Activity 4A: Writing Across the Solar System

Objective

Students will demonstrate their ability to synthesize what they've learned during the project by creating literary works of fact, fiction and/or poetry.

Engage

Ask students about various ways people learn about the sky and objects in space. If they mention only books or programs about science, help expand their horizons. Read them a few poems about the stars, or a science fiction short story, or perhaps a Native American legend about the sky. (See Resources for several easily accessible examples.) Ask them to think about how such writings complement what science tells us. Ask them to think about the social role played by story-telling under the stars, at night around a camp-fire, before there were movies and television to entertain us. Share with them some of the examples of student writing about the stars spread throughout this Guide, and on-line resulting from *Live from the Stratosphere.*

Explore / Explain

Tell the class that they are going to explore space using the tools of written and/or oral expression. Challenge them to reach inside themselves for feelings they experience as they look up at a starry sky or gaze at exotic pictures of other worlds in books or magazines. Don't encourage sentimentality: if you live in an urban area, and they look up and see just sky glow, ask them to write about the contrast between what they know must be out there, and what they can actually observe. If they've been moved by an Imax movie, such as *Destiny in Space*, or a planetarium show they can certainly jump off from there. Tell them that the only limit is their imagination.

Procedure Assign students to discussion and work teams, or have them work solo. Have them research the planets of our solar system, or other objects in the universe, using the resources suggested for Activity 1B, but adding works of science fiction (especially short stories), poetry, or legends and tales from ancient mythology (Greco-Roman, Chinese, etc.), as well as various modern and near-modern cultures.

Ask them to choose and develop a subject and a form of expression. They may wish to write a short story set in the future, or a poem about a starry night last summer. If they are interested in story-telling as oral tradition, have them make-believe they are the chief storyteller of an ancient tribe, who tonight will gather the people and tell them a story of the sky. (Hint: the names of the Constellations are an obvious starting point for stories explaining the "pictures in the sky.")

Expand

When all the students have completed their assignments, have them present or perform their works in front of the class. Class discussion can follow about how such forms of expression complement what we know, through science, about the universe.

Students wishing to write a short story may set it at some point when humans have reached out to one of the HST's target planets. If so, have them incorporate what they've learned about that planet from this *Live from…* project. Challenge them to take into account the scientific wonders they will see, as well as the hazards they might face (intense radiation or the tedium of long-term space flight).

Some students might want to take on the challenge of writing a science fiction story in which the HST is the main character (like HAL in *2001*) and the reader sees and "feels" the excitement of exploration and discovery through the camera eyes and computer brain of the HST itself. How does the Hubble "feel" when these humans periodically come and go, doing eye-surgery, prodding and poking, and then leaving until the next servicing mission? How does Hubble feel, sharing the starlight with these puny, so-called astronauts, when it's he/she (there's a discussion to be had right there!) who's the true seer for the humans down on Earth?

Sharing student work via on-line Kids' Corner

Many of the Activities in this Guide provide opportunities to integrate technology in teaching and learning through the use of computer-based art, word processing, desktop publishing, and multimedia applications. *Passport to Knowledge* invites educators to submit student work to be shared on-line via Kids' Corner, a gallery of student creativity from participating classrooms. Be sure to save your students' work to Mac or IBM diskette, and clearly label file names, content, teacher, grade, school, full address, phone number, and other relevant background information. Send the diskette(s) to:

Marc Siegel, NASA Ames Research Center, Mailstop T-28H, Moffett Field, CA 94035

Student-created image and text files will be added to Kids' Corner as appropriate. Individual student e-mail addresses will not be included. Student name, school names, location, grade level will be cited, unless requested otherwise.

Activity 4B: "Lights... Camera... the Universe"

Objective

Students will collaborate and demonstrate the ability to use research, writing and presentation skills to create a multimedia report based on HST observations of the solar system or the Universe at large.

Engage

Ask students to think of ways that images and sound work together (TV commercials, videos on MTV and VH-1, animated and feature films). Ask them to think about how and why directors and writers compose words, music and pictures as they do. Say their homework is to become students of the media, to become media-literate. Tell them they will then have a chance to become multimedia authors, producers and directors, rather than passive consumers.

Do such works sometimes take their audience to places that are impossible to visit by any current technology, to a "Land before Time," on voyages of the *Starship Enterprise* in a future yet to come? Help them differentiate between fact and fiction, between science documentaries and dramatic imagination. Tell students of the impact made by works of fiction, such as H.G. Wells' *War of the Worlds* and Jules Verne's fictional trips to the moon, on the inventors of modern rocketry. Like art and science, fact and fiction are sometimes complementary. The trick, however, is always to know one from the other when it counts!

Explore / Explain

Encourage students to research the subject by looking at illustrated articles in magazines such as *Odyssey*, *Astronomy* and *Sky & Telescope*, as well, perhaps, as TV shows such as *Star Trek* or *Babylon 5*. Have them write and present an analysis of a piece they find compelling. Remind them that they are watching TV to learn ways in which images articulate the story. You can order slide sets by famous space artists for your class: see Resources for other suggestions.

Have them select a genre for their work. If they choose realism, challenge them to research the science behind the scenes they're going to create. What physical processes are at work? Does their planet have huge storms, gigantic lightning bolts or other interesting features? (see Activity 3C for a list of interplanetary weather.) How can this be effectively shown? If they choose fiction or fantasy, challenge them to develop a coherent, detailed vision of a world. What is this place like? How does it resemble or differ from our own world? (Space artist Adolf Schaller conjured up "Hunters, Floaters and Sinkers," hypothetical life-forms which might exist in the clouds of Jupiter, and an entire ecosystem of hunters and prey: fantasy, sure, but based on substance. Encourage similar creative leaps.)

Materials

- recorded music excerpts (examples: the classical music suite *The Planets* by Gustav Holst, Japanese composer Kitaro's film scores, works by Vangelis—*Bladerunner*, *Chariots of Fire*; the *Music of Cosmos* compilation soundtrack, or other music your students choose.)
- pictures from books, magazines, computer archive or Internet, especially NASA public domain images
- still camera, color slide film, slide projector
- audio tape player
- appropriate materials from art class
- computer Draw and Paint programs, if available

Procedure Have the students form creative teams. Each team will create a presentation utilizing no more than 2 minutes of music, and no more than 24 slides. Ask each team to pick a planet, and search books, magazines, and Internet sites, for pictures of that planet and its satellites.

