions is difficult because it requires the mental labor of seeking and finding defects in the warrants and evidence used to establish the claim or idea as *true*?

[Crit.775] Does the text acknowledge that methodologies for producing and evaluating counterfactual interpretations (to probe warrants) include hypothesis generation and testing, and question formulation?

Reliability: **belief, trust, truth, knowledge, cognitive authority, etc.**

[Crit.776] Does the text acknowledge that a rationale of the learner for concern with belief, trust, and truth is usually that of achieving *certainty*, and, in turn, economizing expenditure of cognitive energy?

See [Crit.763] Does the text acknowledge that assumptions can be recognized through detection of claims of truth, belief, or trust?

What is the role of planning in thinking?

[Crit.780] Does the text acknowledge that, with regard to planning performed by the intermediary on behalf of the inquirer, centers around sequencing material so that each new concept builds on ideas already presented and assimilated?

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[Crit.781] Does the text acknowledge that, with regard to planning performed by the inquirer himself, unless constructed deliberately and consciously, cognitive (or subcognitive) plans are pre-formed, superordinate or idealized cognitive models (ICMs)?

[Crit.782] Does the text acknowledge that, where learning falters, one may look to the models evoked by the inquirer and evaluate their efficacy for learning the intended subject matter?

[Crit.783] Does the text acknowledge that plans fulfill the role of serving as the learner's criteria for knowing when they have reached the terminal endpoint of their inquiry?

See [Crit.210] Is the proposition that "the gaps and misconceptions revealed in contrasting a inquirer's conceptual structure and a reference structure may be used to formulate instructional plans" embraced?

See [Crit.187] Is the proposition that "learners learn an idea best at the moment that idea is important to them" embraced?

What is the role of imagination in thinking? What is creativity?

[Crit.790] Does the text acknowledge that *discovery* of superordinate source ideas from which isomorphic projection operations create new meaning, is an imaginative, creative act?

[Crit.791] Does the text acknowledge that isomorphic projection is an imaginative, creative act because it results in construction of a *new* portion of *dispositio* derived from another concept?

Imagination *is* isomorphic projection of counterfactual concepts

[Crit.792] Does the text acknowledge that *imagination* further encompasses the ability to construct *counterfactual dispositio* and test it as a hypothetical?

Macro isomorphic operations: Idealized cognitive models

[Crit.801] Does the text acknowledge a process by which richly textured (i.e., many component *inventio* and relations) superordinate *dispositio*, ICMs, are projected onto the learner's *dispositio*?

***Recognizing* basic schema, *dispositio*, or idealized cognitive models (ICMs)**

[Crit.802] Does the text acknowledge that a learner's ability to recognize a small number of core ICMs might be sufficient to improve learning outcomes?

[Crit.803] Does the text acknowledge that many superordinate ICMs have been described in the cognitive science literature; acknowledging their benefits?

[Crit.804] Does the text acknowledge that the teacher's task is to (1) *recognize* where the learner might be projecting an inappropriate ICM, then (2) to communicate a more appropriate ICM?

***Anticipating* idealized cognitive models (ICMs)**

[Crit.805] Does the text acknowledge that an inquirer's recognition of a superordinate ICM is easier if the particular ICM *dispositio* is anticipated by the inquirer?

[Crit.806] Does the text acknowledge that reading, for example, may be

regarded, in part, as attempts to ascertain from the provided *elocutio*

which ICMs, or *dispositio* the author is attempting to provoke the

reader-learner to evoke?

Unconscious influence of an ICM is *a perspective* or *preconception*

[Crit.807] Does the text acknowledge that anticipated and recognized ICMs

should be subjected to critical thinking lest they become

misconceptions?

**Dichotomy: anticipating concepts is indispensable, but anticipation can also be
misconception**

[Crit.808] Does the text acknowledge that the learner is confronted with a

dichotomy: anticipating subsequent concepts is both essential to, and

a potential hindrance (misconception) to meaningful learning?

