

NCC 2-915

Title

Take Off! Aeronautics and Aviation Science: Careers and Opportunities

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Objective

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Funded by National Aeronautic and Space Administration's (HPCC/LTP) Cooperative Agreement Award number NCC 2-915, *Aeronautics and Aviation Science: Careers and Opportunities* was operative from July 1995 through July 1998. This project operated as a collaboration with Massachusetts Corporation for Educational Telecommunications, the Federal Aviation Administration, Bridgewater State College and four targeted "core sites" in the greater Boston area: Dorchester, Malden, East Boston and Randolph.

In its first and second years, a video series with a participatory website on aeronautics and aviation science was developed and broadcast via "live, interactive" satellite feed. Accompanying teacher and student supplementary instructional materials for grades 6-12 were produced and disseminated by the Massachusetts Corporation for Educational Telecommunications (MCET).

In year three the project team:

- 1) Redesigned the website
- 2) Edited 14 videos to a five part thematic unit, and
- 3) Developed a teacher's guide to the video and web materials supplement for MAC and PC platforms, aligned with national standards.

In the MCET grant application it states that project *Take Off!* in its initial phase would recruit and train teachers at "core" sites in the greater Boston area, as well as opening participation to other on-line users of MCET's satellite feeds. "Core site" classrooms would become equipped so that teachers and students might become engaged in an interactive format which aimed at not only involving the students during the "live" broadcast of the instructional video series, but which would encourage participation in electronic information gathering and sharing among participants. As a *Take Off!* project goal, four schools with a higher than average proportion of minority and underrepresented youth were invited to become involved with the project to give these students the opportunity to consider career exploration and development in the field of science aviation and aeronautics. The four sites chosen to participate in this project were East Boston High School, Dorchester High School, Randolph Junior-Senior High School and Malden High School. In year 3 Dorchester was unable to continue to fully participate and exited out. Danvers was added to the "core site" list in year 3.

In consideration of Goals 2000, the National Science Standards of, and an educational agenda that promotes high standards for all students, *Aeronautics and Aviation Science: Careers and Opportunities* had as its aim to deliver products to schools nationally that incorporate multi-media approaches in the presentation of a curriculum appropriate in any 6-12 classroom and especially appealing to women and minorities.

The curriculum was developed to provide students with fundamentals of aeronautics and aviation science. The curriculum also involved students and teachers in research projects, and further information gathering via electronic bulletin boards and internet capabilities. Though not prescriptive, the curriculum was designed to guide teachers through recommended activities to supplement MCET's live telecast video presentations and related web activities. Classroom teachers were encouraged to invite local pilots, meteorologists, and others from the field of aviation and aeronautics, particularly women and minorities to visit schools and to field questions from the students.

The video series and interactive website developed by MCET with accompanying supplemental materials were crafted to assist classroom instruction by engaging students in knowledge comprehension, application, analysis, synthesis and evaluation of aviation and aeronautics content. The intent was to go beyond the level of information sharing by inviting students to think about themselves as potentially involved in aviation science and aeronautics career related fields.

Take Off! Project Goals

As stated in MCET's grant application to NASA, the project goals included:

- 1) Developing and delivering live, interactive educational programming, using digital computer, telecommunications, and desktop videoconferencing technologies, that introduces students to concepts, careers and applications in aeronautics;
- 2) Engaging teachers and students in the use of emerging information technologies by involving them in on-line educational exchange in aeronautics using MCET's digital computer network which offers direct access to the Internet;
- 3) Creating an aeronautics curriculum kit, including software, print materials, manipulatives, and video, that models previous successful initiatives designed to encourage learning in non-traditional settings such as homes and community-based organizations and ensure the life of the project beyond its period of funding;

4) Developing bilingual and close-captioned programming appropriate to the audience served, as is MCET's practice;

5) Promoting learning objectives of GOALS 2000 in mathematics and science.

Approach

The approach or project design of this three-year project was multimedia and characterized by six major formats.

- 1) Video Production / Interactive Satellite Broadcasts
- 2) Website
- 3) Hands-on Student Curriculum Kit
- 4) Teacher and Student Print Materials
- 5) Teacher Workshops
- 6) Composite Project Kit

Each of these components including teaching materials and technologies used, is discussed thoroughly below.

Video Production / Interactive Satellite Broadcasts

Year One activities targeted students in grades 6-8. Year Two programs targeted students in grades 9-12. All years included intensive and extensive professional development services to core sites and all registered participants.