Show students how to make slides of these pictures and images by properly pointing and focusing the camera. Don't use flash. Do use a tripod! Suggest they photograph books and magazines outside, or near a daylit window in indirect light if they are using film that is marked for daylight use. Photograph images from a computer screen in a darkened room to reduce glare.

As they are considering the pictures they'll use, have the students also listen to music for their presentation. Ask them to think about what type of music comes to mind when they look at the pictures, but encourage them to experiment with different kinds of music. Expose the techno fans to Holst, and the violinists to rock. But let them end up feeling that the choice is fully theirs.

When the Big Day arrives, have the teams of students introduce and perform their presentations. Depending on the social dynamics of your class, you might want to have a "Golden Planets—Students' Choice Award" for the "best" in the various categories.

Expand

If some students enjoy playing musical instruments, or creating music, allow them to tape their own music for the audio portion of a presentation.

Suggest to the Principal that your students might present to the school, to lower grades, to a PTA meeting (especially if your department needs extra support funds!), to the school board, if it has questions about just what those modems and computers do, or to local citizens on election day. Your students will gain confidence in themselves as authors, as teachers, as well as learners.

Have your students investigate the world of Space Art in greater depth including the International Astronomical Artists' Association and NASA's *Artist in Space* program. Discuss the role that art plays in our exploration of space and our attempts, as human beings, to better understand how we fit into the "big picture" called the Universe.

Review your students' work for Activity 4A or 4B. What knowledge, concepts, processes, skills, attitudes, do you see evidenced there which you can attribute to their involvement in *Live from the Hubble Space Telescope*? How does this relate to your school, district, state mandates, or course of instruction. Now turn to the Teacher Evaluation Forms, fill 'em out and send 'em in… and 500 of you will receive a free copy of NASA's *Astronomy Village* CD-ROM.

Lastly, assemble copies of your students' work, on paper, videotape, or computer disc, and ship to *Passport to Knowledge*, P.O. Box 1502, Summit, New Jersey 07902-1502, clearly indicating whether you need the materials back, and whether we have permission to use them for project evaluation. *PTK* hopes to create its own multimedia report on the new territories of knowledge and imagination your students have been exploring.

Activity 4C: Hubble in the Headlines

Objective

Students will demonstrate the ability to discuss and debate the value to society of major scientific and technological enterprises such as HST.

Engage

Passport to Knowledge feels privileged to have helped construct this unprecedented bridge between students and the *Hubble Space Telescope. (*Review *LHST* Program 1, "The Great Planet Debate") Explain what a truly world-class facility the Hubble is. As you'll learn from *LHST*, the Hubble was much in the news in early 1996, with a whole range of discoveries. Incredible numbers of faint galaxies were detected where none had been seen before. Spectacular regions of star birth were visualized in astonishing detail (as on the co-packaged poster); and planets were detected around distant stars. By getting their "virtual" hands on the Hubble, your students become members of a very select group of astronomers and scientists.

Explore / Explain

Tell students that when Hubble was first launched, astronomers were horrified to learn an imperfection in the construction of the mirror meant images were out of focus. Some in the press and public wrote off the Hubble and "big science" as too expensive, risky, and complex. Efforts by workers at many institutions in NASA and outside the agency—some of whom your students will "meet" on-camera or on-line—placed corrective optics and a new camera system (which we are using to image Neptune) aboard the Hubble, in the first of several always-planned servicing missions. Now Hubble's eye is crystal clear, and the science it had already accomplished took off.

Procedure Have students research the 1995-1996 Hubble discoveries, especially those not yet in textbooks: use on-line services, and current magazines. Tap libraries for books about HST which describe its initial problems, and the technical fixes which have made it the superb tool it is today. If you have access, download some of the **discuss-hst** archive, and see students' initial reasons for wanting to observe specific planets. Review our Planet Advocates' eloquent comments: how studying impacts on Uranus can give clues to the evolution of life on Earth, or how weather on Jupiter or Neptune can reveal new information about our own planet. Marc Buie is concerned with vision and human destiny, as well as scientific knowledge. He argued that our species always looks to new frontiers, such as Pluto, the only planet in our solar system not reconnoitered by our spacecraft, and that this is what keeps young minds and imaginations ("lifelong learners of all ages") engaged and growing.

Brainstorm these issues with students: elicit their opinions, provoke their comments. Group them into teams, based upon natural inclinations ("pro" or "con" Big science and projects like the Hubble), and have them research their opinion for a formal in-class discussion or debate. Remind them that in debate, success often comes to those who understand the best arguments of their opponents, not just their own.

Stage the debate. Record the arguments on audio or videotape. Have students edit the "official transcript" for the school, or local newspaper. As with Activity 4B, look over your students' arguments. What knowledge, concepts, processes, skills, attitudes, do you see evidenced which you can attribute to their involvement in *Live from the Hubble Space Telescope?* How does this relate to your school, district, and state mandates, or course of instruction. (Again, please turn to the teacher and student evaluation pages—and…fill 'em out and send 'em in.)

Glossary

Astronomical unit (A.U.) the average distance between the Earth and the Sun (app. 93 million miles, 150 million kilometers).

Atmosphere gases surrounding the surface of a planet, moon or star.

Blurring the bending (refraction) of waves of visible light or other electromagnetic radiation by Earth's atmosphere, thus preventing an observer from obtaining as clear a view as possible.

CCD a charge coupled device, an electronic detector of electromagnetic radiation, made of silicon chips that respond to incoming radiation by producing an electric current.

Centigrade (or celsius) temperature scale the scale of temperature that registers the freezing point of water as 0^0 and the boiling point as 100^0.

Color the visual perception of an object, which for a radiating object can often be considered an indicator of temperature.

Comet a small ball of rock and ice, typically a few kilometers across, from which emanates a long wispy tail of gas and dust while nearing the Sun in a huge, elongated orbit.

Concave lens/mirror a lens or mirror with an inward curvature.

Convection cell the physical upwelling of hot matter, thus transporting energy from a lower, hotter region to a higher, cooler region.

Diffraction grating a filter ruled with thousands of closely spaced parallel lines, thus causing reflected radiation to spread into its constituent wavelengths and frequencies.

Electromagnetic spectrum the entire range of all the various kinds of radiation; light (or the visible spectrum) comprises just one small segment of this much broader spectrum.

