NASA Conference Publication 3358

The World Wide Web as a Medium of Instruction: What Works and What Doesn't

Marianne McCarthy, Barbara Grabowski, Angel Hernandez, Tiffany Koszalka, and Lee Duke

September 1997

Proceedings of the March
Learning Technologies Conference
NASA Dryden Flight Research Center
March 18–20, 1997

National Aeronautics and
Space Administration

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The World Wide Web as a Medium of Instruction: What Works and What Doesn't

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The chairpersons also want to thank the participants for their candor, willingness to share solutions with others and tolerance of the grueling working schedule.

Thanks to Ronnie Boghosian for arranging the tours, food and conference rooms and to Dennis DaCruz for providing technical support to conference participants.

PREFACE

Purpose of the Proceedings

The team members of Aeronautics Cooperative Agreement projects have learned a wealth of information about the development of Web-based instruction. This knowledge as it relates to "what works and what does not" often remains in the minds of the project team members and is lost to the development world at large. In an attempt to capture these lessons learned, an academic conference was held to offer an outlet to the project teams to share this understanding. The purpose of these proceedings, therefore, was to summarize the lessons learned by the Aeronautics Cooperative Agreement project teams, and to identify solutions and problems that were resolved and those which remain unresolved in the development of Web sites for K-14 classrooms.

This year the research being conducted by Dryden Flight Research Center with The Pennsylvania State University as part of the DFRC Learning Technologies project involves a detailed analysis of issues related to the development of effective Web-based instruction. The analysis phase includes, but is not limited to, best pedagogical practices, effective technologies, and teacher needs. The results of the March Conference comprise one aspect of this research.

Audience

This document was written with the following individuals in mind:

Aeronautics Cooperative Agreement project teams
NASA Learning Technologies project management
Dryden Learning Technologies project management
Dryden Learning Technologies project team
    DFRC Education
    The Pennsylvania State University Instructional Systems students and faculty
Other developers creating Web-based instruction
    NASA developers
    Other developers

Internet Addresses

The Internet addresses for each of the Aeronautics Cooperative Agreement projects can be found at: <http://quest.arc.nasa.gov/iita/k14.html>

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Aeronautics Cooperative Agreement Projects

Aeronautics and Aviation Science: Careers and Opportunities

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K-8 Aeronautics Internet Textbook

Dr. Jani Pallis, Cislunar Aerospace, Inc.*

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Universities

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* Indicates those who completed a conference evaluation

EXECUTIVE SUMMARY

One of NASA's education missions is to capture the interest of students and channel that interest into career paths through the demonstration integrated applications of science, mathematics, and technology. To help realize this mission, the Dryden Flight Research Center Learning Technologies Project is sponsoring several initiatives to investigate the best methods for developing Web-based science, math, and technology instruction.

The goal of this conference, organized by the Dryden Education Office and The Pennsylvania State University, was to capture the diverse knowledge of the Aeronautics Cooperative Agreement teams, share best practices of current efforts, identify obstacles to creating and implementing successful Web-based instruction, and identify potential solutions to these problems.

The conference provided an opportunity to share these Web-based development project knowledge among NASA Installation Representatives, Aeronautics Cooperative Agreement teams, and leading academic researchers.

Discussions in the areas of evaluation practices, pedagogy, teachers, and technology resulted in identification of several key challenges and potential solutions to many of the problems being faced by each of the teams. The cumulative findings from this conference culminate in the following overall recommendations.

Recommendations

Learning Technologies Management can assist the CA Teams by establishing a clearly stated set of criteria for product effectiveness against which the CAs are evaluated. Moreover, Learning Technologies Management and the Cooperative Agreement Teams should establish their criteria for success on the basis of meeting their customers' needs. This criteria can include, but are not limited to, evaluating changes in student knowledge and ability, evaluating changes in teaching practices or materials used, and identifying how adaptable the product is considering the diverse technical infrastructure in schools.

NASA Headquarters has already established evaluation criteria for NASA educational technologies. Planning is underway to incorporate these criteria into Education Computer Aided Tracking System (EDCATS), the Education Division's online evaluation program. Learning Technologies Project Management may want to revisit these previously established evaluation criteria and give input before, during and after the process of implementing the criteria through EDCATS. This review would serve a twofold purpose, to give LTP Management the opportunity to give input as experts on the type of education products they develop and to assist the LTP Management to align their evaluation program with NASA's Education Evaluation Program. Moreover, the existing CA teams should be briefed about this criteria and given an opportunity for discussion and input.

Because content accuracy is a requirement of all NASA developed and sponsored instructional support products, all materials should, at a minimum, be reviewed by content experts. For all Cooperative Agreement Teams not having content experts as team members, it is recommended that NASA assign a content expert to review materials for scientific and technical accuracy.

To promote teacher training in computer and Internet fundamentals, NASA could identify local agencies which train teachers in fundamentals and publish this as national list of available training resources. The approach is similar to the method Spacelink used to identify local Internet service providers as Spacelink phased out of their free teacher accounts. For those teachers who are computer literate but inexperienced with using the WWW, the Educator Kits created by Ames and online tutorials can be used to enhance their abilities and prepare them to use more sophisticated NASA Learning Technologies products.

The Curriculum Support and Dissemination Program is developing strategies for conducting workshops for teachers prior to distributing NASA education materials to ensure that the materials make their way into the classroom. The lessons learned by the Curriculum Division can be applied to the CA projects in particular and Learning Technologies Projects in general.

Details supporting these recommendations are presented in the following sections of this report.

INTRODUCTION

While this conference was conducted to investigate the lessons learned in the development of Web-based instruction by the K-14 Aeronautics Cooperative Agreements, the conference was also undertaken as part of a larger project, the Dryden Flight Research Center (DFRC) Learning Technologies Project.

The March conference was a collaboration among the NASA Aeronautics and Space Transportation Technology Centers (Ames, Dryden, Langley, and Lewis), NASA Headquarters, the Aeronautics Cooperative Agreement Teams and two institutions of higher education, The Pennsylvania State University and the University of Idaho. All of the NASA Aeronautics Cooperative Agreements were represented at this conference. The University of Idaho was included in the conference because of the virtual classroom project being developed under the supervision of Dr. Michael Odell.

The conference was organized by the Dryden Education Office and The Pennsylvania State University (PSU) to achieve three different sets of goals: first, those of the Aeronautics Cooperative Agreement developers and participants and second, those of the DFRC Center Learning Technologies project and the Educational Review of RSPAC Products Project.

Aeronautics Cooperative Agreement Goal

The conference goal for the Aeronautics Cooperative Agreements centered on the identification and description of best practices for designing instruction to be delivered via the World Wide Web (WWW). The participants were asked to identify obstacles and issues related to the development and implementation of Web-based instruction and were given the opportunity to share and develop solutions to these problems through a series of working sessions. What the March conference attempted to do was identify shared problems and encourage the Aeronautics Cooperative Agreement teams to collaborate and support each other by sharing or deriving solutions as a group.

The Aeronautics Cooperative Agreement teams are confronted with two significant challenges. Their first challenge is to deliver instruction effectively via the WWW and their second challenge is to translate elements of aeronautics and aerospace careers into material suitable for use in K-14 classroom.

The March conference focused on the effective development and implementation of instruction using the WWW. Since the Aeronautics Cooperative Agreement teams are diverse in their designs and strategies for meeting these challenges, they served as an excellent source of information about what works and what does not.

Dryden Learning Technologies Project Goals

The Dryden Learning Technologies Project is a collaboration between NASA Dryden and The Pennsylvania State University. The project goals are to:

- conduct an analysis of current teacher needs, learning environments and exemplary instructional Web sites,

- develop Web-enhanced learning environment models which describe collaborative teacher, student and Web roles, incorporate sound instructional design, address access limitations and different teaching and learning styles,

- conduct teacher focus groups to obtain preliminary feedback from the customer on the models developed,

- design and develop a research plan for empirically validating the Web-enhanced learning environment models in the schools,

- validate the proposed models in the classroom to assess short-term impact, and

- investigate the long term impact on teaching practices and assess systemic reform.

The first two goals are relevant to this conference. The analysis phase of the DFRC Learning Technologies project is underway and is being conducted as part of a graduate course in Instructional Design at The Pennsylvania State University. The course participants consist of individuals with backgrounds in teaching, instructional design, Web development, instructional technology, school administration, publishing, and computer systems analysis. The analysis phase includes, but is not limited to, an examination of the levels of K-12 access to the WWW, teacher knowledge of the WWW, teacher use of the WWW in daily instruction, identification of what teachers actually want from the WWW, and an assessment of exemplary Web sites which demonstrate sound pedagogy and are frequently used by teachers and students. Teacher surveys and focus groups are being used to gather some of this information. The surveys are both pencil and paper and electronic. The results of the survey of Spacelink users conducted at Marshall Space Flight Center will be included in this analysis.

Summer focus groups in the form of workshops are being developed to obtain formative teacher feedback about NASA instructional Web sites and the practicality and appeal of the Web-enhanced learning environment models. (This year workshops will be held at Dryden and Langley.) The research segment of the Dryden Learning Technologies Project will be conducted from 1997 through 1999.

Educational Review of RSPAC Products Project Goal

In addition to the DFRC Learning Technologies Project, DFRC and PSU will conduct a product review to evaluate classroom readiness and recommend potential instructional products that could be derived from the efforts of the Digital Libraries and Remote Sensing Database Cooperative Agreements. This effort is conducted by the Dryden Education Office in cooperation with PSU, Ames Research Center and RSPAC. The recommendations are intended to support the Learning Technologies project management of NASA Ames in their attempt to organize, evaluate and disseminate the products of the earlier Cooperative Agreement projects which did not have a required educational product.

Conference Outcomes

The March Learning Technologies conference yielded several interesting outcomes. One major outcome was establishing a broader understanding of interactivity as it relates to Web-delivered instruction. The first view of interactivity is similar to interactivity as commonly found in CD-ROM instruction. The student, or user, interacts with a computer program or Web site. While interaction with other people is a possibility, collaborative learning is not a requirement for effective use of the product. The product is self-contained and self-explanatory. Interacting with the program is sufficient to accomplish the instructional objectives set forth. This type of activity is highly individualized and student-paced. In the second view of interactivity, groups of students or users "meet" on the WWW, gather information and assignments from the Web site's instructor or the Web site, perform hands-on activities off-line, gather further information from the WWW relevant to the instructional goals, and then return to the computer to work with others via email to conduct and deliver their projects to the instructor for evaluation. The latter definition of interactivity exemplifies a collaborative learning model and uses hands-on activities which are not necessarily executed at the Web site.

The issues addressed during the conference included teacher training and support, technology, evaluation and pedagogy. Teacher training and support issues remain problematic. The Aeronautics Cooperative Agreement teams report that they are expending resources and time providing basic Internet training and technical support to participating schools and agree that such support is outside of the scope of their projects.

Rapidly changing technologies challenge developers in many ways. In-depth discussions are needed to develop strategies for coping with this problem. Technology updates are needed in order to maximize the use of new, helpful technological advances. There is growing recognition that a team model is necessary for developing complex instructional Web sites in light of these rapid technological changes.

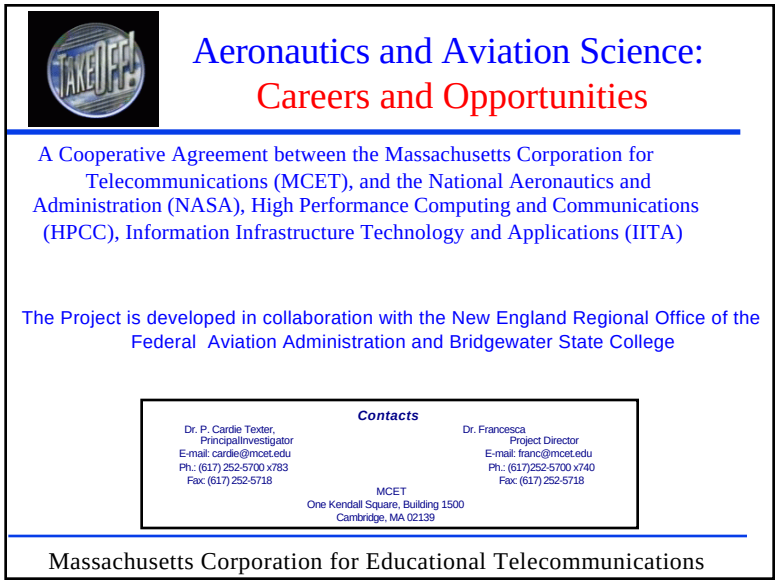
Evaluation issues were also explored during the working sessions. Sessions focused on the incorporation of National Education Standards into products, student assessment, project evaluation by developers and project evaluation by NASA management. Evaluation guidelines and NASA expectations require further clarification.

Pedagogy, for the conference working sessions, centered on how to use the WWW effectively to deliver instruction. The sessions addressed effective teaching strategies, different learning styles, cultural differences, and developmental issues within the context of new, potentially useful technologies and ongoing access limitations.

Of the issues addressed during the conference, many solutions were suggested, however, several issues remain largely unresolved. The details are presented in the section entitled Working Sessions.

Presentations: Significant Accomplishments and Lessons Learned

Aeronautics and Aviation Science: Careers and Opportunities



Presenter: Dr. Francesca
Principal Investigator: Dr. P. Cardie

http://www.mcet.edu/nasa/index.

Aeronautics and Aviation Science: Careers and Opportunities

A Cooperative Agreement between the Massachusetts Corporation for Educational Telecommunications (MCET), and the National Aeronautics and Space Administration (NASA), High Performance Computing and Communications Office (HPCC), Information Infrastructure Technology and Applications (IITA) Program

The Project is developed in collaboration with the New England Regional Office of the Federal Aviation Administration and Bridgewater State College

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Massachusetts Corporation for Educational Telecommunications

Dr. Francesca Casella opened the session by describing the project team involved with the Aeronautics and Aviation Science: Careers and Opportunities project.

The project team is made up of representatives from MCET, NASA, HPCC, and IITA.

The focus of the Aeronautics and Aviation Science: Career and Opportunities project is to stimulate students' interest in mathematics, science, engineering and technology through a curriculum based on aviation topics.

Aeronautics and Aviation Science: Careers and Opportunities

A three year, multiple technology project that offers a unique opportunity to engage students and teachers in grades 6-12, in new curriculum reflecting aviation and aeronautics themes .

The curriculum is delivered using a variety of different media,

- interactive live satellite broadcasts
- Internet
- print and non-print materials

Massachusetts Corporation for Educational Telecommunications

This project uses multiple technologies to provide instruction for grades 6 - 12. It is based on a new curriculum reflecting aviation and aeronautics themes.

Takeoff does not only use the World Wide Web as a delivery mechanism. It uses several different media to reach teachers and students including interactive live satellite broadcasts, print and non-print materials, and the Internet.

Aeronautics and Aviation Science: Careers and Opportunities

Project Goals

- Stimulate students' interest in mathematics, science, engineering and technology through a curriculum based on aviation topics
- Illustrate career opportunities in aeronautics, particularly among women and minorities, traditionally underrepresented in this field
- Engage students and teachers in the use of emerging technologies and their applications to enhance learning opportunities
- Develop and deliver live, interactive satellite programs over MCET Mass LearnPike infrastructure and develop on-line aeronautics curriculum
- Create an aeronautics curriculum kit, including print materials, manipulatives, pre-produced video and the Web

Massachusetts Corporation for Educational Telecommunications

The following goals established for this project included:

- Stimulating interest in math, science, engineering and technology
- Illustrating career opportunities in aeronautics
- Engaging students and teachers in the use of emerging technology including live interactive satellite programs and on-line internet curriculum
- Creating aeronautics curriculum kits

Aeronautics and Aviation Science: Careers and Opportunities

Live Interactive Satellite TV

- uses a familiar technology
- provides access to people and facilities not otherwise available
- delivery of instruction is supported with live demonstrations, graphics, animation and preproduced video
- live broadcasts conflict with classroom schedules
- passivity of users only partially solved by audio-bridge interactivity
- satellite signals available only at selected sites

Massachusetts Corporation for Educational Telecommunications

An important outcome for this project was the ability of the team members of the live interactive satellite TV programs to interest additional schools in using technology in their classrooms . An indicator of this outcome is that these additional schools are now applying for technology grants.

Aeronautics and Aviation Science:
Careers and Opportunities

Web-based Instructions

- use an unfamiliar technology
- provide access to people and facilities, not otherwise available, through hyperlinked documents
- support of graphics, animation and video possible but bandwidth intensive
- learners can access instructions at their convenience
- media is potentially highly interactive
- media provides instantaneous access to information on the global scale

Massachusetts Corporation for Educational Telecommunications

The following two important findings were gleaned from the use of Web-based instruction:

- an underestimation of the training required by the teachers - two months barely got them up to speed, and

- the interest of students was more focused on the Internet rather than on the aviation content.

Using technology in the classroom requires bandwidth, physical access to computers in the classroom, and adequate facilities to do Internet activities.

Problems encountered during the development included:

- Identifying technical support for the students and teachers
- Addressing lack of teacher motivation to take the time to learn how to use technology, revise their lesson plans and to change their teaching strategy

Aeronautics and Aviation Science: Careers and Opportunities

Project Accomplishments Year I

- Selected 4 core sites in Massachusetts, provided all necessary equipment to ensure full participation and supported training needs
- Developed and broadcast nationally Take Off! Part I, a seven-part interactive live satellite series for grades 6-8;
- Created an aeronautics curriculum kit, mailed to all registered teachers, to support classroom activities in connection with broadcast series and Internet
- Developed a web page, with *activities*, a *discussion forum*, *career cards*.

Massachusetts Corporation for Educational Telecommunications

Massachusetts Corporation for Educational Telecommunication continues to get requests from teachers to help them solve their technology problems. This often consists of requests to help put the technology in place and to provide training for teachers or students that do not know how to use the computers.

Aeronautics and Aviation Science: Careers and Opportunities

Demonstration Sites Selected

- **Randolph Jr/Sr High School, Randolph MA**
  Suburban community. Randolph Jr/Sr High School has a very diverse population, over 40% minorities, and about 5% receiving ESL/Bilingual services
- **East Boston High School, E.Boston, MA**
  Residential/industrial land use. Student population: 39% White, 25% African American, 28% Hispanic, 7% Asian and 1% other
- **Dorchester High School, Dorchester, MA**
  Inner-city public school. Student population approx.. 60% African American, 32% Hispanic, 5% White and 3% Asian
- **Malden Middle School, Malden, MA**
  Some thirty-five to forty languages spoken in school, four of which are supported by ESL programs

Massachusetts Corporation for Educational Telecommunications

There are four demonstration sites that consist of a cross-section of rural, suburban and urban schools including multiple grade levels. Students are from a variety of cultural backgrounds and have different language proficiencies.

Aeronautics and Aviation Science: Careers and Opportunities

Demonstration sites represent typical situation of technology infrastructure in the K-12 public school system

- computer labs, when available, have only few old computers for student use
- no Internet connection available to students (and teachers) at school
- teachers need computer and network/Internet training before attempting to use the Web in the classroom

Massachusetts Corporation for Educational Telecommunications

We started first by providing teacher training. During the training we demonstrated how the teacher could use the products. The problem we faced was that the teachers did not have computer or Internet access in their schools after the training sessions.

Aeronautics and Aviation Science: Careers and Opportunities

Lessons Learned

- availability of equipment doesn't guarantee its use; intensive training of students and teachers is necessary
- successful use of Internet in the classroom depends critically upon technical infrastructure at the sites and the personal investment of teachers
- local libraries, science and computer museums might provide additional affordable Internet access for classroom projects
- a single computer is not adequate to allow integration of Internet into classroom activities

Massachusetts Corporation for Educational Telecommunications

The following three important lessons were learned by the project staff:

- having computers does not mean that they will be used or that they are set-up in an infrastructure that supports the instructional material,
- other options for accessing technology include libraries and museums, and
- a single computer is not adequate for full integration of the Internet in to the classroom

Aeronautics and Aviation Science: Careers and Opportunities

Accomplishments (network training)

- each site was provided with one computer and a modem connection to the Internet
- teachers at core sites trained on computer use and network activities (e-mail and web browsing)
- some teachers using e-mail as the main communication method
- one site initiating a classroom web page development with the assistance of Project personnel. Other sites invited to start their own projects
- more teachers requested network training

Massachusetts Corporation for Educational Telecommunications

Through this project we were able to provide each site with some technology and connections to the Internet. Teachers at the core sites were provided with training in basic computer skills. They are now using E-mail as a communication tool.

As a result of incorporating technology and conducting teacher training, some classes are developing Web sites. Also, more teachers are requesting network training.

Aeronautics and Aviation Science: Careers and Opportunities

Future Plans

- additional resources and training will be provided to teachers
- web development projects at other sites will be facilitated; graphic development support, additional server space and account time will be provided to committed sites
- e-mail will be the primary method of communication among project participants
- the *Forum* will provide a starting point for Internet based classroom research projects.