In Year One, two teacher training sessions and five student sessions were developed and distributed via the MCET satellite network, Mass LearnPike, during April-May 1996. 4525 students nationwide (MA, GA, CA, DC, FL, CT, IN, ME, MI, NH, NJ, NY, OR, VA and VT) registered for the program through MCET. More students/teachers were reached through local cable companies that distribute the MCET satellite signal through their network, but their number is difficult to estimate.

First and second teacher training sessions:

- overview of the project, with special emphasis on the interaction between the live interactive broadcast and on-line component, and their applications in the classroom environment, and

- demonstration of various hands-on activities to perform with the students as an aid to reinforce/illustrate math/science concepts.

Student session #1: The beginnings of flight

Demonstration of physical properties of air: introducing the concept of lift/ historical overview of humanly engineered flight.

Student session #2: Forces affecting flight

Aerodynamics of flight/ The Bernoulli's principle/ The four forces of flight/ The influence of aircraft design on airplane performances.

Student session #3: Instruments and Systems

Basic flight instruments and their use/ Instrument flying and macro systems involved in flight.

Student session #4: Navigation

Flight planning/True north and magnetic north/ Cardinal points/ Global Positioning System/ Tour of an Air Traffic Control room.

Student session #5: Weather

Influence of weather on flight/ High and low pressure areas/ Cloud formation and different types of clouds/ Airspeed vs. groundspeed.

The series closed with a visit to the Aviation EXPO at Boston International Logan Airport, May 8, 1996.

Various strategies were developed to outreach to women and minority audiences.

- MCET selected 4 core sites (Dorchester High School, East Boston High School, Malden Middle School, Randolph Jr/Sr High School) to participate in all components of the project, based on student population statistics. The grant provided the necessary resources to upgrade the school's technical infrastructure to allow full participation.

- Women and minority figures that contributed to the history of aviation were highlighted both during the broadcast series and in the accompanying printed curriculum materials.
- Present-day aviation specialists, such as air traffic controllers, pilots and co-pilots, chief operations shift managers, station operations representatives, communications specialists, ramp operations supervisors and lead mechanics, representing a broad ethnic spectrum, are presented throughout the program, with broadcasts from airport facilities, on-the-job interviews and studio guests.

Year Two: Take Off! Part II - Broadcast outline

The same partners that collaborated to the development of the first series were also actively involved in the production process for *Take Off! Part II*, grades 9-12 series.

Shelia Bauer, Manager of the FAA Aviation Education Programs for the New England Regions, acted as a consultant and provided assistance in identifying/acquiring FAA curriculum materials and facilitated access to career role models as studio guests;

David Price, FAA Aviation Education Counselor, President of the Massachusetts Aviation and Space Education Council, acted as curriculum developer and co-presenter for the series;

Veronica Cote, Chair, Department of Management and Aviation Sciences at Bridgewater State College, co-presenter;

MCET personnel: Production Crew, Producer, Associate Producer and Project Director completed the team.

Additional support was provided by external consultants, educators and content specialists in various aeronautics disciplines.

The structure of the new series followed the guidelines developed for *Take Off! Part I*, each show revolving around a major topic, or a limited number of major topics, but Science and Math concepts were upgraded to High School level, and aligned with National Educational Standards. A new student broadcast focusing on human and safety factors pertaining to aviation substituted for one of the teacher training sessions.

The accompanying curriculum guide, mailed to the registered teachers a month ahead of broadcast, illustrated topic-oriented activities with detailed instructions for classroom implementation and tips on adapting the curriculum materials to middle grades.

The design of each 50-minute show was thus modified:

- aviation math and science content delivery was condensed in a 30 minute period; the presenters then summarized the topics discussed and illustrated the activity (-ies) to be performed prior to subsequent live show. During this interval the students were asked to report their respective results or ask questions via the toll-free audiobridge. Classrooms were urged to continue the interaction through the Internet and MCET's website. This design was adopted to ensure continuity across a series spanning a two-month period.
- Each show featured a "Career Corner" with a guest in the studio. Appropriate candidates, selected among disadvantaged groups, discussed topics related to their jobs, but also highlighted difficulties encountered to attain their positions and suggested strategies to overcome obstacles. After the shows, interaction with the guests is continued via the "Career Cards" page on the Project's web site.

3b - Broadcast content

Session #1 - Teacher's session
Session #2 - The Beginnings of Flight
Session #3 - How Does an Airplane Fly?
Session #4 - Instruments and Systems
Session #5 - The Human Factor
Session #6 - Navigation
Session #7 - Weather

Session #1 - Teacher Training

The first of the seven broadcasts illustrated the topics explored during the student broadcasts, provided tips on using distance learning technologies and suggested practical strategies for involving girls and minority students in math and science classes. The unit familiarized educators with the contents of the curriculum kit developed for the program. The kits include a teacher's resource guide to the program and other print and non-print materials and were mailed to all teachers that registered for the series.

