A Scientist's Guide to Successful Presentations to High School Students

How to Leave Them Asking Questions and Wanting More

by
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Passing on the Torch

Three compelling reasons encouraging scientists to become involved in science education need to be considered in detail.

Our scientists are the products of our educating system

I. The products of science and technology give us our high standard of living.

Our nation depends on the quality of our scientists and engineers to maintain our place in the global competitive scientific community. It is indeed a tragedy that the number of young people selecting science and engineering careers has not increased during a generation in which science and technology pervades every aspect of our lives. A variety of reasons, such as the uninteresting curricula in grades K-12, and teachers who are inadequately trained and poorly rewarded, have been given to explain this phenomenon. Some steps to remedy these problems are being taken, but your help is needed to solve this problem before the predicted shortage impacts on our society, economy, quality of life, and survival. You, as a trained scientist, can make a difference by personally making contact with young people. You can share your values, motivation and expertise with students who are still willing to listen. You can make a difference.

The educational system is no longer able to motivate students to pursue studies in these fields.

You can promote a general understanding of the importance of science and its impact on our standard of living. You can help students develop an awareness of science. You cannot do this from your lab or through comfortable, impersonal lectures. But as a scientist who would like to share a method of solving problems that results in cumulative successes, you can help young capable students choose a career in science.

II. Our national educational system is in crisis. We are no longer competitive internationally.

Though most Americans are not scientifically literate, international studies of educational performance indicate that U. S. students rank near the bottom in science and mathematics. A study of National Assessment of Educational Progress has found that despite some small recent gains, the average performance of 17 year-olds in 1986 remained substantially lower than it had been in 1969. A look at our educational system reveals some of the reasons for this situation. Few elementary teachers have even a rudimentary education in science and mathematics, and many junior and senior high school teachers of science and mathematics do not meet reasonable standards of preparation in those fields. It is the system, not the teachers, that is to blame for this state of affairs. Science and mathematics

teachers have not been provided with the opportunity to keep up with recent technological developments. Text books and methods of instruction often impede progress toward scientific literacy. They emphasize the learning of answers more than the exploration of questions, memory rather than experiencing critical thinking, and reading instead of doing. This passive exposure to science is not enough to entice students to pursue careers in science.

III. Discover the personal reward of seeing a child become excited about your work.

You can communicate the true nature of science, the excitement of the pursuit of the "truth", the durability of knowledge, and the evolution of thought. You can convey the excitement of discovery a scientist experiences. You can help students understand that the norm of science is to modify ideas in the light of new knowledge; that powerful constructs tend to survive, grow more precise and become widely accepted. Only the scientist can help the students understand that experiments that do not go well are not failures, but just the next step on a new path.

The best way to communicate the characteristics of scientific inquiry is through examples from your research:

- science demands evidence
- science is a blend of logic and imagination
- science explains and predicts
- scientists identify and avoid bias
- science is not authoritarian
- there are generally accepted ethical principles that govern the scientist

You can make a difference. Come and experience the rewards of stimulating the minds of our youth and opening for them the door to a career in science.

The personal reward to the scientist who reaches out to young able minds is immeasurable.

A Thought

Make your pupil attentive to natural phenomena and you will soon make her curious: but in order to nourish her curiosity never be in haste to satisfy it. Ask questions that are within her comprehension and leave her to resolve them. Let her know nothing because you have told it to her, but because she has comprehended it herself; she is not to learn science but to discover it. If you ever substitute in her mind authority for reason, she will no longer reason.

"A Thought " by J. J. Emile Rousseau, as quoted in Samuel Chester Parker's History of Modern Elementary Education and revised in gender to stimulate thought.

Steps to a Great Presentation

Chapter One

Guidelines for Great Presentations

A quick overview of some important elements of successful communication with high school students.

Keep it Personal! Let the audience know that you like what you do.

Share the personal dimension of your scientific research work. As with any subject, it is important for students to feel a sense of personal involvement with science. As a working scientist, if you communicate your own feelings and emotional involvement in your work, and if you present the more technical content in this context, you will help students find the motivation to study science.

Let the students know that they are the focus of this endeavor.

