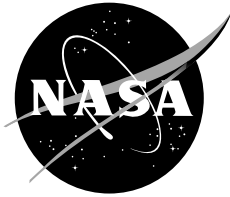


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Web-Based Instruction and Learning: Responding to K-14 Customer Needs

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December 2003

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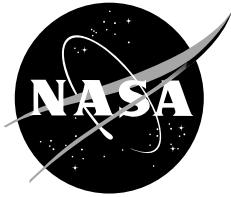
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The chairpersons wish to extend a special thank-you to Carol Galica and Ruth Peterson for their participation in the conference and help with the tours and transportation.

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PREFACE

Purpose of the Proceedings

The September Learning Technologies Conference focused on how effectively the Aeronautics Cooperative Agreement projects are meeting their K-14 customers' needs. The areas identified for project presentations and discussion during the break-out sessions were derived from the Analysis and Needs Assessment conducted by The Pennsylvania State University and NASA Dryden Flight Research Center (DFRC) as part of the DFRC's Learning Technologies Project.

As in the March Learning Technologies Conference, the purpose of the September conference was to capture the experiences and expertise of the Aeronautics Cooperative Agreements and offer an outlet to the participants to share their knowledge with each other and future project teams.

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://learn.arc.nasa.gov/features/features.html>.

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Executive Summary

NASA's education mission is to promote excellence in America's educational system by developing and sponsoring the development of instructional support products which demonstrate integrated applications of science, mathematics and technology. To help actualize this mission, The Dryden Flight Research Center Learning Technologies Project has sponsored several initiatives to investigate and document the best methods for developing Web-based instruction and meet the K-14 educational community's needs.

The goal of the September Learning Technologies Conference was to discuss how effectively the NASA-sponsored Aeronautics Cooperative Agreements are meeting the needs of their K-14 customers based on the findings of an analysis and needs assessment conducted in 1997.

The conference provided an opportunity for discussion of six areas identified as relevant to meeting K-14 customer needs: Classroom Access, WWW Resources, Teacher Training, Different Teaching and Learning Styles, Interactivity, and National, State and Local Education Standards. The collective findings from this conference culminate in the following overall recommendations.

Recommendations

Access

Access to the Internet needs to be broadly defined in order to accommodate teachers' and students' needs satisfactorily. Product developers need to consider three aspects of classroom access: physical or technical access, content or Web site access, and computer literacy or access to skill in using the WWW for teaching. Offering multiple versions of the product, networked access, and recommendations for use with a variety of classroom configurations accommodate different types of access.

World Wide Web Resources

The Aeronautics projects' Web sites incorporate many different types of human and information resources that are accessible through the World Wide Web. In terms of the selection of types of Web resources, however, the project participants strongly recommended that the resources be chosen on the basis of lesson objectives and not just because of the availability of a new technology. Participants emphasized the importance of letting the learning objectives drive the design of the site rather than allowing the technology to drive the design of the site. One way to control the design strategy, ensure consistent participation by teachers and enhance interactivity is to hire a balanced development team that includes teachers, content experts, programmers, professional graphic artists and Web designers.

Teacher Training

Conference participants asserted that teacher training can make or break a project. Effective training on the use of a project site enhances its effective use. Participants recommended that projects establish a

technology implementation plan that involves teachers early in the product development. This technology implementation plan should include several critical on-line and off line components to determine the appropriateness of a school or teacher's involvement: prerequisite technology configurations and support, technology literacy prerequisites, on-line teacher supports, and off-line support.

Different Teaching and Learning Styles

Participants indicated that developers should provide a Web site that allows for flexibility so that teachers are able to use different teaching and learning strategies for instruction using the site. The more the teachers can adapt the Web site to their teaching style the more likely they are to use the site for instruction. The site could accommodate multiple methods of use by suggesting alternatives around current accepted practice and by modeling. An alternative to offering recommendations is to provide space for teachers to document strategies they have used with Web-based materials to share what works with others. Developers emphasized the importance of providing a context for instruction and options for interactive learning.

To accommodate individual learning styles, narratives should be short and concise without compromising technical accuracy. Different learning styles may also require a different screen layout or navigation cues. Pictures, audio and video approaches provide multisensory input to learners. Content dense material can be supported with examples and animations. Reflection checks, review exercises and feedback forms to help learners assess their own learning.

Interactivity

The purpose of interactive lessons is to engage the learners with the materials presented, to stimulate their thinking throughout the lesson or activity, and to enable them to demonstrate their knowledge through some means of communication. Participants had many suggestions for enhancing learning with interactivity and developing sites that keep users engaged.

Without letting text dominate, provide solid definitions, explanations and examples of how to use the Web site. Participants observed that a use of a multisensory approach (pictures, sounds, movies, animation, text) enables many different audiences to interact with the Web sites in multiple ways. Break up content dense sites by suggesting offline, classroom activities. To maximize interactive potential, provide different versions of the product to support various levels of technology access. Participants suggested having students work in pairs to create an opportunity for them to engage in dialogue about their perceptions of the Web-based material. A global approach to learning can be created with national or local events, experiments could be provided in which data are gathered off line and shared with others who have common interests or educational goals.

National, State, and Local Education Standards

The National Standards help teachers link resources to the three global standard perspectives: concepts, applications, and processes. Education standards provide teachers with well-defined and unified criteria for proficiency in science, mathematics and technology, skills critical to competing in a global economy. Given that NASA-sponsored materials are intended to reflect these standards, it is critical that the connection is made overtly to activities on the Web site. Participants recommended

securing the support of an educator or education standards expert early in the product development to identify relevant standards and document how they correspond with the content objectives for the targeted grade levels.

ABSTRACT

Web-Based Instruction and Learning: Responding to K-14 Customer Needs

A follow-up working conference was held at Lewis Research Center (now Glenn Research Center) on September 23-25, 1997, to continue discussing issues related to the development of Web-based education materials for the K-14 community. The conference continued the collaboration among the NASA aerospace technology Centers (Ames, Dryden, Langley, and Lewis [now Glenn]), NASA Headquarters, the University of Idaho and the Pennsylvania State University. The conference consisted of presentations by the Aeronautics Cooperative Agreement teams, and working sessions that addressed issues related to the conference theme, responding to the K-14 customers' needs. The group identified the most significant issues by consensus. The issues addressed were: classroom access, World Wide Web resources, teacher training, different teaching and learning styles, interactivity, and education standards. The working sessions produced observations and recommendations in each of these areas in order to work toward the goal of making NASA sponsored Web-based educational resources useful to teachers and students.

Introduction

INTRODUCTION

The Dryden Learning Technologies Project

Goals

The Dryden Learning Technologies Project is a collaboration between NASA Dryden Flight Research Center and The Pennsylvania State University. The multiyear NASA research project began with an analysis and teacher needs assessment on the effective use of the Internet and World Wide Web in the classroom. Two teacher focus groups were conducted on the use of Web-Enhanced Learning Environment Strategies (WELES) during the summer of 1997. One focus group was held at NASA Langley Research Center with teachers participating in the NASA Educator Workshop for Elementary School Teachers. DFRC conducted a second focus group with teachers participating in the Salish-Kootenai Teacher Ambassador project.

The March Learning Technologies Conference studied best practices for delivering instruction via the World Wide Web. The goal of the second Learning Technologies Conference was to discuss how effectively the NASA-sponsored Aeronautics Cooperative Agreements are responding to the needs of their K-14 customers. Conference participants included the Aeronautics Cooperative Agreement team members, representatives from NASA Headquarters, the four NASA aeronautics centers (Ames, Dryden, Langley, and Lewis [now Glenn]), the University of Idaho, and The Pennsylvania State University.

The DFRC Learning Technologies Project is providing a comprehensive examination of the impact of the World Wide Web on classroom instruction. The purpose of the study is to ensure that NASA's Learning Technologies Projects:

- Adequately serve the K-14 community,
- Are utilized consistently in K-14 classrooms,
- Inspire students to study science, mathematics, and technology using NASA mission-specific activities,
- Assist students in the development of technical competence and literacy, and
- Promote excellence in America's educational system.

The DFRC research project will culminate with an impact study of systemic reform of teaching practices in K-14 classrooms because of Web-based instructional sites. The impact of NASA's Learning Technologies Projects on K-14 instruction and systemic reform of teaching practices will be central to the project.

The Dryden LTP project supports all NASA enterprises equally. While much of the research has focused on the K-14 Aeronautics Cooperative agreements, there is a component that includes Mission To Planet Earth (remote sensing databases) and Space Science (digital library technologies).

While Dryden's major partner in the LTP Center project is The Pennsylvania State University, the project also includes collaborations with NASA Langley, NASA Ames, and the Spacelink team at NASA

Marshall Space Flight Center. Additionally, Dryden has partnerships in LTP-related activities with the Salish-Kootenai College and the California State University, Los Angeles.

Research Approach

The research approach for 1997-8 is to:

- Conduct an analysis of current teacher needs, school technology infrastructure, and exemplary instructional Web sites (completed),
- Develop models of Web Enhanced Learning Environment Strategies (WELES) which incorporate sound instructional design, demonstrate methods of integrating the WWW into the classroom, and address access limitations and different teacher and learning styles (continuing),
- Conduct teacher focus groups to identify needs and obtain feedback on models of Web-Enhanced Learning Environment Strategies (completed),
- Develop an instructional plan for producing and pilot testing the Web-Enhanced Learning Environment (WELE) materials and put on the World Wide Web,
- Identify three groups of teachers (K-4, 5-8-, 9-12) to participate in pilot study,
- Develop assessment and reflection tools for data collection during the a pilot testing phase,
- Orient each team to the pilot materials and begin teacher development of initial lessons,
- Maintain monthly teacher contact and collect data over a period of three months,
- Summarize feasibility of WELES, revise WELES,
- Repeat the fall pilot study with revisions and new group of 15 teachers during spring semester,
- Design and develop a fall impact study, and
- Begin a large group impact study.

Research Project Deliverables

Research project deliverables include:

- Research reports summarizing the analysis and needs assessment and recommended designs for the Web-Enhanced Learning Environment Strategies,
- Exportable, marketable teacher workshops for inservice training in schools,
- WWW instruction to accompany the workshop (the electronic tutorial could also be a stand-alone product),
- Teacher tools and templates to facilitate developing lesson plans using the WWW in the classroom,
- Implementation plan for dissemination of the product into schools, and
- Impact study report and journal articles.

Evaluation Methods

Advisory review has been used to evaluate the classroom readiness of LTP products produced by the Remote Sensing Database and Digital Library Technologies Projects.

Formative evaluation tools, questionnaires asking for feedback in areas such as practicality, user-friendliness and effectiveness were used in the teacher focus groups and will be used with the teachers in the pilot studies.