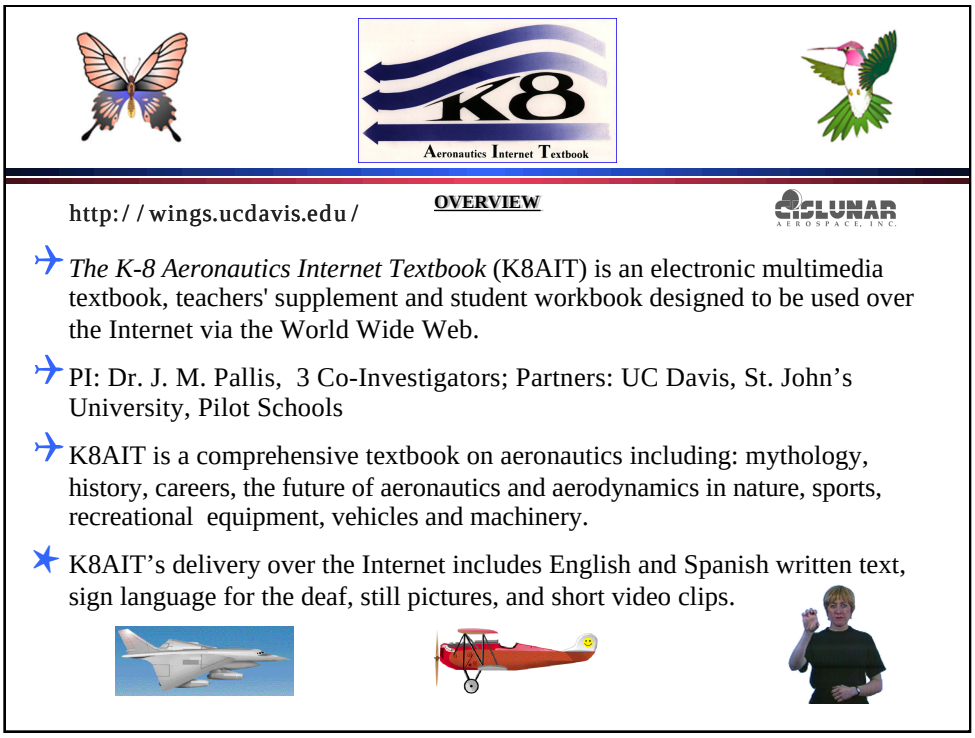
Massachusetts Corporation for Educational Telecommunications

In the future, we will be adding additional resources and training to support teachers. Graphics development support, additional server space and accounts will be provided. We will also use E-mail as our primary communication tool with all participants.

K-8 Aeronautics Internet Textbook

Presenter and Principal Investigator: Dr. J. M.

http://wings.ucdavis.



We have been doing aeronautics education for 15 years. It is not straightforward content, in fact, aeronautics topics are very complex. Teachers and students find it difficult to assimilate the content. We found that having a lot of "fun" activities may be motivating initially but did not get content across.

The K-8 Aeronautics Internet Textbook (K8AIT) is a comprehensive Web-based aeronautics electronic multimedia textbook. There are two other supporting components: a teacher's supplement and a student workbook. There are English and Spanish versions of the written text. The Web pages use pictures and short video clips and animations of sign language for deaf users.

Topic areas covered in the material include mythology, history, careers, the future of aeronautics, and aerodynamics in nature, sports, recreational equipment, vehicles and machines.

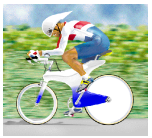
Two findings we have had are that most teachers wanted thematic topics using aeronautics and that administrators said aeronautics topics were not part of curriculum requirements.

K8

Aeronautics Internet Textbook

ACCOMPLISHMENTS

- K8AIT is in four reading levels; there is a Self-Paced Internet Training Class, and *The Scientists and Engineers Guide to Working with Students*
- K8AIT emphasizes "conceptual" learning. Students learn to recognize the same principles of aircraft flight in nature, in sports and in other machines.
- The cooperative agreement has been able to provide computers and Internet access for schools which might not be able to afford this technology, such as:
- A 100 year old school for the deaf in the Bronx and a migrant campsite school in Davis, California
- Pilot schools in New York (2), Oregon (5) and California (7) are utilizing the textbook materials in their classrooms.



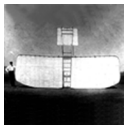
We are careful to account for the developmental level of kids when designing lessons. For example, we would not use activities requiring a great deal of manual dexterity for kindergarteners. We have also designed the material in four reading levels to support the needs of the children at different levels. We also emphasize conceptual learning to help the student recognize the principles of flight in nature, sports, and other machines.

We have also been able to supply technology to pilot schools that would not normally have been able to afford to purchase it. Currently 13 schools across the country are using K8AIT materials.

We have also created teacher guides that are designed to be concise and help the teachers move quickly--in and out--of the lesson content areas.

K8

Aeronautics Internet Textbook



WHAT'S TO COME

- NASA scientists, engineers, projects and facilities will be showcased in the *Careers* and *Future of Aeronautics* chapters of the textbook.
- Future plans include curriculum enhancements for gifted students and students with low vision.
- Additional pilot sites including a children's hospital will be added in Year 3 of the project.
- The *Student Activity Workbooks* will provide interactive problems on the Internet to reinforce aeronautics concepts presented.
- In conjunction with NASA Stennis, uses of satellite imagery in aeronautics will be explored with students.

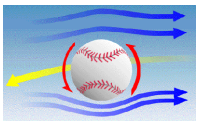


Photo Courtesy of the Dunbar Library, Wright State University

Some of our material will be published in the *Careers and Future of Aeronautics* chapters of a textbook.

We will also be enhancing the curriculum to accommodate gifted and visually impaired students.

We will be extending our pilot sites to include a children's hospital.

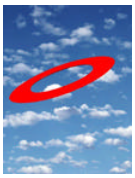
More interactive problems solving will be incorporated into the *Student Activity Workbooks* to reinforce aeronautics concepts. We are planning to produce satellite imagery in aeronautics lessons covering agriculture, forest fire fighting, and general aviation maps.

K8

Aeronautics Internet Textbook

WWW SUCCESSES/ACCOMPLISHMENTS

- The Web minimizes the effects of "geographic distance". For K8AIT participants this allows: migrant students to use the curriculum in the two different agricultural areas they live in; closer communication between itinerant teachers of the deaf and their students; (in the future) less isolation for student's in children's hospital.
- The Web acts as a "free publisher", "public library", "distributor" and "advertiser" for the developed materials; K8AIT is a textbook, teacher's supplement and student workbook - and no one has to "pay" for these items to use them.
- K8AIT is highly graphic and visual.



We have also found that isolated students have more access to their teachers when using the Web for instruction. Therefore, we found that the Web is an effective tool in minimizing the effects of geographic dispersions. For K8AIT, we have provided a vehicle for migrant students in agricultural areas to use the material; we have increased the communication between teachers and their deaf students, and in the future will provide a mechanism for children in hospitals to maintain ties to the classroom.

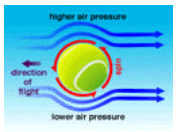
The Web also provides an economical and wide reaching method of distributing educational materials.

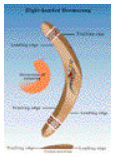
K8

Aeronautics Internet Textbook

WWW SUCCESSES/ACCOMPLISHMENTS

- CAI is "finally" happy with the quality, clarity, size and speed of the animations and videos we have created for the Web; the Web tools and capabilities are improving.
- The subject matter of K8AIT and number of reading levels lends itself to Web related: distance learning projects, home schooling, "aero" magnet schools, and adult reading programs.
- A new "look" and "layout" will remove "scrolling" in the textbook".
- Planned "interactivities" will give Web users an additional amount of Internet participation.

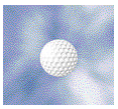




We have been able to gather a lot of information regarding the use of graphics and navigational design for the World Wide Web. For example, we found that graphic visibility capabilities made it difficult for students to see hand signals. We have also designed Web pages that address reading level.

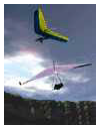
We have materials available at different reading levels on our Web site to accommodate good, average and low readers. The pages look the same - respecting the maturity of the older, low reader, so that regardless of the vocabulary or ability to track words, the low reader learns the same visual concepts.

We found that scrolling made it difficult for younger children, so it was removed. However, interactivity is critical to engaging students. We will be adding additional interactive on-line activities to further engage the students with the Internet.



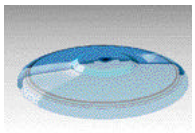
K8

Aeronautics Internet Textbook



ACCESS ISSUES

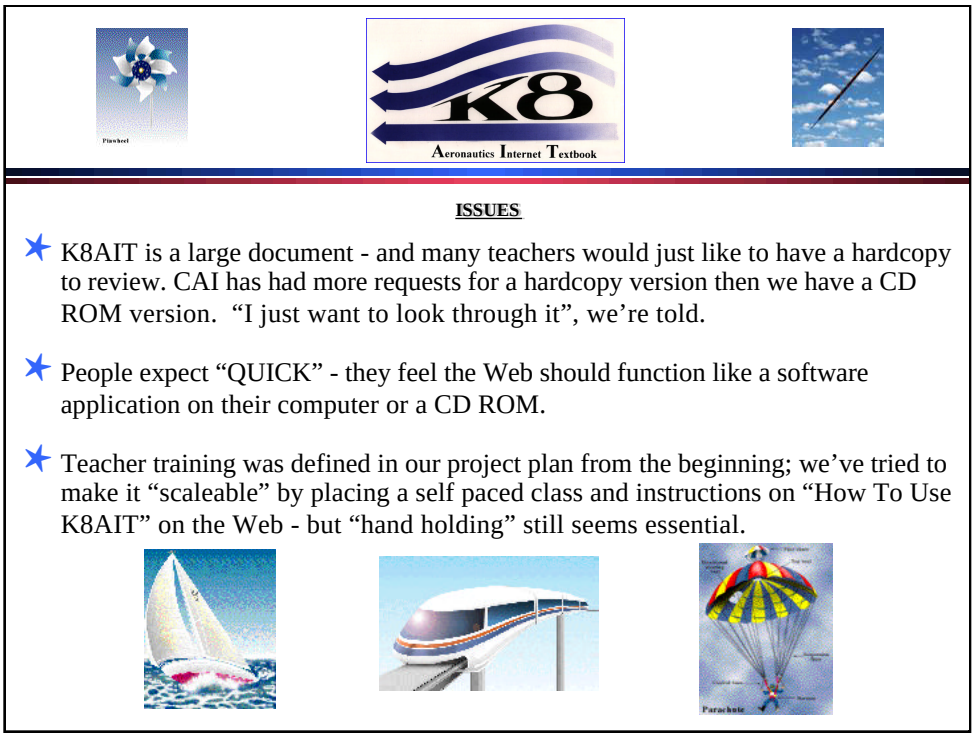
- Classroom Usage: Teachers tell us "I have a classroom full of kids and only a couple of computers to use K8AIT".
- Computer Lab Usage: Teachers tell us: "I have to shuffle the kids to a lab - it cuts into classroom time and takes a while for the kids to settle down" and "If I want to get a lesson plan I have to leave my classroom and go to the lab".
- For us as developers: There are only so many animations and interactive activities we can afford (funding/manpower/performance) to put into K8AIT. Sure, we could have them ftp it or put it on to CD ROM - but that's not Web delivery to us.



Technology availability is still a problem in the classroom, there is a lack of computers for the students to use to access the K8AIT and the Internet in general.

Shuffling the kids from classrooms to computer labs reduces the amount of time available to work on the lessons.

Budgets and timelines are limiting to the developers. Although interactivity is critical to the learning experience, development of interactive activities is time consuming and expensive.



Teachers are used to the quick and easy access of the CD-ROM and expect that the Web will work the same way. They want the K8AIT lessons to operate like a CD-ROM. When access to K8AIT is slow, it is often related to local access problems, such as busy lines, ISP, local computer or router problems. The expectations of the quickness of a CD-ROM and these network access issues all create a perception to the end user that the delivery method is slow. Ultimately it effects the end users' perception of the project.

We have provided Web-based self-paced class and instructions for teachers on "How to Use K8AIT." However, we have found that teachers still need a lot of direct support in the use of technology and the K8AIT material.

We wanted to know that teachers had installed equipment before they took the teacher training. Therefore we requested supporting documents, such a room setup diagrams to enable us to help them ready their classrooms.

Some interesting findings about the teachers was that:

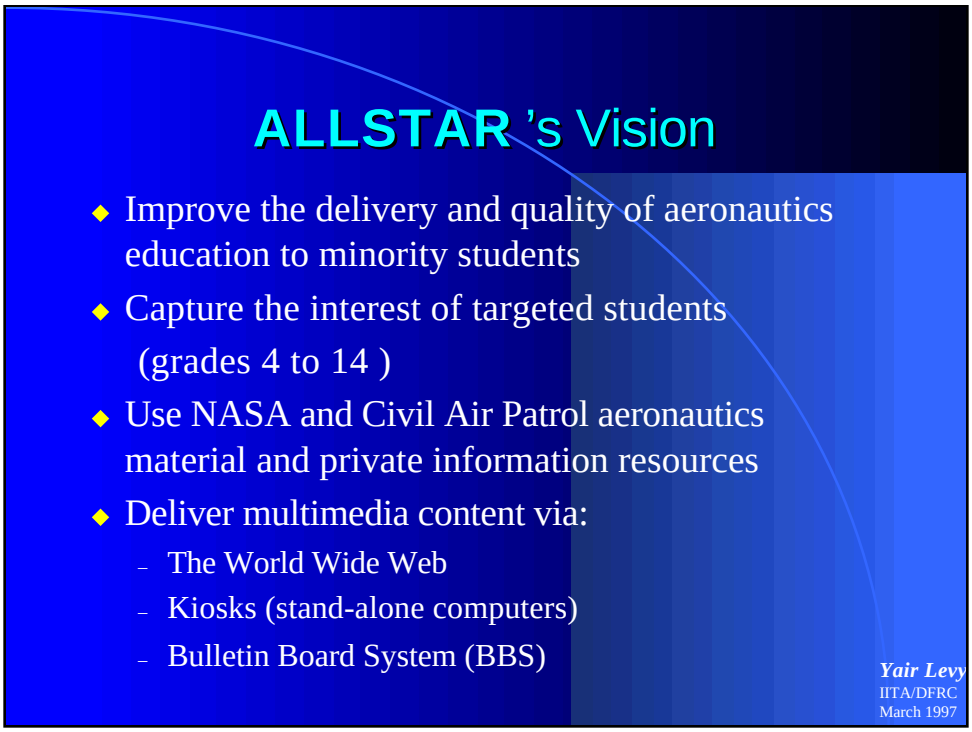
- they were not always interested in airplanes--but did not object to flying butterflies, swimming, etc., and
- they want to teach the way they always have--but the students have changed.

Aeronautics Learning Laboratory for Science Technology and Research (ALLSTAR) Network

Presenter: Yair
Principal Investigator: Dr. Cesar

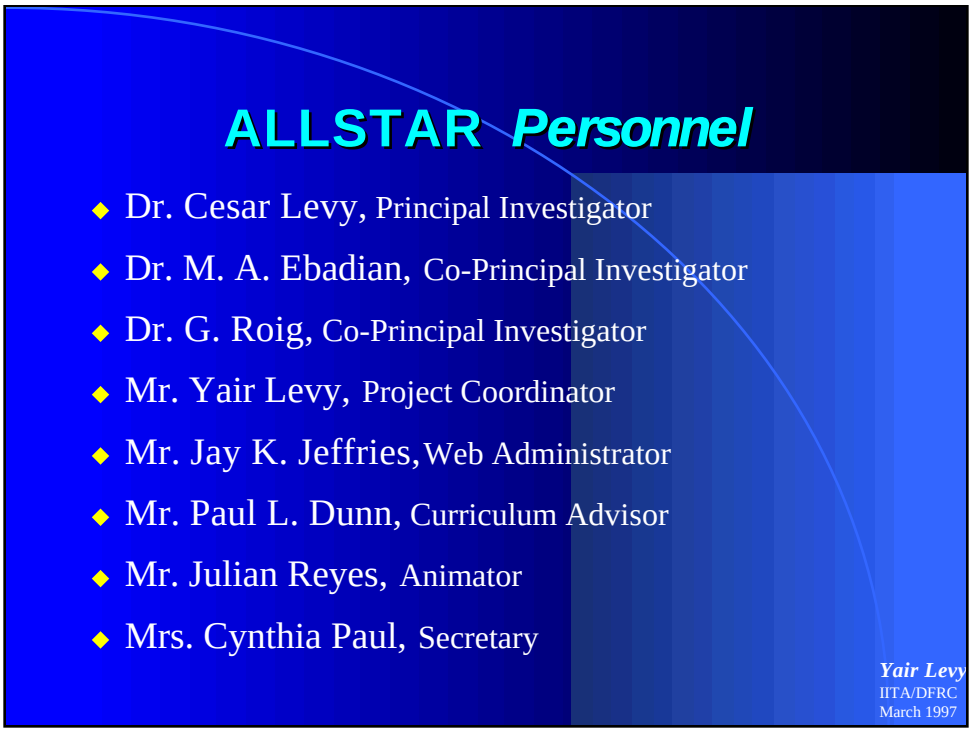
http://www.allstar.fiu.e

The focus of ALLSTAR is to improve the delivery and quality of aeronautics education to minority students. It is designed to capture the interest of students in grades 4 through 14.

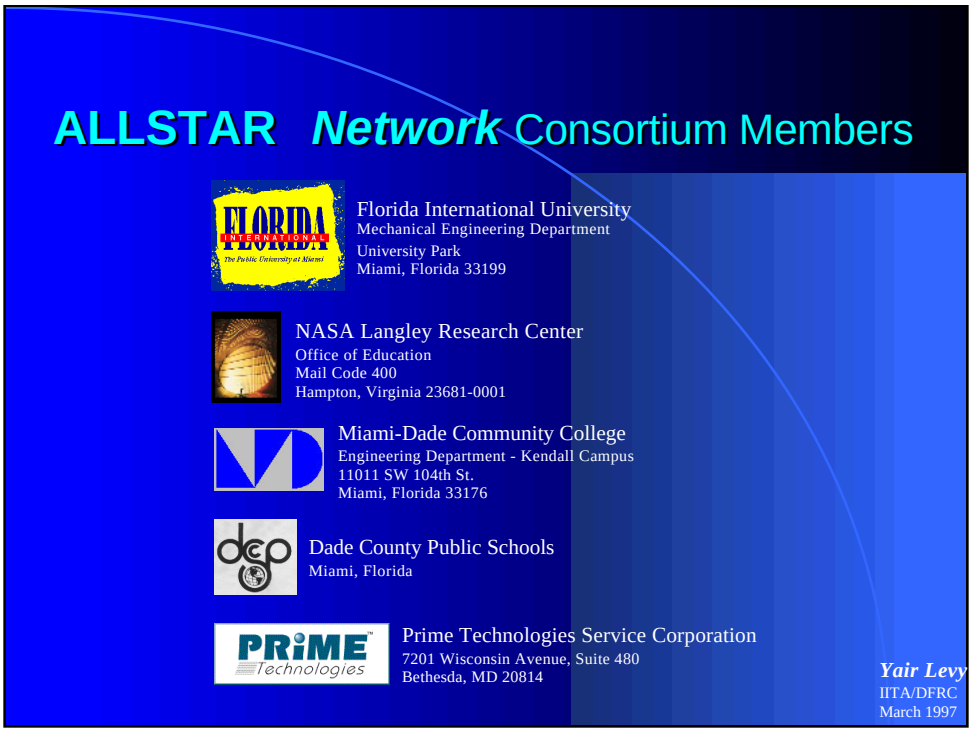


Currently seven high schools, four middle schools, and three elementary schools are involved with ALLSTAR.

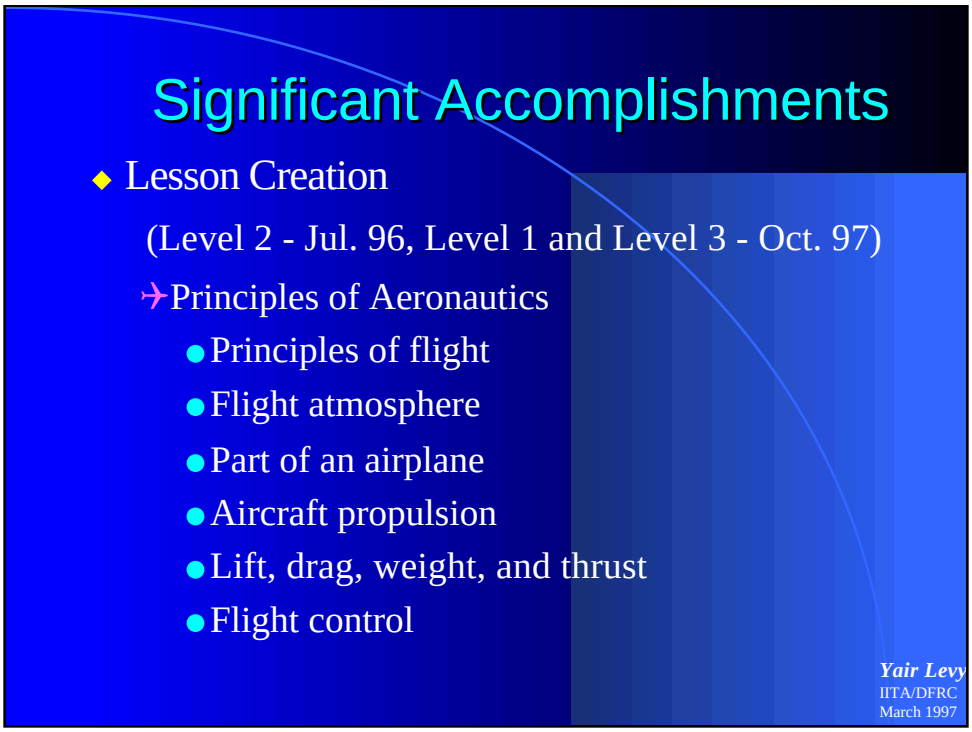
Four kiosk computers are in the field now and we expect to have 14 more in the near future. These kiosks are not connected to the World Wide Web, they simply mirror the Web sites.