Let students know that they are important; acknowledge the significance of their own study and questions. Students learn more when they are treated with integrity, sincerity and openness. They will learn more science with an atmosphere of a positive interpersonal rapport between the scientist and student. One important finding in regard to helping others is that aloofness has a negative correlation with effectiveness. If students are treated as objects, the relationship becomes impersonal.

Caring is the quickest way to reach the students.

Effective communication is the idea that covers most of the important aspects of personalizing science. Take time to talk to the students. You must reciprocate by listening to the students and discussing topics that interest them. Listening unhurriedly, responsively, and empathetically will enhance your personal image with students. The message, “I care” comes through and it is always well received.

Discovery, Feedback, and Success all obtain a positive response from the student.

Discovery Promotes Confidence

When presenting a problem to students, try to provide opportunities for the student to solve it themselves. Your role may include questioning, assisting, giving clues or hints at possible solutions, suggesting new directions for solving the problem. The discovery process is an excellent motivator because it promotes a sense of self confidence and confidence supports risk taking.

Success Motivates

Few things motivate students like success. To use success as a motivator design activities where students will have to expend an effort in an uncertain situation. The activity must be challenging but not beyond achievement. The potential for success quickly becomes frustration when success is not achievable.

Feedback Reinforces Learning

The amount, specificity and immediacy of feedback are critical in improving student motivation. Make the feedback specific like “your pipetting techniques are excellent”, or “your question about the reliability of my data is an important factor to consider”. Show the students respect for their abilities and concerns.

Feedback can be in the form of question and answer which is prepared. Questions may be planned before class or may arise spontaneously because of student interaction. Before you devise your questions consider the following:

Keep student interest

Utilize the students' interest in themselves. Almost any lesson can be related to some facet of the students lives. Use such simple attention getting techniques as changing your voice or position in the room. Keep variety in the talk.

1. What talents are you going to try to develop? (mathematical, problem solving etc.)
2. What critical thinking processes will you try to nurture? (analysis of concepts from more than a single source)
3. What subject matter objectives do you want to develop? (relate the talk to the content of the course if possible)
4. What types of answers will you accept? (tell the students if you wish them to include an example or explanation in their answer)
5. What skills do you wish to develop? (laboratory skills may need some practice before implementation)
6. What attitudes and values do you wish to emphasize? (ethical or practical applications of research knowledge)

Wait-Time Affects the Quality of Responses

When instructors wait three to five seconds before responding, the following occurs:

1. Students give longer and more complete answers instead of short phrases.
2. There is an increase in speculative, creative thinking.
3. "Shy" students increase their participation.
4. Instructors become more flexible in their responses to students.
5. The number of suggested questions and experiments increases.
6. Instructors ask fewer questions, but the ones they ask require more reflection.
7. Students give a greater number of qualified inferences.
8. Instructors' expectations for student performance changes: They are less likely to expect only the brighter students to reply.

Keeping the student's interest, and Pausing to allow the student time to think are techniques that greatly enhance the value of the presentation for the student.

Role Modeling

To function as a role model the speaker may include a short resume of academic preparation and career experiences. Making use of scientific knowledge and techniques in dealing with the students will add credibility to the role.

The visiting scientist may be the only scientist role model many of the students have. Be friendly and enjoy the experience.

Closure

Students should be encouraged to summarize skills, knowledge and understanding of the presentation at the conclusion of the experience. Important points include:

- encourage the students to summarize the knowledge, skills and attitudes they assimilated from the presentation.
- relate objectives of the talk to concepts they have previously learned.
- communicate a sense of

Summarizing the experience with the students will ensure that they leave the presentation knowing more and feeling better about themselves.

Bringing Your Presentation to Life

Students succeed in learning content by becoming involved in the process.

Students are often thrilled to discover fundamental ideas for themselves and not simply be told.

Discussion Versus Lecture

Students become more interested because they are involved. The objective of modern science instruction is to teach science as a process with emphasis on the cognitive development of the individual, students must have the opportunity to think. A lecture is passive learning with little thinking required, just staying awake. Students are often thrilled to discover fundamental ideas for themselves and not simply be told.