MCET staff and advisors from aviation organizations and educational institutions were available, during the live session and throughout the series, to provide guidance for teaching aeronautics, and assist in integrating the content into existing science and math curricula. Teachers had the opportunity to ask questions of the presenters and their colleagues via phone, fax, or posting their messages on the web "Forum".

During the six student broadcasts, the presenters explored math and science concepts through aviation and aeronautics themes using an exciting combination of pre-produced video, live demonstrations in the studio, graphics and animations. The students had the opportunity to "meet" with the Career Guests, engineers, air traffic controllers, meteorologists, pilots, aviation psychologists and more, during the shows and on MCET's web site.

Session #2 - "The Beginnings of Flight" -

What is so exciting about the world of aviation? - The presenters tried to answer the question throughout the series, exploring with the students the scientific basis of flight, from Newton's laws of motion, used to describe the forces acting upon the aircraft in flight, to pressure differences in a fluid resulting in an upward force on an airfoil in relative motion relative to it. Properties of fluids, such as air and water, and different types of flying objects were also covered during the show. Archie Stewart, President of Kite Fabrications, and Vice President of Kites Over New England, was the first guest in the "Career Corner". Students were encouraged to contact Archie with any questions regarding kite building or kite flying.

Session #3 - "How Does an Airplane Fly?"

How do we control the movement of an airplane in flight, but first of all, how can we define the movement? In relation to what? The three axes of rotation, the factors affecting lift and drag and the principle of conservation of energy were the subjects of this broadcast.

The effect of the angle of attack on lift was explored using a wind tunnel model suitable for classroom use. Blueprints are available on-line at <http://ldaps.ivv.nasa.gov/>.

Jim Jones, Assistant Directorate Manager, Engines and Propellers Division, Federal Aviation Administration, was the guest in the Career Corner.

Session #4 - "Instruments and Systems"

How do pilots know where they are? This broadcast introduced the basic instruments of the airplane: instruments based on air pressure (air and vertical speed indicators, altimeter), and instruments based upon the gyroscopic property of rigidity in space (attitude and turn coordinators, directional indicator).

The show builds upon the concept of *Systems*, from the airplane to the airport and transportation systems, (ticketing and security check-ins, luggage and cargo handling, mechanical maintenance and more). The Air Traffic Control system is introduced by John Melecio in the "Career Corner". Mr. Melecio, air traffic controller at Logan International Airport and FAA Hispanic Employment Program Manager for the New England Region, explained what air traffic controllers do, why their job is so important to ensure safety, and what he finds most exciting about his work.

Session 5- "The Human Factor" -

This session focuses on *human physiology in relation to flight*, and more specifically, on the concept of *space orientation* and *our relationship with the surrounding environment*. The show explored the visual, kinesthetic and vestibular canals - How humans achieve a sense of balance through the integration of the different nervous impulses - The difference between nighttime and daytime vision and the consequences for color interpretation and adaptation of the eye to varying light intensities.

"Career Corner" guest: Dr. Margaret Rappaport, psychologist and pilot of seaplanes, gliders and single engine props. Dr. Rappaport has taught Psychology at the University of Dar Es Salaam, Tanzania, and in schools in Uganda, Kenya and Ethiopia.

Session #6 - "Navigation" -

How do we get from here to there? - Velocity as a vector and composition of vectors - Coordinate systems on plane surfaces - Meridians and parallels on the Earth's surface -

Three-dimensional frames of reference: our position relative to fixed objects in the sky, were all discussed in this broadcast. The Global Positioning System of reference was introduced by Colleen Donovan, engineering psychologist at the Volpe National Transportation Center in Cambridge, MA.

- *How does GPS work?* - How many satellites are necessary to determine our position on the surface? - The program explored the past and future of navigation through the technical innovations introduced over the years.

Ann Wood Kelly, former World War II pilot, was the guest in the "Career Corner". Ms. Kelly was one of 24 young US women transferred to England to work with the British Royal Air Force and contribute to the war effort as airplane pilots. Ann Wood Kelly shared some of her memories of the war years with the participating students.

Session #7 - "Weather" -

Students were shown how different branches of science relate to each other by understanding how meteorology influences the design of aircraft and airport runway according to prevailing wind patterns. The show covered weather systems and meteorological factors, like air pressure, temperature variations, the structure of the atmosphere and the mechanisms of cloud formation.