Summative tools to determine the impact of the WELE instruction on teaching practices and actual diffusion of the WELES into the classroom will collect data from the teachers in the pilot studies and the large group impact study.

NASA's Education Computer Aided Tracking System (EDCATS) will be used to collect data and feedback from teachers in the pilot studies and impact group.

Dissemination Strategies

The products will be delivered electronically using the World Wide Web. Printed versions will also be produced. One of the deliverables is an implementation plan.

Analysis and Needs Assessment Report: A Summary

The Analysis and Needs Assessment, conducted between January 1997 and May 1997, was the first phase of the Dryden Learning Technologies Project. The purpose of the Analysis and Needs Assessment was to develop a picture of the state of schools with regard to their current and future use of the World Wide Web (WWW) for enhancing learning environments. The specific focus was NASA's Learning Technologies K-12 customers.

The investigation reconfirmed many of the preconceptions held about the K-12 educational environment and provided insights into trends and needs relative to the use of the WWW in the classroom environment.

The team, led by Drs. Grabowski and McCarthy, consisted of a diverse group of individuals representing:

- Educational, business, and government environments
- A variety of levels of exposure to Web-based technologies and practices
- Multiple cultural orientations
- Interests and perspectives with regard to Web-enhanced learning environments.

Team members included representatives from:

NASA education programs

- Teachers from K-12 and university settings

- Technology industry experts
- Education publishing
- Graduate students from the Instructional Systems program at Penn State University.

The focus of the analysis and assessment was on three critical areas of the educational environment:

- School context,
- Science, mathematics, and technology content, and
- Teaching and learning processes.

The investigation about school context focused on areas that are critical to integrating and using computer technology to deliver instruction in an educational setting. These included:

- Administrative infrastructure,
- Technology infrastructure, and
- Teacher factors.

In the second phase of the assessment, school-appropriate science, math, and technology content areas were explored. The structure of the National Education Standards and school curriculum were studied along with how existing NASA Web-based material might fit within this structure. The areas of study included:

- School curriculum, and
- Existing NASA material.

Within the third phase of the needs assessment, the teaching process was investigated. The investigators reviewed the ways that instruction could be presented most effectively for the teacher and the student. They included:

- Best practices using the WWW in the classroom,
- Teacher tutorials, and
- Learning theories and teaching practices.

The purpose of the in-depth investigation of each of these eight areas was to identify which dimensions defined the area and further specify the critical factors for each dimension. These dimensions and critical factors provided a structure for reporting the results found for each area.

Each team used a variety of sources to gather data, including:

- Web searches
- Chat room and listserv participation
- Literature reviews
- Interviews and focus groups with teachers, administrators, industry, and educational leaders
- Attendance at education and technology conferences.

Each area was investigated through multiple dimensions, for example Technology Infrastructure was investigated in terms of points of connectivity, number of instructional rooms having access to the Internet, types of connections, existing plans for connection by the year 2000, and technical support.

Summary of Findings

School Context. For the WWW to be integrated into a school successfully, administrative, technology, and teacher areas of the school context must be addressed and resolved. Teachers are motivated to learn about the WWW and how it can be used in their classroom. Teachers, however, are faced with major challenges in the following areas:

Access. Although Internet access in schools is changing daily, teachers who do not have instructional access cannot consider the WWW as an educational resource. Teachers need to prepare for the eventuality.

Four different configurations of access currently exist: classroom access, lab access, resource room access, and home access only. These access options also vary depending on the number and type of computers available. Each access option presents unique challenges for using the WWW in the classroom. Teachers need help in determining how the WWW can be used within their own school and classroom configuration so that its use is seamless to their instruction, rather than being used solely as a “big-time event.”

Speed of access challenges even the most creative and motivated teacher when they only have slow modems. Teachers need to understand that the WWW has many options and strategies to compensate for slow modem speeds, and that the glitzist may not be the most educationally effective.

Skill. Teachers have a limited understanding of what resources exist on the WWW. Teachers need to be exposed to the many different types of resources that exist on the WWW that are classroom appropriate.

Teachers are unaware of efficient search strategies to find materials and resources quickly. Teachers should be trained on resources and efficient search strategies.

Teachers lack skill in preparing and using Web-based material in their classroom. For those teachers with a genuine interest, training in the areas of how to develop, produce and integrate Web-based material should be provided and encouraged.

Perception. Teachers have a limited and biased perception that the best use of the WWW is for the teachers or their students to “program” material to place on the WWW. Teachers need to be exposed to other strategies for using the WWW in their classroom.

Teachers fear that if they choose to use the WWW that it will take a great deal of already limited time for planning and development. Teachers need to be trained to understand the type of resources that are available on the WWW and efficient strategies for finding useful Web resources quickly.

Teachers are concerned that the computers will break down or things will go wrong in the middle of their lessons. Administrators should budget technical support for teachers rather than rely on the teachers

to have to troubleshoot and do systems administration as well. An analogy is that when teachers use the school car to transport students, they are not expected to maintain it as well.

Time. A teacher's day is already taken up with tremendous amounts of responsibilities just to meet the minimum requirements of teaching and maintaining safety in the school. WWW use should be viewed as another classroom resource. Choosing what and whether to use the WWW should be done in same way as deciding to use other materials. This selection is a natural part of writing lessons plans rather than being an additional task for teachers to accomplish.

There is a high initial investment of time that teachers expend in learning new techniques to be used in the classroom. Administrators should view learning the WWW in much the same manner as upgrading other skills and provide release time and training to teachers about the potential of the WWW as an instructional resource.

Science, Mathematics, and Technology Content. The second area of investigation was an examination of the school curriculum to determine how the link could be made between school curriculum and existing WWW resources. Primarily the National Education Standards were considered as representing school curriculum. The WWW was then examined to determine the breadth of resources that are available to teachers and students. Several challenges to teachers for incorporating the WWW into their classroom emerged from this analysis.

Curriculum. Curriculum standards are changing to a more process and problem solving oriented curriculum. Web-enhanced lessons can help teachers meet the changing curriculum standards by bringing to learners problems anchored in reality. Instructional resources that are designed specifically for the WWW should reflect these changing curriculum standards.

School curriculum is based on National Education Standards. Any material that is put on the WWW for specific school use should be tied to the National Education Standards for easy linking back to school curriculum.

Not all teachers are aware of the National Education Standards, and in fact, are sometimes in conflict with understanding how their state and local standards fit into that scheme. Whenever possible, WWW materials should also be tied to state and local education standards.

WWW Content. Resources on the WWW contain a variety of materials made up of resources and people, including databases, information and resources, lesson plans, projects, student activities, tools, references and links, and tutorials. This variety of resources makes it even more feasible to incorporate some aspects of the WWW in the classroom without it being experienced as an additional responsibility in an already overloaded schedule. Web-enhanced lessons should take into account the large amount of materials to offer the most flexible strategies for WWW use.

Learning Theory and Teaching Practices. In this area of the investigation, contemporary perceptions about how children learn were examined, along with general classroom teaching practices. In addition, as a key part of this investigation, classroom uses of the WWW were studied to determine demonstrated strategies that were school tested. Finally, existing teacher training about WWW use in classroom was assessed. This analysis has revealed several conditions that should be considered when developing Web-based or Web-enhanced classroom strategies and training for teachers.

Classroom. The classroom is being changed from a teacher-centered to a learner-centered environment in which the children become active generators of knowledge rather than passive recipients of information. Classroom strategies for using the WWW should take into account this new perception of the learning environment and the learning process.

Web Practices. Interactivity on the WWW does not simply mean interaction between the learner and the computer information, but rather that interactivity can be viewed in the broadest sense of creating learning partners within the global Web environment. This broad definition of interactivity needs to be taken into account when any Web-enhanced learning models are created.

The WWW offers the classroom a global rather than a local view of information, jobs, science, mathematics, and technology. Anchoring local classrooms in real life activities through the WWW is one model of its use in the classroom.

The Web offers information resources for demonstration in the classroom. Using the WWW in the classroom does not always have to mean elaborate or extensive use. Using simple resources of the WWW to expand those that are available locally is another method of using the WWW in the classroom.

The WWW can be a source of information, or it can be repository of teacher or student generated content or activities. When students or teachers have the inclination to learn how to create content for the WWW, they should be encouraged to do so, however this should not be the only way the WWW is promoted for classroom use.

Teachers use a variety of effective teaching and learning strategies currently in their classrooms. Strategies for using the WWW in the classroom should take into account the most prevalent and effective learning strategies currently used by teachers and not be limited to only one approach.

Instruction about the Web. Instruction exists that teaches teachers how to develop WWW materials. Fewer materials exist which help teachers to integrate the WWW into the classroom. Often, however, both types of Web use are not differentiated, resulting in the integration tutorials being subsumed and lost under production lessons. Simple to use models that stand alone as WWW integration strategies should be developed and disseminated.

Overall Recommendations

Teachers need to be trained to manage the WWW in their classroom in a manner that does not take a great deal of additional time. Rather, the integration needs to be seamless in the normal planning activities required of teachers.

Classroom strategies for WWW use need to be developed that exemplify good teaching practices, are simple to use, and incorporate the variety of WWW resources that provide access to people and information. Training on the use of these strategies needs to include efficient WWW search methods to lessen the time required to find relevant material for the teachers' lessons.

Administrators need to acknowledge the advantages of WWW use, and provide teachers with appropriate access, technical support, training, and time for training with this new classroom resource.

WWW developers need to fit their material into classroom teaching models that consider access, types of Web resources, teaching and learning styles, and specify several options for teachers to use their materials given the realities of the classroom environment, curriculum content and teaching practice. The goal for developers should be to create material that provides the most flexibility and adaptability to the teachers who are their ultimate customers.

When considering potential possibilities of the WWW, we must not forget to weigh the realities of the educational environment (context), science, math, and technology subject matter (content), and teaching and learning philosophies (process).

As the WWW becomes more prevalent in the classroom, Web-enhanced learning environment products and strategies need to focus on helping the teacher help the students learn.

Web-Enhanced Learning Environment Strategies (WELES)

The Origin of the WELES

From the analysis and needs assessment results, the team determined that teachers would benefit most from information and instruction on strategies for integrating existing Web materials into their classrooms rather than from instruction to teach them how to create Web materials. Plenty of sites and other instructional materials exist that teach the latter, however, few materials exist that teach the former, and what does exist in this category is deeply embedded in Web and Internet fundamentals.

An Approach for Developing the WELES

The approach to offering this type of instruction evolved from an attempt to capitalize on what teachers do best, that is, to write effective lesson plans using whatever materials are available to them. The WWW simply becomes another available resource for materials in this model.