Energy the ability to do work.

ESA the European Space Agency, whose thirteen members are Austria, Belgium, Denmark, France, Germany, Ireland, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom. Finland is an associate member and Canada a cooperating state.

Extraterrestrial an adjective meaning "beyond the Earth."

Filter wheels aboard Space Telescope, wheels that hold 48 different filters, each of which removes electromagnetic radiation at particular frequencies and wavelengths from the beam of incoming radiation.

Fine guidance sensor (FGS) a device sensitive to ultraviolet and visible light, used aboard Space Telescope to detect guide stars astride the telescope's field of view, and thus to direct the telescope accurately toward a particular target.

Fixed head star trackers small telescopes with a wide field of view aboard Space Telescope, used to find relatively bright stars to serve as preliminary guide stars, in order for the fine guidance sensors to track the actual, fainter guide stars.

Geosynchronous orbit an orbit around the Earth at an altitude where a satellite moves at just the speed at which the planet rotates; hence, an orbit in which an orbiting satellite remains nearly stationary above a particular point on the planet.

Goddard Space Flight Center (GSFC) NASA's field center in Greenbelt, Maryland, from which the Space Telescope is controlled.

Gravitational force the (always attractive) force that holds matter together on a large scale, such as stars within galaxies, atoms within stars, and people on Earth. (**Gravity:** an abbreviated term for gravitational force.)

Great Red Spot a semi-permanent feature in the upper atmosphere of Jupiter, apparently a sort of cyclone, several times larger than the Earth.

Interplanetary space regions among the planets, moons, and related objects of the solar system.

Jovian planets the four, big, gassy planets in the outer parts of the solar system; Jupiter, Saturn, Uranus, and Neptune.

Kilometer a unit of distance equal to 0.6214 miles.

Light the kind of radiation to which the human eye is sensitive.

Light-year the distance traveled by light in a full year, equal to some 10 trillion kilometers (or about 6 trillion miles).

Mercator map a map projection in which the meridians are drawn parallel to each other and the parallels of latitude are straight lines whose distance from each other increases with their distance from the equator.

Milky Way Galaxy the specific galaxy to which the Sun belongs, so named because most of its visible stars appear overhead on a clear, dark night as a milky band of light extending across the sky.

Orbit a path described by one body in its revolution about another (as by a planet around the Sun).

Pixel a single element in an image, corresponding to a single dot in a mosaic picture.

Planet a rocky and/or gaseous body, generally much cooler and smaller than a star; the Earth is one such planet in orbit around the Sun.

Primary mirror the main mirror of a reflecting telescope, which gathers electromagnetic radiation and directs it toward a smaller secondary mirror, which in turn brings the radiation to a focus.

Prime focus the place to which a telescope initially directs its collected radiation.

Radiation a form of energy, consisting of mass-less particles called photons, which travels at the speed of light.

Reflecting telescope a telescope that uses a polished, curved mirror to gather light and reflect it to a focus.

Refracting telescope a telescope that uses a transparent lens to gather light and bend it to a focus.

Revolution the orbital motion of one object about another.

Rotation the spin of an object about its own axis.

Satellite a celestial body orbiting another of larger size.

Scientific method the investigative technique used by all natural scientists throughout the world. In general, some data or ideas are first gathered, then a theory is proposed to explain these hypotheses and finally an experiment is devised to test the theory.

Secondary atmosphere gases that a planet exhales from its interior after having lost its primary or primordial atmosphere.

Secondary mirror in a reflecting telescope, a small mirror mounted in the beam of radiation that strikes the primary mirror, and from which radiation is reflected and brought into focus.

Solar system a collection of 1 star, 9 planets, 60 moons, and innumerable smaller objects (asteroids, comets, meteoroids) orbiting about the Sun; both the Sun and Earth are members of the solar system.

Space Telescope Science Institute (STScI) an international research center operated by AURA for NASA and located at Johns Hopkins University in Baltimore, from which Space Telescope's science mission is designed and conducted, and where data is archived.

TDRS NASA's Tracking and Data Relay Satellite System, a network of communication satellites high in geosynchronous orbit, used to relay data from Space Telescope to Earth and to relay commands from Earth to Space Telescope.

Temperature a measure of the heat of an object, namely of the average kinetic energy of the randomly-moving particles in an object.

Terrestrial planets the four, small, rocky planets in the inner part of the solar system: Mercury, Venus, Earth and Mars.

Wavelength the distance between successive crests of a wave.

I can only imagine how access to this much information would have changed my own school experience. The highway will alter the focus of education from the institution to the individual. The ultimate goal will be changed from getting a diploma to enjoying lifelong learning.

BILL GATES, *The Road Ahead*, ©1995.

Whether you're a classroom teacher, home schooling parent, science center or museum educator, or an advocate of school reform and lifelong learning, on-line resources can radically transform the learning process. NASA's K-12 Internet Initiative, our on-line partner, provides a wide array of on-line materials and opportunities freely accessed via the Internet (often referred to as the "Information SuperHighway"). Teachers' responses to our previous projects convince us that going on-line will enhance and enrich your students' learning environment.

You needn't be an Internet expert to benefit from our on-line resources. *Passport to Knowledge* consciously tries to provide a wide and flexible menu of alternatives for those educators with limited time, technology, connectivity and support. Simple electronic mail (e-mail) via a slower, cheaper modem and regular phone line provides a great deal of information, as well as opportunities for interaction with working scientists and project participants. And it's easy to use, even for a newcomer to the Internet. At the same time, with *Live from the Hubble Space Telescope*, we've made a commitment to those of you with more advanced networking skills and access, by expanding our Web site to include special features such as Web Chat and videoconferencing.

What's Available?

Electronic Mail

Electronic mail provides an easy-to-use medium for exchanging ideas and receiving and sending information (some e-mail programs even allow you to attach graphics files). E-mail is the traditional first step for those who are new to the "net" and can be stimulating even if a little overwhelming at times!

Mail lists: **updates-hst** and **discuss-hst**

Two essential *Live from the Hubble Space Telescope* e-mail resources are the **updates-hst** and **discuss-hst** mail lists. When you subscribe to a mail list, you automatically receive all messages or "postings" sent out from the folks managing the list. In the case of **discuss-hst**, you may also send messages to the list.