Mishelle Michaels, the "7NEWS" weekend meteorologist for WHDH-TV (NBC) was the "Career Corner" guest. Ms. Michaels explained what is necessary to do to become a meteorologist, and how to plan your education. She shared with the student's video clips showing her as a young TV meteorologist, at the beginning of her career. Ms. Michaels answered student questions using e-mail.

Website

The development of the final version of the NASA site posed some unexpected challenges, primarily due to the lack of proper standardization among the different web browsing software available at the user's end. Maximization of access independently of technical capabilities has been the guideline followed by the development team. Major incompatibilities were identified between some Java powered animations and software (Netscape 2.x, Internet Explorer 2.x don't support Java), and between Java Script routines and Macintosh platforms (incompatibility at the Operating System level). To solve all the related access problems, the new pages were actually duplicated and adapted to individual users through an automatic, transparent routine. The pages are now error-free, accessible to everybody, from text-based Java powered users: however the most advanced features can be enjoyed only by using the latest Netscape browser version (the standard for the site)

Major innovations include

- A Broadcast section, with individual pages dedicated to each *Take Off!* Unit
- A Glossary section, with a collection of aviation-related terms with embedded links to additional resources ranging from Atmospheric Science to additional educational sites offering lesson plans and ideas for classroom activities.
- A History section divided in two parallel sub-units, Aviation Timeline and Notable People in Aviation. The two units are extensively cross-linked, so the users are constantly traveling back and forth, following aviation's pioneer's biographies on one side and framing the person's achievements within the more general technology innovations and historical events of the period.
- An Activities section developed with the FAA for students and teachers with three levels, 1-12.
- The Career Card, probably the most innovative feature developed for the website. The cards are completely animated and designed to look like cards in a photo album, include profiles of career guests from the first and second *Take Off!* Series. Development of additional career cards featuring role models not necessarily connected to the *Take Off!* video series continued during Year III, as feedback from the website users suggests that the career cards are highly successful and really appreciated
- The Forum section. The messages posted by the users do not appear immediately on the screen, but are subject to preliminary screening to eliminate content inappropriate for an educational site.
- The Cool Links section is a selection of additional web resources divided by subject.
- A Teacher's Lounge.

The curriculum kit

Includes:

- Teacher's guide,
- NASA educational materials - list of useful Internet links; photographs of airplanes, aviation posters, ordering information for the CD-ROM "Winds of Change";
- FAA educational materials - "Aviation Science Activities for Middle and Secondary School Level"; "Guide to Aviation Education Resources"; "Aviation Career Series"; "Women in Aviation and Space"
- Manipulatives - Balsawood model planes; E6B flight calculators and sectional charts; Kite building kits

- Two different evaluation forms:

MCET's Program Evaluation Form - teachers are required to fill this form and return it to MCET in order to receive Certificates of Participation in the program

NASA EDCATS Forms

- K-12 Teacher Participant Data and Feedback forms; Student Participant Data (7-12) and Feedback forms -

Teachers and students were strongly encouraged, although not required, to submit these evaluation forms.

Project personnel input the data thus collected into the NASA EDCATS computerized database.

Print Curriculum

- “Women in Aviation and Space”, “Aviation Science Activities for Elementary Grades” and “ A Guide to Aviation Education Resources”, all published by the Federal Aviation Administration;
- A “Teacher’s guide to Aeronautics and Aviation Science: Careers and Opportunities”, developed by MCET NASA project team.

Teacher’s guide covers the following topics:

- Overview of program and useful hints on how to organize students in the classroom, with special focus on strategies to engage girls and minority students in on-line activities.
- Separate chapters dedicated to the five student sessions, with list of core concepts introduced/demonstrated by presenters in studio, and activities to perform prior, during and after broadcast.
- Bibliography and list of on-line resources on aviation and education.
- Aviation timeline and historical figures.