Possibilities of what the Web has to offer were examined and matched with the realities of what teachers face in the classroom and the need to either improve or enhance classroom teaching. The result was captured in a “Use the Web” Model and Web-Enhanced Learning Environment Strategies for teachers.

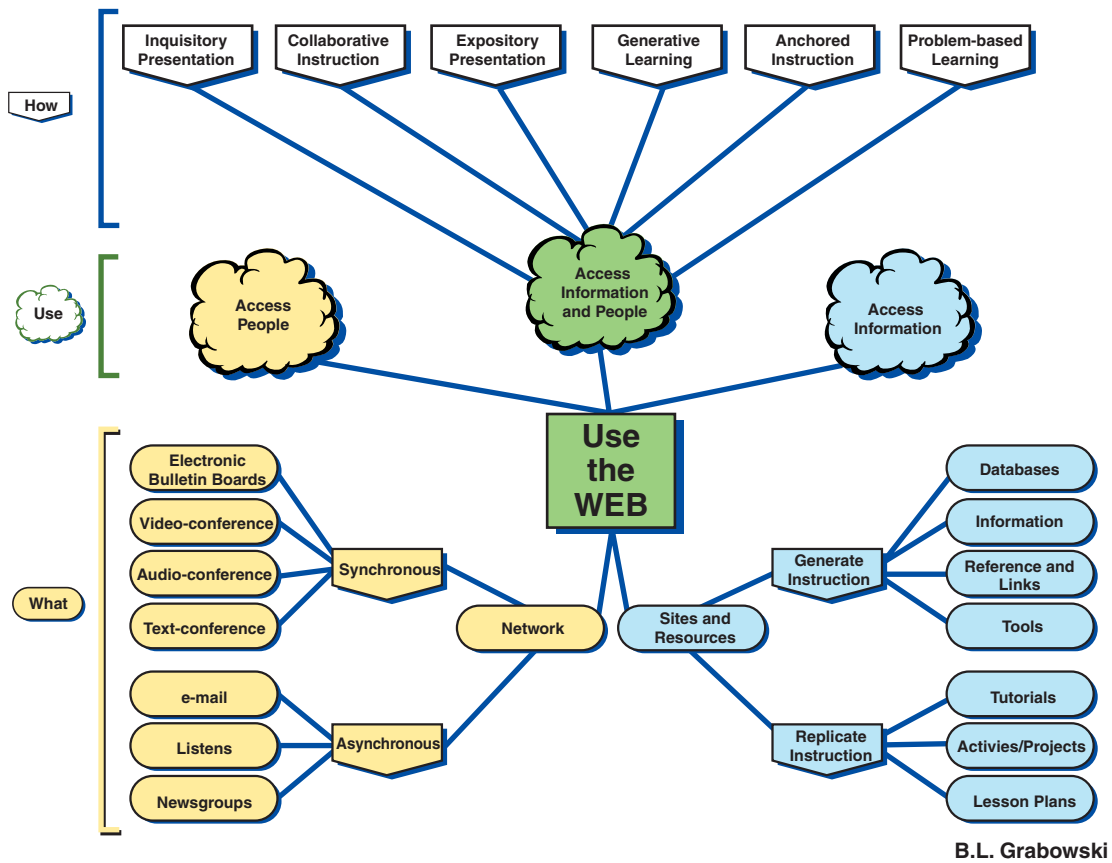
Issues about the types of WWW resources, interactivity, access, National Education Standards, teacher training, teaching, and learning styles were taken into account in the development of the WELES.

The Use the Web model shown in Figure 1 and the six WELES were tested with two focus groups in the summer of 1997 at two teacher workshops at NASA centers—one at Langley Research Center and the other at Dryden Flight Research Center. The input from the teachers has been used to improve the presentation of the strategies.

Use the Web Model

The “Use the Web” model attempts to provide an overall conceptualization of the World Wide Web, and a merger of the resources of the Web with specific, fundamental classroom teaching strategies.

Figure 1 conceptualizes the Web and its use for classroom learning in three parts: the what () located at the bottom of the figure, the how () located at the top of the figure, and the use () located in the center of the figure which merges the two.



“Use the Web” Model for Classroom Lesson Planning

Figure 1: WELES and Web Resources for Classroom Access to Information and People.

The bottom portion of the “Use the Web” model outlines two major Web resources: information through sites and resources and people through synchronous and asynchronous networks. An analysis of Web information for types of resources appropriate for teachers yielded two other categories: those which would help teachers write lesson plans or generate instruction and those which would provide instruction that is easily replicable. Databases, general information, references, and tools provide the building blocks for a good lesson plan, whereas, existing tutorials, student activities, projects, and lesson plans provide a “building” that has already been constructed. An analysis of Web networks resulted in identifying four types of synchronous access to people: electronic bulletin boards and video, audio, and text conferences. Three types of asynchronous access to people were identified: e-mail, listservs, and newsgroups.

To provide guidance to teachers on how Web-based information and people can be used in a manner that is conducive to learning, six Web-Enhanced Learning Strategies (WELES) are offered at the top of the figure. These WELES are based on contemporary learning theory and an understanding about how people learn and an understanding of the resources offered by the Web.

The center of the figure merges the ideas from the top and bottom to encourage teachers to “use the Web” purposefully and intentionally to access information and people to enhance their lessons.

The Six WELES

Six Web-enhanced learning environment strategies are divided into two groups: the Inquisitory, Cooperative, and Expository (ICE) WELES, and the generative, anchored, and problem-based (GAP) WELES. The ICE WELES include Inquisitory, Cooperative and Expository teaching strategies whose Web use focuses on the rich resources available in the following ways:

- For the inquisitory strategies, informational and people resources available on the Web are used for student-led inquiry,
- For collaborative learning strategies, people resources available on the Web are used as global learning partners, and
- For expository strategies, informational and people resources available on the Web are used for teacher-led presentations.

The GAP WELES include generative, anchored, and problem-based teaching strategies whose Web use provides focus for teaching and learning in the following ways:

- Generative learning strategies focus the teaching and learning on what the student does. The strategy suggests that when using people and informational Web resources the students should actively search or construct understanding from what and whom they encounter on the Web.
- Anchored instruction strategies suggest selecting real problems from information sources on the Web, or collaborating in a specific role as a team member with other individuals available through the Web.
- Problem-based learning uses Web resources for selecting a problem to give context to what a student is learning.

Note that there is overlap between the WELES, and that it is not important that each strategy is mutually exclusive. For example, you might say that collaborative learning is generative, or that an inquisitory presentation is problem based.

Issues

The “Use the Web” model and the WELES addressed the issues being discussed in this conference in the following ways:

- Access—it was important to provide the most flexibility for teachers with a variety of access, and so we considered a broad model of the Web, one which a teacher can just copy lesson plans, or generate their own using raw data available on the Web.

- Types of WWW resources—are interrelated with access issues. Some resources are “inaccessible” to teachers with minimal access, but our model suggests alternative sources for those cases.
- Different teaching and learning styles—by suggesting six different teaching strategies teacher preferences and strengths are acknowledged. Learning styles of students can be accommodated through the lesson plans that teachers create, thus putting those critical decisions in the hands of the one who knows the class best, the classroom teacher.
- Teacher training—currently preservice and in-service training on the “Use the Web” Model and WELES are under development for delivery as graduate and undergraduate university courses, but the intent is also to create an online “advisor” that aids teachers in the development of these learning strategies.
- Interactivity—is a key element in the strategies represented as a dialogue between students and teacher, teacher and student, student and student, student and him or herself, or student and content.
- National Education Standards—since the WELES are lesson plan templates there is a place where teachers can designate which education standard corresponds with their lesson.

**Presentations:
Responding to K-14 Customer Needs**

STUDENT PROGRAM FOR AERONAUTICS RESOURCES KNOWLEDGE

Kay Brothers, University of Idaho

Idaho SPARK

Learning Technologies Conference

NASA Lewis

University of Idaho

NASA



Types of Classroom Access

Materials, Procedures, and Collecting Data

Challenge

- FAST LOADING
- PRINT & GO

Using index cards to make ailerons, elevators, and a rudder for your balsa glider, demonstrate/explore how to use controls can effect the flight of your plane.

- TEAMS OR INDIVIDUALS

Materials

Preparation

- RETURN & ENTER

Testing - Ailerons

Testing - Elevators

Testing - Rudder

Testing - Final

Additional Variables



The SPARK site accommodates many access configurations. While the target schools have 56K access we are mindful of modem access users.

Our lesson can be printed in one shot.

The interactive activities allow for individual and group access.

Each interactive activity allows the user to enter data, submit, view, and correct information within the next day, next period, next minute return access.

Types of Resources Used

- Interactive activities
- Lesson plans
- Projects
- Students' favorites
- Links
- Add your favorites



Some Examples include:

- Classroom and project-initiated student work like the Dryden Experimental Aircraft design quiz.
- Classroom and project-initiated interactive activities are our current focus.

Teaching and Learning Styles

- Reference

Principles,
Glossary

- Take it & Use it!

Demonstrations, Experiments,
Lesson plans

- Take it! Do it!
Communicate it!

Interactive activities

- Stand alone

Internships

- Native American interest

Template for reporting ease

- Passing through

Cultural connection

Links to others



SPARK offers material which allows for a variety of teaching and learning styles. We do, however, guide or hope for interactivity: student-teacher generative, real world, and teacher-student site interactions.

Teacher Training and Support

Higher Education

- Content
- National Standards
- Use of the Internet, Email
- Model Teaching Practices
- Web Authoring



Because we are located in a higher education institution we do teacher training activities. These efforts are currently funded with other non-federal funds. All teacher training can be offered for graduate and/or undergraduate credit.

Ways of Creating Interactivity

- Take it! Do it!
Communicate it!
- Stand alone

Interactive activities

- teacher initiated
project initiated

Internships

- business partners

Template for reporting ease

- teacher & student starting
place



Interactive activities include: Teacher initiated work with classroom teachers to get the aeronautics that they do in the classroom off the net and into the net in an interactive forum.

Internships stand alone as a way to get tremendous industry and business support. New in 1998, on-campus counter parts that prompt and communicate with the interns.

Template of reporting. Get it on the net and use it. Initiated in Netscape Gold because it was an easy place to start.

National, State and Local Standards

Idaho SPARK

- NASA and University Support
- Teacher, School, State Partnerships
- apply science & mathematics
- real research and design problems
- standards that meet local, state, and national for grades 9–12
- apprenticeships



The teachers, schools, and state are working toward the Local, State, and National Standards. SPARK and the university are helping in this endeavor. Meeting the National Standards is a given for SPARK.

A value-added product could be examples and stories of teachers successfully meeting the standards.

