

TECHNOLOGICAL INNOVATIONS AND PUBLICATIONS RELATED TO SPACE SCIENCE EDUCATION

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ABSTRACT

As NASA Administrator Dan Goldin has noted, children are especially interested in three things: ghosts, dinosaurs, and space. We need to capitalize on the interest in space to develop and encourage a continuing understanding and curiosity about space-related issues from the grade school level through adulthood. Unfortunately, because astronomy is usually only offered in college as an introductory-level elective or as a specialized area of graduate study, most pre-college educators are uncomfortable teaching space sciences in the classroom. Additionally, the particularly dynamic nature of the field leaves educators with materials that are out-of-date and inadequate. In the framework of the new educational pedagogy focusing on hands-on activities, this paper presents a discussion of technologically innovative resources for the space science classroom (primarily at the high school level) which utilize hands-on activities for the students. The discussion will focus in five areas: major high-tech programs (which require specialized equipment in the schools), national and local workshops available to educators, hands-on activities commercially available, educational astronomical resources, and examples of hands-on activities developed and expanded upon by teachers and astronomers attending an educational workshop in Hawai'i from 1993-1995.

INTRODUCTION

With the general level of public scientific literacy declining, there is a large push to raise scientific literacy standards. This has been reflected in a White House statement issued in 1994 which stated that a goal of the United States in this area is to both produce high-quality scientists and engineers to meet the needs of the next century and to increase the level of scientific literacy in the general public by the turn of the century. An increase in science appreciation has become a national priority (Yager and Lutz, 1994) as evidenced by the national science education reform movements which include the NRC National Science Education Standards, the AAAS Project 2061 and the AGU Earth Systems Science programs, among others. Astronomy is a unique field in that it evokes a fundamental interest in exploration and the search for our origins which has long been rooted in humankind's curiosity - perhaps more so than in any other field. This public appeal, combined with the general interdisciplinary nature of the field gives it a high potential as an educational avenue for increasing scientific awareness. However, in these tight fiscal times, many educational programs are focusing on areas which can provide practical training for future job-related skills. This is particularly pronounced in areas such as Hawai'i, where recent state fiscal limitations are resulting in reductions in funding

for school supplies by as much as 30%. For many public high-schools in Hawai'i, only 20-30% of the students may continue on to higher education, and districts with large percentages of minority populations have Standardized Achievement Test (SAT) scores which are below the national average. Whereas some may consider space science to be somewhat esoteric, the fascination that the field holds for young people in particular, suggests that while astronomy might not provide practical on-the-job training skills, the critical thinking skills and motivation which can be developed in students through space science and astronomy education are probably far more valuable assets than specific skills.

Astronomy and space science education in the U.S. occurs primarily in middle schools, appearing as a unit in earth sciences classes. For younger ages, while there may be some introduction to the members of the solar system, the cognitive development of elementary school children is not sufficiently advanced to understand the spatial concepts inherent with the three-dimensional nature of the field (Bishop, 1996). Unlike other sciences which get revisited in the high school years, unless there is a special interest on the part of the teacher, astronomy and space science often do not re-appear in high school. Students have their first real experience with astronomy as an introductory level course in the Universities, and a large number of students take these astronomy courses each year as a means of fulfilling distribution requirements. From this group, a few continue on to do research in the space sciences. While there is no question that the U.S. is a leader in the production of astronomy and space research scientists, we are not doing a good job at maintaining a strong science literacy in the general population. This is due in part to the fact that most astronomy is introduced rather late in the educational process, in large lecture-style classes which are not as conducive to hands-on learning. Studies have shown that the inquiry-based, hands-on learning is a far more effective concept to develop meaningful understanding for most students than the traditional lecture-based curricula.

Unfortunately, since most middle and high-school educators have themselves gone through this same system, they feel unprepared to introduce innovative space science resources into curricula at younger levels. If astronomy is taught at all, it is often limited to the identification of constellations (Slater *et al.*, 1996). Much of the problem stems from the fact that teachers have limited content background in astronomy and related sciences, with less than half the secondary teachers having had more than 6 hours of college level earth science (Weiss, 1994). Additionally, astronomy and spaces sciences are particularly dynamic fields, and those teachers who do include space science in their curricula quickly find themselves out-of-date with neither the time, resources nor the knowledge as to how to keep up in these rapidly evolving areas. There has been a recent explosion in the availability of new, innovative materials which reflect the current understanding in space science, and which incorporate the new educational standards (*e.g.* Project 2061, 1993). The purpose of this paper is to highlight sources of information on how to obtain these materials for the classroom.