The first series was developed as an enrichment in the curriculum of junior high school students, allowing the alignment of the curriculum developed with various subject areas at the teacher’s discretion. This approach assumes that the teacher is playing an active role in shaping the program and adapting it to the particular classroom. This model was only partially successful, as it requires that the teachers review all available support materials and acquire additional knowledge. The 9-12 program series was more clearly aligned with high school math and physics curricula, and every 50 minutes show was divided in three major segments, dedicated to:

- the exploration of math/science concepts through aviation;
- a career corner, with a studio guest representing a career in the aviation/aeronautics fields;
- an Internet corner with live explorations of aeronautics education web sites;

The curriculum guide developed for the second Take Off! series featured substantial improvements compared to the previous one. Each individual broadcast unit was covered with an outline of the topics covered and a relative brief description of the math and physics behind the particular theme; a list of educational web sites providing additional curriculum support and the identification of the guest in the career corner. Each chapter also contained background information and complete lesson plans for one or two major activities, designed for the purpose of helping the teachers to reinforce the concepts explored during the live broadcast through hands-on practical demonstrations in the classroom. Each activity, demonstrated at the end of each show by the presenter, was also intended to help in building the "classroom momentum" between subsequent broadcasts, separated by two-week intervals, as the students were asked to report their findings to the project team either through e-mail or directly on the audiobridge at the beginning of each new unit.

Teacher workshops

Summer 1996 Workshop agenda:

Overview of the Aeronautics and Aviation Science: Careers and Opportunities - past, present and future. The workshop emphasized the interactive satellite series: Possible ties with other MCET satellite programs scheduled for the fall 1996 and spring 1997 seasons and the importance of the teachers' role in program development and the necessity of their active involvement in the planning stage.

Session 1: Practical activity: Navigation

Planning a flight using weather information, aviation charts and flight computers. This particular activity requires detailed explanations and is not well suited for TV demonstration.

Session 2: The Internet component:

What is the Internet and what are the components of Internet.

Basic features of e-mail software with practical applications.
Basic features of ftp software - Practical application: retrieving data through anonymous ftp. Introducing the newsgroups - Practical application: subscribe to aviation newsgroups - Read the articles and post a reply.

Introducing the World Wide Web: navigating with web browsers.

The WWW as an electronic library: Searching for information

Accessing web sites of known URL - Introducing the NASA project web page at <http://www.mcet.edu/nasa>.

Search engines. Applications of searching strategies.

Session 3: Videoconferencing and its educational use

Part I - point to point videoconferencing through a desktop unit - Introducing the file sharing software - Working on the same file updating information on-line.

Part II - Videoconferencing as training:

Teleconnection to the NASA Langley Research Center - NASA personnel demonstrate wing characteristics and design using a paper model and instruct on how to use NASA educational resources.

Session 4: The flight simulator facility at Bridgewater State College

Overview of the aviation program at BSC. What is the advantage of using flight simulators to instruct future pilots -. Visit to the facilities - Practical exercise on the flight-sims.

Workshop Report:

12 teachers, attended the workshop "Integrating Technology in the Classroom: an Aviation Science Perspective" on July 1, 1996. The workshop was very successful. The morning session with the flight planning and the videoconference <ring wing> exercise were particularly appreciated, as they provided the teachers with ready-to-use instructional material. The videoconference desktop unit demonstration attracted many favorable comments, although the technology was considered still too expensive for high school budgets. More time allowed for computer exploration and hands-out with description of key procedures were asked for the Internet session, and will be implemented in future workshop planning. The workshop was successful in achieving goal of dissemination/training outside core site teacher's network. More teachers committed to participate live during next series.

Workshop Two, January, 1997

All middle school and high school Massachusetts teachers registered for the spring and fall 1996 Take Off! series (grades 6-8) were offered the opportunity to participate in the one-day workshop (January 27, 1997, at the Moakley Center, Bridgewater State College).

The workshop, developed in conjunction with the satellite-based teacher training session, provided an opportunity to explore the contents of the curriculum package, practice the hands-on activities developed to support the program before the teachers try them in a classroom setting, familiarize the participants with the different media (satellite broadcast, video, Internet and CD-ROM technologies).

Ten teachers participated, three from project demonstration sites and others from middle and high schools in Massachusetts. At least one teacher from each of the project core sites was required to attend the workshop, but only one teacher from East Boston High School and two from Randolph Junior/Senior High School were present.

Bridgewater State College provided an electronic classroom with a computer with Internet connection and a CD-ROM drive for each participant.

Agenda for winter 1997 workshop:

- General overview of project activities, information regarding the Spring 1997 series, and contents of curriculum package
- Additional FAA and NASA resources and how to access them were presented by Shelia Bauer, FAA Manager for Aviation and Education Programs in New England. (The Maxwell Library at Bridgewater State College is a NASA Regional Teacher Resource Center for Massachusetts).