SHARING AERONAUTICS PROJECTS ELECTRONICALLY

Carey Brock and Dr. Judy Fish, Antelope Valley Union High School District

**SHaring Aeronautics
Projects Electronically** 

Learning Technologies Conference
NASA Lewis Research Center

Classroom Internet Access

Classroom often have 2 - 5 computers available

Access of SHAPE site can be small groups

Access of SHAPE site can be as individuals with other students involved in alternative activities - the groups a rotated through the different activities

The most common SHAPE access is in classrooms that have two to five computers. Teachers use varying strategies:

a) Individual students access SHAPE. The teacher will have several classroom activities in which groups of students are involved. The “computer” group will have a specified amount of time to work on the material. Other groups will have alternate activities. Groups are rotated through the activities. This strategy allows the individual engagement with the material.

b) Students access SHAPE in small groups. With 5 computers in the classroom the groups will include 7 students each for a class of 35 students. This strategy allows for collaborative learning. However, a disadvantage is that only about 2 students per group will be actively involved with the material on the computer. The others are uninvolved and consequently disinterested.

Because the SHAPE material works well for individual students and for collaborative strategies, the standard classroom access allows for learning. Teacher must be on the alert for classroom disruption when groups as large as five or even seven students must access one computer.

Lab Internet Access

Lab setting - individual student access

- best suited to event decision points

- best suited for high school instruction

Results -

- good student engagement

- learning on a “need to know” basis during lab period

- “one time” use of the product - constrained by time

- number of simultaneous hits slows transmission

One strength of a lab setting is that all students have access to a computer and are able to work through the material at their own pace. The SHAPE aeronautical events were designed for the students using the material individually and making the decisions at critical points in the flight narrative.

This individual access to the narrative results in good student engagement with the material. Additionally, students can learn on a need to know basis - that is, they can access those teaching links that they need for meaning and can skip links they may have mastered in some other way.

The lab setting poses two disadvantages. First, since lab time must be scheduled, students have only a limited period of time to use the lab and the Internet resources. That may be one period or several periods during the school session. However, the student may not be at liberty to return to the site and review material or search for new material to augment learning that has taken place after exposure to the SHAPE material in the lab and based on those initial concepts presented. Second, our experience indicates that the number of hits over the Web slows the rate of transfer considerably when an entire class is working on the same site at one time.

Resource Room Internet Access

- an identified small group of learners

allows small group discussion

SHAPE's three reading levels enable resource students to use the aeronautical events in the resource room or in the mainstream classroom

Resource room access allows a small, identified number of students to access material. It can lend itself to small group discussion and collaboration. The lessons using SHAPE material can be teacher lead with one computer in class and displayed to the group. Alternatively, SHAPE can be used by individual students as they take turns using the computer.

SHAPE is written to three reading levels:

- K – 4
- 5 – 8
- 9 – 12

Resource room students can often use the SHAPE material in the regular classroom setting because a reading level is available that suits their reading ability. In the SHAPE glider event the appearance of the three levels is nearly identical; therefore, students with limited reading skills can use the SHAPE product for their level without being identified as learning handicapped by other students.

Home Internet Access

Good individual immersion

Parent support for the produce

Parent support for the student

Home access of the SHAPE Web site has received outstanding parent support. This support is particularly true with parents of the primary and middle school children who have had access to the SHAPE material in school. Of course, those parents tend to be more involved with their child's education at that age.

We have received requests for additional information on aeronautics from students around the world. We did not determine how they accessed the SHAPE Web site (whether it was an at-home connection or as part of a school assignment).

WWW Resources

Information and Resources - Curriculum &
Tutorials

Lesson Plans - Curriculum Site

Projects - Curriculum Site

SHAPE leaves use of WWW Resources under
the direction of teachers

Although the SHAPE aeronautical event narrative is a self-contained module, the SHAPE Curriculum and Aeronautical Event Tutorials are linked to other Web sites. Additionally, the SHAPE team is working to develop a Web resources site that links to other sites for aeronautics, math, and science.

The SHAPE Web site includes extensive lesson plans. Most of those lesson plans are project oriented. They can be accessed by teachers, directly by students, or by parents and students at home. Because these lessons are project oriented, they provide an interactive component to the SHAPE Web site. The student is not interacting with the computer hardware/software, but is involved with a hands-on lesson. Often the materials used for the labs are available in a typical (American) home. Materials for some of the labs are available in hardware stores or home improvement stores. These lessons provided a basis for understanding the concepts necessary to make the decisions in the aeronautical event narrative.

The WWW sites that teachers direct students to access will vary with grade level and subject matter as appropriate. Teachers familiar with SHAPE use the bookmark feature of their browser to save Web sites that they want to encourage students to visit.

WWW Resources

Student Activities - Curriculum Site

References and Links - Curriculum Site

Tutorials - Event Tutorials

Tools

More WWW Resources

Just as the SHAPE curriculum library Web site addresses the issue of projects it also addresses the concept of student activities. The majority of lessons are hands-on material for students. Some teachers will elect to do them as class demonstrations. Others will elect to do them as small group activities. Finally, some teachers will use these activities as individual projects for students.

SHAPE educators have begun addressing the common tools of computer technology - word processing and spreadsheets. However, those tools are not used formally on the SHAPE Web site yet. Suggestions for their use are found in several of the SHAPE curriculum library lessons.

The SHAPE curriculum site references material outside of the SHAPE site. We leave to teacher discretion the use of these sites in the classroom with students. In the aeronautical event, SHAPE does not have links to sites outside of the SHAPE Web. This feature is important for classroom control.

The SHAPE Event Tutorials are available for teachers and students. They are written at about an 11th grade reading level. For this reason most younger students will not be able to use the Event Tutorials or the Curriculum directly as individuals.

Teaching and Learning Styles

Generative Learning - real-world decision point encourages student to construct meaning and generate knowledge

SHAPE anchored in National Standards

Inquisitory - real-world decision points

Expository - limited to teaching links in narrative

Collaborative - enabled by flexibility of product

Generative Learning - The real-world, application-based nature of the SHAPE aeronautical events lend themselves to generative learning. Students actively and constructively generate meaning for standard math and science information and their existing knowledge by applying this knowledge to a real-world scenario. This results in comprehension due to the proactive transfer of existing knowledge to new material. Learners are required to consciously and intentionally relate new information to their existing knowledge rather than responding to material without using personal, contextual knowledge.

Anchored Instruction - The SHAPE curriculum is anchored in the National Math and Science Standards and supports the state frameworks.

Inquisitory presentation - The SHAPE decision points allow students to engage in a task or a representation of the task which is similar to the real world. Students receive feedback concerning the adequacy of his or her decision.

Expository strategies - The teaching links within the event narratives are expository in nature and provide information needed for students to answer the inquiry posed by the decision points. However, the SHAPE design is not expository in nature.

Collaborative learning- Many teachers use the aeronautical flight narratives in a collaborative manner. They find this material to generate excellent collaborative interaction and learning. The decision points are a focus of the collaborative process.

Teacher Training

Beta Test Training is developed to produce product evaluation and improvement

Product use training is not developed—the SHAPE site is self-explanatory for those individuals who have even limited experience using the Web

SHAPE Beta Test Training provides teachers with an introduction to the classroom use of the Web. More importantly for SHAPE, the Beta Test Training focuses on developing critical review skills for beta test teachers. They are asked to assess the strengths of the product. They are asked to assess the product weaknesses and suggest improvements. They are required to indicate what materials they need to develop to use SHAPE with their students and curriculum.

Teacher Training

National scalability limits teacher training

Product should be user-friendly

Suggestions on possible uses are available within the site

We have developed a site that seems to be easy to navigate and use. We feel that a site that required extensive teacher training for its use would not be nationally scalable.

We are upgrading our Teaching Strategies Web page to include more suggestions as well as to describe some possible use strategies. Beyond this, we feel that no training is necessary for teachers to use the site effectively.

Interactive Lessons

Hands-on Activities available in SHAPE curriculum web site

Aeronautical Flight narratives are thought engaging

As mentioned previously, the SHAPE Curriculum Web Site includes many project-based, hand-on activities for students. Some teachers use these as classroom demonstrations. Some use these activities in a class lab setting. Often the activities are done in small lab groups.

The SHAPE aeronautical flight narratives are thought engaging. That is, they are interactive with the learner's mind. Students and teachers are enthusiastic about the narratives. The integrated nature of each decision point segment requires real-world thinking skills on the part of students. SHAPE has held with the concepts that learning is an individual, constructive activity and that knowledge is mediated through student thought processes and not the medium itself. The design of the SHAPE aeronautical events focuses thought process activated by the learning activities.

National, State, Local Standards

Curriculum lessons directly linked to National Standards

Decision Points are process oriented

The curriculum Web site includes lessons that are project oriented. This is in keeping with curriculum development theory. Our teacher-writers develop material that is aligned with their mandated curriculum. They cross check it with the state frameworks as well as national standards.

The aeronautical flight narratives with decision points are process oriented. The decisions required are integrated in nature. Students must consider multiple factors that include math and science. The decision points represent real-world decisions that individuals were required to make at the time of the flight. The decisions are integrated with a representation of the same information that the adults would have available in making the decision. However, just as importantly, some information is not available. This is a real-world scenario representing the kinds of decisions that adults often have to make when not all the desirable information is available. These decision points require learners consciously and intentionally relate new information to their existing knowledge.

Conclusions

SHAPE is

process oriented

real-world and application based product that

lends itself to constructive meaning and

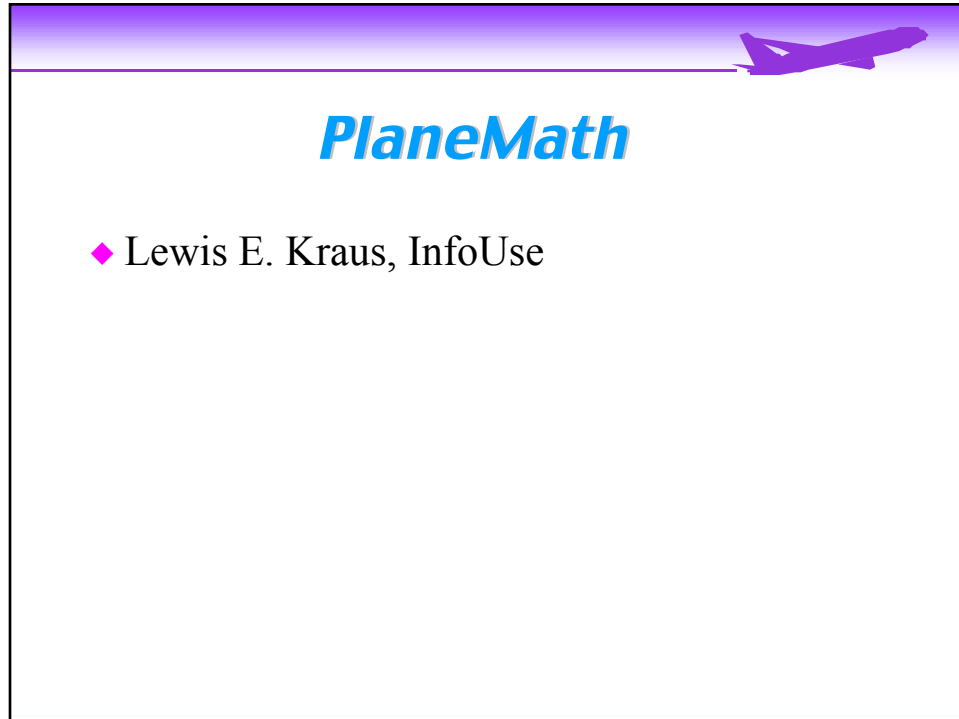
generative learning

thought engaging

user friendly

PLANEMATH: AN INTERACTIVE CURRICULUM ON MATH AND AERONAUTICS FOR CHILDREN WITH DISABILITIES

Lewis Kraus and Michael Hornsby, InfoUse





Analyses done at project design stage:

- ◆ audience
- ◆ environment
- ◆ technical
- ◆ pedagogical

The six issues to be addressed in this paper are: different types of classroom access, the types of World Wide Web resources used, different teaching and learning styles, teacher training, different ways of creating interactive lessons, and meeting national, state, and local education standards. In trying to address these issues, a return to the design stages of PlaneMath provides the impetus for examination.