The **updates-hst** mail list provides the key link between you and the project by keeping you informed of late-breaking project news, announcements, timely resources and special events. Once you've subscribed to this list, you will automatically receive all **updates-hst** postings, until you remove yourself from the list.

The **discuss-hst** mail list is a special conference or discussion forum for educators interested in sharing lesson plans and resources, teaching strategies, innovative ways to integrate the project into the classroom, coordinating collaborative efforts, and planning special events. It's also a great place to discuss concerns and questions (and even gripes!) as well as to make suggestions and provide input to the *LHST* project team. All members of **discuss-hst** should also be subscribed to **updates-hst**.

To join either or both of these mail lists:

1. Send a message to **listmanager@quest.arc.nasa.gov**
2. Leave the subject field blank
3. In the message body, write: **subscribe updates-hst**

You may also add a line stating: **subscribe discuss-hst** directly under the above line in the message body

Once your e-mail message is received by our automatic mail program, you will be sent a file providing essential introductory information about the operation of the list. Please save this information for future reference.

Researcher Q & A

Another resource is available to educators and students beginning March 1, 1996 and extending "live" through the end of April, 1996. This opportunity is known as *Researcher Q & A:* it enables students to ask questions about the Hubble Space Telescope, astronomy and what's been happening in the project, with answers coming back directly to each individual student inquiry. HST researchers, engineers, and support staff—some of whom will have also be seen on-camera during the videos—will correspond with classrooms, students, and educators in this interactive exchange. Questions will be acknowledged and answered as quickly as possible. All questions and answers will be archived on-line at our Web site. A useful keyword search function will allow quick access to existing Question and Answer pairs. Suggestions about submitting questions will be posted in the regular **updates-hst** newsletters, which will also provide tips for asking questions and practical logistics. Be sure to subscribe to **updates-hst** for this key information!

Field Journals via e-mail

From February through April,1996, the day-to-day lives of Hubble astronomers, researchers, and support staff will be shared via these research logs/diaries. Students and educators will meet the men and women who ultimately make the Hubble an unparalleled scientific resource. *Field Journals* from people at the Space Telescope Science Institute, Goddard Space Flight Center, from astronauts, university astronomers and other project participants around the world, will provide an "over-the-shoulder" view of their lives and work—rare, anecdotal and personal insights on the successes, challenges, and "human side" of contemporary astronomy and high-tech careers. Many educators have used previous *Field Journals* as models and motivation to help students document their own participation in the electronic field trip. These journals are intended to help students appreciate the great diversity of people and skills needed for success in a modern-day science project. *Field Journals* will be distributed via **updates-hst**, and also archived on our Web site for easy access.

World Wide Web Resources

NASA's K-12 Internet Initiative has provided an extensive array of resources, available to those who have access to the World Wide Web, a graphical interface allowing easy links between computer resources regardless of their location. Participants need special software called a "Web browser," such as Netscape or Mosaic, as well as an Internet account supporting Web access. Once you are connected with our Web site, you will find the following resources:

- Project News: Welcome, background files, recent updates
- HST Team: Biographical sketches, *Field Journals,* related files
- Video Broadcasts: Schedule and other key information about the live telecasts, including current public television and NASA TV schedules
- Featured Events: special time-critical activities
- Background on the Hubble Space Telescope and the target planets, and links to related Web sites
- *Researcher Q & A* access and database
- Photo gallery of interesting and relevant images including the HST planets, and Hubble's "Greatest—and latest—Hits!"
- Teachers' Lounge: a place for educators to meet and greet one another via an on-line database, Web chat, and sharing of curriculum resources. You can also check out the **discuss-hst** archive, respond to the latest on-line discussion topics and access an on-line version of the Teacher's Guide
- Kids' Corner: a place for sharing student work (computer, art, language arts, multi-media projects, desktop publishing, etc.)

Special Upcoming Features

- a Virtual Tour of the Hubble will be available for all to explore the inner workings of the Hubble Space Telescope and its support network
- Web Chat: weekly opportunities, at regularly scheduled times and dates, or as arranged by you and newfound, geographically-remote colleagues. Web chat enables real-time, text-based conversation with other people on the Web. You're likely to encounter K-12 teachers, students, HST project developers and *Passport to Knowledge* development team members. Web chat schedules will be posted to the **updates-hst** mail list and on our Web site.
- Videoconferencing: For those participants who have access to videoconferencing capabilities (which requires special software, camera, and higher speed connectivity: for CUSeeMe, this can be as low-cost as a $100 camera, with free software available: see on-line for more information) a regular schedule of videoconferencing sessions will be posted to **updates-hst** and on our Web site. We plan to have some of the HST team on hand for informative and fun interactions with students and educators.

We hope you find these Web and e-mail resources a key project component as you integrate *Live from the Hubble Space Telescope* into your own unique learning environment, and adapt it to your needs.

The URL (Uniform Resource Locator, or simply the "Web address") for *Live from the Hubble Space Telescope* is:
http://quest.arc.nasa.gov/livefrom/hst.htm

Getting Connected

Whatever your unique situation, there are five essential ingredients to Internet connectivity:

1. Computer: updated Mac/IBM with expanded memory for World Wide Web use (8M recommended)

2. Modem: device which connects computer to the outside world via phone line. Recommended speed: 14.4 baud or higher (28.8 if you can)

3. Phone line which may be used for voice or fax when not in use by the modem.

4. Internet account: access to the Internet may be provided by local Internet providers, university accounts, commercial services like America Online, Compuserve, Delphi, Prodigy, Apple's E-World, Microsoft Network, etc. Check with your Department of Education regarding statewide education networks: many states provide reduced rate access for local teachers, so asking around with school colleagues and at the district level definitely pays off.

5. Software: communications software and Internet application software including e-mail program, Web browser, etc. are usually provided by the Internet service provider. Commercial services provide a package of software that is readily available by contacting their 800 customer service number.

Since there are so many regional variations, you are encouraged to check with your in-house or district technology expert about local Internet access and specific logistics about using your computer, software, modem and the Internet. If you have general questions which remain unanswered, or specific *Live from Hubble* issues, feel free to contact Jan Wee, *Passport to Knowledge* Education Outreach Coordinator. (See inside front cover for phone, fax and e-mail contact information.)