Activities explored during the workshop included:

- Kite building and use of kites in the classroom. Assembling a kite kit and developing new models.
- Applications of the principles of conservation of energy and the Hook's Law using a simple rubber band powered balsa plane and measuring the relationship between energy stored and performance of plane.
- Human Factors in aviation: how important are personality factors in aviation? Activity designed to assess personal traits like Anti-Authority, Impulsivity, Invulnerability, Macho, and Resignation, using scenarios designed to make future pilots aware of potential hazardous attitudes.
- Things pilots need to consider before take off: the I'M SAFE checklist

- Communications between air traffic controllers and pilots: simulation of a take off using a map of Logan airport.
- Internet training: web search strategies using different search engines.
- Exploration of the CD-ROM “Winds of Change”

Evaluation reports from attending teachers

Generally expectations were met. Teachers found the demonstrations of hands-on activities, models of integration into existing curriculum and clear identification of math and science standards most useful. Many favorable comments were received on aviation education resources unit available through the teacher resource centers.

Take Off! Kit

In January 1998 we started the development of the final Take Off! kit prototype, part of the deliverables of Year III of project activities, developing an outline of the work plan, benchmarks and deadlines, and hiring a producer.

The kit includes

- A video series based on five thematic units
- A teacher’s guide
- Web-based software
- Promotional materials

The video series targets middle to junior-high school students and features units developed around the following topics

- The physics of flight
- How does an airplane fly
- Aircraft instruments and airport systems
- Navigation
- Weather and aviation

The units build upon materials developed for the live shows and re-elaborated to fit within a different media and selected taking into account feedback and suggestions received from teachers and students that participated in the live broadcasts, and following a set of guidelines developed by the evaluation team (EdAlliance @ Brown University), that carefully reviewed the tapes of the broadcasts to check for accuracy of

content/appropriateness of the pedagogical approach/appropriateness of the use of the media and assessed the effectiveness of the program in meeting the project goals. Two additional units were developed for the broadcasts that were not incorporated in the final kit for technical and practical reasons - the *Teacher Training* and *Careers in Aviation*.

The Teacher's Guide (print) developed for the final series includes an important introduction to the contents of the kits and the many ways it can be used in the classroom. The new guide builds upon the content developed for the 2nd Take Off! series, but all chapters will be updated to align with the outline of the modified video series, and will include additional curriculum, covering GPS satellite navigation, Human Factors (biology) and Weather. Additional activities, some updated from existing materials, some newly developed, are also part of the guide. All the activities clearly identify relevant Standards covered (content, process, assessment).

The software part of the kit, developed in HTML, provided additional information about the kit and its uses, and include a list of resources available on- and off-line. The lists will help the teachers to find locally some of the resources included in the curriculum kits mailed to registrants the past years, both print- and non-print, that is impractical to include in the final package.

Accomplishments

In reviewing the five program goals originally prepared for the contract with NASA, all but goal number four were realized. MCET did not develop bilingual or close-captioned programming for the grade 6-12 audience. This can be attributed to budget constraints.

The MCET project team demonstrated progress in the development of the video series from Year 1 to Year 2. Also, supplementary curriculum materials were cited by teachers as being very useful in building upon the concepts portrayed in the video series. More emphasis on outreach and dissemination would have benefited the "core sites" both for monitoring their use of the project materials and in troubleshooting on utilization of technology.

Both teachers and students indicated that their use of technology had increased as a result of their participation in *Take Off!* The four core site schools were generally "low-end" users in terms of capability and some had difficulty with downloading web pages and even admitted to growing impatient with the time lag in doing their web searches. The

lack of compatibility at core sites and differing teacher proficiency in technology was problematic at times. Students however enjoyed the curriculum and the activities.

The participation and results varied among the core sites, depending on the personal investment in technology of the individual teacher. The teachers in Malden, with no previous connection to the Internet, and little familiarity with computers, systematically used e-mail to communicate with one another. In East Boston, the teacher started a classroom web page, organized field trips, and documented it with digital photography. Dorchester's difficulties with sustaining their participation were a result of both teacher apathy and lack of administrative support. One of Randolph's major strengths was (is) its Aviation Club which acted as an excellent outlet for students interested in aviation to explore the subject of flight both in terms of hobby and career.

Overall, the Project Team has agreed that MCET's *Take Off!* project completed its goals. MCET produced gains in student awareness of career opportunities for minorities and women in aviation science and aeronautics, and provided solid curriculum and activity packets to supplement the video series. The telecast quality was high. The video products improved from Year 1 to Year 2 and reflected greater attention to the intended student audience for interest level, diverse types of information and integration of content. Significant gains were made from the beginning to the conclusion of the project, which demonstrate that *Take Off!* has achieved many of the programmatic goals it had planned for this project. Professional development gains of a small focus group of teachers are discussed in the next sub-section.