Tips for a good discussion:

1. The speaker should present an appreciation for student involvement in your presentation.
2. Discussion may be initiated by a model, object observation, demonstration or audio-visual display.
3. A discussion may center around a case history and branch out into what needs to be known to treat the patient, understand the problem, or find a common characteristic from many examples.
4. Relax the audience, you may use humor to reduce tension.
5. Avoid embarrassing anyone.
6. Keep the discussion moving at the students‘ pace, which can be ascertained by the level of questions asked.
7. Reword any comments that might be misunderstood, such as the misuse of scientific terms.
8. Be aware of anyone monopolizing the discussion or going off on a tangent.
9. Ask a variety of questions that draw on different levels of thought.

Demonstration

Demonstration can be used for a multiplicity of reasons: lower cost, availability of equipment, economy of time, less hazard from dangerous materials, direction of the thinking process or to show the use of

equipment.

1. Make all activities easily visible.
2. Show personal excitement over the event taking place.
3. Involve the students in observation, suggestion, predictions, evaluations and assisting.
4. Start the demonstration with a question; teach inductively.
5. Ask questions constantly.
6. Use the blackboard to reinforce, illustrate or collect data during the demonstration
7. Verify that objectives are clear and that conclusions relate to those objectives.
8. At the conclusion of the demonstration, have a student summarize what has occurred and why.
9. Expand the questions to the broader philosophical basis of science. For example, you may ask:

    - How certain are we of our data?
    - What evidence is there of certainty in science?
    - How do scientists fractionate knowledge to find answers to bigger problems?
    - Are there social implications of the concepts presented?

Effectiveness of the Laboratory Experience

Effectiveness of the laboratory experience is directly related to the amount of individual participation by students. The ideal arrangement would be to have each student wholly responsible for conducting the experiment from start to finish. This would include the preliminary planning, gathering materials, preparation of apparatus, designing the method, collecting data, analyzing results, and drawing conclusions. Such an ideal situation would insure that the work of the individual student could be evaluated and that every student would have a maximum learning experience.

If the facilities available or the time allotted do not allow for individual work, teams may be formed to accomplish the task. Different activities may be assigned to each team or all teams may work on the same task and the data can be compared and evaluated together. Provide a clear structure and work assignments. Teachers may assist in assigning laboratory chiefs, or group selection. Laboratory chiefs or team leaders can collect or pool data and facilitate all team activities. The atmosphere should be as realistic and professional as possible. This may include keeping accurate data books, safety procedures, solution preparation, and storage of materials. Laboratory activities should foster team work, skill development and a reinforcement of theory in its application. The process of discovery can be exciting and rewarding for students when accomplished in an atmosphere of safe risk taking. A scientist provides the comfort level of the authority to experiment in an appropriate manner with expert guidance.

Discussion, Demonstration and Laboratory Experiments are all possible vehicles for a successful presentation.

The active involvement of the scientist adds credibility to any of these vehicles in the high school setting.

What you should know before entering the classroom:

1. Type of class e.g. Biology, Anatomy

(see sample curriculum on pages 10-11)

2. Level of class e.g. advanced, average.
3. Grade range of students e.g. 10th or 10 -12
4. Time you will have for presentation 30 - 90 minutes (see sample forms on page12)
5. Size of audience
6. Equipment available for audio visuals
7. Laboratory facilities available
8. Students' preparation for presentation
   a. articles sent ahead and distributed beforehand.

...Be Aware of Students' Abilities and Background

The following is a list of curriculum topics covered in selected high school science courses

Science Curriculum

What can I expect a student to know?

Biology A

(9-10 grade students)
The first semester usually includes study of cell biology, reproduction, genetics, evolution, and plant and animal classification.
Students should be able to:

1. use methods of qualitative and quantitative observation
2. describe the general structures, functions, biochemistry and diversity of cells
3. describe levels of organization
4. explain perpetuation of species
5. apply laws of classical genetics and the principles of chromosomal inheritance to problems of genetic differences in individuals
6. explain the general functions of DNA and RNA
7. compare scientific theories of the origin and evolution of living things
8. apply methods of taxonomy to classify organism
9. identify career opportunities in the biological area

What skills will the students possess?