The project team consisted of eight key members bringing different types of expertise to the effort. These areas of expertise included management, WWW development, animation, curriculum and support.



Important to the success of the project were consortium partners: Florida International University, Mechanical Engineering Department, NASA Langley Research Center Office of Education headed by Dr. Samuel Massenberg, the Engineering Department of the Miami-Dade Community College, Dade Community Public Schools, and Prime Technologies Service Corporation, a minority-owned company.



We have had a number of significant accomplishments with the ALLSTAR project. In terms of lesson creation, we have delivered level 2 lessons on the principles of aeronautics. Level 1 and Level 3 lessons are targeted for release in October of 1997.

- Level 1 is for middle schools
- Level 2 is for high schools
- Level 3 is for lower colleges

Principles of flight includes airfoil, Bernoulli's principle, relative wind, and angle of attack.

Flight atmosphere includes weight, density, pressure, humidity, and temperature.

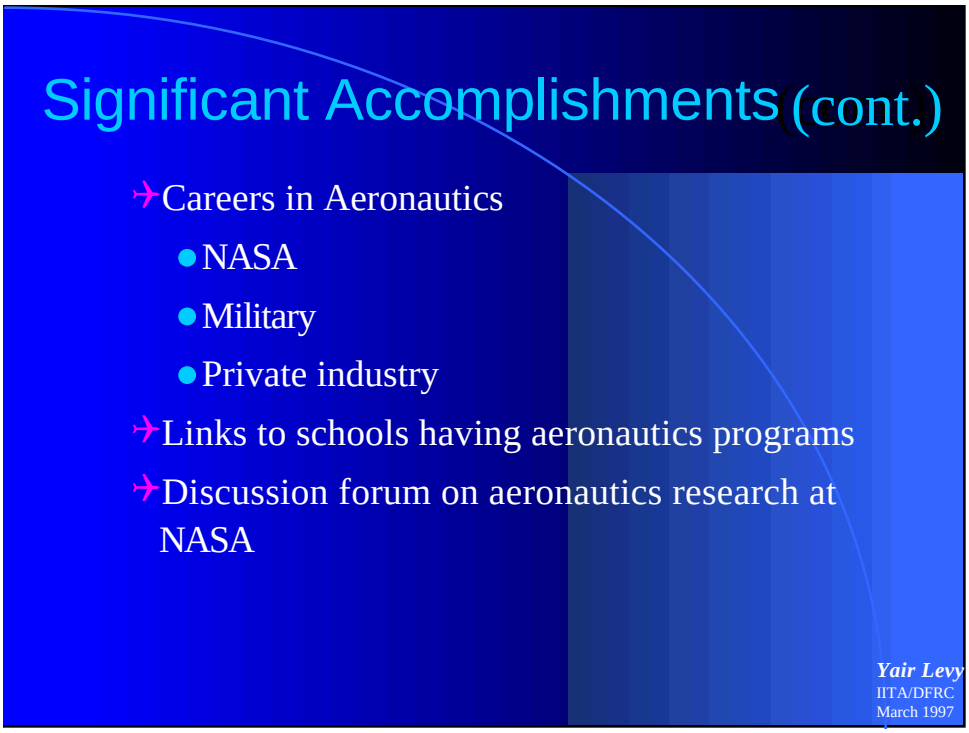
Parts of an airplane includes fuselage structure, wings, landing gear, etc.

Aircraft propulsion includes reciprocating-engine, propellers, turbojet, turbofan, turboprop, and ramjet engines.

The four forces of flight includes lift, drag, weight and thrust.

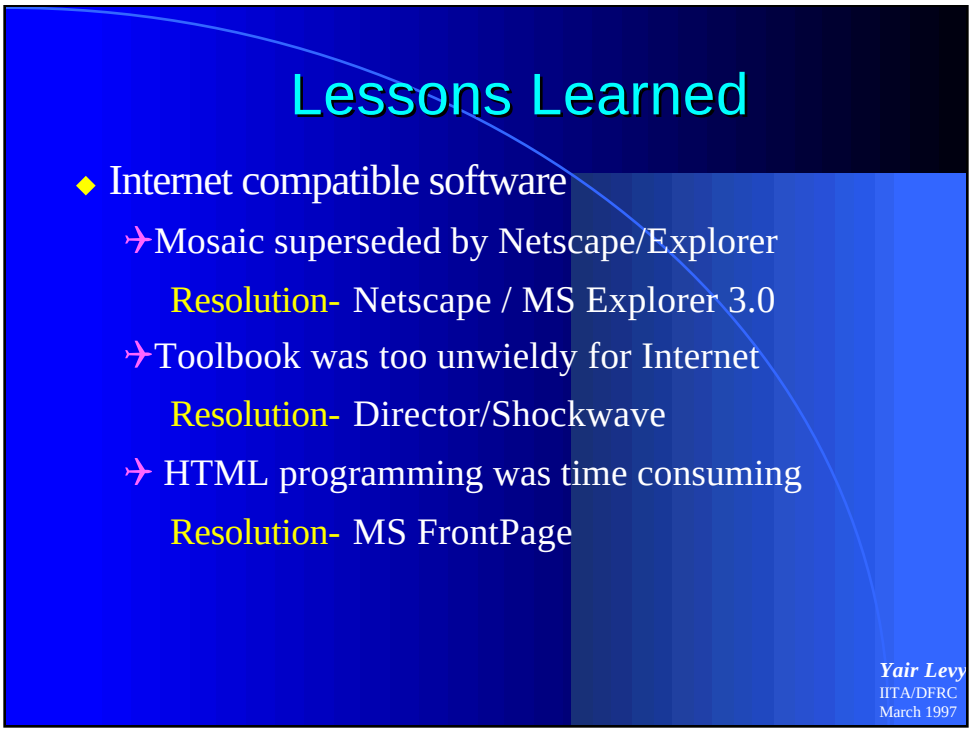
Flight control includes the axes of rotation, yaw, roll, pitch, basic flight maneuvers, takeoff, landing and stall.

History of flight lessons have been produced for level 2 and are in development for level 1 and 3.

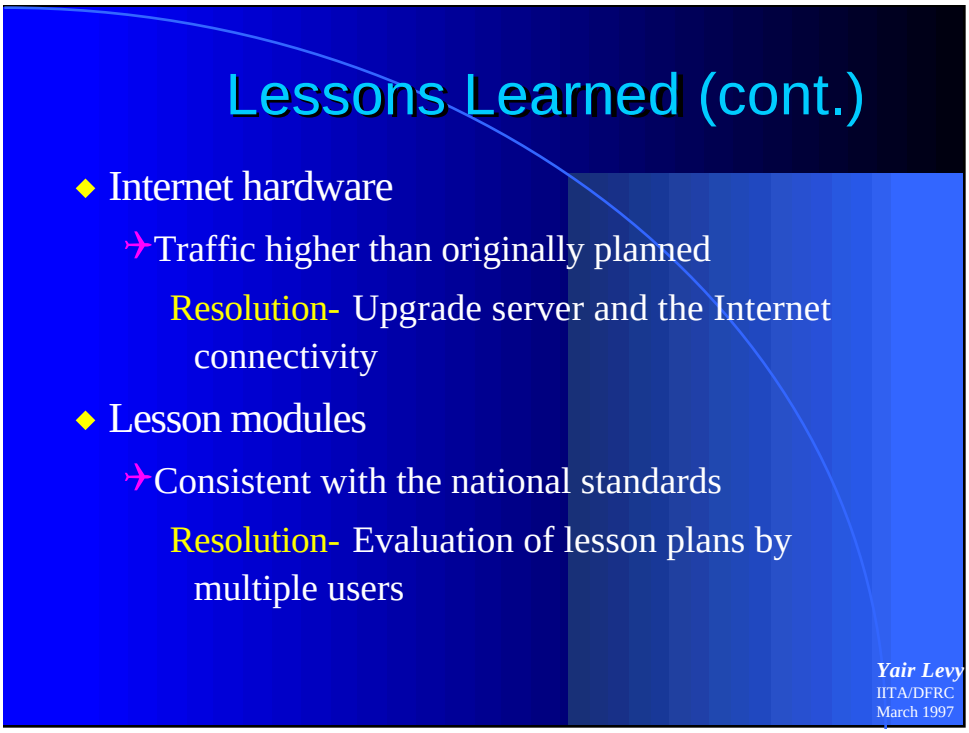


Other significant accomplishments include the development of links with pilot schools and the aeronautic industry to support ALLSTAR.

The discussion forum on aeronatuics research at NASA provides an opportunity for dialogue about the X-33 and the LoFLYTE aircraft.

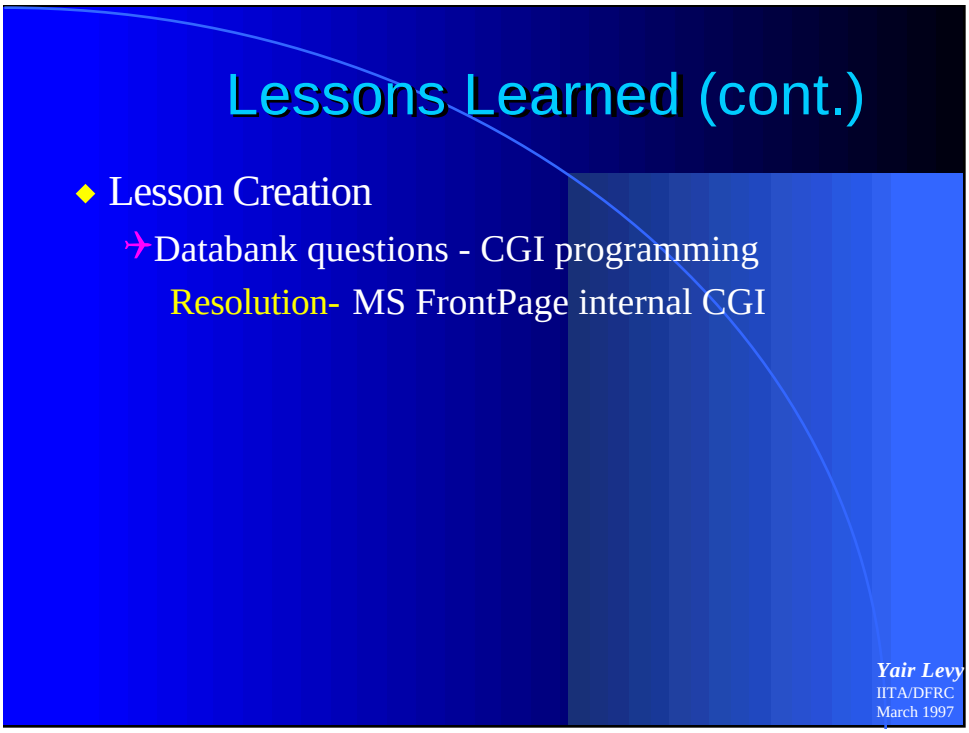


There was a substantial amount of time spent in a software learning curve and debugging. We had difficulties with Internet software compatibility which was resolved by changing from older to more accepted Web browsers. We also changed over to software that can stream over the Web. We abandoned writing HTML to produce over 400 pages for a software tool that edits Web pages with a What You See Is What You Get (WYSIWYG) interface.



Another lesson learned was about user traffic expectations. We severely *underestimated* the number of hits to our site. To resolve this issue we upgraded our server and the Internet connectivity.

We also had consistency issues between our materials and the National Standards. To resolve this issue we implemented a strategy to include multiple users evaluating our lesson plans. Evaluators included curriculum specialist, technical experts in the content area, and sample audience students.



CGI programming combination with data base allows for more flexibility in development. CGI programming was very complex and time consuming. Development time sometimes takes months to get one animation to work. This issue was addressed by using software that has internal CGI to deal with automatic databank question and form submission.

ALLSTAR ***Network***

http://allstar.eng.fiu.edu/

Yair Levy
IITA/DFRC
March 1997

Aviation Academy 2000

Presenter: Tom Schieffer
Principal Investigator: Bob Archer

http://www.mecca.org/~tschieff/AVIATION/ACADEMY/index.htm

A main goal of this high school program is to re-interest students into learning math, science, communication, and technology.

Aviation Academy 2000 Staff

- Principal Investigator
  Mr. Bob Archer, Principal of
  Wooddale High School
- Mr. Tom Schieffer, Aviation Teacher
  NASA AA2000 Program Coordinator
- Ms. Carole Shipman, Coordinator
  for the Travel & Tourism Program

The project team consists of four key members representing schools, aviation content, and travel and tourism specializations.

Project Overview

- The NASA-Aviation Academy 2000 Project encourages students to improve their skills in mathematics, science, communications, and technology by using an integrated aeronautical curriculum enhanced through the use of LAN computers which are networked into the WWW.
- The project encourages students to develop lifelong learning skills towards aviation careers.
- Provides shared-local access to a repository of categorized aeronautical information.

It was difficult to get students into the Web at first, but once they get to the interesting Web sites they get interested.

Web surfing was used to find Internet sites that introduced the students to different careers in aeronautics. Once the students learned about the careers they went to meet with people at NASA that are making major changes in the different fields. This provided the students with context and high levels of motivation.

Students are also given the task of researching a career of interest to them via the Internet. Then, they have to develop and present a report to class about their career choice. Fellow students provide them with feedback on their reports. This process totally immerses the students in technical skills and the content area.

Aviation Academy 2000 Accomplishments

- Created an effective educational partnership that represents a cross-section of Who's-Who in Aviation in Memphis, Tennessee.
- Assembled a creative group of volunteers and teachers who devoted spare time designing an integrated thematic curriculum outline.
- Within one year, implemented a systematically planned block-scheduled course of instruction.

A key success of the project was getting direct involvement of high level executives from partnering aviation organizations. We elicited content expert involvement to do some task-based analysis and create a curriculum. The teachers that were also involved in this curriculum development process became the core group of teachers for this technology environment.

We created horizontal and vertical integration of curriculum and formed a learning center concept that integrated disciplines. For example, to increase the applicability to multiple disciplines we created lesson such as "Why does it fly?" and "Why does the wind blow?".

Aviation Academy 2000 Accomplishments (cont.)

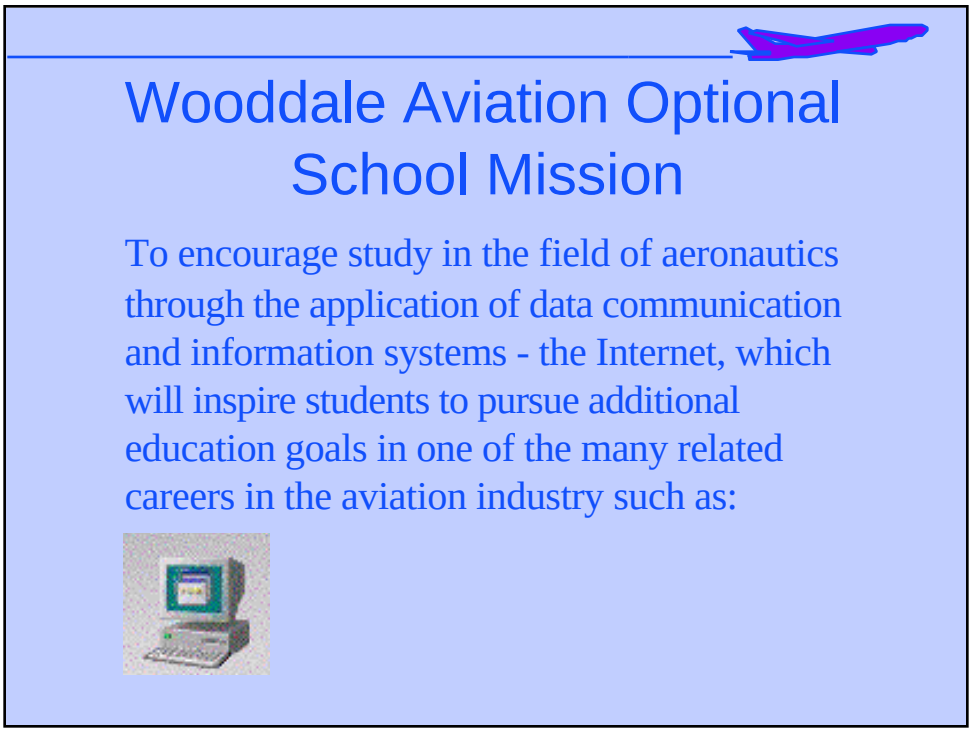
- Learned from scratch how to write HTML
- Designed and listed a web site for the NASA-Wooddale Aviation Program
- Assembled over 35 Lesson Plans for future incorporation onto the World Wide Web
- Acquired one full-time aviation scholarship
- Secured support agreements with three major Aviation Universities and Colleges

Accomplishments on the project included building programming and Web-based skills, building Web sites for the project, creating 35 lesson plans, and developing partnerships with major aviation schools. In the process we were able to secure a full-time aviation scholarship.

Institutional & Community Partnerships

- Federal Express Corp.- Flight & Charter Ops, and the Maintenance Training Div.
- Northwest Airlines-Memphis Station
- IAM Local 2763- Machinist Union
- Memphis International Airport Authority
- Memphis Educational Computer Connectivity Alliance (MECCA)
- Douglas Aviation-Flight Instruction/Rentals

We learned a lot about partnerships along the way. We found that unions can be good partners. They are interested in education of students and provided us with meeting places. We were able to secure city sponsored jobs for students through our partnership with MECCA. We don't pay for connections to Internet due to a partnership we have established. And, Douglas Aviation provides flight lessons and gives our students rides.



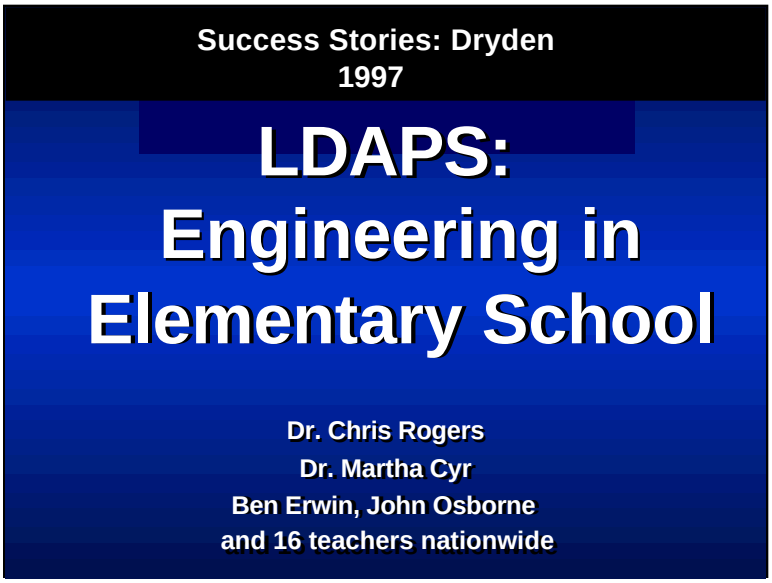
This project was conducted to meet the Wooddale Aviation optional school mission.