When we started PlaneMath, as with our other multimedia presentations, we examined needs in four main areas: audience, environment, technical issues, and pedagogical issues.



Audience

- ◆ Students with disabilities in 4-7th grade
 - ability to access with adaptive hardware
 - math that can be done without paper and pencil
 - models of people with disabilities in careers

Our audience for PlaneMath is students with physical disabilities in 4th to 7th grades. The design needed to take into account the issues for our audience: that these students have fallen behind in math at the 4-7th grade level because of the need to use paper and pencil to solve math problems at that point, that to use the computer they will be using adaptive hardware that may not work well with current math software, and that they rarely if ever see models of individuals with disabilities in aeronautics careers. These issues are what we needed to address.



Audience

◆ Result

- Make site totally accessible for students
- Be careful about leading to other sites because of lack of accessibility
- Design for math that is conceptual
- Provide ways to visually present to students how arithmetic operations were carried out
- Include pages of interviews with experts with disabilities

Our solutions include creating a design that would be adaptive hardware “friendly” or “aware”. The resulting design ideas guided the design of PlaneMath. Once established, we noted that other sites would not necessarily be conforming to the access design guidelines we established that allowed students with disabilities to use the WWW. Therefore, we felt we needed to be aware of that limitation in allowing access to outside sites.

In order to solve the “paper and pencil” way of presenting math, we reviewed the national math standards and designed activities using as many conceptual parts of the standards as needed. When a standard requested the use of calculations which were more paper and pencil, we provided visual reinforcement of the arithmetic calculation.

Our design also included resources of experts with disabilities to provide that needed career model. We are still exploring the possibilities of allowing for e-mail access to these professionals. But we feel strongly that the access needs to be consistent with the design and the project objectives.



Environment

- ◆ What is the typical educational situation for a student with a disability?
 - mainstreamed
 - separate classrooms
 - separate schools
- ◆ How do teachers assign students to work?
 - as 1 student
 - as a group
 - as a class
 - at home

We also assessed the environment that the product would be used in. For a student with a physical disability, there are several ways that their educational location may occur: mainstreamed into a regular education classroom, in a separate classroom in the same school as regular education students, or in a separate school. This has ramifications, of course, for the environment in terms of speed of education, types of education, teacher familiarity with disability issues, and assignment of work to students. We discovered that teachers might assign work on a computer to one student alone, to a small group, to the entire class, or the student may work on it at home as an assignment or with their parents (also the advent of home schools provides another environment).



Environment

- ◆ Result
 - Must be designed to work as individual or small group
 - Must have group activities that can be done off-line
 - Parent or Teacher - both need to be targeted

Our design, therefore, stressed the need for flexibility. The educational environment could be totally different from one setting to another. Thus we decided to create activities which could be worked on as an individual or a small group. We also emphasized the need to have off-line activities which could be worked on as a group. This will allow for students with a disability to play an important role in the group.

Because both parents and teachers may be guiding the students, we designed a parent/teacher page to include all of the relevant information a parent or teacher may need to help make the activities relevant for the student. The page includes a matrix of activities to the national standards, the objectives of the project, and other resource materials.



Technical

- ◆ What is the typical computer set up for schools with students with disabilities?
 - Issue of Macintosh/PC mostly irrelevant because of Internet
 - Capability of machines assumed to be low
 - Assumed slow modems (14.4kbps or lower) at outset
 - Assumed Netscape at outset (found more AOL than anything)

We examined the technical issues for students in our target group. The computer/modem connections for students with disabilities are generally far behind other student set ups in classes. Therefore, we generally assumed the capability of the machines used by these students to be low (low RAM, slow machine, older processor). We also assumed the modems to be slow (14.4 kbps or slower). And we assumed Netscape Navigator. (In fact, many of the first schools weren't even on Netscape, but were using America On-Line 2.5 or earlier). Of course, these assumptions were at the beginning of the project two years ago.

Because the technology a class or school has is a temporal issue, the situation has changed. We have found in recent signups from schools that the machines are being upgraded, the connectivity is T1 as frequently as it is 14.4 Kpbs, and Netscape or Internet Explorer was common. Of course, we realize that those signing up are the "early adopters" or are ahead of the curve, but we feel there is a significant enough base of schools with higher capability now, that we can comfortably aim at a higher technological benchmark.



Technical

- ◆ Result
 - Not heavily graphics based
 - Not reliant on plug-ins
 - Video not likely
- ◆ Review each year in trades and from our database
 - New capabilities discovered

The design took into account these assumptions and findings and therefore we aimed to make the Web site not be heavily graphics-based to speed loading, not to be reliant on plug-ins because the target computers may not have the capability, and not to include video. This had major ramifications on the interactivity of the site. We were designing something that would look more like a HyperCard stack of 8 years ago than a currently available CD-ROM.

Because of the findings from our registration page that schools may be more advanced technologically than we initially expected, and due to the increased capability of software and hardware to present a Web site more interactively, we have been upgrading our designs. Since our project, from the start, was to watch the changing technological landscape, we have been prepared to make changes. New designs will take advantage of animations, sound, and possibly even video.



Pedagogical

- ◆ How are teachers teaching math?
 - Curriculum vs. materials
- ◆ What are national standards for learning math?
 - National standards (4 process, 9 content)
 - States creating own frameworks to meet standards

Our design also needed to take into account how teachers were teaching math. In our proposal, we had envisioned this project as a curriculum. During the first months, when we had conversations with teachers and administrators, we discovered that a curriculum would not be what would serve our purpose best. Some teachers said they followed a curriculum, but others noted that they were asked to follow a curriculum by the school administration, school district, or state. Other teachers mentioned that they taught from their own materials. Therefore, it was clear that a curriculum was not what they were wanting.

We also noted the national math standards (NCTM) which described 4 process and 9 content standards for teaching math to 4th grade students. Furthermore, there are state frameworks which take national standards a step further. The teachers told us that they followed the national standards and the state frameworks.



Pedagogical

- ◆ Result
 - Design for materials to be used as teacher sees fit
 - Follow the national standards

We designed our Web site to support the teaching of math in our target grades. We strongly felt that the teacher would be the best one to determine when and how to use these materials. We felt it was critical, and teachers seconded the notion, that if we were to create materials rather than a curriculum, we needed to give teachers a “roadmap” to guide them in how the materials might fit in their educational rubric. Therefore, our design followed the NCTM math standards.

After the first Web site was up, we discovered that it would be even easier for the teacher to select an appropriate activity by giving them a matrix of our activities and the standards they speak to. We have received a lot of positive feedback about this design from teachers.



How can lessons be interactive?

- ◆ Strengths and capabilities of the web
 - good for e-mail
 - good for getting graphic images
 - good for researching
- ◆ Do they match with project objectives?
- ◆ Advent of new technologies and capabilities of web and classrooms allows greater possibilities

In determining how our lessons could be interactive, we first noted the strengths and weaknesses of the Web. The strengths for interactive use are the ability to converse via e-mail, the ability to research vast and varied sources quickly, and the ability to receive graphic images on your own computer. The weaknesses tended to be technological and have been described already (speed of access, need for computer capability, etc.).

We then examined those strengths and weaknesses in relation to our objectives. The needs of students with physical disabilities dictated dealing with conceptual math, which flowed well with the graphical strength of the Web. We used interviews with role models to point out the potential of aeronautics careers. We are still investigating the possibility of putting up the videotaped interview and/or to make these professionals' e-mails available to the students. Since we were creating a model site which would allow students using various types of adaptive devices to access the Web, we were wary of giving them free rein to surf the Web, only because we didn't want other sites' possible inaccessibility to create frustration. At this point, we have included a small, targeted number of other sites.

Do teachers need to learn how to use PlaneMath?

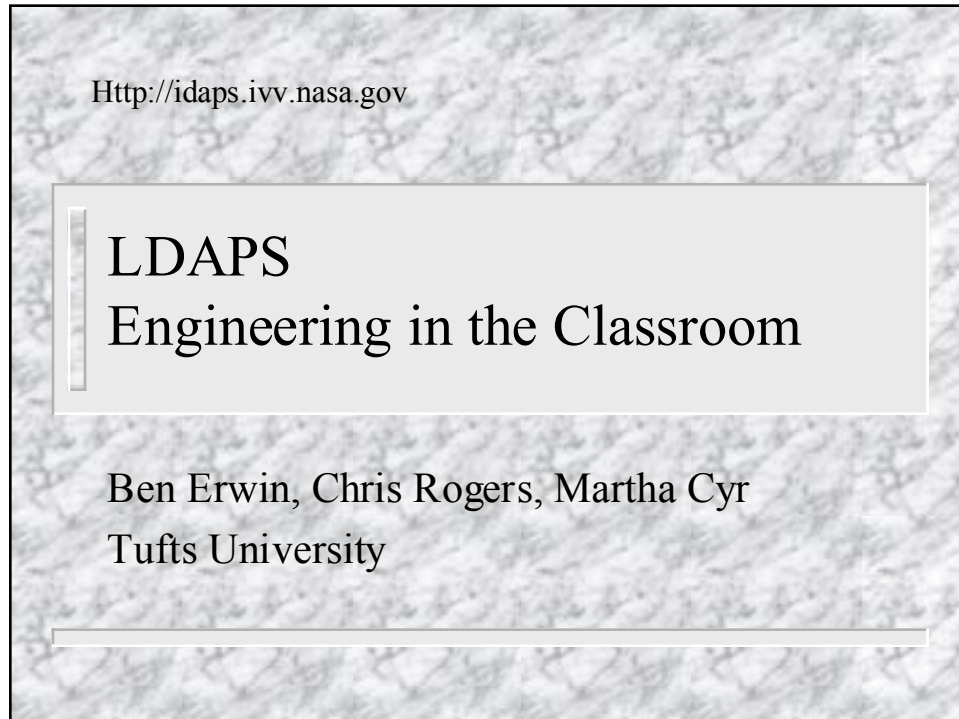
- ◆ Use of teacher training on PlaneMath through Kinko's videoconference sites

We aimed to create a design for PlaneMath that would not need much if any training for teachers or students. The site was designed for exploration by students and has a parent/teacher section to explain the objectives and aims of the project and the Web site.