The resource materials discussed in this paper were collected and developed as a result of an astronomical educational workshop for top high-school teacher-student pairs held in Hawai'i from 1993-1995. The goals of the week-long program were three-fold: (*i*) to make high-school teachers (in science and mathematics) aware of the hands-on material available and train them in the use of the materials; (*ii*) to provide students with information and what careers in science are like; and (*iii*) to create an awareness in Hawai'i of the forefront astronomical research being conducted using the Mauna Kea Observatory facilities – one of the world's premier observing sites. The workshop theme, Toward Other Planetary Systems (TOPS) was chosen in part because it is a focus of research in Hawai'i, and in part because of the interdisciplinary nature of the topic which incorporates astronomy, physics, chemistry and biology. The program was a mixture of lectures, demonstrations, hands-on activities, field trips and research. Guest speakers, totaling upwards of 30 per year, included faculty from the University of Hawai'i system, scientists and engineers from the observatories, scientists from other

research organizations on the mainland, education specialists, local teachers, and graduate students. One of the great strengths of the program was the presence of the high school students which greatly facilitated the learning process for the teachers who could see first hand how the activities they tried were received by students. The students also benefited from working along side their teachers in a new capacity as fellow students. The format of the workshop placed the role of the teacher as one of facilitator and fellow student, rather than the all-knowing source of information.

RESOURCE MATERIALS

The resources described below include a mixture of high-tech materials and those which do not require advanced technology. The reality is that while many schools have modern equipment, with Internet connections to the classroom, there are many areas where resources are minimal. This latter situation is particularly relevant to developing countries, which may be in desperate need of an increase in scientific literacy but which lack any resources to bring innovative materials to the classroom. In many school systems where resources exist, there are no funds available to update and improve the materials. Another common problem which comes with educational fiscal austerity, is that class sizes are becoming larger, and the teachers are being asked to teach more classes. More than financial hardship, one of the major impediments to the introduction of space science materials into the classroom is the lack of space and time. With heavy workloads, teachers cannot be expected to seek out and locate new innovative activities, let alone develop new materials for the classroom. The purpose of this paper is to provide a concise summary of the resources available, and to prevent this listing from becoming dated before it is published, this presentation is being concurrently developed with a homepage on the World-Wide-Web, which will be continually updated as new materials become available. The resource listing may be accessed at: <http://www.ifa.hawaii.edu/~meech/education/asted.html>

In many cases the educational materials may be obtained by direct downloading from the Internet. Full information on how to obtain materials is included on the web site.

Astronomy Workshops and Hands-On Programs

There are a variety of hands-on astronomy programs which have involved significant development of curriculum materials suitable for middle school through university level education that have associated workshops for teacher training associated. Table 1 summarizes these programs with respect to level, science content, equipment / technology requirements, and cost (see also, Percy, 1996).

Hands-on-Astrophysics. This program has been developed by the American Association of Variable Star Observers (AAVSO) with funding from the National Science Foundation. The Hands-on-Astrophysics (HOA) program is based upon the unique and extensive electronic database of variable star measurements which have been made by the predominantly amateur international members of the AAVSO. The activities include measurements of known variable stars (naked eye, binocular and small telescope), followed by use of computer software to manipulate the observations along with data from the AAVSO database. Students in the program are introduced to all phases of the research process in variable star research. Materials should be available to educators in late 1996.

The Jason Project. In this program, younger students learn the principles of scientific investigation through exemplary earth science/astronomy curricula which involve students in a real scientific process. Core background materials, journals, and hands-on activities prepare the students for a project expedition which is conducted as a telepresence encounter via live TV broadcast with the collaborating scientist at the research site. Teachers are prepared for their participation in the program

through development workshops which provide background, introduction to teaching standards and opportunities and instruction on use of technology in the classroom.

Hands-on-Universe. The Hands-on-Universe (HOU) curriculum materials, developed at Berkeley by C. Pennypacker, combine elements of real research into astronomy education. Astronomy labs which would have traditionally been done with the aid of small telescopes, may now be done through this program which links professional astronomers and observing facilities to the classroom. Guided through activities with a comprehensive curriculum, HOU students world-wide request observations from automated telescopes, which they download across the Internet. Participants then use HOU-developed software to reduce the astronomical images. Teachers are trained in the use of the materials through HOU educational workshops and through the use of HOU Teacher Resource Agents.