Careers in:

- Airport Operations Management
- Aircraft Design & Manufacturing
- Aircraft Maintenance Technicians
- Avionics/Computer Technology
- Certification as Commercial Pilot
- Weather/Meteorology Specialist
- Travel & Tourism Marketing

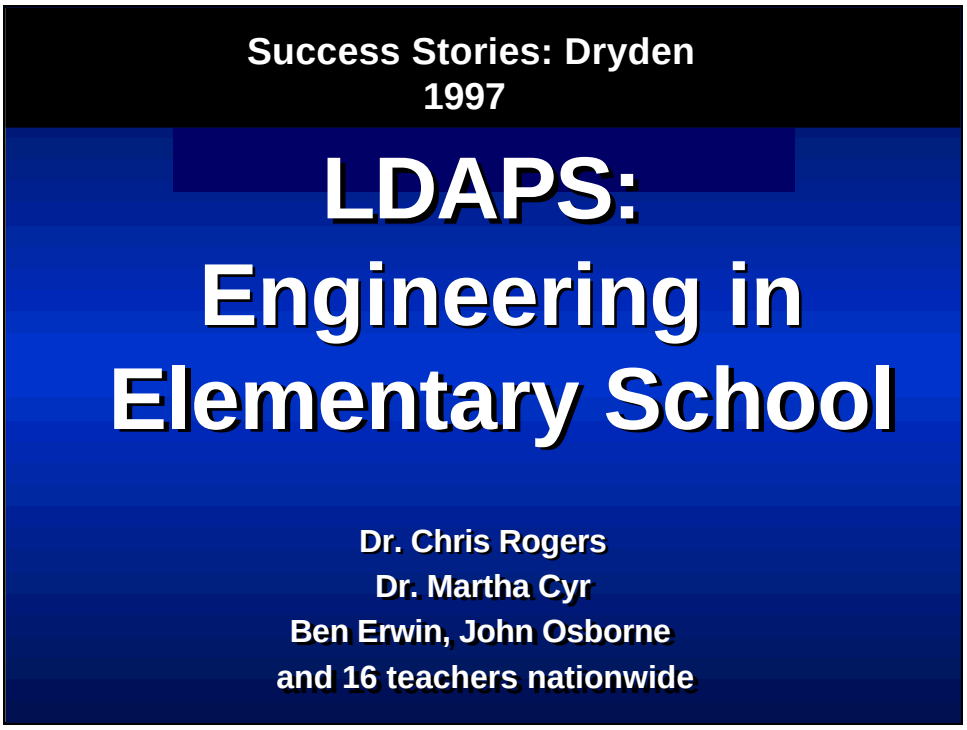
The careers that students can study in Aviation Academy 2000 include operations management, aircraft design and manufacturing specialist, maintenance technician, certified pilot, weather and meteorology specialist, and travel and tourism marketing specialist.

Lego Data Acquisition



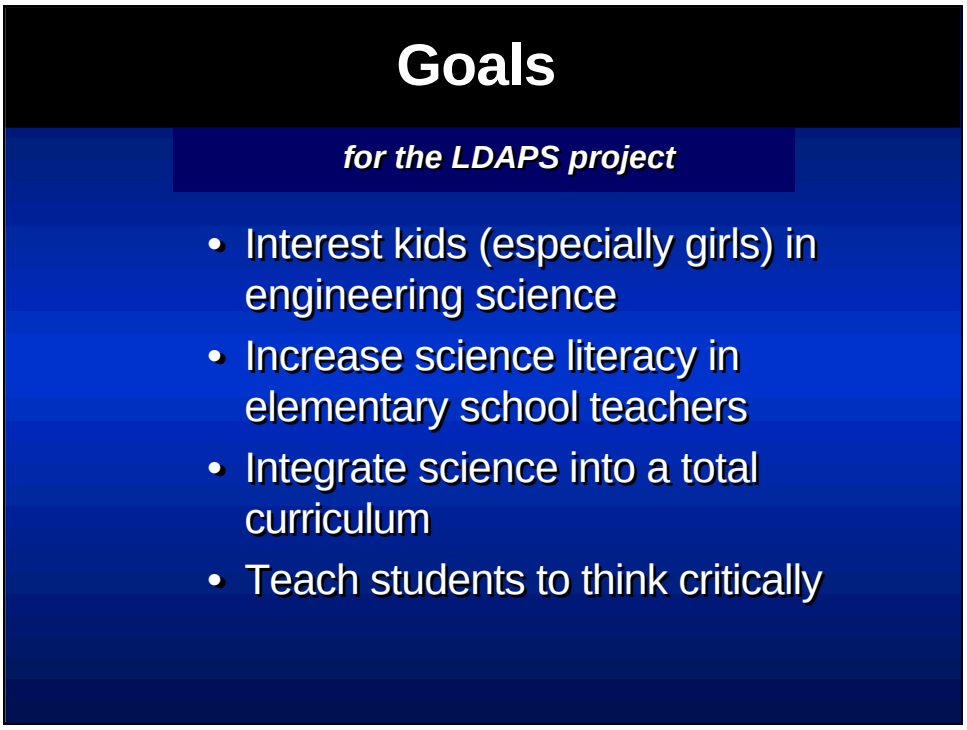
Presenter and Principal Investigator: Dr. Chris Rogers

http://ldaps.ivv.nasa.gov



This project uses “interactive” Legos and an interface box that goes to the computer. Kids “play” with these Legos to learn about engineering and science concepts. We use the Internet as only one medium.

Our projects target “good” schools to get programs to work first, then go down to the less equipped schools. We feel that if we can get the program to work first, then we can adapt them into other, less equipped environments and consult with these low end schools on how to prepare for the program.



Our major goal is to get engineering curriculum into K-6. We are especially interested in getting girls interested in engineering and science. The objective is to get students to start thinking critically.

Our overall philosophy is to get the kids interested in the overall content area first, then lead them into the science and engineering concepts. The hands-on activities for the students encourage the students interact on many levels. For example, kindergartners are writing computer programs with object oriented languages.

The Method

Engineering in Education

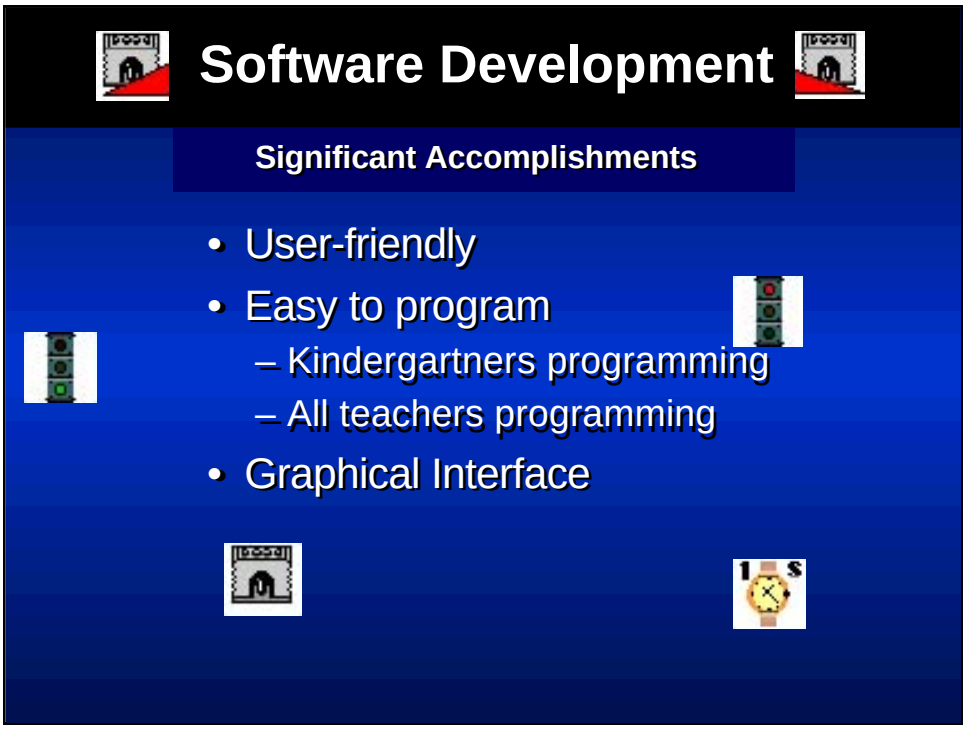
- Engineering Question
- Integration with rest of curriculum
- The Town
  - Airport
  - Aeronautics
- LEGO blocks as workbench
- Computer control
- Web-based interaction

It is also important to increase the science literacy of the elementary school teachers. Our project is doing this by integrating science into the overall curriculum and providing lesson activities that "connect" concepts for the students and the teachers.

Teachers are shown how to use technology in their classroom with these lessons. For example, they are shown how to talk about the science concepts involved in designing a spider's web after the students are asked use Legos to build the web from the story "Charlotte's Web." This way, teachers are integrating reading and science and engineering concepts into a single lesson.

Teachers have highly praised the workshops and there is widespread use of the materials. There are many active Web sites as a result of this program and teachers are coming up with creative ways to incorporate these materials into their classrooms.

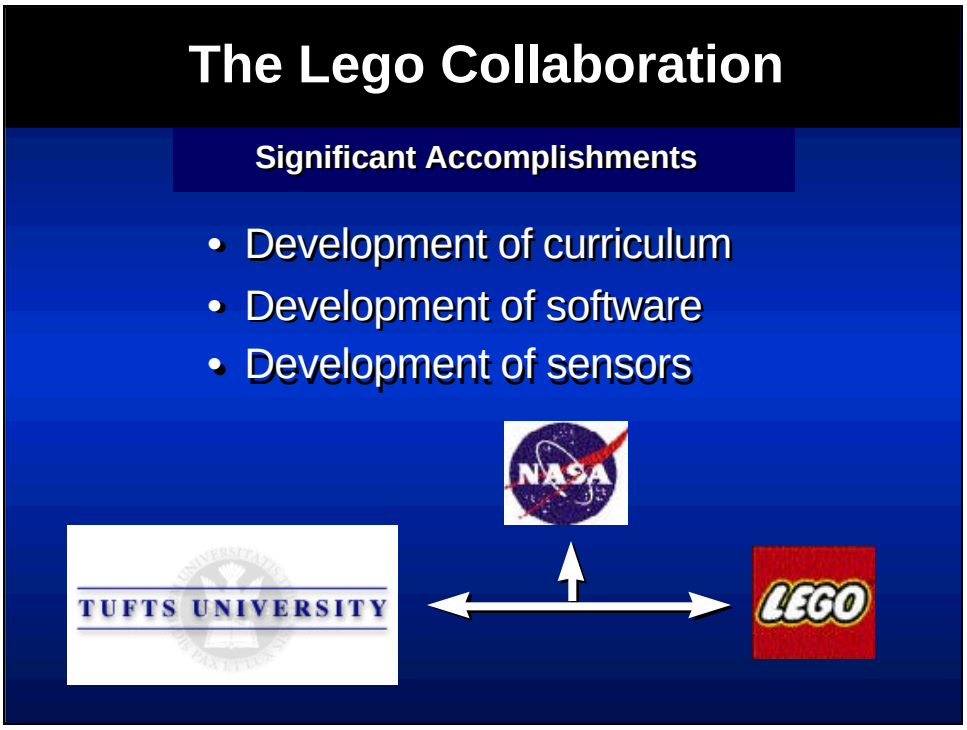
Sustainability of the project is being built through the involvement of the teachers. Most Web sites are built by teachers at their schools so that the program keeps going after grant is over. There are over 100 currently Web sites up or in production.



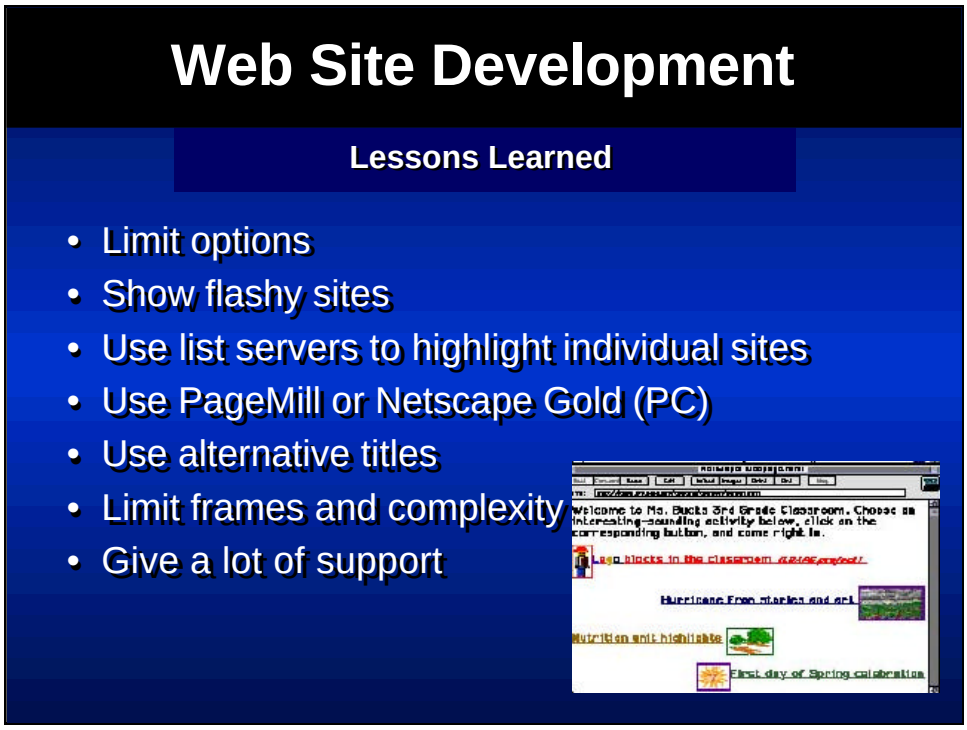
Our Web material is designed to be user-friendly, easily used graphical interface for the students and the teachers.

We have incorporated easy to use programming to encourage students to write their own programs.

We have found that the teachers are also programming their own Web sites.



We have been using the Web to increase the development and use of the science and engineering curricula. We have had a great deal of support for this from our partnership with NASA and Lego. Working with Lego has helped to extend programs and develop additional sensor equipment.

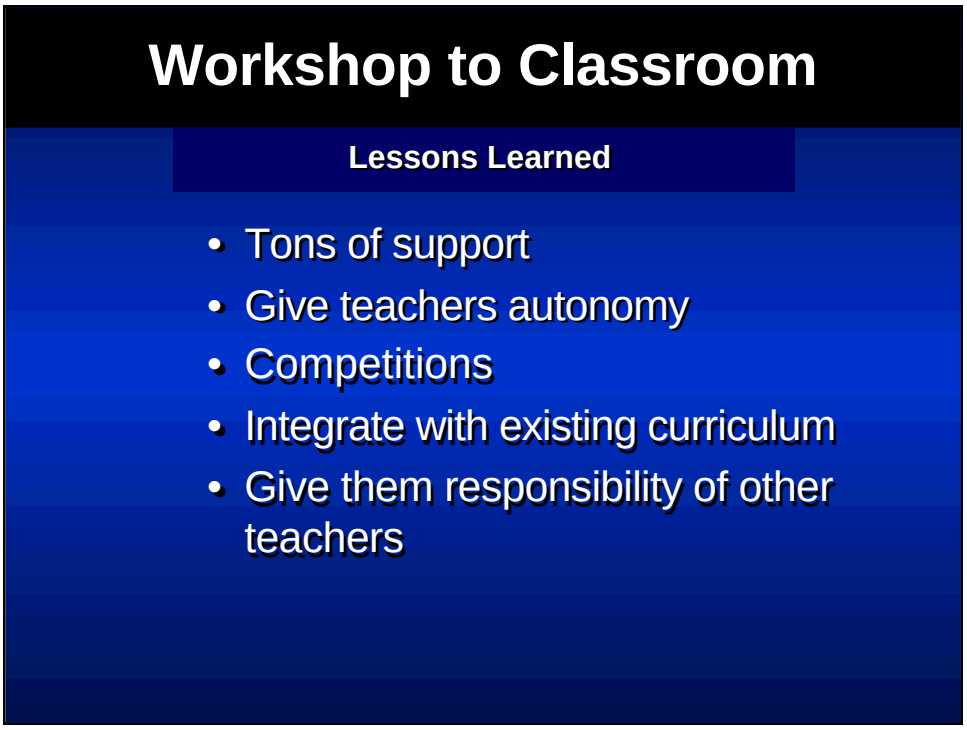


We have learned a lot from our experiences. Limiting the options available on the pages makes it easy for navigation and learning of concepts.

We use “glitz” and flashy sites to grab the students attention and interest. Then we get into fairly plain screens that “get the content across”.

In the workshops we have used contexts and competition to get teachers to find good resource sites on the Web. This encouraged interacting and gaining experience on how to use the Web and how to find material quickly. We also use ListServes to encourage sharing of information and Web site addresses.

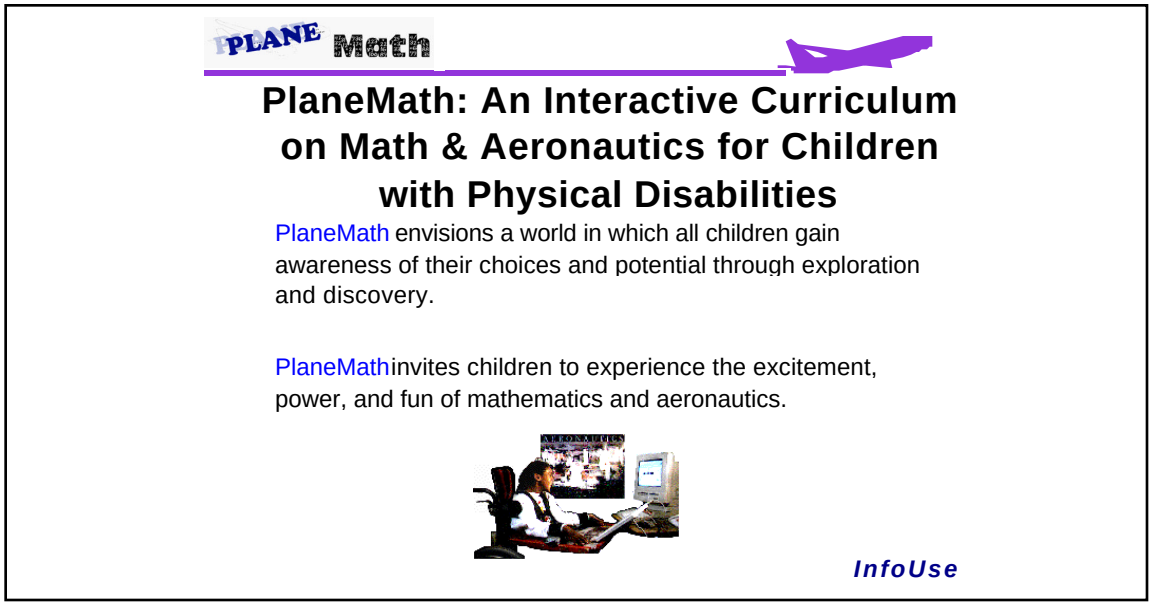
In terms of screen design, we found that simplicity is better. For example, using alternate titles and limiting frames facilitates use of the sites.



Even after the teacher workshops, we found that we needed to go into the classroom and provide support. We encourage teachers to use material the way they want and see as the best use in their class, so they have autonomy to integrate the material into their curriculum and lesson plans.

We also gave the teachers that attended the workshop the responsibility of training other teachers on how to use the technology and material. This has been a great incentive to teacher involvement.

PlaneMath: An Interactive Curriculum on Math and Aeronautics for Children with Disabilities



Presenter and Principal Investigator: Lewis

http://www.PlaneMath.c

PLANE Math

PlaneMath: An Interactive Curriculum on Math & Aeronautics for Children with Physical Disabilities

PlaneMath envisions a world in which children gain awareness of their choices and potential through exploration and discovery.

PlaneMath invites children to experience the excitement, power, and fun of mathematics and aeronautics.

InfoUse

The keyword in the mission is the word “all”. If you design for this population, students with physical disabilities, all students can use the Web site.

In the 3rd or 4th grade, students in this target audience don’t or can’t keep up well in math and aeronautics topics. This program provides a way for students to pursue these topics that otherwise would frustrate and discourage them.

PLANE Math

PlaneMath Goals

- Improve access to mathematics and aeronautics
- Improve mathematics proficiency
- Inspire pursuit of aeronautics-related careers
- Make innovative use of technology, such as digital communication and multimedia

InfoUse

PlaneMath shows these learners that there are not only interesting and exciting careers in aeronautics, but that there are career opportunities for them.

Since PlaneMath has provided better access to math and aeronautics topics through the use of technology, many of the students involved with the program have visited the web site.

Even though the math standards have been incorporated into these lessons, the students are engaged and having fun. “They learn without knowing it.”

PLANE Math

PlaneMath Accomplishments

- **Educational Materials**
  - Posted 9 interactive math lessons on the Web (over 500 pages)
  - Designed aeronautics materials (CD-ROM based)
  - Developed evaluation instruments
  - Coordinated accessibility design with efforts by Department of Education-funded projects
  - Created and distributed Web Access Design guidelines

InfoUse

Web access is less than sufficient for physically disabled students. The PlaneMath developers have made a concerted effort to come up with the Web Access Design Guidelines.

Evaluation instruments have been designed to analyze whether students learned or increased in performance due to the PlaneMath program.

PLANE Math

PlaneMath Accomplishments (cont.)

- **Donations**
  - Match partners - Netscape, Kinko's/Sprint, Progressive Networks (RealAudio), San Francisco International Airport
- **Publications and Presentations**
  - Had articles published in 5 major educational publications
  - Gave presentations at 9 major educational conferences
  - Outreach to 54 national math and education information disseminators

InfoUse

One of the big accomplishments for PlaneMath was establishing and maintaining industry partners. One, for example, was the donation of Kinko's video conferencing time for the project.

Another big player donation was the free RealAudio Server for streaming audio over the Web. San Francisco Airport will run tours for the project.

Partly responsible for success was the marketing efforts, which included:

- Article Publications
- Conference Presentations
- An active outreach to information disseminators

PLANE Math

PlaneMath Accomplishments (cont.)