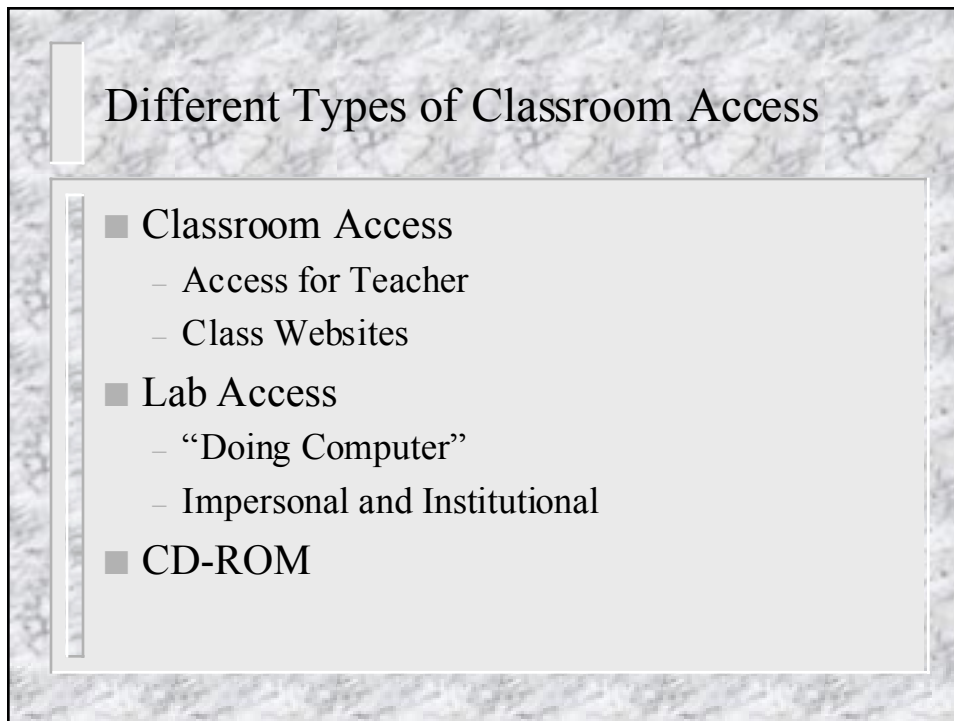
In pursuing match funds, however, we were fortunate to discover Kinko's and Sprint have 300 videoconference sites nationally. They have donated the use of the sites to the project. We are hosting teacher trainings at these sites. Our teacher trainings include a review of the purpose of the project, a brief tour of the Web site, and a sharing of strategies for using the site in class.

LDAPS: ENGINEERING IN ELEMENTARY SCHOOL

Ben Erwin and Dr. Chris Rodgers, Tufts University



Good afternoon. My name is Ben Erwin. I'm here representing Tufts University and LDAPS, which stands for Lego Data Acquisition and Prototyping System. Our goal is to bring an engineering curriculum into K-12 education. I'm here with the principal investigator of our project, Chris Rogers, and we both work with our colleague Martha Cyr back in Massachusetts. My role is and has been to provide support for schools near NASA centers and other school sites that are becoming involved with the LDAPS project.



Lots of the same issues:

The unfortunate reality of the classroom today is that even the ones lucky enough to be “wired” realistically only have one or two computers in the room. In this format it is unlikely that every student will have the time to sit down and interact with an instructional Web page. The format for Web instruction, if it exists, can more easily come as a sort-of hyper-media overhead projector show. In this manner the Web can only distribute information, and not be very interactive where the student has choices, or makes decisions based on certain goals, such as the Goal Based Scenarios in Robert Shanker’s work. Our project reflects that reality by making our Web site more for the teacher instead of the student. But students do get experience with the Web... firsthand.

Every teacher involved with the LDAPS project gets help in setting up a Web site for their classroom either on our server or on their own schools server. Classroom access then becomes more than students getting information from the Web, but students putting their own material onto the Web. We are currently developing pages that allow students and teachers to post creations and ideas to the site and be kept in a library at our site.

Different Types of Classroom Access

■ Home Access

- Downloadable Software and Materials
- Free Distribution of Software

■ World-Wide Access

- Teacher Mailing List
- New Versions Made Public with Announce List

Going to the computer lab to do a classroom lesson gives the student the notion that they are “doing computer” and not “doing science” or “doing math.”

Lab computers are also impersonal and institutional computers. They are big ugly boxes that cannot be customized or personalized.

Our (LEGO/LabVIEW) software is being downloaded by teachers, homeschoolers, and business people alike around the world.

Teachers have access to each other through a mailing list with which they can share ideas with each other about using LDAPS in their curriculum. Announcements for updates on LEGO/LabVIEW drivers are made over an announce list.

Typed of WWW Resources Used in Our Materials

- What We Have
 - Demonstrations
 - Student Activities
 - Links
 - References
 - Tutorial for Lego/LabVIEW
 - Workshop Materials

Demonstrations of different physics and engineering principles can be found at the Web site. Some favor student inquiry into what is happening, such as asking students what they think will happen when 3 push pins are removed from a 2-liter bottle of water. Others involve the students becoming engineers, such as building their own spring scale with a shoebox and a rubberband, where they are learning about accuracy, precision, and calibration.

Links to other NASA sites, other LEGO sites (of which there are a ton), other aeronautics sites, and other education sites. There are a lot of people out there using LEGO for the purposes of education. There is also a publications list we have for papers written about the project that have been published in such journals as the Journal for Engineering Education.

A Web-based and a LabVIEW-based version of a tutorial exist to familiarize participants with using our drivers.

The latest edition to our Web site is an hour-by-hour documentation of the kind of two-week workshop that we have run for elementary school teachers. This will help schools know what they are getting themselves into should they choose to become involved with the project, and also help schools without the means or the funds to participate in the workshop get some ideas about engineering in education.

Types of WWW Resources Used in Our Materials

- What We Will be Working On
 - Inquiry-Based Science Curriculum
 - Engineering Curriculum
 - Supporting Third Generation Developments
 - Getting Support from LEGO

Based on the National Science Education Standards and other current research in science education, soon we will be creating a full curriculum for all grades that use LEGO/LabVIEW. Having a good curriculum never ensures that a group of students learn what you want them to learn, however. What students should learn is that in which they are interested and motivated to learn. In this sense the curriculum is just the base or the model from which the teacher can improvise.

An engineering curriculum for K-6 is a completely new idea. By starting with the 'habits of mind' of an engineer, we will seek to develop curriculum materials that encourage such 'habits of mind' and ways of thinking in young students.

The LEGO hardware we use, the data acquisition board that plugs into the computer, is the first generation development from MIT and LEGO. We are currently working on integrating software and curriculum to the second and third generation developments, which are not public yet.

We have met with LEGO to talk about a possible alliance, and things are looking positive.

Different Teaching and Learning Styles

- Science Concepts
 - Inquiry
 - Expository
- Engineering Concepts
 - Inquiry
 - Taking Things Apart
 - Building Things
 - Hands-On

In our teacher workshops, we model science teaching methods for elementary school teachers. Inquiry and teaching methods need to be built into lesson plans. An inquiry approach to some of our physics lessons is sometimes used. In this way, teachers see an alternative to teaching science besides drill and memorization. By giving the teachers a certain experience such as pulling up a Lego brick with two gears of different sizes, we build an atmosphere of questioning and observation as to what is happening.

Some of the science concepts we teach in our workshops through mini-lectures. The lectures provide the teachers with some background information and mathematical knowledge of the science involved (more than their students need to know) so that they will be more comfortable teaching these concepts to their students. This kind of lecture is usually requested by the teachers.

Different Teaching and Learning Styles

■ Science Concepts

- Inquiry
- Expository

■ Engineering Concepts

- Inquiry
 - Taking Things Apart
 - Building Things
- Hands-On

Engineering inquiry is another model we use in teacher workshops. By using a scientific instrument such as a kitchen diet scale or an egg beater, we take a close look at them and try to understand how these items work and on which principles they operate. Taking a diet scale apart, teachers in a California workshop had a great learning experience. They saw the rack and pinion mechanism that they could mimic later on in their LEGO designs.

Teachers built their own spring scale as well, where they could get a better idea of concepts such as accuracy and calibration.

Through a series of mini-design problems, participants in the LDAPS project (students and teachers) get a hands-on feel for many mechanical engineering principles. Using LEGO bricks, one can demonstrate gearing up, gearing down, the conservation of energy, mechanical advantage, the ratchet and pawl, rack and pinion, torque, and shear, and many other concepts.

Different Teaching and Learning Styles

■ Complex Concepts by Using the Computer

- Feedback and Control
- Behaviors of Systems

■ Systems Engineering

- Cooperative Learning
- Generative Learning
- Anchored Instruction
- Problem-Based Learning

When making a farm for a systems engineering project, a teacher made a greenhouse door open or close depending on the temperature inside.

When making an airport for a systems engineering project, a teacher wrote a program that turned on the runway lights when the room got dark. One kindergarten student in another class wrote a program to have a LEGO school bus drive down the street and stop at houses along the way.

Cooperative: Working in groups is just the beginning in systems engineering. Groups working on different aspects of a project need to talk to each other and coordinate all efforts to make a complex system run smoothly.

Generative: By programming a computer to make a LEGO model work, students need to think about how the computer program needs to “think”. Such a task serves to have students discover patterns in their own thinking, becoming epistemologists themselves.

Anchored: A systems engineering project can be related to a real-world task, such as visiting a recycling center and then coming back to the classroom and building one out of LEGO bricks.

Problem-based: In systems engineering there is never one right answer. With a complex engineering problem, the problem is always open-ended and trade-offs are always encountered. Such an environment fosters good decision-making skills in students.