Project INSPIRE. This unique project, sponsored by the NASA Ionospheric and Atmospheric program, combines a short-term lab activity for physics students with long-term participation in a nation-wide data gathering network. For a small fee, teachers purchase a radio receiver kit (which the students build) that can detect very low frequency radio signals (*i.e.* from lightning). Specific scientifically interesting observing periods are coordinated by Bill Pine at Chaffey High School where students then can record data (with a standard tape recorder) and send the data in for analysis.

Project ASTRO. Developed by the Astronomical Society of the Pacific, this innovative program partners professional and amateur astronomers with 4-9th grade teachers to improve astronomy education and increase student interest in astronomy and science. The program helps to establish a true partnership between the three groups by providing a developmentally appropriate resource book, *The Universe at Your Fingertips*, which is a compilation of already existing hands-on materials. Additionally, the astronomers and teachers attend a training workshop to maximize the collaboration before contact with the students. The professional astronomers then make 4-10 visits to a classroom.

Image Processing for Teachers. This project educates teachers in both the technique of image processing (using a Macintosh computer) and of the content of various scientific data sets. This NSF-funded program was developed by Dr. Richard Greenberg at the University of Arizona's Department of Planetary Sciences. Teachers use the National Institute of Health software to manipulate data and to learn to teach science through scientific process. The program fee is to run a full workshop for local teachers to fully train them in the use of the software and to provide classroom materials.

FOSTER Program. The Flight Opportunities for Science Teacher Enrichment (FOSTER) program creates the opportunity for teachers to fly aboard the Kuiper Airborne Observatory (KAO). Developed in 1963, this C-141 aircraft houses a 0.9m telescope. Flying high in the Earth's atmosphere, this telescope specializes in infra-red observations impossible from the ground. Prior to flying, teachers attend summer workshops, are instructed in the use of curriculum supplement materials and the Internet. The goal is to develop a partnership between scientists and schools, and to infuse scientific method into the classroom via excitement from teacher participation. Although the KAO is being retired, its successor, SOPHIA, which will be a Boeing 747 aircraft with a 2.5m telescope, is likely to develop a similar educational outreach program concurrent with its anticipated 120 yearly missions.

Table 1 summarizes all of the above programs. The target grade level (MS = Middle School, HS = High School, Univ = University level), as well as approximate program costs, and required equipment are included. The final 7 columns indicated the focus of each program: P = Physics, A = Astronomy, E = Earth Science, C = Chemistry, M = Math, B = Biology and T = Computers and Technology.

Table 1. **HANDS-ON PROGRAMS**

Program	Inquiries	Level	Cost	Equip	P	A	E	C	M	B	T
HOA	AAVSO, Birch St., Cambridge MA 02139	HS/Univ	Free	PC/Mac binoculars		x			x		x
JASON	Jason Foundation, 395 Totten Pond Road, Waltham MA 02154	MS	Free	live TV	x	x	x			x	x
HOU	C. Pennypacker, Lawrence Berkeley Lab, B50 R232, Berkeley CA 94720	HS/Univ	Free	486PC co- proc	x	x					x
INSPIRE	B. Pine, Chaffey High School, 1245 N. Euclid Ave., Ontario CA 91762	MS/HS	\$56	tape recorder	x	x	x				
ASTRO	A. Fraknoi, ASP, 390 Ashton Ave., San Francisco, CA 94112	4-9	\$30	None		x					
IPT	R. Greenberg, Univ. AZ/IPT, LPL, Tucson AZ 85721	MS/HS	\$900	PC	x	x	x	x	x	x	x
FOSTER	SETI Inst., 2035 Landings Drive, Mountain View, CA 94043	3-12	Free	None		x					x

Hands-on-Activities and Curricula

In addition to the extensive programs described above there have been a wide variety of excellent curriculum materials and hands-on activities developed. Most of the activities will encourage use of technology in the classroom, and will encourage students to work in collaborative settings which engage them in inquiry-based learning.