- **Recognition**
  - Digital Dozen, Eisenhower National Clearinghouse, 11/96
  - Featured on Internet Cafe, PC-TV, on PBS, 2/28/97
  - Selected for inclusion on Classroom Connect CD of Outstanding Web Sites, 1997
  - Site of the Week, www.moms.com, 11/96
- **Teacher Training and Support**
  - Held videoconferenced teacher training
  - Created on-line registration for schools; awarded first of several prizes to randomly-selected registrant

InfoUse

PlaneMath also measures its success by external reviews.

We discovered some of the recognition for using PlaneMath by using the "link" command at the Alta Vista site to get a list of who has visited the site.

Originally, plans did not include offering teacher training. It only became apparent later that teacher training on how to use PlaneMath would be useful. A side benefit to this training was that information about the site was being disseminated--thereby contributing to the marketing efforts of the project.

PLANE Math

Who Are PlaneMath's Registered Classrooms?

- Seven from West Coast, 8 from East Coast, 1 from Arizona
- Serving approximately 475 students, 75 of whom disabilities

InfoUse

Registration has come in very handy. It allowed the program to see where the population using PlaneMath is located.

It also gave a clearer picture of the users themselves. At this point in time, after one month of the registration being online, we registered 16 schools with 75 students of 475 being served having disabilities.

(Two weeks later, we had 32 schools registered.)

PLANE Math

Instructional Design Lessons Learned

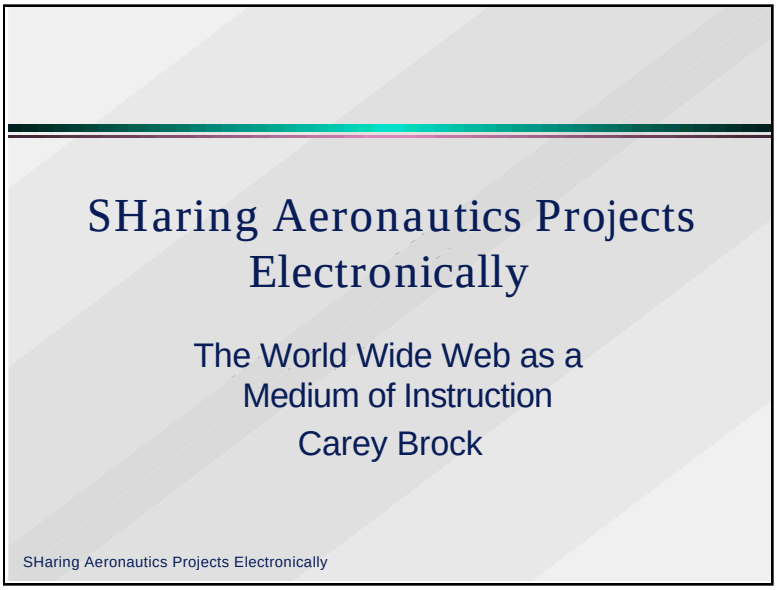
- Need for interactivity beyond question/answer (CD-ROM)
- Need to address multiple learning styles (upcoming activities are historical and aeronautics-based)
- Limitations in capability of the Web, assistive devices, and technology in schools

InfoUse

The program staff has learned much during its development. At this point, the access capabilities of the average Web user limits the amount of needed interactivity.

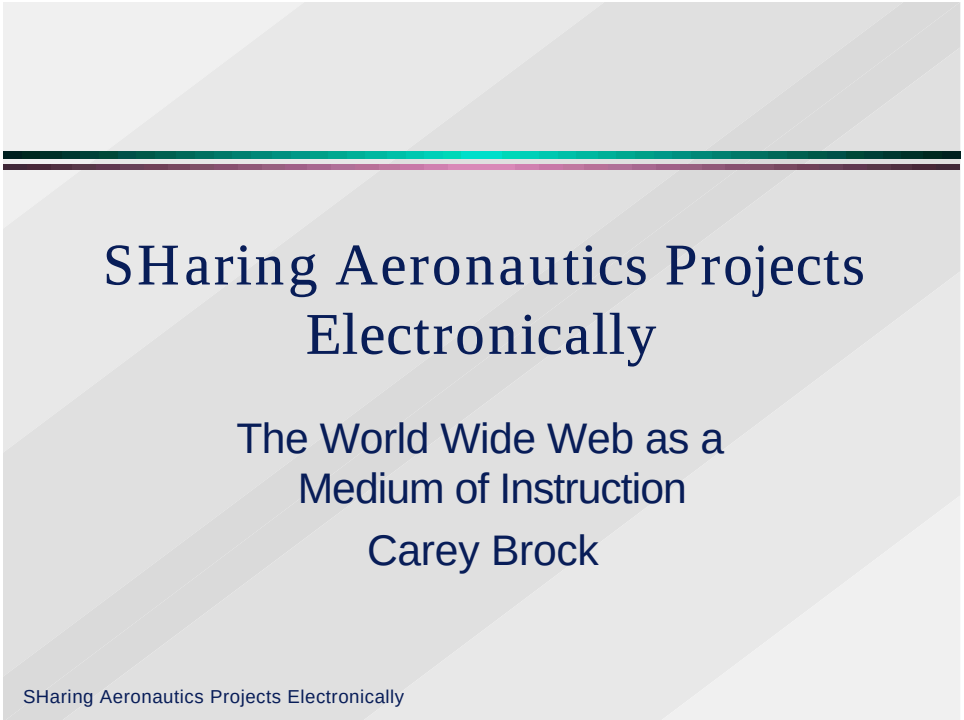
There is also a need to address multiple learning styles as well as the limitations faced when developing a program of this type.

SHaring Aeronautics Projects Electronically



Presenter: Carey Brock
Principal Investigator: Dr. Judy Fish

http://trc.dfrc.nasa.gov/shape
(updated slides unavailable)



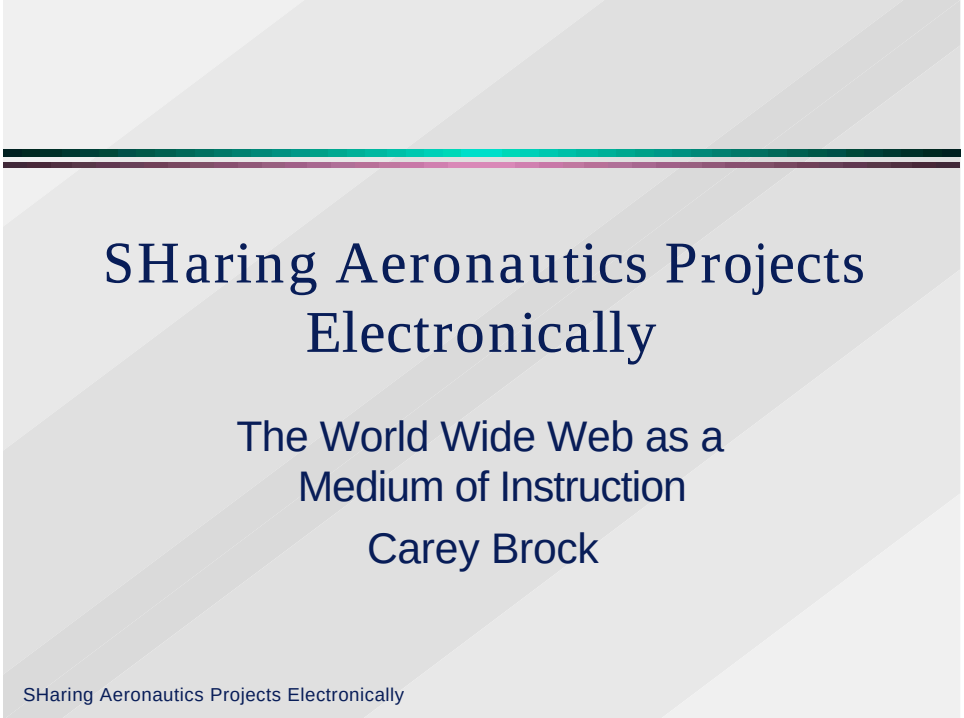
SHAPE is a project that is not “top down”. This is a program that lives where “the rubber meets the road”. It has a collaboration with two school districts: Antelope Valley Union High School District and the Palmdale School District.

There is a high usage of community partners. Retired engineers volunteer their time and knowledge to different aspects of the program.

Even before motivating students to use this program, project team members need to reach and support teachers.

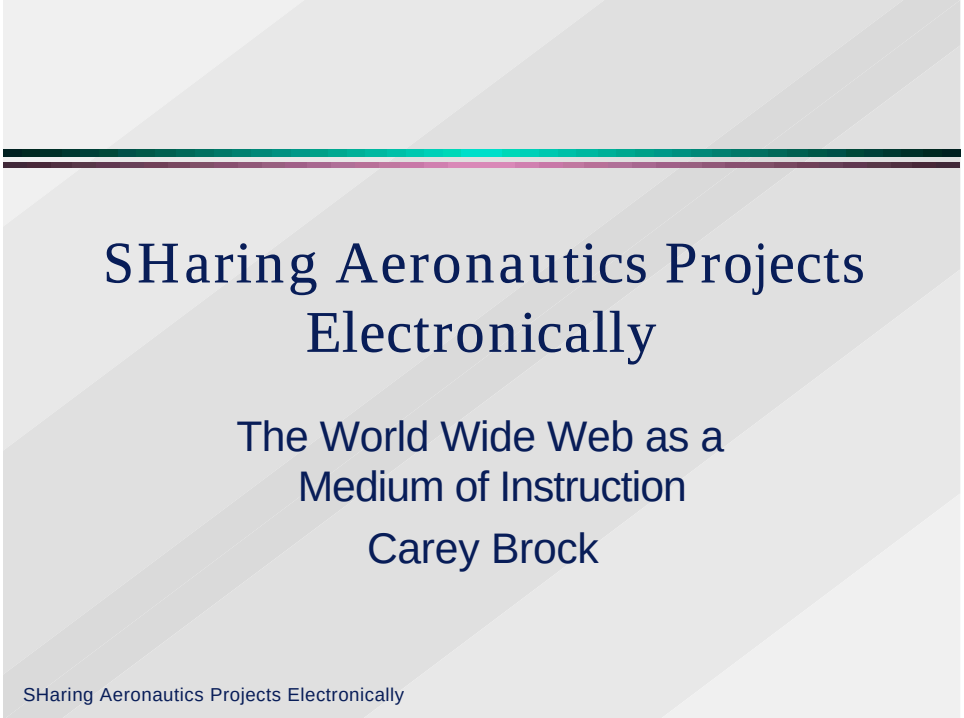
Another issue is that the curriculum that is mandated by the districts has to be addressed.

A quote from an interview: “The first year out of college is where the real world application happens.” From this quote, the SHAPE team realized that there is a need to apply content to the real world in the early years of education.



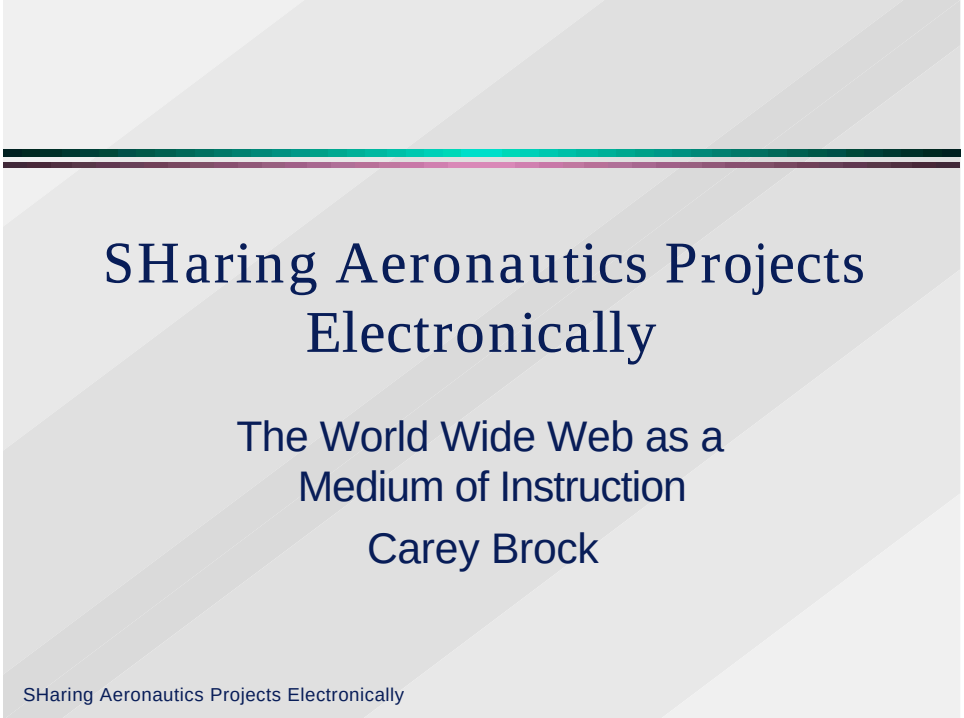
This program takes advantage of some of the capabilities of technology. SHAPE gives the students real world information such as flight plans or weather conditions. The students are then faced with a decision point of what the pilot should do next.

This is a very engaging technique especially if you can visually represent every decision point.



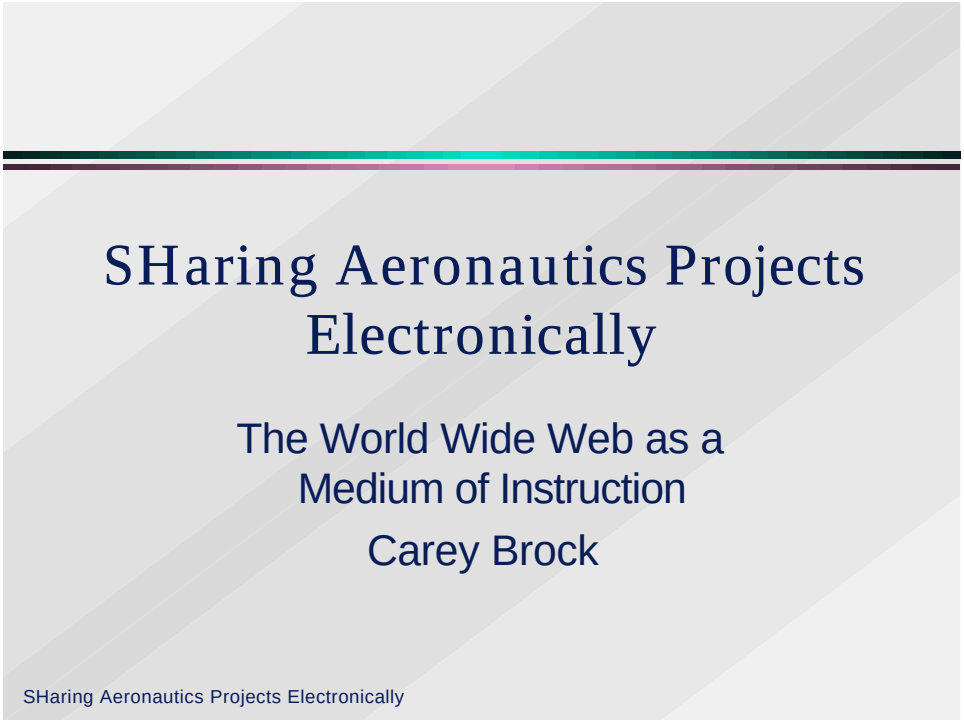
The first step for developing the SHAPE curriculum is to take narrative(s) to the educator and allow the teacher to teach what they can and what they know will reach their kids. Community partners and engineers go back and revise their content, while the teachers develop classroom activities.

During the development, the community partners and teachers collaborate. From this collaboration, students get relevant and applicable activities for the classroom.



SHAPE found that teachers have a huge range for what they were willing to do. Some were completely willing to integrate the SHAPE into the entire curriculum, while others wanted very little involvement. It may take a visit and some time to show them how they can use SHAPE (or any other program).

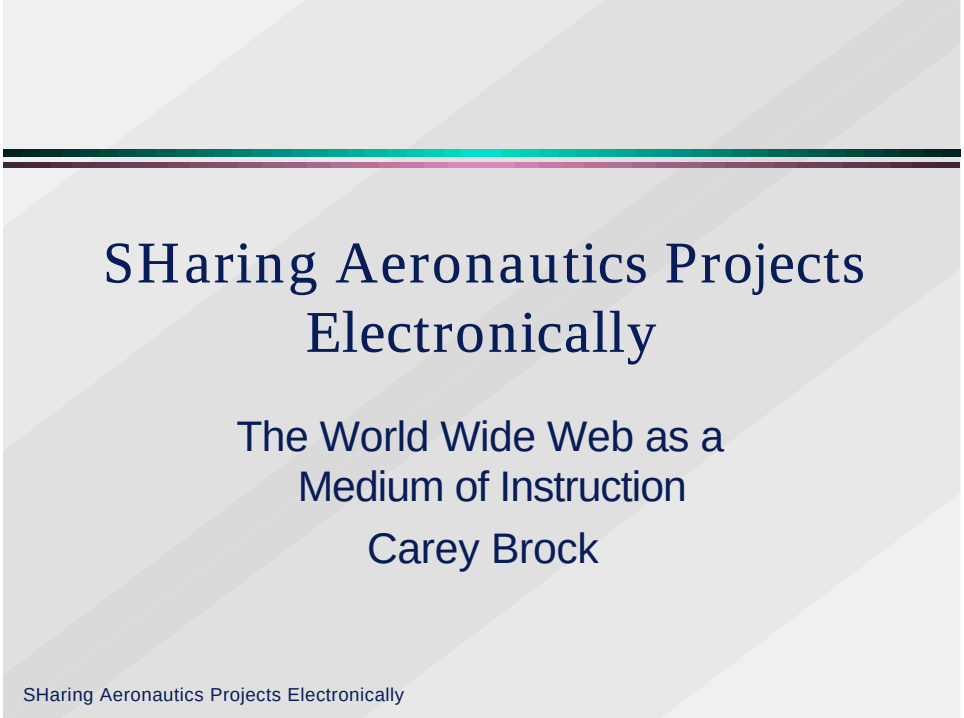
High School teachers were a little different than the elementary teachers. They had a more difficult time integrating SHAPE into their classroom. One reason for this is that high school teachers tend to have a class to themselves and are less willing to accept external “influences”.



With expectations, you can assume that there would be a range. End users of SHAPE were on either end-- either blown away or “where’s the 3D”? Some were amazed at the things on the Web *or* were disappointed because they were comparing the speed of animations etc. to that of the CD-ROM technology.

Everyone, teachers and students alike, want animations and they want them quick!

Future plans include adding animations at decision points. Another addition would be to formalize the problem solving process.



For teachers to use SHAPE successfully, a “teacher interface” may be added. This could be a search engine. A suggestion made by ALLSTAR was that there are products available that have free search engines. Another comment added that search engines are better utilized if the sites or information that is being searched is organized in a useful manner.

Student Program for Aeronautics Resources Knowledge

Idaho SPARK

Student Program for Aeronautics Resources Knowledge

PIs: David Atkinson, EE
Isabel Bond, Upward Bound
Kay Brothers, Director

University of Idaho

1

Presenter: Kay
Principal Investigators: David Atkinson and Isabel

http://nasaui.ited.uidaho.

Idaho SPARK

Student Program for Aeronautics Resources Knowledge

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University of Idaho

1

The purpose of SPARK follows the educational strategy for NASA to reach under-represented groups.

Those Involved

- C & S Tek
- First Step Research
- Idaho Division of Aeronautics
- Idaho National Engineering Laboratory
- Idaho Space Grant Consortium
- Interstate Aviation
- NASA IITA Office
- Public Schools
  Lakeside, Potlatch, Lapwai
- University of Idaho
- Upward Bound

2

Ten key members comprise the Idaho SPARK team.

GOALS

- To increase interest, awareness, and knowledge of aeronautics in grades 9-12.
- To increase information and support mechanisms for students and faculty.
- To link Native American, rural and urban communities of Idaho to the world through use of the Internet.

3

The audience that SPARK reached is very specific. Every summer Upward Bound brings students onto campus that “matched” NASA’s educational strategy. SPARK and Upward Bound paired up to deliver a needed curriculum to a practically captive audience.

There is a similarity to PlaneMath. If you reach this group; you can reach “any” group.

SPARK: Curriculum

Aeronautical Studies

- Acceleration
- Gravity
- Newton's Laws
- Vectors to represent forces
- Principles of Aerodynamics

Human Factors

- Memory
- Forces used in controls
- Operating controls
- Effects of gravity
- Physical restriction
- Mental exertion

4

The SPARK curriculum was made up of two areas: aeronautical studies and human factors. The aeronautical studies dealt with acceleration, gravity, Newton's laws, vectors, and the principles of aerodynamics while the human factors component dealt with memory, controls, effects of gravity, physical restriction and mental exertion.

Accomplishments

- Provided Aeronautics and Internet in-service training to 40 public and tribal school teachers and pre-service teachers.
- Delivered Aeronautics and Internet instruction to 60 rural, Native American and disadvantaged youth through a six week residential summer program.