The *Eureka!* event

[Crit.820] Does the text acknowledge that the degree of felt sensation of the

Eureka event corresponds to the magnitude of (1) the improvement of

the learner's inadequate *dispositio*, distress, or discontent, (2) the

magnitude of the disparate *dispositio* that a new idea organizes and (3)

the "distance" as indicated by the traversal of subject matter

boundaries one reaches to import the projection into the subject

domain of interest.

**Relations among *inventio*, not *inventio* themselves, are best determiner of underlying
structure**

[Crit.821] Does the text acknowledge that the important attributes of a
superordinate ICM *dispositio* may not be its component *dispositio*, but
rather the relations among them that are projected to the target?

What is inquiry?

[Crit.900] Elements of inquiry. Does the text acknowledge that *inquiry*
encompasses an overall model as reflected by [Crit.900.0] -
[Crit.900.7]?

[Crit.900.0]   Does the text acknowledge that, in *inquiry*, over the course of their
professional career, a teacher-subject specialist develops and maintains
their own conceptual structure, i.e., subject-specific knowledge of their
field or collection, a *conceptual reference structure*?

[Crit.900.1]   Does the text acknowledge that, in *inquiry*, learner impels *curiosity*
(probing their own *dispositio*)?

[Crit.900.2a]   Does the text acknowledge that, in *inquiry*, learner's recognition of
their *inadequate dispositio*, that is, a *cognitive question*, is evoked?

[Crit.900.2b]   Does the text acknowledge that, in *inquiry*, a set of linguistic terms
is derived, an *expressed question (elocutio)*, is produced?

[Crit.900.2c]   Does the text acknowledge that, in *inquiry*, a *question*
(*pronuntiatio*), i.e., a performance of those terms (2b), may be
produced and transmitted to a teacher-subject specialist?

[Crit.900.3a]   Does the text acknowledge that, in *inquiry*, the teacher or subject
specialist produces re-construction of the inquirer's cognitive question

and context (adjacent concepts) (2a), i.e., the teacher's *re-construction of the inquirer's conceptual structure*, by *unpacking* (*pronuntiatio* ➤ *elocutio* ➤ *dispositio*) the *pronuntiatio* transmitted by the inquirer?

See [Crit.122] Is the proposition "ascertain the inquirer's prior knowledge" embraced?

See [Crit.476] Does the text acknowledge that derivation *inventio* ➤ *dispositio* is *analytic*, revealing its component concepts and the structure among them? Is *unpacking* used in this sense?

[Crit.900.3b]   Does the text acknowledge that, in *inquiry*, the teacher-subject specialist performs *isomorphic mapping from* concepts expressed in their *re-construction of the inquirer's conceptual reference structure* (3a) *to* their own *conceptual reference structure* (0)?

See [Crit.149] Is the proposition that "cognitive structures can be incomplete relative to some external conceptual reference structure, or have internal inconsistencies (i.e., be wrong, untruthful, misinformed)" embraced?

[Crit.900.3c]   Does the text acknowledge that, in *inquiry*, the teacher-subject specialist performs *isomorphic projection* of concepts and relations *from* portions of their *conceptual reference structure* selected to ameliorate the inquirer's cognitive question (3b), *onto* their *re-construction of the inquirer's conceptual reference structure* (3a), forming an *explanatory path*;?

See [Crit.791] Does the text acknowledge that isomorphic projection is an imaginative, creative act because it results in construction of a *new* portion of *dispositio* derived from another concept?

[Crit.900.3c1] Does the text acknowledge that a model that excludes (3c), Projecting explanatory concepts from a conceptual reference structure to the inquirer's cognitive question, places the burden of performing the original projection of explanatory concepts onto the inquirer.