Teacher Training and LDAPS

- Workshops
 - Two-week Sessions
 - Continued Support
 - Training Trainers
- On-Line Training
 - Workshop Materials
 - Demonstrations and Tutorial
 - Archived Mailing List

The workshops we run for the teachers involved in the project are not simply “teacher training” sessions. While there is a lot of training - how to use a Macintosh laptop, how to write Web pages, etc., there is also a big element of teacher education. I model a teaching approach when I run a workshop. Any new instructional material, whether it be a Web site or a computer program, might not be utilized if the teacher feels unprepared to answer questions the student might have. The Internet is opening up avenues for students to explore the answers to questions much faster than what was once possible, but teachers need to have the background knowledge to know how to help their students determine which information is useful and reliable. We offer teachers not only workshops but continued support year-round after the summer workshops are over.

The next step in our dissemination (and eventual take-over of the world of K-12 engineering) is to train more trainers. We at Tufts are but a small collection of professors, graduate students, and consultants, and cannot be everywhere at once. Training other NASA members and selecting the best teachers in a given area to become trainers themselves, dissemination becomes more realizable.

As mentioned before, everything we do in the real world is mirrored (or will be) on-line. From the workshop materials to an archived version of the mailing list, the LDAPS Web site is a pivotal component of the project.

I would like to expand the first two items on this list as they are both important components to the success of the project.

Teacher Training and LDAPS

■ Workshops

- Two-week Sessions
 - LEGO Engineering
 - Physics Concepts
 - Classroom Demonstrations
 - Web Design
 - LabVIEW Programming
 - Systems Engineering Project

In the workshops, we give teachers first-hand experiences of what it is like to be an engineer, much in the same way that a computer program like LOGO gives students a first-hand experience of what it is like to be a mathematician. Mainly by exploring, teachers learn about such things as stability, engineering trade-offs, and the design of everyday things. Teachers tell me that they start to see the world differently - looking at everyday things and thinking about the engineering and science behind it.

I mentioned earlier the physics concepts and classroom demonstrations that we do at the workshops, and

There is also time for teachers to learn about the Internet. They learn things such as how to send Email, FTP files, and write Web pages using Netscape Gold.

Teachers also learn some basics of the graphical programming language called LabVIEW that can be used to sense and control from the Dacta LEGO models.

The workshop culminates with a systems engineering project, where the teachers work together to build a large complex project.

Teacher Training and LDAPS

- Workshops
 - Continued Support
 - Site visits and Guest Speaking
 - Web Page and Curriculum Contests
 - Mailing List and Email
 - Teacher Websites

Instead of throwing the teachers into the classroom to fend for themselves, we offer continued support for the teachers in many forms. At a school's request, we may be able to send an LDAPS representative to give a talk or help out in some way in the school. Schools that are closer to our center at Tufts have regular site visits and are sometimes videotaped for review. Teachers that are farther away from Tufts are also encouraged to videotape their students using LEGO materials for engineering and science projects.

Periodically we hold Web page and curriculum contests to encourage teachers to make a Web page that shows everything they are doing with engineering in their classroom. Prizes awarded are things such as more LEGO kits to memory upgrades in their computers.

Teachers can also keep in contact over the Internet in various ways. By communicating via the LDAPS mailing list they can share classroom ideas and strategies.

By loading up another teacher's Web page they can get curriculum ideas in the form of movies and images as well as text.

Different Ways of Creating Interactive Lessons

- Child Programming the Computer -- Not the Computer Programming the Child
- Hands-On Science
 - Concept Demonstrations
 - Student Inquiry
- Hands-On Engineering
 - LEGO
 - Everyday Objects

Seymour Papert, one of the greatest technology education theorists, coined this phrase about the use of computers in the classroom. With control over the computer instead of passively taking in information, the student is empowered. The student, by making the computer “think” through a program, has to become an epistemologist themselves.

As mentioned earlier, science is very hands-on when done through the demonstrations and experiments we have collected.

By building a model of an everyday object out of LEGO, a child gets a better feel for how that object works, even if they have used the everyday object often. Understanding the inner workings of engineered items in their daily lives gives students a new perspective on the world, an “engineering perspective”.

Meeting/Addressing National, State and Local Education Standards

- National Level
 - National Science Education Standards
 - Board of Engineering Education
- State and Local Levels
 - Teachers Modifying Existing Curriculum
 - School Systemic Change (Lincoln, MA)

The National Science Education Standards notes that students learning different scientific concepts one after another tend to lose sight of the big picture. They see science as a collection of different rules and laws that are unrelated and a bunch of facts to memorize instead of a human undertaking of uncovering the secrets of how the universe operates. The NSES therefore call for students to be able to see things as systems. By combining science with engineering, students are able to create their own system, and be a part of a system inside of the classroom.

The NSES also calls for Scientific and Technological literacy among the students of today and tomorrow. The school is an impoverished environment if we think about the role of technology in the world today. By bringing in a variety of technologies, from ice-cream scoops (a good engineering example of a rack and pinion combined with a torsion spring) to the Internet, we are furthering this cause.

While mainly dealing with post-secondary education, the BoEE addresses some issues in K-12 education. Among other things, they call for K-12 students to understand engineering as a profession, and for engineering college faculty members to establish links to K-12 teachers.

Meeting/Addressing National, State and Local Education Standards

- National Level
 - National Science Education Standards
 - Board of Engineering Education
- State and Local Levels
 - Teachers Modifying Existing Curriculum
 - School Systemic Change (Lincoln, MA)

LDAPS is now being implemented in at least five states in public education, and numerous other institutions and homes around the world. The first crack that teachers usually make at incorporating engineering into their classrooms is simply to modify what is already in place. With no major changes to the curriculum already in place, state and local standards of what is being taught are still being followed. In California, one school's second grade science consists of planting and maintaining a small garden behind the school. By incorporating LDAPS into their existing curriculum, they can now monitor the light and temperature that their garden receives, and control an automatic LEGO flower-waterer by computer.

In Lincoln, MA, almost every teacher in the elementary school is becoming involved with the LDAPS project. A change will take place not only in individual classrooms but system-wide. The principal, technology specialist, computer specialist, and science specialist are also all involved, providing an entire network of support to the elementary school teacher.

The main idea here is that engineering is naturally interdisciplinary. We can show that engineering can be related to any aspect, any subject, any domain of learning in education.

**AERONAUTICS LEARNING LABORATORY FOR SCIENCE TECHNOLOGY
AND RESEARCH (ALLSTAR NETWORK)**

Dr. Cesar Levy, Florida International University

ALL STAR Network

**Aeronautics Learning Laboratory for Science,
Technology, and Research**

Network

<http://www.allstar.fiu.edu/>

NASA Communicating Science

*Dr. Levy
IITA/LeRC
Sept. 1997*

Classroom access

Our material can be accessed through:

- Internet/WWW
- BBS
- Kiosks (in school libraries)

The information can be used as

- Self explanatory for students at home
- Enhancing teachers' curriculum
- Information resource for homework assignments
- After hours programs (e.g. CAP cadets)

Dr. Levy
IITA/LeRC
Sept. 1997

We endeavor to provide the widest access to the material through the use of the Internet Web site;

Stand-alone kiosks that contain the same material as the Web site but with the links disabled; and,

Through a toll-free bulletin board system (BBS) where questions and answers are batched to NASA scientists, answered and re-posted on the BBS.

The information can be used in several modes by teachers and students. For teachers there is a teachers' guide that provides correlation between the material on the Web site and state standards. It can also be used in class and laboratory by teachers to teach certain ideas and principles. The material is self-explanatory and can be reached while at home by students, as well. The material can also be reached through our search engine and can be used by students to answer homework assignments. The material has the potential of being used in structured after-hours programs, such as in the Civil Air Patrol's cadet programs.

Classroom access (cont.)

We developed our product to support teachers, students (from home or after hours programs), and labs (e.g. science labs) by

- Module based curriculum
- Multi-disciplinary resource
- Three levels (MS/HS/College)
- Created experiments
- Developed Shockwave & GIF animations
- Videos & Pictures from NASA
- Teacher resource guide to our site

Dr. Levy
IITA/LeRC
Sept. 1997

The material has been created to reach students in Grades 4-14. The material has been divided into 3 levels with Level 1 geared to the middle school student and tending to be more “hands-on” and experimental/experiential in nature. Level 3 is geared to the high school/lower division college student and tends to be more theoretical in nature. Level 2 bridges Level 1 and 3. The material has been created as modules so that a curriculum can pick and choose the topics to be used. Our philosophy was to create pages that were no more than 100 Kb so that download time would be minimized. Our overriding philosophy was to create a site that could be reached by the slowest computers as well. Though we have shockwave and GIF animations, we also have stills that portray the essence of these animations as well. Finally, our site is multi-disciplinary in nature covering topics in History, the Social Sciences, the Physical Sciences, mathematics, career planning and technology.

Classroom access (cont.)

Our material is configured to support the following:

- Teachers
 - At home to enhance their curriculum
 - At schools in the classroom
- Media specialists in labs
- Students
 - At school's library as resource
 - At home as resource for homework
 - Fun

Dr. Levy
IITA/LeRC
Sept. 1997

Our project provides access to the material in many ways:

For teachers--the teachers' guide can provide material to enhance their curriculum. The Web site or the kiosk can also be used by teachers in the classroom as a tool.

For media specialists--how they can help students to register and to navigate the kiosk material.

For students--it can be used in a "surfing" mode whether at school or at home; a directed learning mode by teacher assignment; or just for fun such as trying out the experiments on Level 1.

WWW resources used

- Demonstrations
- Hands-on activities
- Interdisciplinary activities
- Internet/technology training sessions
- Lectures
- Mentoring (grades 4–12 and College students)
- Movies/videos
- Problem solving activities

Dr. Levy
IITA/LeRC
Sept. 1997

We use many resources on our internet site. We have used as much public access material that we could get our hands on. For example, in Level 3 we use materials for NASA's Kennedy Space Center and Lewis (now Glenn) Research Center to enhance our material. We have also used pictures and video from Dryden to enhance our photo galleries and our video galleries.

We have also used materials with permission from private sources--Beechcraft, Civil Air Patrol, and the San Diego Air and Space Museum.

WWW resources used (cont.)

Databases

- Knowledge Review exercises forms
- Feedback form
- Gallery feedback form

Lesson plans (Teacher Resource Guide)

- Experience-based activities
- Scientific/engineering methods of inquiry
- Technology
- Interdisciplinary approaches
- NASA material

Dr. Levy
IITA/LeRC
Sept. 1997

The materials that we created can be used by teachers to teach other teachers, as well, about our material and its possible uses. We also ask teachers in the teachers' guide portion to give us feedback and tell us how they've used the site.

But feedback is not only requested from teachers. We ask students to evaluate our site through various feedback forms and we also provide review exercises as a "check on learning" for the materials in the modules. These review exercises provide immediate feedback to the student.