Poetry and Astronomy

Ackerman, D. "The Poetry of Diane Ackerman." in *Mercury*, Jul/Aug 1978, p. 73

Franknoi, A. & Friedman, A., "Images of the Universe" in *Mercury,* Mar/Apr 1975, p. 14. On astronomical poetry throughout history.

Marschall, L., "Modern Poetry and Astronomy." in *Mercury*, Mar/Apr 1983, p. 41

Marschall, L., "Comets and the Muse." in *Mercury*, Jan/Feb 1986, p. 10

Maynard, C., "Robert Frost: Poet of the Night." in *Sky & Telescope*, June 1992, p. 692

Weitzenhoffer, K., "Well Versed in Astronomy." in *Sky & Telescope*, Oct. 1990, p. 365
Brief introduction to astronomy in poetry over the centuries.

Mythology and Legends

Caduto, M.J. & Bruchac, J., *Keepers of the Night.* Fulcrum Pub., Golden ,CO, ISBN 1-555-91-177-3, (800) 992-2908. Native American Sky Legends.

Krupp, E., *Beyond the Blue Horizon: Myths and Legends of the Sun, Moon and Planets.* Harper Collins. Collection of astronomical tales from many cultures.

Krupp, E., "Along the Milky Way." in *Mercury* Nov/Dec 1991, p. 162 An excerpt from the above book on legends and stories about the Milky Way.

Monroe, J.G. & Williamson, *They Dance in the Sky.* Houghton Mifflin Co., ISBN 0-395-39970-X, Native American stories and legends.

Ridpath, I., *Star Tales.* 1988, Universe Books. A collection of myths about the constellations, mainly from Greek and Roman tradition.

Art and Astronomy

Chaikin, A., "Images of Other Worlds." in *Sky & Telescope,* Nov. 1982, p. 423

Davis, Don, "The Worlds of Don Davis." in *Sky & Telescope*, June 1985, p. 503

Hardy, D. *Visions of Space: Artists' Journey Through the Cosmos,* 1989, Limpsfield. Featuring the work of over 60 artists.

Hartmann, W. et al., *Cycles of Fire.* 1987. Workman Pub., Book on stars and galaxies with many paintings by an artist and planetary astronomer.

Hartmann, W. et al., *In the Stream of Stars: The Soviet/American Space Art Book.* 1991, Workman Pub. Over 200 paintings and text by artists in the U.S. and former Soviet Union.

Miller, R. *The Dream Machines.* 1993, Krieger Pub. An illustrated history of the spaceship in art, science and literature by a noted space artist.

Miller, R. & Hartmann, W., *The Grand Tour: A Traveler's Guide to the Solar System.* 2nd. ed., 1993, Workman Pub., Introduction to the planets with many artists' paintings.

Miller, R. & Durant, F., *Worlds Beyond: The Art of Chesley Bonestell.* 1983, Donning Pub., Album and tribute to space artist pioneer.

Olson, D. & Doescher, R. "Van Gogh, Two Planets, and the Moon." in *Sky & Telescope,* Oct. 1988, p. 408

O'Meara, S., "Kazuaki Iwasaki: Japan's Astronomer-Artist." in *Sky & Telescope,* July 1985, p. 64

Astronomical and Space Art may also be found in *Sky & Telescope, Astronomy* and *Odyssey* magazines. Also look in *Astronomy* and *Sky & Telescope* for ads on sets of color slides from various space artists.

On the Internet, view space art and learn about the International Astronomical Artists Association at:
http://www.novaspace.com/IAAA/IAAA.html

For bulk orders of the hands-on materials sampled in this "mini-kit":

Thermal paper and UV beads: Educational Innovations, (203) 629-6049, or e-mail: EdInnov@aol.com

Diffraction gratings and color filters: R&R Packaging (508) 433-6835

HST "Greatest Hits" and other space slides and videos: Finley-Holiday Films 1-800-345-6707

ON-LINE ON DISK

This may sound like a contradiction, but if you have no, or slow, access, you and your students can still take advantage of the extensive on-line materials described above, by using regular floppy disks, formatted to work with any computer and word processing program. You'll be able to read *Field Journals,* search the *Researcher Q & A* database, and—we hope—see so many things of interest, that you'll be sure to be on-line for future *Passport to Knowledge* projects!

Richard Seltzer of B & R Samizdat Express, a small Boston publisher, downloads all current files on our Web site and makes them available in Mac or IBM formats. You may order diskettes for $10.00 per 3.5" high density diskette. You are authorized and encouraged to make as many copies as you need to share with students and colleagues. *Live from the Hubble* diskettes will be available in late February and may be ordered by e-mail or postal mail. Be sure to indicate whether you want IBM or Mac format, your full name and address, and enclose a check, purchase order, or current credit card information. In the U.S., there is no charge for shipping and handling. Massachusetts residents should add 50 cents per disk for sales tax. Outside the U.S., add $2.00 for shipping per order.

For orders via postal mail: B and R Samizdat Express, P. O. Box 161, West Roxbury, Massachusetts, 02132-0002. For e-mail orders: samizdat@samizdat.com (Send payment via postal mail) For more information about the "Please Copy This Disk" service, call Richard Seltzer at 617-469-2269.

Check our 1-800-626-LIVE (626-5483) *Passport to Knowledge* Hotline, mailbox #6, for updated information about how many diskettes are offered.

Student Evaluation Form

The *Passport to Knowledge* team has tried to make *Live from the Hubble Space Telescope* informative and fun. Please tell us a little about your response to the project so we can do still better next time. Thanks!