[Crit.900.3c2] Does the text acknowledge that the expenditure of cognitive labor by the inquirer, in some cases, is changed to the extent that an authored text expresses the result of isomorphic projections, other assimilation operations, or the construction of other relations (3c). This constitutes *reception learning* and is distinct from the inquirer having to construct a projection without the benefit of the projection being expressed by a teacher or authored text (discovery learning).

[Crit.900.3c3] Does the text acknowledge that both inquirer and teacher-subject specialist construct a temporary model of the conceptual structure of the other, teacher of the inquirer (3a), and inquirer of the teacher, as part of (2b).

See [Crit.536] Does the text acknowledge that HCI model consisting of . . . (1(a)) the inquirer's mental model of the intermediation system?

[Crit.900.3d]   Does the text acknowledge that, in *inquiry*, linguistic terms, *elocutio*, expressive of the *isomorphic mapping* performed (3b) and the

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isomorphic projection performed, i.e., the *explanatory path* (3c) are

derived?

[Crit.900.3e]   Does the text acknowledge that, in *inquiry*, indication of texts

expressive of *dispositio* (concepts and relations among concepts) that

comprise the explanatory path (3c), is performed by the teacher-

subject specialist, including indication of how and where the concepts

and relations that comprise the *isomorphic projection* are expressed in

the document?

[Crit.900.3f]   Does the text acknowledge that, in *inquiry*, *elocutio* derivations of

the *explanatory path* (3d), and the identification of texts expressive of

the explanatory path (3e), may be performed, *pronuntiatio*, and

transmitted to the inquirer?

[Crit.900.4a]   Does the text acknowledge that, in *inquiry*, the inquirer, through

their physical senses, perceives transmitted *pronuntiatio*?

[Crit.900.4b]   Does the text acknowledge that, in *inquiry*, the inquirer unpacks

(*pronuntiatio* ➤ *elocutio* ➤ *dispositio*) the transmission from the

teacher-subject specialist (3f)?

[Crit.900.4c]   Does the text acknowledge that, with the *dispositio* re-constructed

(4b), the learner-inquirer performs isomorphic projection (and other

assimilation processes) of those new concepts onto (4b) their own

conceptual reference structure (2a)?

[Crit.900.4d]   Does the text acknowledge that, in *inquiry*, through engagement

with the *dispositio* expressed by the texts recommended in (3e), the

learner-inquirer replicates further isomorphic projection (and other assimilation processes)?

[Crit.900.5a] Does the text acknowledge that, through (4c) and (4d), the learner-inquirer assimilates, that is, relates new concepts to their existing knowledge, thus becoming *dispositio*, and that only at this point has the learner-inquirer *become informed*?

[Crit.900.5b] Does the text acknowledge that, in *inquiry*, through use of inquirer's prior knowledge, such as concepts of *warrant*, cognitive authority, and other ICMs, the inquirer not only relates new concepts to existing knowledge, but also imputes attributes of trust, belief, truth, or relevance, or alternatively, as counterfactual or prevarication?

[Crit.900.6] Does the text acknowledge that, in *inquiry*, assimilation of explanations gives rise to *understanding* (in-*form*ed *dispositio*)?

[Crit.900.7] Does the text acknowledge that, in *inquiry*, this model of inquiry and portions of it, iterate, and that the type of iteration is at the level of the model as a whole, with feedback communication between inquirer and teacher-subject specialist?

See [Crit.130a] Is the proposition that "the intellectual effort the inquirer expends is a cognitive component of the price or cost of meaningful learning" embraced?

[Crit.900a] Does the text acknowledge that elements (0) and (3a)-(3f) of the Model of Inquiry may be regarded as *intermediation*?

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[Crit.901] Does the text acknowledge that *inquiry* encompasses the entire

Divisions of Rhetoric communications reference model in full circle?

[Crit.902] Does the text describe *all* the elements in [Crit.900] or omit any? If

omissions, are those elements included only *pronuntiatio*, or are

conceptual elements acknowledged for their role in *using* the external

pronuntiatio?