5

The SPARK program also delivered Aeronautics and Internet in-service training. The training was leveraged so that the schools picked up the rest of the training. Names and contacts were also provided to do in-service training if the school could not do it.

SPARK was able to create the curriculum for a 6 week residential program. In this time period, the program was delivered to 60 rural, Native American, and disadvantaged students.

Accomplishments

- Established a support mechanism for teachers and students as they learn more about Aeronautics and the Internet.
- Collaborated with Salish-Kootenai College.
- Secured another industry partner
  Interstate Aviation

6

SPARK established further support for teachers and the students while securing further partnerships.

Lessons Learned

- It is difficult to establish group on the Internet
  - **»Offers the ability to shine**
- School timelines are not always our timelines
  - **»Needed to get real buy in**

7

One of the most difficult hurdles is “How does one establish group identity?”

The Internet facilitates this by providing the resources to make that group. Now, students can have the capabilities to have ownership to a “product.”

Another difficulty is that the timelines that SPARK works on are not the same as the school’s timeline. There was a need to have a total commitment from the teachers and Upward Bound.

Lessons Learned

- It is difficult to convey the essence of the project on the Internet
  - **»Student favorites**
  - **»Interactive activities**

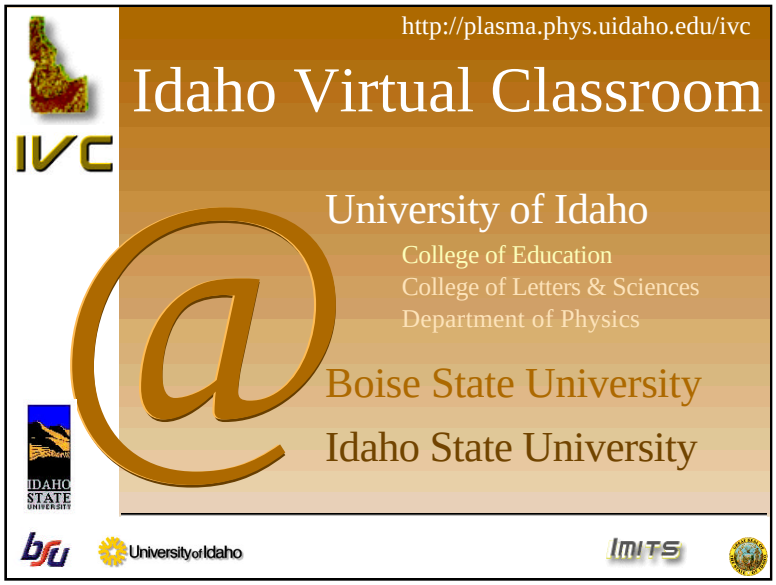
8

SPARK offers resources to appropriate subject populations. One of the resources is a place where the students can develop and showcase their own projects or Web pages.

In another area, students can address aeronautics issues into which they want further insight.

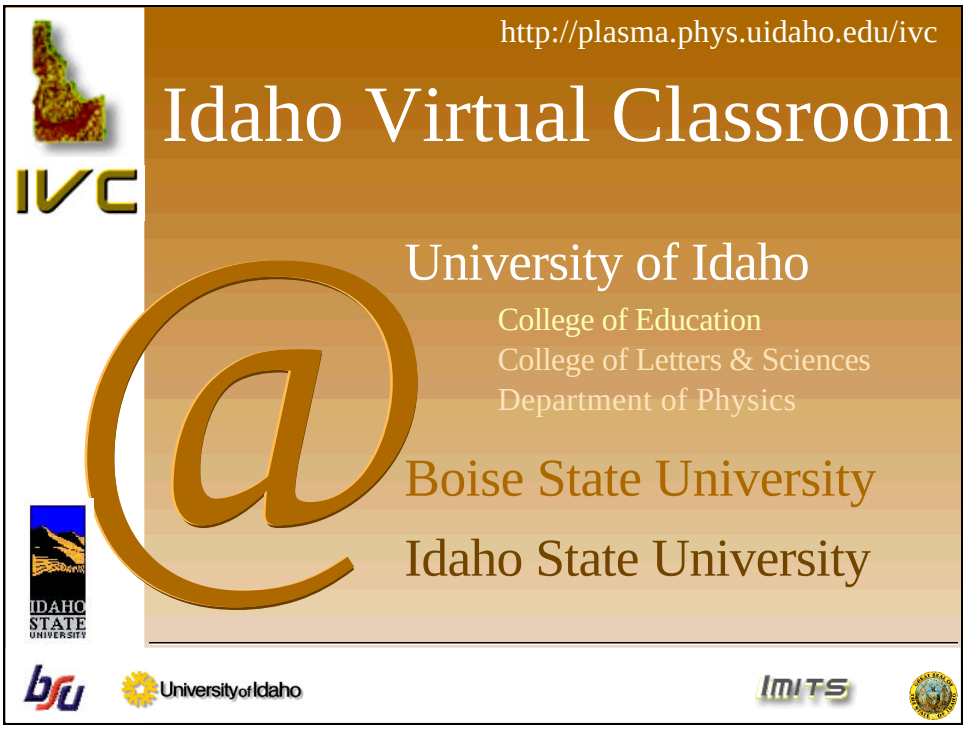
These students need a high number of visuals. The Internet allows us to use interactive activities such as developing Web pages through the use of a CGI programmed form.

Idaho Virtual Classroom



Presenter: Dr. Mike Odell

http://plasma.phys.uidaho.edu/ivc

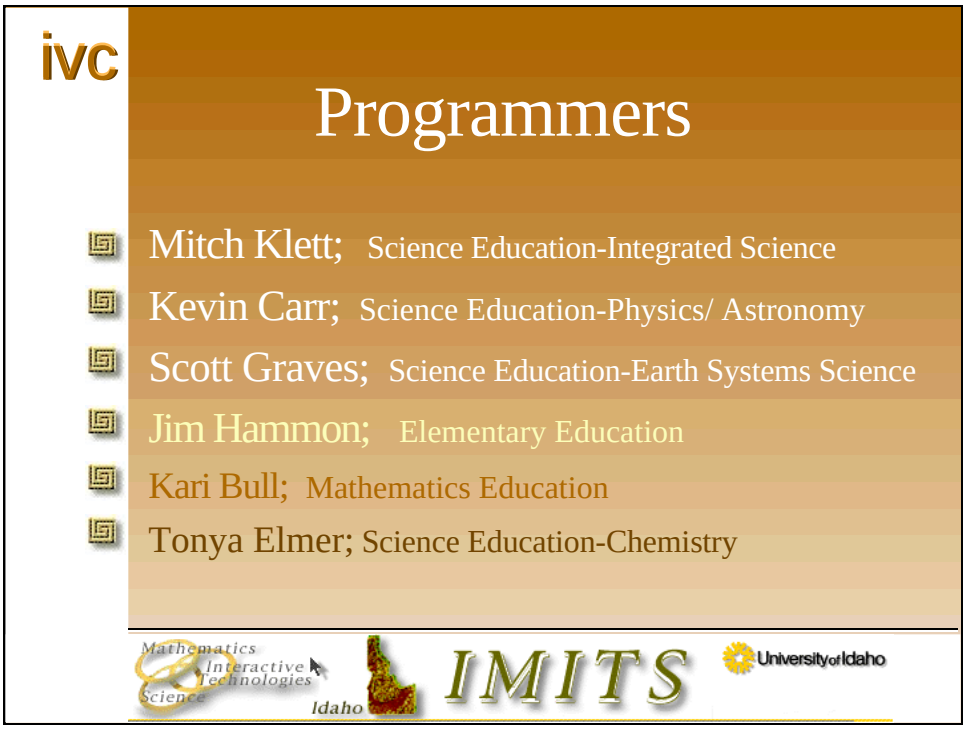


Mike Odell introduced himself and the project.

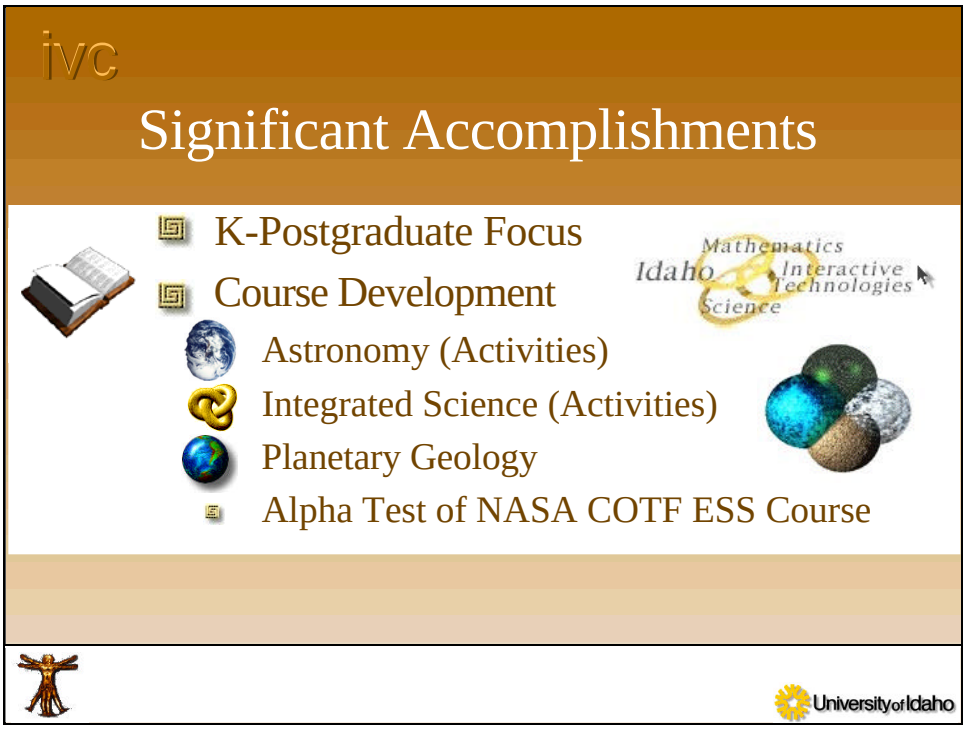
Interactivity means different things in different parts of Idaho. The Virtual Classroom program has a different focus than the other NASA programs. Its focus is on K-12 teachers. The virtual classroom models itself after a correspondence course, except that it is very interactive.

Another value of the program is that it does not want to develop*more* curricula, but rather take existing curricula and make it interactive and available.

The project staff comes from all over Idaho.



It is vital to have a staff with programming know-how. Our funding is low and any way to get help is fair game. There are two graduate students on staff who supervise all the programming done by undergraduates.

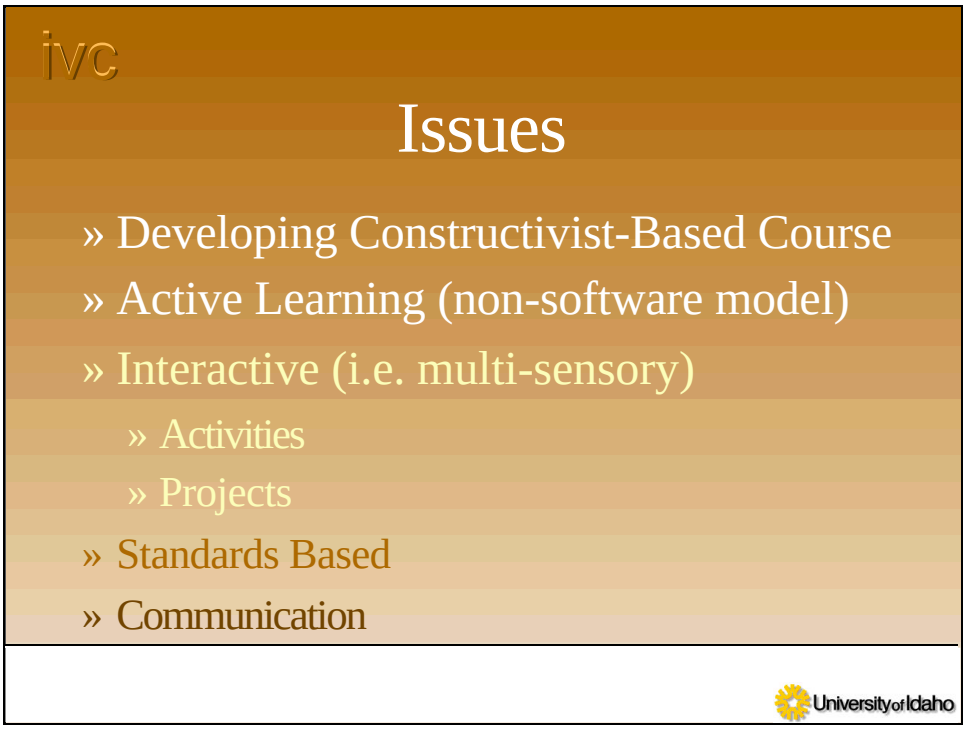


We developed three courses and a fourth which is being alpha tested for the Classroom of the Future in Wheeling, West Virginia.

The K-postgraduate focus creates activities that have to be done in teachers' classrooms and not just "for homework". The power of the Internet can offer global connection. This would allow for great amount of interaction. Interaction in this case means student to student (remember the students are the K-12 teachers). One activity allows students to collect data from different students in different places.

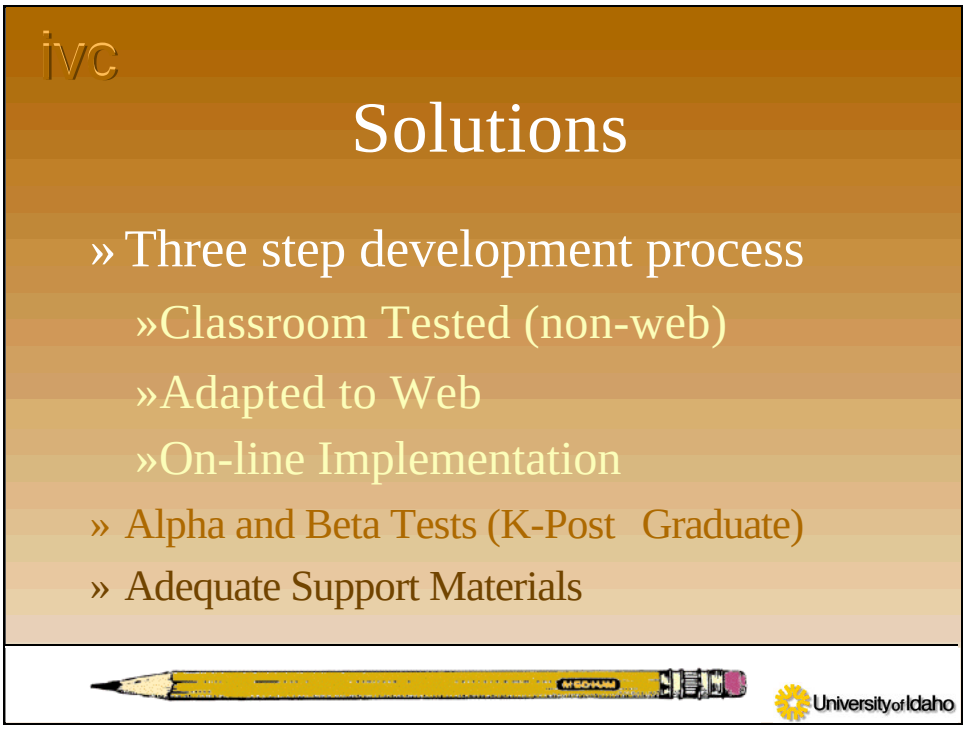
The Virtual Classroom group has also developed and delivered workshops for Idaho faculty, taken existing courses and added a Web component to them, and finally, implemented full on-line courses.

Again, there is emphasis not to develop new curricula. There was a concerted effort by our development team to find existing science courses and apply Web-based interactivity to them. A long term goal is to establish on-line certification and degrees.



How does one develop augmentation using Constructivist learning theory? One way is to model courses on the Web with modifications for interactivity. For example, you can find information on the Web, go do an activity and then come back to report findings.

You also need to ask yourself how to accomplish this and what someone needs to know to participate.



One way to be successful with this type of project is to have a strategy up front. Our group has a three step development process.

One major focus is to test materials thoroughly and to make sure that the materials go through alpha and beta testing. Another aspect to keep in mind for success is to provide adequate support materials.

The program has been designed to work with the “one-computer” classroom. The activities and interactivities can still be carried out because there isn’t that dependency to stay at the PC the entire time.

Here is a list of Web sites developed by the Virtual Classroom group.

Issue Selection

ISSUE SELECTION

Process for Selecting Issues

The goal of the conference was to evaluate the significant accomplishments and lessons learned by the K-14 Aeronautics Cooperative Agreement (CA) teams in the development of instructional programs which are delivered via the WWW. A six phase strategy was selected to invoke collaboration on the identification and description of best practices for designing instruction to be delivered via the WWW.

1. Prior to the conference, eight topics were compiled from the following sources:
    - attendance at IITA quarterly meetings,
    - participation in small group and informal discussions,
    - participation in and evaluation of the Dryden Electronic Mainstream Project,
    - reports from the DFRC Aeronautics Cooperative Agreements projects, and
    - investigations from a jointly taught course by NASA Dryden and Penn State University.
2. Participants were asked to prepare a presentation to the group that emphasized their significant accomplishments and lessons learned. The purpose of the lessons learned requirement was to provoke reflection on what worked and what did not rather than on simply providing an overview of their project and significant accomplishments.
3. At the conference, the participants were provided a form on which to write questions for the other participants and issues that were brought to mind.
4. At the end of the presentations, the participants were asked to write down their most significant problem which was solved and then identify one for which they are continuing to seek resolution. Using this process, nine problem areas were identified. What was important about this list was that several of the unresolved problems from one group matched those resolved by others.
5. The input from each of these steps were summarized into a list of the most important issues about Web-based development.
6. From this list, participants selected five key areas for discussion during the working sessions.

Using this process, the majority of the participants (fourteen out of eighteen) felt that the most significant issues related to designing instruction for the WWW were identified. Two participants indicated that they expected the conference would be more focused on technology issues. Two participants indicated that the format and the time constraints of the program were limiting.

Summary of the Issues Identified

The six-phase strategy yielded seven broad issues and fifteen major sub-issues. These topics and their sub-categories include:

1. Teachers:
    - Teacher training
    - Teacher motivation
    - Administrative support
    - Technical support
    - Teacher expectations of the Web

2. Curriculum:
    - Integration with existing curriculum

3. Schools:
    - Access to the Web
    - Access to NASA materials
    - Access to being involved in NASA funded projects

4. Web development:
    - Appropriate use of the Web for instruction
    - Interactivity
    - Adapting to multiple learning styles and cultures
    - Student assessment

5. Web technology:
    - Speed of downloading and access to sites
    - Design strategies to ease locating information and navigating the Web
    - Constantly emerging hardware and software

6. Web evaluation:
    - Evaluation of the effectiveness of Web-based materials

7. Project administration:
    - Development timelines
    - Dissemination
    - Project evaluation

Issues Selected For the Working Session Discussions

After votes and discussion, the following five areas were selected as topics to discuss during the working sessions:

- Teacher issues--included in this topic were issues such as administrative support, curriculum integration, teacher training and support, teacher motivation, teacher expectations and National Education Standards.
- Evaluation--included in this topic were issues such as how to develop appropriate Web-based student assessment, how to gather data for EDCATS evaluation, how to incorporate National Education Standards, and how to conduct appropriate project evaluation.
- Pedagogy--included in this topic were issues such as creating Web sites that adapt to multiple audiences or ones that accommodate different learning styles and cultural differences, and incorporating development strategies that exemplify a broad definition of interactivity.
- Marketing--included in this topic were issues such as establishing partnerships, scaling the project to reach a broader audience, and finding continued funding once the NASA sponsorship has ended.
- Technology-- included in this topic were access issues related to speed and navigation, continuously changing software and hardware capabilities, and software advances that enable student manipulation and data entry which make Web-based lessons interactive and engaging.

Since there were only three people who indicated an interest in participating in the marketing discussions, it was eliminated from the working session topics and pedagogy was divided into two subgroups. Each of the two subgroups selected the areas under pedagogy that would be discussed.

Were the Top Issues Identified and Discussed?

Twelve out of seventeen participants felt that the relevant issues were raised (one participant did not respond). One participant felt that the group needed to be able to address technology, particularly "glitz," to explore the issue of the technology driving the CA product versus content driving product development. Another participant indicated that "other goals" were "promised" in an earlier meeting, but did not indicate what goals they felt were omitted from this conference. Moreover, the participant referred to feeling uncomfortable with the "spectre" of NASA management. One participant wanted to spend more time discussing the discrepancies between their projects' initial goals and unexpected problems during the implementation phase of the projects and indicated the need to identify ways to maximize available resources to meet modified expectations. One participant felt the need to discuss the issue of marketing and "resources support by

NASA (pictures, etc.)". Another participant felt the issues were addressed but was not comfortable with "the degree of multiple solutions."