Biology B

The study of human structure and function , behavior and ecology are covered.
Students should be able to:

1. describe the characteristics of micro-organisms
2. describle general anatomy and physiology of plant and animals
3. explain the biological behavior of living things
4. understand the relationships in energy flow patterns, and the development of the ecosystem
5. analyse the skills required for the practice of biotechnology

(11-12 grade students)
Students usually have had an introductory course in chemistry and biology.
Students should be able to :

1. explain the phenomena of free energy change and entropy
2. trace the history of cytology
3. relate the C3,C4, and CAM pathway to plant anatomy, photosynthesis and the environment.
4. describe the models for gene regulation
5. understand genetic abnormalities with emphasis on chromosomal aberrations.
6. discuss the structure, physiology, reproduction, pathology and economic importance of viruses and Monerans
7. trace various immunological responses
8. relate the Hardy -Weinberg law, genetic drift, and balanced poly-morphism to evolutionary situations
9. interpret current issues in biology, including population growth, ecological intervention, and biomedical progress

By knowing what the students have been exposed to the scientist can make his presentation understandable and yet stimulating and challenging.

Anatomy and Physiology

This course in intended for students who have had general biology and may have had chemistry. Students study cells, their sub-microscopic parts and how their structure relates to function. They study the major organ systems of the human body: skeletal, muscular, nervous, and digestive system.

Chemistry A

Chemistry A topics include the organization and classification of matter, atomic theory and radioactivity, the periodic table of the elements, principles of chemical reactions, heat and molecular motion, and chemical bonds.
Students should be able to:

1. Differentiate among elements, compounds, and mixtures, using physical and chemical properties
2. Distinguish among physical, chemical, and nuclear changes
3. Select and use mathematical relationships and computational skills
4. Perform laboratory skills appropriate to chemistry
5. Use chemical symbols to write formulas and name compounds
6. Describe the sequence of selected discoveries which resulted in modern atomic theory
7. Predict physical and chemical properties based on the periodicity of the elements
8. Imply the mole concept operationally and conceptually
9. Construct chemical equations
10. Solve problems involving quantitative relationships in equations
11. Relate the state and energy content of a

substance to the degree of motion in its molecules
12. Apply the gas laws
13. Account for the attractions among particles and the effect of these forces on the properties of the resulting substances

Chemistry B

Chemistry B topics include energy and chemical reactions, rate of chemical reactions, equilibrium reactions, chemical solutions, acids, bases and salts, electrochemistry, and carbon and its compounds.
Students should be able to:

1. Determine the amount of energy involved in a reaction
2. Determine the driving forces of a reaction
3. Interpret the practical implications of the laws of thermodynamics
4. Describe the factors which affect the rates of reactions
5. Describe systems of equilibrium
6. Calculate the quantities needed to prepare and use solutions employing various units for expressing concentrations
7. Analyze factors that determine the properties of solutions
8. Identify reactions involving ions in aqueous solutions
9. Analyze the role of acids, bases and salts and their interactions
10. Apply electrochemical principles
11. Balance oxidation-reduction equations
12. Apply principles of oxidation and reduction
13. Classify carbon compounds
14. Illustrate the significance of carbon and its compounds

Physics A

This course treats vector analysis, the study of motion (kinematics), the effect of force on moving bodies (dynamics), energy, and momentum.

Student should be able to:

1. Apply vectors to the solution of physics problems
2. Analyze rectilinear motion
3. Analyze curvilinear motion
4. Apply Newton's laws of motions
5. Develop the law of universal gravitation
6. Apply the law of conservation of mass-energy
7. Apply the law of conservation of momentum to the interaction of objects

Physics B

Physics B covers the topics of thermodynamics—the effect of heat on motion, electricity, magnetism, wave motion, and modern physics.
Student should be able to:

1. Solve problems of thermodynamics
2. Describe the phenomena related to electrostatic charge
3. Apply Coulomb's law
4. Apply principles of electrostatic potential and potential difference
5. Solve problems involving electrical circuits
6. Solve problems involving magnetism
7. Analyze the behavior of waves
8. Describe models of the atom
9. Describe the dual nature of light and matter

If there is a particular area the scientist would like the students to be aware of the teacher can be notified. Pertinent pamphlets, handouts, a film (if available) or other preparation can be provided several days before the presentation.