[Crit.903] Does the text acknowledge that the cycle of (1) *curiosity*, (2)

recognition of inadequate *dispositio*, and (2a) *questions*, is iterative?

[Crit.904] Does the text acknowledge that products of these motors are concept

sequences that can eventually form a *path*?

See [Crit.927] Does the text acknowledge that an *explanation* is a conceptual *path*

of connected concepts leading from the learner's existing knowledge to

the *dispositio* to be assimilated and that it *displaces* a cognitive

question?

[Crit.905] ([Crit.900.7] used instead.).

What is curiosity?

[Crit.906] Does the text acknowledge that *curiosity* may be understood as a

desire to know or *fear* of consequences of not knowing?

[Crit.907] Does the text acknowledge that curiosity-as-feeling is distressing

ignorance or constructive discontent?

[Crit.908] Does the text acknowledge that curiosity-as-rational-process is *critical*

thinking, one's systematic probing of one's own knowledge structure

(or interrogating another's) for both concepts and relations that might be "inadequate" or absent?

[Crit.909] Does the text acknowledge that regardless of the form of *curiosity*, emotional or rational, appetites for meaning vary, and thus do degrees of curiosity?

[Crit.910] Does the text acknowledge that curiosity can also vary over time?

Motivation: *drive*

See [Crit.924]Does the text acknowledge cognitive drive as a desire for knowledge as an end in itself?

Cognitive question: inadequate *dispositio* (*gaps* and *blocks*)

[Crit.911a]Is the proposition that a conceptual reference structure is *dispositio*, not *elocutio* or *pronuntiatio* (e.g., expressions of a classification system or a concept map) acknowledged?

[Crit.911] Does the text acknowledge that a specific inadequate *dispositio* may be regarded as a *cognitive question*?

[Crit.912] Does the text acknowledge that *cognitive questions* are differentiated from their expression in natural language terms, an *expressed question*?

[Crit.913] Does the text acknowledge that inadequate *dispositio* may be of at least two kinds:
a *gap* is a missing relation between *inventio*, preventing one from activating the other;

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a *block* is an existing relation, a preconception, that prevents establishment of a new idea or relation from one *inventio* to another?

[Crit.914] Does the text acknowledge specific conditions that may be described as *gaps* include:

unsatisfactory or null (missing) relations among *dispositio*

unsatisfactory or null (missing) concepts, and

unsatisfactory or null (missing) structure (concepts and relations)?

[Crit.914a] Does the text acknowledge that derivation of *pronuntiatio* ➔ *elocutio*, by the teacher-subject specialist, by itself, is not adequate to comprehend the inquirer's cognitive question; the teacher-subject specialist's re-construction of the inquirer's cognitive question must replicate or reflect the inquirer's concept structure.

See [Crit.181] Is the proposition that "inquirer's inability to express their gap is a dilemma: they are unable to express requests for help the very concepts and relations they do not possess and thus cannot express" embraced?

See [Crit.182] Preconceptions

[Crit.915] Does the text acknowledge that cognitive questions may be constructed and recognized (inferred) from an expressed question as from a teacher, a felt sensation, or from probing (curiosity-as-rational process)?

[Crit.916] Does the text acknowledge that a *dispositio* structure may be recognized as inadequate in several ways: *relative to* some *reference*

dispositio (an *expectation*), relative to a *warrant dispositio*, simply insufficiently rich, as the result of a counterfactual (hypothetical) scenario, or detection of the pronoun *what*?

[Crit.917] Does the text acknowledge that expressed questions are often recognized as the initiation (initial endpoint) of an inquiry, but it is the conceptualization of a cognitive question that must precede any other step in originating an inquiry?

The *question* as expression, *elocutio*

See [Crit.912] Does the text acknowledge that *cognitive questions* are differentiated from their expression in natural language terms, an *expressed question*?

How does the learner formulate an expressed question?