Year 3 Evaluation: Summary of Teacher Focus Group

The teacher focus group was convened on April 27, 1998 following a trip with teachers and students to the Boston Museum of Science. After explaining the purpose of the focus group as a component of the external evaluation, teachers were led in a discussion of several questions facilitated by Roger Blumberg of the Education Alliance. Brian Marcotte of Strategic Analysis recorded the teacher's responses. Overall, the feedback on the part of teachers was favorable about the concept of a hypermedia approach to complimenting classroom instruction. Teachers indicated that they were appreciative of the computers they received as part of the *Take Off!* project.

Teachers uniformly reported that their first year of involvement with *Take Off!* was the most active. One teacher stated that his administrator's were supportive of his involvement in *Take Off!* The four teachers cited the Massachusetts Statewide

Assessment as dictating the school's focus during Year 3 on curriculum standards and improving test scores, resulting in less instructional time utilizing the *Take Off* videos or curricular materials. Teachers stated that they felt pressured to focus on curriculum content to prepare students for those statewide assessments, however, two of the four teachers indicated that they did attempt to integrate aviation into their curriculum.

Teachers were in agreement that *Take Off!* had an impact for instruction. They reported that *Take Off!* provided: "practical applications for abstract scientific concepts"; "practical applications of physical concepts (that) led students to new insights"; "the greatest impact was in math class where pattern recognition using graphs is important"; and "The program's emphasis on aviation careers...for directing student career choices..." Teachers reported that they found the demonstrations in the videos to be one of the best features of the videos with one teacher stating that she was able to repeat demonstrations with her classroom audiences.

Teachers agreed that the project exposed students to career choices though they varied on the extent of impact with one teacher stating that "students involved were too young for much interest, but it (*Take Off!*) did diversify their interests and provoked some questioning."

The role of technology is a critical component of *Take Off!*. Teachers reported mixed reviews to their use of the technology provided. Some teachers reported using the web site only occasionally. Teachers expressed some frustration with their school's lack of resources to make computers more generally available to students. One teacher suggested that the web site needs an "answer" person who can talk in the language of the consumer.

When asked about the *Take Off!* curriculum materials teachers agreed that materials were good, though one recommended "better graphics and print materials". Teachers were in unison in their reporting that despite good quality, that time constraints caused by schools' focusing on curriculum implementation directed at improving student test scores caused a reduction (elimination) of time devoted to *Take Off!* activities and materials.

Respondents indicated that the highlight for teachers and or students were: "the first year contest was very exciting. The students loved it!" "Students found the Balsa plane experiments very interesting...the visit to the Volpe Transportation Center with its simulator was of the greatest interest." "The computer and concepts of aviation were most interesting...the Challenger Center at Framingham State College was an excellent activity"; and one teacher summed it up in saying, "a wider world opens for students in *Take Off!*"

When asked if these teachers would continue to use the *Take Off!* video series, the three teachers who have used the series responded “yes”. Some qualified their response with reference to time and or viewing particular segments with their students.

Overall, teachers expressed their satisfaction with their and their students’ involvement in Project *Take Off!*. They cited external factors to the project (lack of school equipment, resources, time, etc.) as obstacles which prevented them from fully utilizing the project.

Significance / Benefits

Over the three-year project period (July 1995-July 1998), the multimedia NASA initiative Aeronautics and Aviation, reached thousands of students and teachers. Over 8,500 registered for the two seven-part broadcast series and an unknown number participated in the rebroadcasts and web activities. Students and teachers learned basic mathematics, science and technology applications in the field of aviation and aeronautics through hands-on multimedia activities and interactions with various professionals in this growing field. MCET has statistics for the spring 1996 broadcast series (grades 6-8), the spring 1997 broadcast series (grades 9-12) a fall special outreach to Native American audiences and the web as monthly reports became available.

Month	Number of Hits	Kilobytes Transferred	Unique IP Addresses
May 1998	49,482	263,183	2794
June 1998	48,465	258,685	3135
July 1998	45,341	272,298	2693
August 1998	56,785	340,270	3136
September 1998	61,501	391,226	3124
October 1998	64,743	385,789	3239

Broadcast series

Two teacher-training sessions and five student sessions were developed and distributed via the MCET satellite network, Mass LearnPike, during April-May 1996.

4525 students nationwide (MA, GA, CA, DC, FL, CT, IN, ME, MI, NH, NJ, NY, OR, VA and VT) registered for the program through MCET. More students/teachers were reached through local cable companies that distribute the MCET satellite signal through their network, but their number is difficult to estimate at present.