References

Books:

Trowbridge, L. & Bybee, R. W. (1986). Becoming a Secondary School Science Teacher (4th ed.) . Columbus: Merrill Publishing Co.

Reports:

American Association for the Advancement of Science. (1989). Science for all Americans, a Project 2061 report on Literacy Goals in Science, Mathematics, and Technology. Washington, D.C.

Periodicals:

Attkinson, R. C. , (1990). Supply and Demand for Scientists and Engineers: A National Crisis in the Making. Association Affairs, 248 . 425-432.

Holden C. , (1989). Wanted: 675,000 Future Scientists and Engineers. News & Comment, 244. 1536-1538.

Pool R. , (1990). Who Will Do Science in the 1990s?, Science: News & Comment, 248. 433-435.

Request for Speaker

The request for a speaker should be sent to Gloria Seelman at least three to four weeks before the speaker is needed. The teacher will be notified if the speaker is available within a week from the time of request. The request may be made on the bbs or sent by voice mail.

Fax 402-0483

To be completed by teacher:

Speaker requested: _____
Requested date of talk: _____ Alternative dates: _____
Time of presentation: _____
Length of presentation: _____
School Name: _____
School Location: _____
School Phone Number: _____
Teacher's name and room number: _____
Teacher's phone number: _____

Presentation Guidelines

Objective of the presentation: _____

Grade level: _____

Ability level of class: (example: regular, honors, advanced placement)

Science background of students related to the topic being presented: _____

Number of students: _____

It is suggested that the teacher and presenter com phone shortly before the presentation date.

The teacher may request a speaker using this type of form.

Your response with a form such as this is the first step towards organizing your presentation.

To Be Completed by Speaker

It is suggested that if you are not available on the date requested. You may propose two alternative dates.

Your Name:_____
Requesting Teacher:_____
Requesting School:_____
Requesting Date:_____Alternative Dates:_____
Length of Presentation: _____
Title of Presentation: _____

Suggested readings for students before presentation: (articles may be on file in the Office of Education to be distribute to the teachers)

1.

2.

3.

Outline or description of presentation:

Permission to audio or video tape talk: name of presenter

_____

Audio Visual Equipment needed:_____

It is suggested that the presenter and teacher communicate by phone shortly before the presentation date.

Critique of the Presentation

Please evaluate the presentation. Use 1 as inappropriate to 4 as excellent.

Enthusiasm of speaker	1	2	3	4
Voice quality and articulation	1	2	3	4
Adaptability and flexibility	1	2	3	4
Appropriate Use of English	1	2	3	4
Organized procedure	1	2	3	4
Adequate summary	1	2	3	4
Appropriate content level	1	2	3	4

Comments:

1. What are the strengths of the presentation?

2. What were the weaknesses of the presentation?

3. What would you change in the presentation?

4. Would you have the presenter again next year?

Teacher evaluator: *signature*_____

Feedback from presentations may be gathered on forms such as these. The speaker will be sent an evaluation as a guide for future presentations.

Students in the class may receive this type of form to help the speaker improve future presentations.

Student Critique of the Presentation

Please evaluate the presentation. Use 1 as inappropriate to 4 as excellent.

Enthusiasm of speaker	1	2	3	4
Vocabulary level appropriate for audience	1	2	3	4
Interesting content	1	2	3	4
Warmth of personality of the presenter	1	2	3	4
Career of presenter appears interesting	1	2	3	4
New ideas presented	1	2	3	4
Talk was easy enough to follow	1	2	3	4

Comments:

1. What new information did you learn from the presentation?

2. What was the most important concept presented by the speaker?

3. Have you become aware of a new potential career for you?

4. Would you like to spend a summer working with the presenter at NIH if you had the opportunity?

5. What further questions do you have that the presenter might be able to answer ?

student information:
age: _____
grade level: _____
gender: _____
course: _____

speaker: _____
teacher: _____
school: _____
date: _____
topic: _____