Project CLEA. Gettysburg College, with the support of the National Science Foundation, has developed a series of Contemporary Laboratory Experiences in Astronomy (CLEA), which consist of realistic observing simulations using digital images and Mac and PC based software. In this age of increasing remote observing, the software creates a very realistic open-ended research experience, where the student must make decisions about the acquisition and analysis of the simulated data similar to the process that the research astronomers go through. The level is appropriate for high school and for college level astronomy at all levels. The software is accompanied by student manuals and teachers guides, and is available at no cost by anonymous ftp ([io.cc.gettysburg.edu](ftp://io.cc.gettysburg.edu)), via the web: <http://www.gettysburg.edu/project/physics/clea/CLEAhome.html> or via U.S. mail.

Astronomy Village. The Astronomy Village is a CD-ROM based multimedia program which was developed by the NASA Classroom of the Future program at the Wheeling Jesuit College. The program was designed to supplement 9th grade earth science classes, but it is also suitable for older age groups. Using this program, students conduct astronomical investigations. While in the village, students are guided by an electronic mentor. They can listen to lectures, receive email, use the library or the computer center to process data (using the NIH image processing program) which they obtain at the village observatory. The open ended research problems mirror areas of current forefront astronomical research. This exemplary product not only introduces students to the scientific method with a wide variety of tools, but also gives the students an idea about what the life of a real astronomer is like through personal glimpses at the village cafeteria. In addition to the CD-ROM, the Wheeling Jesuit College offers no-cost teacher workshops. The Astronomy Village may be obtained at no cost through the NASA Teacher resource Centers, or through NASA CORE for a nominal shipping fee. Further information may be found at The Astronomy Village website: <http://pulsar.cotf.edu/AV/>.

Event-Based Science Modules. The Event-Based-Science (EBS) Program is an NSF-funded program developed by R. G. Wright for the Montgomery Public Schools in Maryland. The program has developed modules for middle-school earth science classes. The EBS modules are interdisciplinary in nature and rely upon the middle school student fascination with disaster in order to draw them into activities associated with a disaster, and in the process teach them science. Each module begins with video news footage of the related disaster, then the curriculum materials assist the teacher to lead the students in tackling projects simulating real-life interaction with the disaster through hands-on activities. The modules are available at a nominal cost through Addison-Wesley publishers.

Life in the Universe. The SETI Institute has developed a science curriculum project, funded by the National Science Foundation, aimed at improving the teaching of science in elementary and middle schools (grades 3-9). The project is developing teachers' guides, each of which has 10-12 science activities which focus on the possible existence of life elsewhere in the universe and is based on the experience of the SETI scientists. The guides include instructions on how to set up the activities, reproducible materials, lists of materials required and how to obtain them, lists of software, posters and slides or other materials. Classroom kits, which include a book, videotape and poster range in price from \$50-\$60, and can be ordered from Libraries Unlimited/Teacher Ideas Press, Dept. 9503, P.O. Box 6623, Englewood, CO 80155-6633. Sample lessons may be viewed on the web.

Project Star. Project STAR hands-on materials were developed at the Harvard Smithsonian Center for Astrophysics with funding from the NSF. High school astronomy teachers and scientists developed the curriculum materials in order to teach physical science, using astronomy as the motivation. After development, the materials were thoroughly tested and evaluated by educators and students nationwide. Materials include activities such as building a celestial sphere, building a refracting telescope, a solar system scale model, light measurement and spectroscopy etc. The materials may be obtained from Learning Technologies, Inc., 40 Cameron Avenue, Somerville, MA 02144, either individually or as teacher samplers. Those who are conducting workshops for teachers to highlight the use of the materials can obtain the kits free of charge.

Sources of Astronomy Resources Materials

Once educators become familiar with the technology that can be used in the classrooms and begin to use the available hands-on materials which have been developed, it is likely that there will be a need for additional supplementary materials. However, tracking down sources for these materials, which might include recent mission images, astronomy tools which can be integrated into existing curricula etc. can be time-consuming. Several organizations, such as the Astronomical Society of the Pacific and the SETI Institute, publish regular newsletters which are free of charge to educators, which can help keep them current. Information on subscribing to these newsletters is found in the education web page described above and, in addition, hyperlinks to useful tools are found on the page.