Grade level: _____ Teacher name: _____

School: _____

Are you male/female? _____

1. I watched: Program 1: The Great Planet Debate yes ❑ no ❑ Program 2: Making YOUR Observations yes ❑ no ❑ Program 3: Announcing YOUR Results yes ❑ no ❑
2. Our class prepared for the electronic field trip by: (list any classroom activities you did before viewing the videos) _____
3. Our class followed up the electronic field trip by: (list any classroom activities you did after viewing the videos) _____
4. The BEST classroom activity we did was: _____

   The WORST classroom activity we did was: _____
5. The BEST part of the videos was: _____

   The WORST part of the videos was: _____
7. We accessed the on-line materials via computer and modem: yes ❑ no ❑
8. The MOST interesting material we found on-line was: _____
9. The MOST interesting thing I learned from the whole *Live from the Hubble* project was:

   _____
10. Describe one thing you learned about:

    Astronomy: _____

    How the Hubble Space Telescope operates: _____

    How scientists work: _____

    How school subjects are used in the world beyond school: _____
11. *Live from the Hubble Space Telescope* gave me:

Factual Information about Astronomy	yes ❑ no ❑
Factual Information about Careers in Science	yes ❑ no ❑
Better understanding of basic Scientific Concepts	yes ❑ no ❑
Better understanding of the Scientific Process	yes ❑ no ❑
Increased interest in Science and Technology	yes ❑ no ❑
Increased interest in a Career in Science or Technology	yes ❑ no ❑
Increased appreciation for Teamwork	yes ❑ no ❑
Increased sense of Connectedness across distance	yes ❑ no ❑
Greater ability to use Computers and Telecommunications	yes ❑ no ❑
Greater ability to ask good questions and synthesize information	yes ❑ no ❑

12. If in the future you could take more electronic field trips like *Live from the Hubble Space Telescope*, where would you MOST like to "visit"? _____

How about the following places? Check all that sound interesting: Dinosaur Dig ❑
Amazon Rainforest ❑ Ocean Deep ❑ Mars ❑ Return to Antarctica ❑

13. Next time I hope my teacher will once again DO: _____
14. Next time I'd advise my teacher NOT TO: _____

_____

Teacher Evaluation Form

Live from the Hubble Space Telescope is the third in the ongoing series of *Passport to Knowledge* field trips. We've tried to incorporate feedback from teachers into our previous projects: please take a few moments to tell us how you used the video, print and on-line components so we can learn still more. Returning this form will also place you on our mailing list for future Modules. (A shorter evaluation form to be completed by students is also provided.)

Please note: *Passport to Knowledge* will distribute 500 free copies of NASA's new *Astronomy Village* CD-ROM to educators returning completed Teacher **and** Student evaluation forms by May 30, 1996. Yes, this also applies to home-schoolers with just a few students!

I. GENERAL INFORMATION

Your name: _____

Professional status (e.g. teacher, principal, Library Media specialist, etc.) _____

School/Contact Address: _____

Phone: _____

Grade Level taught: _____

1. Number of Classes who participated: _____ _____ # of Students _____ # of Teachers
2. Check all subjects in which this project was used.
   General Science: ❑ Biology: ❑ Earth Sciences: ❑ Physics: ❑ Math: ❑ Computers: ❑ Language: ❑ Social Studies: ❑ Other: _____
3. Was the project used as a "Team Teaching" activity? yes ❑ no ❑
4. Did your school/institution connect with local astronomers, science museums, planetariums, etc. to support your activities? yes ❑ no ❑
5. Please check yes/no to your use of the various Project Components
   Live videos yes ❑ no ❑ — Taped videos yes ❑ no ❑
   Teacher's Guide (print) yes ❑ no ❑ — NASA's *Space Based Astronomy* yes ❑ no ❑
   Other co-packaged print materials yes ❑ no ❑ — Hands-on "mini-kit" (poster, filter, beads.) yes ❑ no ❑
   On-line resources yes ❑ no ❑ — 1-800 "Hotline" yes ❑ no ❑
6. Were you able to integrate this project with your teaching goals? yes ❑ no ❑

II. VIDEO COMPONENTS

1. Which program(s) did you and/or your students watch?
   Program 1: The Great Planet Debate yes ❑ no ❑ — Program 3: Announcing YOUR Results yes ❑ no ❑
   Program 2: Making YOUR Observations yes ❑ no ❑
2. Please indicate by checking your source of the videos: PBS: ❑ NASA-TV (NASA Select) ❑ Educational Network: ❑ Videotape ❑
3. How many lessons did you give *before* students viewed the videos? _____
4. How many lessons did you spend on *follow-up* after the videos? _____
5. On a scale where 1 is *lowest* and 4 is *highest,* please rate the Importance of the videos to the project, and rate their Quality:

	IMPORTANCE	QUALITY (1 = lowest, 4 = highest)
Live programs	1 2 3 4	1 2 3 4
Taped programs	1 2 3 4	1 2 3 4

6. Rate the Importance of the **Live** aspect of the project: 1 2 3 4 — 1 2 3 4
7. Please describe the most important learning that your students gained from the video components?

_____

_____

8. Do you plan to use the programs again, on tape, in the future? yes ❑ no ❑

III. PRINT MATERIALS

1. Rate the Importance and Quality of the Teachers Guide, "mini-kit" and co-packaged publications:

	IMPORTANCE	QUALITY (1 = lowest, 4 = highest)
Live from the Hubble Space Telescope Teacher's Guide (overall)	1 2 3 4	1 2 3 4
Individual Guide components:		
Broadcast Information	1 2 3 4	1 2 3 4
How to use an "electronic field trip"	1 2 3 4	1 2 3 4
Program Overviews	1 2 3 4	1 2 3 4
Classroom Activities	1 2 3 4	1 2 3 4
Materials and Resource Lists	1 2 3 4	1 2 3 4
"How to Get On-line"	1 2 3 4	1 2 3 4
Interdisciplinary matrix and icons	1 2 3 4	1 2 3 4
Glossary	1 2 3 4	1 2 3 4
Co-packaged materials:		
NASA *Space Based Astronomy*	1 2 3 4	1 2 3 4
Space Telescope Science Institute "Starcatcher"	1 2 3 4	1 2 3 4
Poster	1 2 3 4	1 2 3 4
Color Filters	1 2 3 4	1 2 3 4
UV Beads	1 2 3 4	1 2 3 4
Diffraction grating	1 2 3 4	1 2 3 4
Heat sensitive paper/cardboard	1 2 3 4	1 2 3 4

2. Which classroom activities did you work on with your students? Please list ALL used, by page number in the Guide:

_____

3. Was there sufficient information to adapt the activities/material to the needs/grade level of your students? yes ❑ no ❑
4. Please describe the most important learning that your students gained from the Print and "mini-kit" materials: _____

_____

IV. ON-LINE COMPONENTS

1. Did you and/or your students use the On-line resources? yes ❑ no ❑
2. Please check all on-line formats used: e-mail ❑ gopher ❑ Web ❑
3. How did you access the materials? NASA Quest ❑ NASA Spacelink ❑ PBS ❑ Other (please specific) _____
4. On a scale where 1 is lowest and 4 is highest, please rate the Importance of the On-line components, and rate their Quality:

	IMPORTANCE	QUALITY (1 = lowest, 4 = highest)
(a) Informational resources (i.e. non-interactive)		
Teacher's Guide	1 2 3 4	1 2 3 4
HST Updates (newsletter)	1 2 3 4	1 2 3 4
(b) Interactive opportunities		
Researcher Q & A (e-mail to and from the scientists)	1 2 3 4	1 2 3 4
Field Journals/Logs	1 2 3 4	1 2 3 4
Junior-HST *Field Journals*/Logs	1 2 3 4	1 2 3 4
Discuss-HST	1 2 3 4	1 2 3 4
(c) On-line collaborative activities, (e.g. star-census, weather)	1 2 3 4	1 2 3 4

5. Did your students send questions to *Researcher Q & A?* yes ❑ no ❑
6. Did your students incorporate the results of their work with on-line materials in their own presentations/reports? yes ❑ no ❑
7. How would you rate the ease of use of the on-line materials, where 1 is very easy, 2 quite easy, 3 quite hard and 4 very hard 1 ❑ 2 ❑ 3 ❑ 4 ❑
8. Please describe the most important learning that your students gained from use of the on-line materials:

_____

_____

V. STUDENT LEARNING

1. On a scale where 1 is Least Valuable and 4 is Most Valuable, please rate what kind of student learning resulted from the project.

	Least Valuable	Most Valuable (1 = least, 4 = most)
(a) Factual Information		
Factual Information about Astronomy	1 2 3 4	1 2 3 4
Factual Information about Careers in Science	1 2 3 4	1 2 3 4
Better understanding of basic Scientific Concepts	1 2 3 4	1 2 3 4
Better understanding of the Scientific Process	1 2 3 4	1 2 3 4
(b) Attitudes		
Increased interest in Science and Technology	1 2 3 4	1 2 3 4
Increased interest in Career in Science or Technology	1 2 3 4	1 2 3 4
Increased appreciation for Teamwork	1 2 3 4	1 2 3 4
Increased sense of Connectedness across distance	1 2 3 4	1 2 3 4
(c) Skills		
Ability to use Computers and Telecommunications in schoolwork	1 2 3 4	1 2 3 4
Ability to ask good questions and synthesize information	1 2 3 4	1 2 3 4

2. Please describe the most valuable learning outcome you saw in your students: _____

_____

VI. Future *Passport to Knowledge* Modules

1. If your students could take more electronic field trips, where would they *most* like to "visit"?
   Dinosaur Dig Amazon Rainforest Ocean Deep Mars Return to Antarctica Other: _____
2. What improvements can you suggest for future *Passport to Knowledge* Modules?

_____

_____

3. Other groups are offering electronic field trips at varying costs per school/student:
   how much would you/your school pay for a *Passport to Knowledge* project such as *Live from the Hubble Space Telescope?* _____
   Would/could not participate unless free/low-cost yes ❑ no ❑ $50 ❑ $100 ❑ $150 ❑ $200 ❑ $300 ❑ more ❑

Questions? Please contact *Passport to Knowledge:* fax (908) 277-9590: e-mail: **ghaines@quest.arc.nasa.gov**

Please mail this completed form, together with student evaluations, to:

LIVE FROM THE HUBBLE SPACE TELESCOPE,

P.O. Box 1502, Summit, New Jersey, 07902-1502

Cross-Curriculum Connections of Programs and Activities

	Science	Math	Language Arts	Social Studies	Tech. Ed.	Computers & on-line	Art
Opening/Program 1							
Activity 1A	x	x		x		x	x
Activity 1B	x	x			x	x	x
Activity 1C	x	x			x		
Program 2							
Activity 2A	x	x			x		
Activity 2B	x	x			x		
Activity 2C	x	x		x	x	x	
Activity 2D	x	x		x	x	x	
Activity 2E	x	x			x	x	x
Program 3							
Activity 3A	x	x			x	x	x
Activity 3B	x	x		x	x	x	
Activity 3C	x				x		
Activity 3D	x		x	x	x	x	x
Closing							
Activity 4A	x		x	x	x		
Activity 4B	x		x	x	x	x	x
Activity 4C	x		x	x	x	x	

Concepts, Themes and Interdisciplinary Connections

Correlation of *Live from the Hubble Space Telescope* programs and Activities with concepts and themes suggested by Project 2061 and the *California Science Framework*

Project 2061 *Ca. Science Framework*	Systems & Interactions	Constancy Stability	Patterns of Change	Evolution Evolution	Scale Scale and Structure	Models ***	*** Energy
Opening/Program 1							
Activity 1A	x	x	x		x	x	x
Activity 1B	x		x	x	x	x	
Activity 1C				x	x		
Program 2							
Activity 2A	x	x	x			x	x
Activity 2B	x				x	x	x
Activity 2C	x	x	x		x	x	x
Activity 2D	x		x		x	x	x
Activity 2E	x	x	x		x	x	x
Program 3							
Activity 3A	x	x	x		x	x	x
Activity 3B	x	x	x	x	x	x	x
Activity 3C	x	x	x	x	x	x	x
Activity 3D	x	x	x	x	x	x	x
Closing							
Activity 4A		x	x	x		x	
Activity 4B	x	x	x	x	x	x	x
Activity 4C	x				x	x	