When asked if the "top" issues were discussed, fourteen participants indicated that they felt the top issues were discussed. One participant felt that "new technology" and "bringing it into the classroom with one teacher and computer" needed to be discussed with greater depth. Scalability, future funding and "strategies for survival lacked sufficient exploration" according to another participant. One participant "liked the flexibility of the conference and being able to change to what we wanted to focus on." Another wrote that the major topics were not covered because "even though only 3 people signed up for marketing, the group should have met." One participant responded to this question by indicating that "issues outside the scope of the project should receive very little discussion time, examples are national teacher training and teacher/school training" but did not indicate which issues were omitted, while another participant felt that they did not have enough time to discuss teacher support.

The majority of the participants felt that they had adequate input into identifying the issues discussed at the conference (fourteen out of seventeen; one participant did not respond). With regard to what aspects of the conference impeded their input, one participant indicated that they did not have adequate input but did not identify what impeded their input. Another wrote, "trying to make an outline by committee is difficult, to say the least, and inefficient. Perhaps assessing the needs and proposing the topics ahead of time would be more efficient." Three participants who felt they had adequate input had comments about the process of the working sessions. One wrote that they were "a little uncomfortable with some of the process and some of the dance between process and logistics" and another wished that the sessions "had been moderated' a little better in regards to people who were 'interrupting' others too much." A third participant wrote that "clarifying issues could have been done at the same time as identifying" and "since we [were clarifying] the topic to the small groups, the gist of what someone's issue was may not have always been given or understood." Two participants mentioned time as a factor affecting their input and their ability to discuss all of the issues with depth adding, "but that is to be expected."

With regard to the aspects of the conference that facilitated input, one participant referred to "the structure of the conference and the facilitators," and another to the "informal atmosphere" which "facilitated a more realistic (and honest) attitude" adding that "no NASA headquarters officials might have helped."

Working Sessions

WORKING SESSION: EVALUATION

Participants

Carey Brock, Kay Brothers, Christiy Budenbender, Francesca Casella, Lee Duke, Barbara Grabowski, Scott Graves, Angel Hernandez, Jay Jeffries, Lewis Kraus, Beth Lewandowski, Sam Massenberg, Mike Odell, Jani Pallis, Chris Rogers

Issue Clarification

Definition

Evaluation was defined as the means of determining the value of a NASA program. The group divided this issue into three areas of concern.

NASA Evaluation

Concerns for refunding or continuation of a program fueled a discussion about how to develop a product so that it will "survive" a NASA evaluation. NASA's Education Computer Aided Tracking System (EDCATS) was discussed as a new evaluation tool which was unfamiliar to some of the participants. More uncertainties arose with the discussion of NASA's education strategy and goals. Problems were discussed and suggestions offered to resolve some of this lack of clarity. In this section, the role of EDCATS, Executive Order #12999, and NASA's educational strategy were used to convey how NASA measures the success of a program and what developers need to know and do to provide that information.

Project Evaluation

Evaluation of each project is determined by one's project goals, making this process different for each project. However, discussions provided insight into the process and the outcomes of evaluations that might be common across projects. Also, evaluation as a whole was divided into formative and summative stages. The former occurs during the development of the program and the latter as a means to measure program impact at the end.

Web Evaluation

Evaluation of the Web materials was separated from project evaluation. Since the focus of the workshop was on Web development, discussions in this section related to strategies for determining the effectiveness of their Web sites in terms of learning outcomes. Many caveats were provided arising from the identified limitations of the World Wide Web.

Problems and Solutions

NASA Evaluation

Problem:

The group noted that their understanding about how NASA evaluated programs was unclear. EDCATS was used as an example. Some members expressed that there were no clear rules about how to fill out the EDCATS forms. Also, there was some indication that because EDCATS was new, or arrived in the middle of some of the projects, its purpose and role in their project was also unclear.

One specific example of this uncertainty was demonstrated in a situation in which project managers felt there was no place in the EDCATS form to show impact specific to their projects.

Solution:

The point was made that regardless of the discomfort people had with the system, EDCATS was required. The impact data mentioned above, were referred to as "below the fence items."

One participant recommended that, "A way to do both is to *do* both. Enter the data requested by the form, and enter the 'below the fence' items too." For assistance in completing this form, participants were strongly encouraged to call the Headquarters contact directly.

Problem:

Given that a program's impact was equated with success, project participants felt uncomfortable since they did not feel they had a clear understanding of NASA's criteria for successful impact. In addition, this discomfort was heightened since it appeared that continued funding would be determined by project impact.

Solution:

Recommendations were offered to help project team members align their projects with NASA goals and missions by reviewing several NASA documents. Listed in the discussion were:

- Executive Order #12999
- The NASA Strategic Plan
- The Strategic Plan for Education
- Draft of Educational Plan for the Office of Aeronautics and Space Transportation Technologies.

The NASA Strategic Plan and the Strategic Plan for Education are available on the World Wide Web and in print.

Project Evaluation

Problem:

One problem faced by participants was determining by whom, how, and on what criteria their programs should be evaluated. There was agreement among the group that evaluation is comprised of two stages: formative and summative, however, they did not have a clear understanding of the purpose or what information would be gathered during each stage. Finally, the group noted that determining criteria was problematic because the project team was having difficulty defining success.

Solution:

Formative evaluation is conducted while the product is still in the development phase, even though the product may be in alpha or beta tests. This part of the evaluation identifies problem areas—be they technological or pedagogical. Summative evaluation is conducted when the program is released. During the summative evaluation stage, information is gathered that indicates if the program succeeded.

Some participants suggested that success meant meeting one's defined goals when the project has been implemented. They felt that determining the indicators of success should have been addressed at the proposal stage; however, if they were not, they should be specified as soon as possible. These indicators are developed from project specific as well as NASA missions and goals.

Problem:

Measuring the accuracy of Web content was identified as a major problem. Teachers and developers, for the most part, are not content experts. The technical level of the content may make it difficult to deliver accurate lesson materials.

Solution:

A majority of the participants suggested allowing enough time to do research on the related content. This solution, though logical, may not be reasonable considering the time constraints. Another suggestion was an external content review. Other content experts can be invited to review the Web site for content accuracy.

Problem:

Assessing the impact on students was another identified problem area. Assessing students can provide developers with challenges at many different levels. Besides the issue of selecting appropriate measures of assessment, technological capability may limit collecting those appropriate measures *via* the Web. Another less familiar problem with assessment was the legal issue of collecting data without parental permission, as one participant shared.

Solution:

There were several logistical issues that participants suggested that required careful examination. One participant suggested that impact on students should be measured in ways which require learners to *apply concepts* rather than just regurgitate the facts of the lesson.

Another solution focused on long term effects. One way a program can measure success is to look for an increase in career choices related to the careers represented in the program. The participants recommended that a checklist be developed with preferred *task* choices rather than *career* choices. Inference could then be made based on the selection of tasks that relate to various careers.

With regard to the legality of collecting data on students, developers should inquire about the necessity of acquiring parental permission prior to using the data in any public reports. The Federal government developed guidelines to protect the rights of human subjects. Advice about these rights can be obtained from the Office of Human Compliance of any University or Governmental Agency.

Problem:

While the group agreed with the importance of evaluating the impact of their project during the summative evaluation stage by examining the teacher's ability to use their programs, they felt they needed strategies for determining this impact.

Solution:

Participants agreed that if teachers were given a Web site which offered multiple implementation suggestions for the classroom, and were asked to select their own strategies, there would be a greater likelihood of the site being used. Enabling teachers to make changes to a program also may instill a better sense of comfort with using the site.

Web Evaluation

Problem:

Participants needed strategies for evaluating the effectiveness of their Web sites. They were also seeking evaluation strategies which could be carried out over the Web.

Solution:

Participants offered many suggestions on how to get a Web site evaluated. One shared experiences about registering a Web site with different agencies and companies. As an example, there are a few companies whose mission it is to evaluate different aspects of Web sites. Other agencies and companies mirror sites

or link to them in order to make the sites more accessible to those who are looking to evaluate sites. Another suggestion was to disseminate the site or URL to peers and request reviews.

A recommended Web-based strategy to evaluate or get feedback from students was to create and implement easy-to-use forms (CGIs) in which students could enter responses and send them back to the instructor. The use of reflective questions was suggested as a means for assessing higher order learning in addition to the basic understanding of the facts.

Another option for assessing student learning is to use pre- and post-surveys. The WWW can be used to collect and sort this type of information. One participant shared that there are databases available to analyze this type of data.

Since students can now use the WWW and make their own site, students can be measured in different ways, such as innovativeness and conceptual understanding. As students continue to learn a topic and create their own Web site, their changing Web site can also be evaluated for any indication of change in their understanding of the content studied.

The development of rubrics was stressed to assess student learning. By establishing clear goals for students and a checklist against which to measure achievement of these goals, developers gain a clearer understanding of the impact of their sites.

One recommendation that was emphasized was *not* to use the Web as a means for collecting assessment data. The participants suggested that using tried and true teacher methods of testing students “off-line” may still be a legitimate method for assessing what has been learned via the WWW.

WORKING SESSION: PEDAGOGY

Participants

Joel Albright, Carey Brock, Kay Brothers, Christiy Budenbender, Francesca Casella, Lee Duke, Molly Frey, Barbara Grabowski, Scott Graves, Angel Hernandez, Jay Jefferies, Mitch Klett, Tiffany Koszalka, Lewis Kraus, Yair Levy, Beth Lewandowski, Marianne McCarthy, Sam Massenberg, Mike Odell, Jani Pallis, Lisa Peite, Chris Rogers, Tom Schieffer

Issue Clarification

Definition

Pedagogy is defined as the art, science, or profession of teaching. In this session, the participants were asked to address issues related to how the WWW could best be used in the classroom. From this question, the two groups divided the issue of pedagogy into five areas. While all of the areas represent best and appropriate uses of the WWW, they were significant enough to warrant separate discussions.

Best and Appropriate Uses of the Web

Best and appropriate use of the WWW was discussed in terms of the profile of the end user, role-modeling strategies, providing student-driven activities, context-setting, and strategies for teacher facilitation of learner-driven activities.

Providing interactive access and interconnectedness to the world, providing a non-threatening means for obtaining information, and providing real-time information from one point of access were considered to exemplify best uses of the WWW. The group also considered best characteristics as helping to break down social barriers and providing a learning environment in which students can proceed at their own pace through a powerful graphical interface.

Interactivity

Interactivity was defined as a two-way transaction that occurs between two entities--such as a person and a computer, several people and a computer or among several people regardless of location. The potential of the WWW offers the teacher opportunities for teaching interactions that may be slightly or radically different from current teaching practices.

Identifying the purpose of any interaction is very important when using the WWW. For example, the purpose of the interaction may be to gain student's attention, engage

students or help students learn. Issues regarding the appropriate use of the WWW for creating an interactive learning environment can include resource use, communication, collaboration, or role playing in which students or teachers interact with other people in different locations.

Individual Learning Styles and Cultural Differences

Learning styles and cultural differences included a discussion of learning preferences and special populations (deaf, visually impaired, physically handicapped, etc.) in the context of interactivity and the learning environment.

Learning Environment

The environment issues having the greatest effect on learning and effective Web-based instruction were defined as follows: technical configuration, physical setting, interactivity outside the Web site, interdisciplinary teaching, changes in teacher roles from lecturer to facilitator, application of different learning strategies to the WWW, and teachers adaptation to student preferences and learning styles.

National Education Standards

Participants felt that there were three major issues involving education standards: conforming to the National Science and Mathematics Standards, state and local districts' resistance to using National Education Standards, and the requirement for teachers to teach at a concept versus a fact level.

Problems and Solutions

Best and Appropriate Use of the Web

Problems:

When the lesson is designed to use the WWW in traditional classroom activities or to research information, it may not fully engage the student.

Solutions:

Design Web pages to support quick information searches and provide a motivational front-end to draw the student into the content. Web pages do not necessarily have to be the only learning activity to be effective.

Problems:

The WWW is often used as a repository for lesson plans for teachers. One problem is that materials cannot always be easily located. There was also a

question as to whether teachers *should* use existing lesson plans found on the WWW or whether they should create their own lessons from content they find on the WWW. This question presents a dilemma for NASA as to whether they should develop more lesson-based Web sites, develop a tool to help teachers find useful content and informational Web sites, or develop specialized curricula.

Solutions:

The participants felt that teachers should build their own Web pages to create autonomy and comfort with the use of the WWW.

They also felt that strategies and instructions should be provided to teachers to encourage them to identify content relevant to students before using their WWW activities. They recommended that teachers start their lessons with activities outside the WWW, motivate students to want to know something about the topic, and then introduce the WWW to explore, collaborate, and interact with the lesson. Other strategies included keeping activities, screen designs, and content concepts simple, avoiding frames, which can be distracting, unless there is a critical need, and avoiding scrolling, since it is difficult for younger students and those with physical disabilities to manipulate.

Problems:

Quality assurance is an issue when using the WWW because content accuracy of Web sites, in general, is not necessarily guaranteed and links may not always be appropriate or “live”.

Solutions:

No solutions were suggested by the group, although the issue of content accuracy of NASA projects was addressed in the session on evaluation.

Other recommendations for best and appropriate use of the WWW:

Recommend to other Web developers a team approach which includes a content expert, designer, programmer, target audience member, and target teacher support.

Web sites should tell students how to use the WWW to accomplish an activity. Instructions and navigation should be clear and concise.

Electronic journals should be used to provide the students with an opportunity to provide the teacher with reflective, honest feedback on the lessons and use of technology. To be effective, the electronic journal needs to be a mandatory part of the class.

To reduce the complexity of learning how to use technology and the WWW, the number of navigation and interactive options should be limited at first. Then, as the user gradually builds familiarity and confidence, new functionality can be included. For example, start off by teaching how to send and retrieve E-mail. At a later time, send the learner a message with an attachment and introduce the concept of attachments.

Before teachers begin to use technology and the WWW, they must have their computers and other equipment in place and working properly.

Lessons should be clustered to facilitate integration of content across the curriculum.

To help secure buy-in for the use of the WWW by the teachers, provide a place for them to showcase their work as well as that of their students.

Web sites should integrate E-mail, plug-ins, Web features, and manipulatives. This integration will reduce the need to download or find functionality outside the Web site. Active FTP should be provided within the Web site to facilitate down loading for use in classrooms that have computers but not Web connections.

Teachers should be encouraged to share content, interesting Web sites, and their experiences with the WWW.

Interactivity

Problems:

The participants noted that current use of the WWW was limited in many cases to being employed as the only catalyst in the classroom to provide interactivity. They felt that the use of technology should not drive the learning environment, it should be used a tool to support interactive exploration and collaboration among and between students and teachers.

Differentiating between the use of the WWW to provide information versus learning activities was noted as being very important. Simply engaging students in Web searches and reading activities does not ensure learning.

Solution:

Design interactive Web sites that facilitate students' comprehension and practice within lessons. The WWW should be used as only *one* component of the lesson, and not necessarily as the entire learning experience. Activities need to include manipulatives, collaboration, and communications outside the Web site.

Problem:

Social isolation can occur when a user is totally immersed in a Web-based lesson and does not interact with anyone else--including teacher to teacher, teacher to student, student to student. Teachers can lose the students' attention when the students are isolated in a computer activity.

Solution:

One strategy to combat social isolation is to design lessons that require teachers and students to use the Web to get information to complete an activity, then do hands-on activity with others offline. After completing the activity the student can return to the WWW to share his or her results or to communicate with people outside the classroom to get clarification of their questions. In this way, the students have interactions with the teacher and other students throughout the learning process.

Individual Learning Styles and Cultural Differences

Problem:

Several issues were identified regarding differences between individuals. These differences, including physical impairments, cultural differences, and individual learning styles, can impact the success of instruction delivered via the WWW. For example, Web capabilities may not be powerful enough to support "signing" video needed by the hearing impaired.

Solution:

An audience (end user) profile should be developed before a Web site is designed.

Project teams should include members with different cultural and ethnic backgrounds, or people with disabilities based on project objectives, teacher needs, and the developmental stage of the students.

Guidelines should be developed to support instructional designs that meet the needs of multiple audiences. The design criteria should include how the Web site "looks and feels" including background colors and textures and use of graphics. Criteria should be reviewed by target audience representatives, as well as technical, design, and content experts. Students should also provide feedback on Web sites based on their cultural backgrounds and learning styles.

Problem:

Since the Web sites are available to a broader audience beyond the target audience, a major concern among developers was being able to design their Web site so that it appeals to that broader population.

Solutions:

No solutions to this problem were developed by the group, however, solutions to the differences between individuals problem may be relevant here.

Learning Environment

Problem:

The participants were concerned about how to develop an effective learning environment given timeline constraints and multiple learning styles.

Solutions:

Two solutions were offered:

- Provide development templates for new Web users.
- Design lessons in which the content has more breadth than depth. Designing for breadth allows greater flexibility in accounting for multiple learning styles.

National Education Standards

Problems:

Participants felt that since standards are always being revised, it was difficult for them to keep up with the changes. There was also an indication of resistance by state and local districts to the National Education Standards.

Participants needed suggestions about how to design for the National Education Standards that require teachers to focus on concepts versus facts, thereby representing higher level learning that requires more processing by the students.

Solutions:

Tie content directly to specific standards and provide this information to teachers in a Web site description page.

Incorporate activities that require the students to manipulate content online and offline of the Web page. Develop activities that require students to process at a conceptual level.

WORKING SESSION: TEACHERS

Participants

Joel Albright, Molly Frey, Mitch Klett, Tiffany Koszalka, Yair Levy, Marianne McCarthy, Sam Massenberg, Tom Schieffer

Issue Clarification

Definition

Teacher issues that were central to the group's concerns included teacher training, motivation, support, and matching curriculum with the National Education Standards.

Teacher Training

Participants were quite concerned about whether it was necessary for them to be responsible for teaching teachers to use their Web sites, and if that training should include basic computer and Web skills. Another pressing aspect of the teacher training was whether the Cooperative Agreement projects should provide *both* technology and aeronautics training to the teachers involved in their projects.

Teacher Motivation

Teacher motivation was discussed in terms of teachers' interest and factors affecting that interest in using technology and NASA material to support their science and mathematics curricula. Teacher literacy about technology and ease of using the Web to find supporting resources were discussed. A key issue was the teacher's sense of being overwhelmed by what the Cooperative Agreement projects were asking them to do. Teachers noted they had to learn how to use the computer, how to use the Internet and WWW effectively, how to integrate these lessons into their curriculum, learn aeronautics concepts, teach their students how to use the computers, and facilitate students use of new types of activities. Participants found that teachers felt that they needed to use aeronautics and technology curriculum in addition to their existing curriculum. This compounding of curriculum increased time pressures that teacher already faced.

Teacher Support

Teacher support was also defined as part of this issue. Participants were concerned about how much support should be given and how this support would affect scalability.

Curriculum Integration and National Education Standards

Curriculum integration and use of National Education Standards were also discussed as part of this issue. Participants felt that teachers were not sure how to incorporate aeronautics topics into their curriculum or how or when to use technology to increase the effectiveness of their lessons. Participants also wanted to discuss how the NASA projects support teacher requirements for science, mathematics and technology curricula.

Problems and Solutions

Teacher Training

Problems:

Many teachers are uncomfortable with *both* the technology and aeronautics content, and without that knowledge or comfort, the Cooperative Agreement project would not be used in the classroom. The participants were concerned not only about how to train, but how to encourage teacher buy-in and motivation so that technology would be considered as a viable teaching method by those teachers at different levels of resistance.

Often, students are more advanced than teachers in the use the of computer, causing an even greater affront to a teacher's confidence. Since teachers may no longer be the "expert in the room" they may be motivated *not* to use technology. Having enough confidence to give up this expert role is lacking in many teachers.

Solution:

A potential solution suggested for increasing comfort level with technology was to team teachers and students together to learn how to use the technology and develop ideas together on how to use it most effectively in class. This teaming idea may encourage teachers to change the way they interact with and work with their students.

It is also important not to assume that teachers should or could do everything with regard to using technology, new content or new lesson ideas in their classrooms. Rather, teams can be created that include teacher, technical support, multimedia and librarian support, all focusing on different aspects of the WWW and aeronautics content use in the classroom. Students should also be recruited to help support technology use and troubleshooting. These partnerships can provide a real world experience for students and leverage some of the classroom responsibilities away from the teacher, to the students.

Problem:

Many conference participants were concerned with the fact that teachers were at different levels of technology proficiency, different levels of technological acceptance or resistance, had different needs and abilities in aeronautics knowledge (generalist *versus* specialist), and used different computer platforms.

Teacher turnover, demonstrated by the fact that the average length of service for a teacher today is 3 to 5 years, was also problematic for developers since the turnover meant that training needed to be continuous.

Participants also felt it was critical to determine the appropriate content needed by the teachers. For example, they questioned whether the focus should be on how to use software, how to use the computer, how to integrate technology into teaching strategies and the classroom, or how to keep technically literate given the rapid change of technologies and software.

Solution:

The participants suggested that teacher training should be provided to build the teachers' basic technology skill levels. This training should cover technical vocabulary, acronyms, and basic computer functionality. Training should be provided on different platforms and targeted to different teacher skill levels. One suggestion was to develop a table of technical skills and competencies to track each teacher's progress. This table could also be used as a scheduling tool to plan for different levels of training.