[Crit.918] Does the text acknowledge that expressed questions may be formulated by describing the inquirer's concepts surrounding (*context*) the inadequate *dispositio*; however this is not a description of the *dispositio* that is missing?

[Crit.919] Does the text acknowledge that the labor of deriving an expressed question sometimes leads to a modified *dispositio* that is no longer inadequate, or a changed or improved cognitive question?

[Crit.920] Does the text acknowledge that expressed questions that ask for more evidence may be accompanied by those that inquire as to the warrant for accepting evidence?

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[Crit.921] Does the text acknowledge expressed questions that ask for clarification?

[Crit.922] Does the text acknowledge expressed questions that are open?

[Crit.923] Does the text acknowledge expressed questions of other types?

[Crit.924] Does the text acknowledge cognitive drive as a desire for knowledge as an end in itself?

See [Crit.907] Does the text acknowledge that curiosity-as-feeling is distressing ignorance or constructive discontent?

Explanations **mitigate inadequate** *dispositio*

[Crit.925] (not used)

An explanation is a conceptual *path* **that displaces a cognitive question**

[Crit.926] Does the text acknowledge that an elementary principle of public speaking is that, in organizing their remarks, the speaker should "take the listener-reader-learner from where they are to where the speaker wants them to go"?

[Crit.926a] Does the text acknowledge that, to accomplish "taking listener-reader-learners from where they are . . ." a teacher-writer must ascertain "where" they (listener-reader-learners) are?
See [Crit.122] Is the proposition "ascertain the inquirer's prior knowledge" embraced?

[Crit.927] Does the text acknowledge that an *explanation* is a *conceptual path* of

connected concepts leading from the learner's existing knowledge to

the *dispositio* to be assimilated and that displaces a cognitive question?

See [Crit.206] Is the notion that "concept maps depict inquirer's existing

knowledge, and can show both well-connected concept paths and

gaps" embraced?

[Crit.927a] Does the text acknowledge that an *explanation* may be comprised of

multiple or alternate conceptual *paths* of connected concepts]?

See [Crit.441a] Does the text acknowledge that variant paths were possible

from one retelling of a text (story, poem) to another using memory

palace techniques?

[Crit.928] Does the text acknowledge that the function of *explanation* is

"bridging the gap between what the learner already knows, and what

he needs to know"?

[Crit.929] Does the text acknowledge that paths are constructed primarily

through *continuous derivation*?

[Crit.930] Does the text acknowledge that *explanation* itself is *not* the terminal

endpoint of an inquiry, but rather the assimilation of the explanation

into the learner's *dispositio* is the terminal endpoint of an inquiry

event?

[Crit.931] Does the text acknowledge that the terminal endpoint is generally

either a sense of cognitive satisfaction that a "line of reasoning," *path*,

or new meaning, has been constructed, or a conclusion that such a path cannot be constructed at present?

See [Crit.163] Is the notion that "an endpoint may occur upon completion of a continuous concept path from prior knowledge to goal concept" embraced?

Recognizing *dispositio* as explanatory

[Crit.932] Does the text acknowledge that recognition is facilitated by the learner's construction of an estimate of conceptual attributes the eventual explanation might comprise?

[Crit.933] Does the text acknowledge that an explanation cannot be recognized *as* resolution to inadequate *dispositio* until the explanatory conceptual path is evoked, *thought of* (and then subsequently assimilated)?

[Crit.934] Does the text acknowledge that explanatory expressions can be ineffective or unrecognized *as explanations* if they are not associated with the same linguistic terms as the expressions of inadequate *dispositio*, i.e., problem statements?

Understanding

[Crit.935] Does the text acknowledge that achievement of a condition of *understanding* is the goal, and a terminal endpoint of a specific inquiry event?

[Crit.936] Does the text acknowledge that types of terminal endpoint events that comprise the achievement of an understanding include decisions, conclusions, and beliefs?

Appendix II

Selected LIS texts from each theme

Theme 1   Philosophical treatises

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