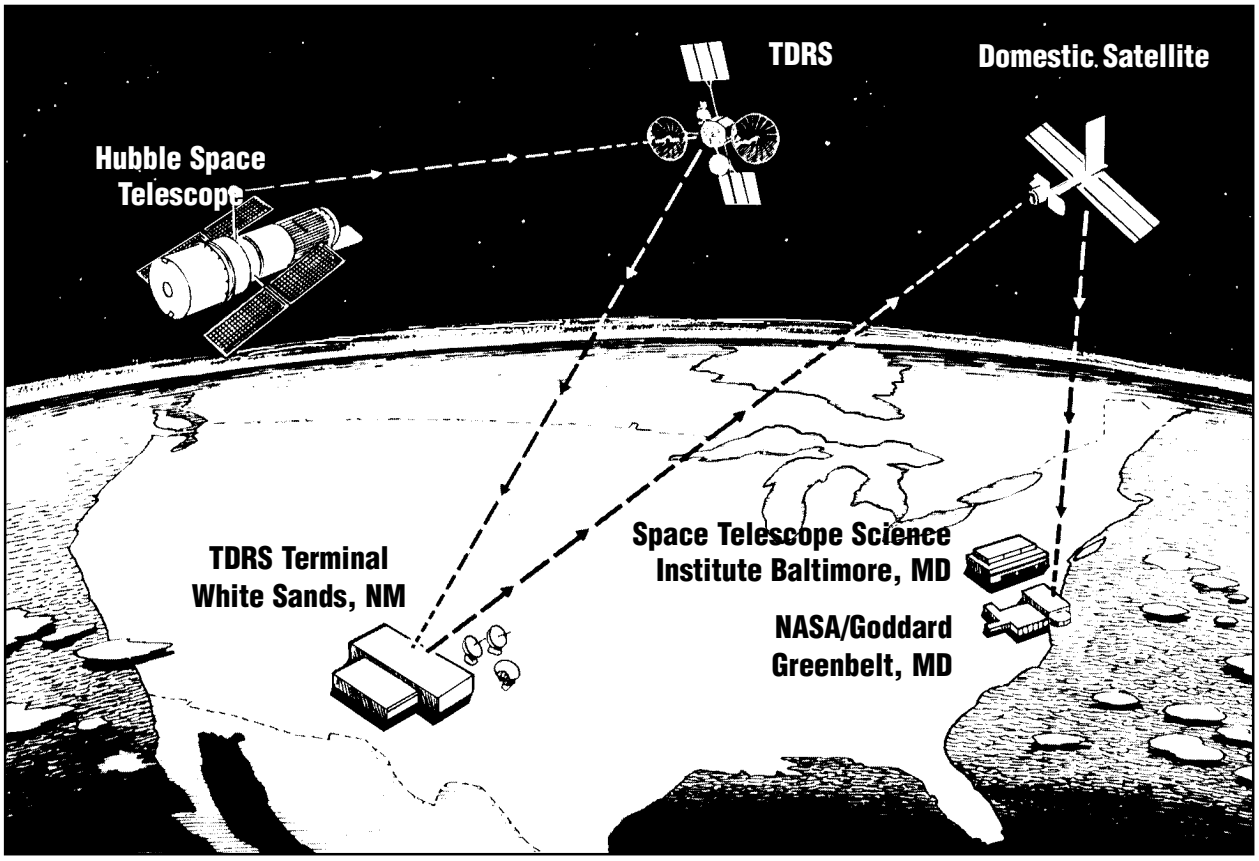
Dr. Anne Kinney, Education Manager/ Project Scientist, STScI

Scientists tend to ask the same questions that kids do when they play… They ask a question and that invokes another question… It's something that people know intrinsically when they are children and somewhere they forget it. Scientists still do it, and the more successful they are, the better they are at honoring the questions that come up.

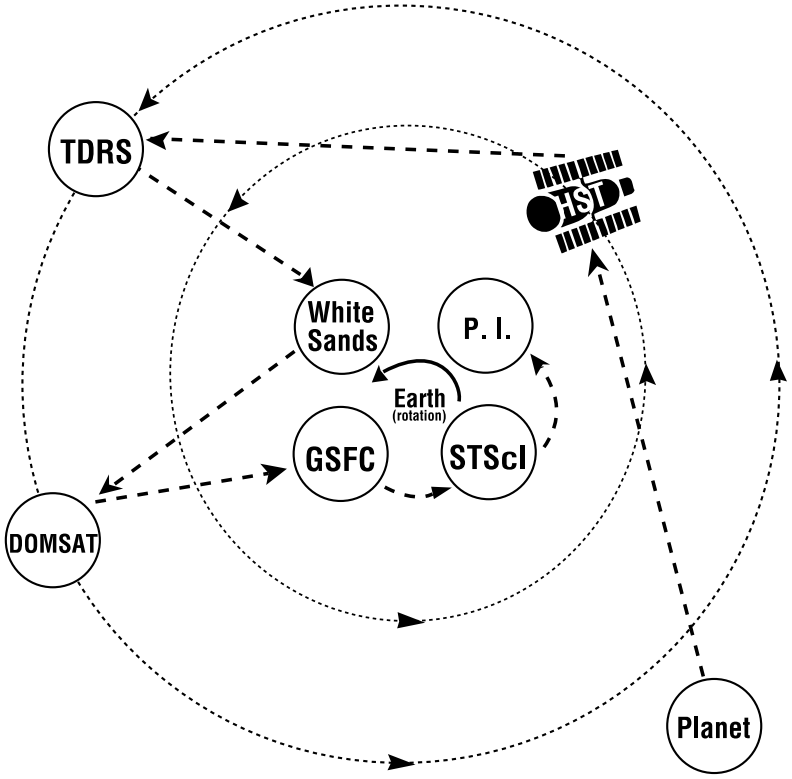
…Science is on-going, but the greatest criticism about the way I learned science is that it was always taught that someone else did it, and that they were usually wearing a white coat and, of course, they were usually male and they knew all the answers and, of course, what was the point. In fact it is really not that way. Science is on-going and if you want to know the answer to something you better be the one who is asking the questions—you yourself—not someone in another room with a different background than yourself.

Live from the Hubble Space Telescope is unprecedented, we never used Hubble Telescope orbits for classroom use before. Another unique thing… is that we are trying to have students involved in which planet to look at… I would be very happy if they had a feeling that they were the scientists. I would be very happy if they had a lot of unanswered questions. When it was over, I would be happy if they were not content with the plan that was chosen, in fact they wished it was of another planet because they didn't get their question answered. In other words, if we caused a lot of trouble I would be very happy!

Signal Path



Student Placement for Activity 2D: Bouncing Data...



Passport to Knowledge is looking to the future and hopes to work with you to design other new and exciting Modules. Some ideas for future programs are: *Live from Mars*, *Live from Antarctica 2*, *Live from the Amazon Rainforest*, *Live from the Ocean Deep*, *Live from the Place the Dinosaurs Died*, *Live from Shuttle/MIR*, *Live from the Fastest Planes on Earth* and *Live from the North Pole*. We hope you agree these are exciting and significant topics for "students of all ages"!

PTK invites you to be a member of a global learning community and come along for some very exciting adventures over the coming months and years. We look forward to working and learning with you on this exciting adventure.

Real Science

Real Time

Real Scientists

Real Locations