Problem:

A question was raised as to whether teachers needed to have specific prerequisite skills before attending training in the use of the products of the K-14 Aeronautics Cooperative Agreements.

Solution:

The participants felt that prerequisite skills for each training session should be specified and a requirement be put in place that these prerequisites be met before teachers would be permitted to attend the training.

Teacher Motivation

Problem:

Participants were concerned about how to motivate teachers, and questioned whether compelling teachers to use the World Wide Web in their classroom instruction was appropriate. Some teachers perceive that the use of the WWW

transfers the educational emphasis away from teaching practices and towards technology thereby displacing teachers.

Solution:

Participants felt that one major way to motivate teachers was to provide administrative support. They felt that securing up-front administrative support from the school system to grant release time to teachers to learn how to use technology, provide encouragement, and foster acceptance for risk taking was essential. It is important that teachers know that their principals and administrators actively support and encourage their use of technology in their classrooms.

Teacher Support

Problem:

A problem was noted that some teachers attend training sessions and return to classrooms that are not equipped to run the lessons. This problem raised an issue of whether technology infrastructure prerequisites should be put in place before teachers qualify for training in the Web-based programs being developed by the K-14 Aeronautics Cooperative Agreements.

Solution:

One participant felt that it was very important to select only those schools with the appropriate technology infrastructure to participate in the projects to prevent this problem from occurring.

Problem:

Teachers already spend a great deal of time creating lessons using traditional teaching methods. They are then overwhelmed not only by how much they need to learn, but how much time it takes to be able to find appropriate material from the WWW to use in their classrooms.

Solution:

To minimize the time teachers need to spend surfing for relevant lesson Web sites, participants recommended that home pages provide quick access to what is in the site, and provide an optimized browsing strategy, such as fast browsing, with no requirements for downloading.

Checklists to support effective and efficient Web-based resource searching strategies should be developed. For example, give teachers a checklist to facilitate searching for resource Web sites and include an evaluation tool for students to evaluate the usefulness of the Web sites for the activity.

A search engine should also be created that is accessible to teachers to help them identify the materials that support their lesson needs. The search engine should be intuitive and easily used to search for Web sites and programs that are identified by grade level, National Education Standards, or content or curriculum topics.

Curriculum Integration and National Standards

Problem:

A critical problem for teachers is transferring what they learn from their training sessions back to the classroom, and align their activities with National Education Standards.

Solution:

Teachers need support to incorporate new technology and lessons into their district curriculum requirements. For example, in a teacher training session designed to target science and history teachers, the attending teachers should first become interested in the idea of using technology. They then could be shown how to use NASA materials to facilitate learning in their science and history curricula, and how these materials align with the National Education Standards.

Web designs should also provide teachers with instructions and examples on how to integrate the materials into their curriculum.

Problem:

Teachers already asked "How do I add yet another topic into a full curriculum?" even before the Cooperative Agreement projects began. With the addition of these projects, they expressed additional pressure to cover aeronautics and technology content in addition to their existing curriculum.

Solution:

One way to tie their Cooperative Agreement projects to a teacher's curriculum is to link the project objectives to the National Education Standards. Therefore, development teams should have a strategy to do this. One suggestion was to use content experts, curriculum specialists, teachers and students to review the materials to determine how the objectives comply with the National Education Standards.

The search engine solution for Teacher Support in finding materials could also be used to help teachers integrate newly developed aeronautics based programs into their required science, mathematics and technology curricula.

WORKING SESSION: TECHNOLOGY

Participants

Joel Albright, Carey Brock, Kay Brothers, Christiy Budenbender, Francesca Casella, Lee Duke, Molly Frey, Barbara Grabowski, Scott Graves, Angel Hernandez, Jay Jefferies, Mitch Klett, Tiffany Koszalka, Lewis Kraus, Yair Levy, Beth Lewandowski, Marianne McCarthy, Mike Odell, Jani Pallis, Lisa Peite, Chris Rogers, Tom Schieffer

Issue Clarification

Definition

With the WWW permeating the lives of almost everyone, methods of using, managing and supporting the WWW appropriately become increasingly important. The following section outlines the technology issues as defined by the participants.

Technical Support for Schools

It has become evident that simply inundating teachers, schools and students with computers and communications technology is an insufficient solution. Providing technical support to schools that have these technologies as well as those developers involved with NASA programs is essential for continued use and success of those programs. Also noted was that support was not necessarily a *post hoc* issue. The success of their projects, as one program group shared, was attributed to training on the front end of a program.

Degradability and Design

Technology prices are rapidly dropping. Unfortunately, the infrastructure of many schools is not as advanced as other institutions that can keep up with the pace of technology. While much of the technology required to offer powerful interactive activities on the WWW is available, it is really only available to a few who have the newer machines or faster connections. The participants agreed that it is important to have Web pages that everyone can access and, more importantly, utilize to their intended potential.

Sustaining Access

Some schools are now connected to Internet, however, grants may expire or not be continued. This termination of funding could leave a school without the monetary support to continue Internet connectivity. Participants shared experiences that could help schools establish low cost networking solutions and become self-sustaining through the establishment of partnerships.

Best Practices for Populations with Disabilities

Discussions during other working sessions suggested that designing content and interactivity for populations with disabilities would facilitate design and development for almost all populations of learners. The discussion of this issue in this working session focused on making specific design suggestions that capitalize on the strengths of the technology.

Dynamic HTML

A new industry specification is being proposed by a 40-company consortium. This new standard, if accepted, enables designers to create interactive learning activities without taxing low-end systems found in many schools.

Problems and Solutions

Technical Support for Schools

Problem:

The participants of this workshop agreed that if a school is involved, the success of a program is dependent on the support of the school's administration. School administrative support, however, is not automatically assured.

Solutions:

Securing the support of the school administration is vital to the successful adoption of Web-based instructional products. The school administration needs to endorse teacher training in the use of computer technology and the WWW and to provide adequate release time for inservice teachers to make maximum use of the WWW as an instructional tool. The Cooperative Agreement project teams can leverage this support by selecting only those schools who agree to meet this requirement *prior to* receiving hardware, training or other resources from the Cooperative Agreement Projects.

Problem:

Many teachers still need training in the fundamentals of computer technology, putting the Cooperative Agreement teams in the awkward position of having to provide basic training in addition to training relevant to the unique aspects of their programs. This basic training and support of teachers takes time and resources. Most participants felt that providing this additional training was outside of the scope of their project requirements.

Solutions:

The participants felt that in order to leverage the training, an analysis should be done to find out what teachers already know about technology and what they do not know before they are even selected for participation in the Cooperative Agreement Projects.

It was agreed that the training that is provided should enable teachers to become independent as quickly as possible and enable them to use new products or upgrades without a re-training session. They felt that the training must be hands-on.

Non-NASA teacher resource centers may be available or created in different school districts. Partnering with industry or universities was one suggestion that was made to create these centers or provide this technical training. An example is the teacher resource center of Wooddale High School in Memphis, TN that provides E-mail, student credits, and classes to teachers on Saturdays at no cost.

If a program is affiliated with a university, there may be a credit offering for teacher training. This affiliation can expand project resources to carry out the training as well as provide the motivation to take the "course".

Another participant suggested that the technical training be implemented in much the same way publishers sell their books. In the publisher model, a sales representative from each program would demonstrate to the teachers how to use the software or Web site in their specific classrooms.

Degradability and Design

Problem:

Access to high-end Internet connectivity continues to be a problem for many schools and limits the type of Web material available to them.

Solutions:

The simplest way to approach this problem is to create pages for lower end systems. While this solution would work for the low end users, it is an inefficient and time-consuming task for the project developers.

One Cooperative Agreement project team designed their Web site so that the content was not dependent on video and graphics. This Web site provided still images in case video files could not be downloaded. If the Web access capability of the end user did not enable downloading these still images, then they provided text describing the graphics.

Another suggestion was to set up an FTP site so that graphics and video (if the user's system had the capability to view them) were still available to download.

One participant mentioned a new intelligent software which enables the project's server to determine the capability of the students' or teachers' Web browsers. The server then displays the pages in a format that can be viewed by that browser.

Sustaining Access

Problem:

NASA funding for programs is not permanent. If a program utilizes a space on the WWW, a big concern was how programs could be maintained on the Web sites during the out years.

Solution:

One participant suggested securing partnerships. These partners would then take over the server or the space on the server and the responsibility that goes with it. Adding to this, it was suggested that "NASA" be used to entice partners to "come on board."

A few participants referred to a white paper authored by Gary Warren entitled "NASA Langley Research Center Low Cost Networking Solution." Jeff Seaton at Langley Research Center can be contacted for further information; the paper is also available online at the Langley Research Center Web site. This white paper describes a low cost networking option that may be a viable alternative when NASA funding ends. For example, looking out for "flat fees" as opposed to "per connection" costs is one of those alternatives. Another example described a school obtaining an ISDN line because it was cheaper than the business rates charged to them. NASA Lewis has also developed a low cost networking solution.

Best Practices for Populations with Disabilities

Problem:

With the disabled population, there are physical limitations with the different input-output devices and conventions. All developers need to be aware of these limitations.

Solution:

Lewis Kraus and the PlaneMath development team have put together Web Access Design Guidelines for developing Web pages for physically disabled users. He will make a summary of these guidelines available.

Dynamic HTML

Problem:

There are many software packages that build or help build interactive Web sites. A major disadvantage of these new technologies is that the end user will also need to have specialized software. This lack of software tends to diminish the power of cross platform development and access. Many school computers have very limited hard drive space and do not have the technical capacity to constantly download plug-ins to view a few Web sites' animation files.

Solution:

A consortium of WWW industry giants is developing a new standard of the markup language recognized by Web browsers. This proposed industry standard purports being able to deliver motion on Web pages with simple text as the programming code extension to HTML. This proposal suggests that there will be more that can be done on a Web page without having to download anything more than the text code you would need to view a Web page.

A few participants pointed out the following caveat for dynamic HTML. As with any industry specification, its successful use on the WWW will depend on its adoption by Web browsers' creators. Using dynamic HTML before its full adoption could eliminate many potential users.

Concluding Remarks

CONCLUDING REMARKS AND RECOMMENDATIONS

Over the course of the issue selection process the participants were invited to shape the direction of the conference working sessions so that the topics would reflect their needs and issues. As the working session summaries reveal, the group wanted to talk about more than the best practices for developing instruction for the WWW.

One possible explanation for this diversion from the stated central topic is that the shift reflected the need for the CAs to talk about a variety of issues and problems with which they have been confronted over the past year and a half. The drawback was a loss of focus which is sometimes evident in the working session summaries. The reality is that the CAs may not be able to focus on effective instruction issues until they have had the opportunity to share, discuss and resolve more fundamental concerns.

The other issues, many of which were discussed during the working sessions, included NASA's evaluation criteria for the CA projects, which the project teams related to continued funding, sustaining a Web site during the out years, teacher training in computer and Internet fundamentals, CA developer training, the difficulty of ensuring content accuracy with highly technical subject matter, and the impact of rapid technological advances on project development. For some of these issues there was resolution, for others there was not.

The working session summaries are reported faithfully and, as far as is humanly possible, reflect the problems and solutions discussed by the participants without additions from (or, one hopes, omissions by) the authors. Other than the limits of time and the necessity to adhere to a schedule, the conference chairpersons and facilitators attempted to adopt a neutral position during the working sessions in order to encourage an atmosphere in which participants could speak candidly about their problems and issues. The chairpersons and facilitators are nonetheless deeply invested in understanding and describing the best practices for delivering instruction via the WWW and supporting NASA's Learning Technologies Program and projects in their efforts to serve their customers in the K-14 educational community.

Evaluation:

Evaluation was a very problematic issue for the group. Two different aspects of evaluation--how NASA Learning Technologies Management evaluates the Cooperative Agreements and how the Cooperative Agreement Teams evaluate their own products—appear to be confounded. The first of these aspects relates to the success of the project in terms of continued funding and related issues of project viability, the second aspect relates to product effectiveness. A key issue here is "who is the customer?"

Recommendations:

Learning Technologies Management can assist the CA Teams by establishing a clearly stated set of criteria for product effectiveness against which the CAs are evaluated. Moreover, Learning Technologies Management, including Center Technical Liaisons, and the Cooperative Agreement Teams should establish their criteria for success collaboratively on the basis of meeting their customers' needs. These criteria can include, but are not limited to, evaluating changes in student knowledge and ability, evaluating changes in teaching practices or materials used, and identifying how adaptable the product is considering the diverse technical infrastructure in schools.

EDCATS:

During the conference, the topic of EDCATS arose as an example of the problems surrounding the evaluation of projects. The confusion surrounding EDCATS is somewhat justified and is shared by NASA management as well as the conference participants. EDCATS has undergone several transformations and revisions in the course of its development and its development is not yet complete. The online evaluation system needs to be elaborated to collect more qualitative data and instruments need to be incorporated or developed which establish evaluation criteria for unique products like those created in NASA's Learning Technologies Project.

The participants could not agree upon what the evaluation criteria for Web-based instructional products should be. Evaluation criteria varies to some extent because different projects have different instructional goals. EDCATS and the identification of a core set of evaluation criteria remains an issue for Learning Technologies Project Management as well and will be addressed during the Strategic Planning Sessions and probably thereafter until appropriate evaluation criteria are identified.

Recommendation:

NASA Headquarters has already established evaluation criteria for NASA educational technologies. Planning is underway to incorporate these criteria into EDCATS. Learning Technologies Project Management may want to revisit these previously established evaluation criteria and give input before, during and after the process of implementing the criteria through EDCATS. This review would serve a twofold purpose, to give LTP Management the opportunity to give input as experts on the type of education products they develop and to assist the LTP Management to align their evaluation program with NASA's Education Evaluation Program. Moreover, the existing CA teams should be briefed about this criteria and given an opportunity for discussion and input.

Content accuracy:

Content accuracy is *not* an issue it is a *requirement.* The real issue, is how the Cooperative Agreement Teams ensure content accuracy. Peer review is not sufficient to ensure content accuracy, unless the peers are scientists, engineers, physicists, meteorologists, and so forth. The Cooperative Agreement Project Teams described this as a major problem.

Recommendation:

Because content accuracy is a requirement of all NASA developed and sponsored instructional support products, all materials should, at a minimum, be reviewed by content experts. Learning Technologies Project Management indicated that it is the Center Technical Liaison to the Cooperative Agreement who is assigned to either review the materials for content accuracy or designate a content expert to ensure technical accuracy of the products. Since this issue was identified by some participants as a major problem, Learning Technologies Project Management and Technical Liaisons need to devise and adhere to an ongoing schedule of content review and engage in an open dialogue with the Cooperative Agreement Project teams to determine if they need assistance, paying particular attention to those teams that do not have content experts as team members.

Training:

Training issues ranged from teacher training to developer training. Some appropriate solutions were derived relative to teacher training in computer and Internet fundamentals. The participants concluded that basic training could be conducted by school districts, county offices of education, and universities which is consistent with the view of Learning Technologies Project Management. The issue of training teachers to use LTP products, however, was largely unresolved. The idea of creating self-explanatory Web sites was discussed, however, the criteria for what exactly constitutes self-explanatory remains unclear.

Also unresolved was the issue of training for CA developers who were confronted by rapidly evolving Web technologies. Some CAs teams conveyed that NASA should provide this training in some manner. Just as training teachers in Web fundamentals consumes time and resources and therefore is not cost effective, so does training developers in advanced techniques. At some point training is outside of the scope of either group's responsibility. The key issues here are identifying the type of orientation and training teachers will need to effectively use the Web site for its intended purpose and the type and level of technical training developers require to create effective products.

Recommendations:

Identify local agencies which train teachers in fundamentals and publish this as national list of available training resources. The approach is similar to the method Spacelink used to identify local Internet service providers as they phased out of their free teacher accounts. For those teachers who are computer literate but inexperienced with using the WWW, the Educator Kits created by Ames and online tutorials can be used to enhance their abilities.

NASA's Education Curriculum Support and Dissemination Program is well aware of curriculum support materials that lay unused because an author thought they were self-explanatory when, indeed, the technical content and structure of the material was such that the teachers did not know how to use them. *Self-explanatory* has to be tested during the formative evaluation of a product. The Curriculum Support and Dissemination Program is developing strategies for conducting workshops for teachers prior to distributing NASA education materials to ensure that the materials make their way into the classroom. The lessons learned by the Curriculum Division can be applied to the CA projects.

The CA Teams are engaged in ground-breaking projects. In the past, it may not have been possible to predict how rapidly technologies would evolve and what impact that would have on the needs of CA developers. Just as fundamentals could be taught in universities, so could advanced Web techniques. For future projects, LTP Management may want to suggest in their requests for proposal that funding be set aside for developer training since that need has been identified by the pioneering group. The current CA teams can use the resources they save teaching teachers fundamentals to acquire needed training for themselves.

Appendix

ABBREVIATIONS AND TECHNICAL TERMINOLOGY

CA – Cooperative Agreements

CD-ROM – (Compact Disk – Read Only Memory) External optical storage device that allows computer retrieval of stored data.

CGIs – (Common Gateway Interface) A standard for interfacing external applications with information servers, such as HTTP or Web servers. A plain HTML document that the Web daemon retrieves is static, which means it exists in a constant state: a text file that does not change. A CGI program, on the other hand, is executed in real-time, so that it can output dynamic information.

DFRC – Dryden Flight Research Center

Education Division Computer Aided Tracking System (EDCATS) – EDCATS is a reporting system being developed by the Education Division of NASA. EDCATS currently collects nominal data and feedback from participants in the various NASA Education programs. EDCATS' goal is that by December 1999, all NASA Education Programs and activities will use the on-line EDCATS data collection and evaluation instruments. NASA's Education Evaluation program has as its goals the development of standardized, NASA-wide Education indicators which reflect NASA's Education goals and is fully responsive to Federal laws and the National Performance Review Directives.

E-mail – (electronic mail) Messages that are sent via computer network, i.e., electronically. The messages are stored until the addressee accesses the system and retrieves the message.

Executive Order #12999 - Educational Technology: Ensuring Opportunity for All Children in the Next Century. This Executive order, signed by President Clinton in 1996, states "the Federal Government is committed to working with the private sector to promote four major developments in American education: making modern computer technology an integral part of every classroom; providing teachers with the professional development they need to use new technologies effectively; connecting classrooms to the National Information Infrastructure; and encouraging the creation of excellent education software. This Executive order streamlines the transfer of excess and surplus Federal computer equipment to our Nation's classrooms and encourages Federal employees to volunteer their time and expertise to assist teachers and to connect classrooms..." (from *Computers for Education: A Federal Agency Guide to Executive Order 12999*, U.S. General Services Administration, Office of Policy, Planning, and Evaluation, Office of Transportation and Personal Property, July 1996)

FTP – (File Transfer protocol) An application used to transfer files between a user's computer and another on the Internet. FTP is a special way to login to another Internet site to retrieve and send files.

Home Page – The introductory page to a World Wide Web site.

HTML – (HyperText Markup Language) Coding language used to create hypertext documents to be posted on the WWW.

Hypertext – Any text that contains links to other documents or files.

IITA - Information Infrastructure Technology and Applications Program; a NASA component of the Federal High Performance Computing and Communications (HPCC) program.

Internet – A worldwide network that connects many smaller networks with a common set of procedures (protocols) for sending and receiving information.

ISDN – (Integrated Services Digital Network) A digital telecommunications system in which all types of data may be sent over the same lines at very high speeds.

K-12 – Kindergarten through grade 12.

K-14 – Kindergarten through junior college.

LTP – Learning Technologies Project.

NASA – National Aeronautics and Space Administration

PSU – The Pennsylvania State University

RSPAC – (Remote Sensing Public Access Center) A cooperative program among NASA, BDM International, Inc., and West Virginia University (WVU) to support the NASA Information Infrastructure Technology and Applications (IITA) component of the Federal High Performance Computing and Communications (HPCC) program.

URL – (Uniform Resource Locator) Addressing scheme used to identify World Wide Web sites.

WWW – (World Wide Web) The network of hypertext servers which allow text, graphics, and sound files to be mixed together and accessed through hyperlinks.

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13. ABSTRACT (Maximum 200 words)

A conference was held on March 18–20, 1997 to investigate the lessons learned by the Aeronautics Cooperative Agreement Projects with regard to the most effective strategies for developing instruction for the World Wide Web. The conference was a collaboration among the NASA Aeronautics and Space Transportation Technology Centers (Ames, Dryden, Langley, and Lewis), NASA Headquarters, the University of Idaho and The Pennsylvania State University. The conference consisted of presentations by the Aeronautics Cooperative Agreement Teams, the University of Idaho, and working sessions in which the participants addressed teacher training and support, technology, evaluation and pedagogy. The conference was also undertaken as part of the Dryden Learning Technologies Project which is a collaboration between the Dryden Education Office and The Pennsylvania State University. The DFRC Learning Technology Project goals relevant to the conference are; conducting an analysis of current teacher needs, classroom infrastructure and exemplary instructional World Wide Web sites, and developing models for Web-enhanced learning environments that optimize teaching practices and student learning.

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