The National Space Science Data Center (NSSDC) has had the duty of data archiving and dissemination for the NASA missions for the past 25 years. In a lesser known capacity, however, they have also played an important role in the dissemination of information to educators from elementary through high school levels. To this end, they have set up a series of Teacher Resource Centers (TRCs) at NASA Centers throughout the country. Upon written request from educators (on their school stationery) the centers will send free printed materials, and will provide videos and slides for users who submit blank media (videos/film). The TRCs are partnerships of NASA with universities and museums that serve as regional centers to provide a variety of educational materials. The Central Operations of Resources for Educators (CORE) is designed for the national and international

distribution of aerospace education materials to enhance the NASA resource network. The materials available include audiovisual and curriculum materials. CORE will process teacher requests by mail for a minimal fee. For a catalog and order form write to NASA CORE, Lorain County Joint Vocational School, 15181 Route 58 South, Oberlin, OH 44074.

In addition to the NASA centers, digital images are available from many other Internet sources. A large collection is summarized in the web page being developed with this paper. A particularly useful collection of planetary images has been compiled by the NASA Planetary Data System on a CD-ROM entitled "Welcome to the Planets". This multi-media presentation highlights the best images from the NASA planetary exploration program along with associated text, audio and mission descriptions. This is available both as a CD-ROM through the NSSDC, or can be accessed directly on the web <http://pds.jpl.nasa.gov:80/planets/>. For those who do not have ready access to the technology required to access some of these materials, there is an excellent compilation of ideas and activities which have been tested in college astronomy and physics classrooms. These are compiled in a book edited by S. Pompea (1994), entitled *West's Great Ideas for Teaching Astronomy*, 2nd edition. Copies may be obtained from West Publishing, C.O.P Department, P.O. Box 64833, St. Paul, MN 55164-1803, (800) 340-9378, for \$11.50 each.

National Educational Web Sites

NASA and its centers all have extensive educational resource websites which contain links to many other useful resources. Surprisingly, however, many of the national and international astronomy centers and observatories are only beginning to develop strong educational outreach programs which include information available on the Internet. These websites are listed in Table 2. There are, in addition, several web sites which contain extensive hyperlinks to sources of astronomy information on the web. A particularly thorough site is the Astroweb, and its educational resource link is shown as the last entry in Table 2.

Table 2. **ASTRONOMY EDUCATIONAL WEBSITES**

Site	Web Address
NASA Online Ed. Resources	http://www.nasa.gov/nasa_online_education.html
NASA Online Ed. Resources 2	http://quest.arc.nasa.gov/OER/
NASA Public Affairs	http://ccf.arc.nasa.gov/dx/
NASA Teacher Resource Centers	http://nssdc.gsfc.nasa.gov/planetary/ntrc.html
JPL Educational Outreach	http://learn.jpl.nasa.gov
Space Tel. Science Inst. Outreach	http://www.stsci.edu/pubinfo/edugroup/educational-activities.html
NOAO K-12 Outreach	http://www.noao.edu/education/noaoeo.html
Mt. Wilson Obs. Tel. in Ed. Pgm	http://www.mtwilson.edu/.MWO/Science/TIE/
ESO Ed. and Public Relations	http://www.eso.org/educnpubrelns/edupubrel.html
Lunar and Planetary Institute	http://cass.jsc.nasa.gov/K12.html
AAVSO Educational Programs	http://www.aavso.org/educational/programs.html
Space Science Institute Education	http://www-ssi.colorado.edu/Education/1.html
SETI Institute	http://www.seti-inst.edu/
The Planetary Society	http://planetary.org/tps/
AAS Education Initiative	http://earth.ast.smith.edu/ED/ed.html
Astroweb Educational Resources	http://fits.cv.nrao.edu/www/yp_education.html

Space Missions

With the growing national emphasis on education and science literacy, all new NASA missions are required to have a substantial educational component associated with them. Most of the past and current missions have project information and data accessible through the WWW, either via their own homepages, or through the various planetary data science nodes which serve to disseminate planetary data. There are only two missions which have engaged in extensive educational outreach development on the WWW: Galileo and the NEAR Asteroid Rendezvous Mission. The Galileo mission has online curriculum materials available and will have an online “quick response” system where students and educators can send in questions. The NEAR Mission has an excellent online resource with information about the mission, the spacecraft, and an abundance of downloadable curriculum materials and teacher information. Other missions, such as Cassini, which have been in development much longer than the fast-track Discovery class missions, have excellent web pages which clearly explain the mission details in terms accessible to the general public; however, there is no specific online educational curriculum material. The NSSDC also maintains web pages containing a wealth of information (including useful educational tools) on past, present and future missions. These may be accessed via: http://nssdc.gsfc.nasa.gov/planetary/planetary_home.html.