Participant data: 2,509 participants (approximately half of them live), registered for the Take Off! Part II live broadcast for the spring of 1997 through MCET. The program was viewed by students in five different states (MA, NH, IN, FL, CA). The curriculum kits were sent to 60 teachers. The total number of participants for both series, Take Off! Part I and II, in the period spring 1996- spring 1997, is 8,500.

Special Audience Outreach

An Outreach project aimed at dissemination the Take Off! Series among disadvantaged students at Native American schools and communities was completed during the month of October 1997. The project, supported through a grant from America West Airlines Foundation in the amount of \$3,000, provided an opportunity to expand the project's audience beyond the base MCET membership. Recipients of the Take Off! Kit were:

Tucson Unified School District, Tucson AZ (Attn.: Ms. Linda Todd, Media Coordinator)

The Take Off! program will be distributed through a local cable network. The school district serves 63,000 + students - 2,379 Native American. The district is wiring all the buildings and Internet connection will be available soon.

Greyhills High School, Tuba City, AZ (Attn. Mr. Scott Dunsmore, Superintendent)
Total student population is 500 - 495 Native American. The school is already connected to the Internet.

Mesa Unified School District, Mesa, AZ (Attn.: Mr. David Luna, ITV Coordinator)
The program will be distributed on a local cable network. The district serves 70,000 students - 2,500 Native American.

San Pasqual Valley School District, Quechuan Indian Nation, and Winter Haven, CA (Attn.: Imperial County Office of Education)

The school district serves 923 students - 413 Native American

Ahfachkee School, Clewiston, FL (Attn.: Ms Sharon Bird, Ass. Principal)
No demographic information available for this site. The Curriculum Committee will review the materials to check for alignment with Florida State Curriculum Frameworks and report its findings to MCET.

Kickapoo Nation School, Powhattan, KS (Attn.: Arthur Davis, Principal)
A 100% Native American student population of 125. Severely underserved school district. No Internet connection available.

Tiospa Zina Tribal School, Agency Village, SD (Attn.: SD Dept. Education & Culture)
165 students, 100% Native American

Chamberlain Academy High School, Chamberlain, SD (Attn.: SD Dept. Education & Culture)

59 students served, 25% Native American

Crazy Horse School District, Wanblee, SD (Attn.: SD Dept. Education & Culture)
77 Students, 100% Native American

Eagle Butte High School, Eagle Butte, SD (Attn.: SD Dept. Education & Culture)
31 students, 50% Native American

Isleta Indian School District, El Paso, TX (Attn.: Mr. Mannie Soto, Superintendent)
No demographics available for this site.

Future Direction and Funding Sources

The NASA supported *Take Off!* Initiative continues to be used extensively by students and teachers. The website remains highly active and is the most popular MCET sub-site. In July, the website had 51,470 hits, 13,912 page views and 4301 user sessions. MCET will maintain activity on this site and monitor the forums for as long as interest and resources prevail. The active areas of the website <http://www.mcet.edu/nasa/> are as follows:

- Broadcast
- Glossary
- Activities
- Career Cards
- History
- Forum
- Cool Links
- Teacher's Lounge

The Take Off! Website is more than just a companion to the Take Off! Broadcast series; it is an on-line aviation reference library. It is a resource for both students and teachers who are interested in aviation history, aviation science, careers in aviation, or aviation-related activities for the classroom. While most of the materials on this site are appropriate for middle or high school, they can be adapted for younger students as well.

The NASA Kit is also generating continued interest in the project. The kit contains:

Five edited, thematic units from the series

- 7) Miracle of Flight
- 8) How does and Airplane Fly?
- 9) Instruments and Systems
- 10) Navigation
- 11) Weather

The kit also contains an extensive teacher's guide. Developed to support teachers using the new five part Take Off! Video series in the classroom, the guide provides additional background content and an extensive selection of lesson plans. The guide presents two different types of activities, Thought Experiments and Exploring Further. The first type develops critical thinking and communication skills, the second type describes hands-on experiences that encourage students to touch, feel and see the scientific implications of the mathematics, science and technology principles presented.

All activities are clearly aligned with the National Science Education Standards, The National Council of the Teachers of Mathematics, and Evaluation Standards for School Mathematics.

Two disks, one for the PC platform and one for the Macintosh platform serve as a web supplement to the Take Off! main website. The kits are available for distribution and/or purchase through MCET.

MCET continues to seek aggressively new funds to support and extend the multimedia components of the project, particularly the website. It is hoped that kit sales will offset some web activity costs.

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