Educational Software

There exists a wide selection of astronomy-related shareware available for a variety of platforms. It would be impossible to discuss any of the software in the limited space here; however, there are several good sources which have compiled the shareware into easy-to-access formats. Network Cybernetics Corporation (<http://www.ncc.com/cdroms/as1/index.html>) has been packaging the shareware on CD rom for sale; there there are also services which summarize some of the software and make it available free of charge.

ISSAC, the Information System for Advanced Academic Computing, is a communications service funded by IBM which is operated at the University of Washington. ISAAC collects and tests a wide variety of free IBM-based software and makes it available electronically across computer networks. Researchers and educators can register for ISAAC by either by remote Internet access (telnet 128.95.32.61, and typing register at the prompt), or by submitting their name, school affiliation, mailing address (and email address, if known), and status (faculty, staff or student) to ISAAC, m/s FC-06, University of Washington, Seattle, WA 98195.

Sky & Telescope Magazine has made software available in machine-readable form that has been published in its monthly software department column since 1984. The software is written in simple BASIC, and there are nearly 100 programs available for either a Mac or DOS format as downloadable files from <http://www.skypub.com/software/software.html>. The software ranges from simple programs to calculate eclipses, ephemerides, sunset/rise times, signal to noise estimates for CCD detectors, to orbital mechanics and the computation of black hole gravity fields.

One of the goals of the Exploration in Education Initiative (ExInEd) program at the Space Telescope Science Institute is to build meaningful connections between the federally funded research astronomy programs and education of young people. To this end, they strive to make recent research results available in a useful and timely manner by publishing electronic picturebooks which are hypercard stacks (Macintosh) containing interactive information about planetary science, Earth science from orbit and space science. The stacks may be downloaded from the Internet, or may be purchased on a CD rom from either the NASA CORE office or from the Astronomical Society of the Pacific.

Funding Sources

There are sources of funding for both the professional astronomer interested in educational outreach and for the teacher who needs funds for the implementation of new activities in the classroom.

IDEA Grants. The Initiative to Develop Education through Astronomy (IDEA) program was developed by NASA in 1991 to create opportunities for the public to participate more directly in space science and astronomy. The program, which is administered through the Space Science Telescope Science Institute, offers research astronomers the opportunity to apply for public outreach grants in two categories (\$6K and \$20K). For information on how to apply for these grants, contact IDEA@stsci.edu, or browse the WWW IDEA site at <http://www.stsci.edu/EPA/education.html>.

NSF Programs. The National Science Foundation funds a wide variety of public outreach and educational programs through its Division of Elementary, Secondary and Informal Education (ESIE) in the Directorate for Education and Human Resources. This Division funds programs in Informal Science Education, Instructional Materials Development, Teacher Enhancement, Young Scholars and Advanced Technological Education, as well as the Presidential Awards for Excellence in Mathematics and Science Teaching. The ESIE program guidelines may be requested over the Internet at esiepubs@nsf.gov, by providing the publication number (NSF95-150), your name, address and telephone number. Forms may also be obtained by sending a request in writing to: NSF Forms and Publications Unit, 4201 Wilson Boulevard, Room P-15, Arlington, VA 22230.

Space Grant Program. The Space Grant College and Fellowship program has established Space Grant sites throughout the U.S. to develop interdisciplinary research, education and public outreach programs related to space science and engineering. As of 1995 there were 52 Space Grant Consortia involving over 550 institutions. These affiliate members gain access to fellowship and scholarship funds for students, and local educators can apply for mini-grants for the development and / or implementation of new curriculum in the classroom. Each of the Space Grant web sites has information on local contacts where educators can enquire about the availability of funding.

Other National Programs. There are several programs which are available nationally which provide funds for teacher professional development and for the implementation of new activities in mathematics and science classrooms. These include the GTE Grant program (available in 30 states) and the Tapestry Grant (concentrating on physical and environmental sciences), among others. For a complete listing or information on the various programs, contact your local Department of Education office.

CONCLUSIONS

The field of technologically innovative astronomy resource materials is growing at a tremendous rate, and there are a large number of exemplary materials available which range from complete teacher training programs, to hands-on activities and curriculum materials, to software, images and tools available over the Internet. Because the field is growing so rapidly, the description of the resources contained within this paper will be updated and maintained on the webpage discussed above.

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