WWW resources used (cont.)

Workshops

- One day workshop for History & Science
- Teachers in conjunction with Kiosk placement
 - High school teachers workshop - December 1996
 - Middle school teachers workshop - October 1997

Student activities

- Sixteen experiments for students/teachers on principles of aeronautics and instruments
- FLAME summer programs

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Sept. 1997

WWW resources used (cont.)

References and links

- Schools with Aeronautics education
- Aerospace industry
- Employment opportunities
- Potential Employers
- Associated Resources
- Careers with airlines
- Airport careers
- Military/Government careers
- Career Planning

Dr. Levy
IITA/LeRC
Sept. 1997

In our “Careers” section we provide links to educational institutions, aerospace-related companies, and technical schools on our Web site. Our material also provides a point of contact and a telephone number as well for the kiosk-based material. This material is a “one-stop shopping” list that may be used by high school students to look for colleges and universities that offer aeronautics-related programs and by college students for possible employment opportunities.

Teaching and learning styles

- Experiment-based activities
- Module-based activities
- Scientific/engineering methods of inquiry
- Technology
- Interdisciplinary approaches
- NASA material

Dr. Levy
IITA/LeRC
Sept. 1997

The material has been created to reach students in grades 4-14. The material has been divided into 3 levels with Level 1 geared to the middle school student and tending to be more “hands-on” and experimental/experiential in nature. Level 3 is geared to the high school/lower division college student and tends to be more theoretical in nature. Material can be used by the teacher in several ways--generative learning, anchored instruction, inquisitory, and expository strategies.

Teacher may ask a question to which students need to find the answer using the search engine and by proper querying of the search engine. Teacher may use a block of instruction as reading material that can be discussed in class. Teacher may use the material in a normal “chalk-and-talk” manner. The manner of material usage is up to the teacher.

Teacher training

Local workshops

- Invite History and science teachers for a one day session at Florida International University
- Walk through the modules on the Web site
- Explain and demonstrate access to the kiosk

National workshops at the NSTA conferences

- Walk through the modules on the Web site
- Explain the various uses of the curriculum

Dr. Levy
IITA/LeRC
Sept. 1997

To ensure proper usage of the material, we have held teacher workshops on navigating the Web site. We have ensured that the teachers invited covered the spectrum of subjects--history, social sciences, natural science, career counselors, and engineering teachers. We are also holding workshops at the NSTA to show teachers how to use the site.

When we set up the kiosk, we have a session with the media specialist or the librarian on how to use the kiosk and how to help the students use the kiosk.

Teacher training (cont.)

Media specialists (local)

- Explain and demonstrate access to the kiosk, so they can train the students (train the trainer)
- Walk through the modules on the kiosk (Web)
- Explain how to administrate the kiosk (passwords, troubleshooting, warranty issues, etc.)

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Sept. 1997

Interactive lessons

- Shockwave animation
- Web discussion forums answered by FIU and NASA LaRC scientists
- We answered more than 200 e-mail messages mainly from students sent to our aeromaster e-mail this year
- BBS discussion forums answered by NASA LaRC scientists

Dr. Levy
IITA/LeRC
Sept. 1997

Since we wanted to reach the student with the simplest system, we minimized the technology that would take long to download. However, the material is fairly interactive. The student gets to learn how pitch, yaw, and roll are caused; how hydraulic systems work; what shear, bending, and tension are. He can click on icons to make shockwave animations/GIFs operate. A majority of the material requires the student to read. Only at Level 1 do we have “hands-on” type experiments that students can do, and, normally, under adult supervision.

As for the Bulletin Board System--we tend to batch questions to be answered by NASA scientists or FIU faculty. So far we have answered over 200 e-mails sent to aeromaster this year.

We have also set up discussion forums in the area of research for people to discuss subjects like LoFLYTE, X-33, and other topics.

Interactive lessons (cont.)

Strategies incorporated

- User feedback to enhance site
- Student responses to feedback forms
- Teacher response to teachers' guide
- Teacher/Student/Administrator feedback to improve the pilot kiosk format

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Sept. 1997

Functional Diagram of the Electronic Discussion Forum

Schools (In Mid-Atlantic Region)

- Each school uploads unanswered questions
- Each school downloads questions w/answers



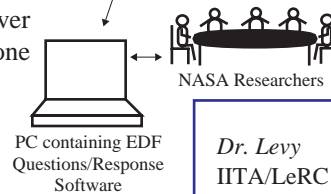
Prime Technologies Sysop

- Questions consolidated for all schools
- EDF Sysop manages and tracks all questions and answers
- Consolidate questions available for download to NASA LaRC
- Responses available for upload to schools



NASA Researchers

- Consolidated questions downloaded from EDF Server
- Researchers review all questions and assign one individual to respond to each question
- All responses entered onto a single PC
- Answers to consolidated questions



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Education standards

- Dade county uses the Sunshine State standards
- Florida's Sunshine State Standards
 - Provide a list of all standards
 - Link the applicable ones to the right section
 - Covering
 - Science
 - Math
 - Social Studies
 - Career counseling

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Sept. 1997

The teachers' guide connects the material to the Sunshine State (Florida) standards, which are also the Dade County Public School Standards. We are working with several agencies representing national standards on listing their standards in our teachers' guide as well. Listed in the next slide are those agencies.

As the standards change, we will re-evaluate our site and update the teachers' guide to meet those changes. We will also continue to upgrade our site with more material, further enhancing our site's worth.

Education standards (cont.)

National

- We are working with National Academy Press on the National Science Education Standards
- We are working with National Council of Teachers of Mathematics to use their standard pack in conjunction with our material
 - Curriculum and Evaluation Standards for Schools Math
 - Professional Standards for Teaching Mathematics
 - Assessment Standards for School Mathematics

Dr. Levy
IITA/LeRC
Sept. 1997

ALLSTAR *Network*



<http://www.allstar.fiu.edu/>

Dr. Levy
IITA/LeRC
Sept. 1997

Visit our site at: <http://www.allstar.fiu.edu/>

K-8 AERONAUTICS INTERNET TEXTBOOK

Dr. Jani Pallis, Cislunar Aerospace, Inc.



INTERNET ACCESS



- ✈ K8AIT is used in all four settings and instructions are given in the “How To Use K8AIT” guide for classroom, lab, and home access.
- ✈ For K8AIT the issue of access deals more with “who” and not “where”. For example, home access can signify a teacher preparing lesson plans, a child or adult having fun or using K8AIT as a resource for a report, or parents that use the information for home schooling. So we have always tried to understanding who our audience was in each situation and tried to address needs for these different populations.





WWW RESOURCES

- ✈ K8AIT is a textbook in 4 reading levels and the Spanish version. K8AIT has information, lesson plans, projects, student activities, references and tutorials.
- ✈ A new interactive portion of K8AIT called “Tennis Over the Net” will also have tools and databases of information.
- ✈ Only one section in K8AIT has links to outside sites. This was intentional because the PI did not want the staff to spend time maintaining K8AIT for “dead links”. “Tennis Over the Net” will link to NASA sites to support the downloading of software to support internet videoconferences.





TEACHING AND LEARNING STYLES

- ✈ K8AIT was actually designed to teach educators the basics of aerodynamics, to provide those educators with a comprehensive text and novel lesson plans and activities. K8AIT's two additional goals were to develop these materials for deaf students who would be "conceptual" learners and to provide the materials in Spanish.
- ✈ The lesson plans, curriculum bridges, student activities and projects are relevant to the various teaching and learning styles. Some are expository, some are inquisitory, etc. The student activities are oriented towards problem solving.
- ✈ Concentrated on the three types of learning: auditory, kinesthetic and visual versus any particular teaching due to the emphasis in special education.



Photo Courtesy of the Dunbar Library, Wright State University

We have never had an educator criticize K8AIT based on teaching style - - it has never been an issue.

One thing K8AIT does is re-emphasize and present the same aerodynamic principles applied to different problems; for example the forces around an aircraft versus the forces around a sports projectile.



TEACHER TRAINING

- ➔ K8AIT has an interactive self-paced internet for teachers. Lesson plans have step by step instructions and most have short videos that demonstrate the experiments.
- ➔ The “How To Use K8AIT” section includes information on: the different parts of the textbook; how to use the materials in a classroom, computer lab, home schooling and adult reading program; how to integrate the materials with the units an educator is required to teach or how to use the materials as a complete course.
- ➔ There is a toll free number to support the pilot schools and an e-mail account to send questions and comments.



Just had a conversation in the past week with a teacher who said that she had seen a lot of “self-paced” information on the Web. She was looking for a project like K8AIT, but wanted a “real person” to lead her through it.

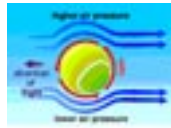
I have always liked that InfoUse trains via videoconferences.

Teachers have liked the self-paced class and CAI is considering making the How To Use K8AIT instructions interactive.



INTERACTIVE LESSONS

- ➔ K8AIT has: animated icons, animations, animated sign language, video clips of children conducting science experiments, a self-paced class and student activities that are interactive.
- ➔ In “Tennis Over the Net” students can follow, participate and emulate an actual research project conducted by aerospace engineers, sports scientists, educators and athletes. Three internet videoconferences and chat sessions are conducted during the year for students. There is a software tool and video footage provided via the net so that students can analyze the footage just as the research team does.



NATIONAL, STATE, LOCAL STANDARDS

- ➔ At the National level, the lesson plans have a chart which describe how the lesson fits into the standards. One of the staff is responsible for periodically reviewing the standards. The newest materials reflect process learning; for example in the sports section the scientific method is stressed as the students emulate the steps in a research project. In the last of the student activities an airplane must “virtually” be developed.
- ➔ At the State level, we ask each pilot school in a new state to determine how the curriculum meets the requirements. This has been done in New York and California.
- ➔ Local can mean many things - district, school, principal, supervisor. K8AIT describes in its “How To Use K8AIT” guide, how to teach the entire curriculum or alternately how to integrate the materials into units the educator is required to teach. Because of the broad subject areas of K8AIT (mythology, history, aircraft, animals, machines and sports) educators have always found a way to blend K8AIT into their required curriculum.

AERONAUTICS AND AVIATION SCIENCE: CAREERS AND OPPORTUNITIES

Dr. Francesca Casella, Massachusetts Corporation for Educational Telecommunications



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), Learning Technologies Project (LTP)

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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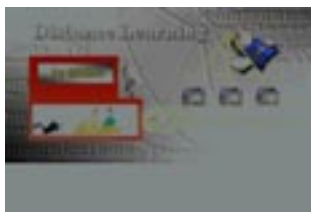
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September 1997 - Learning Technologies Conference



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

September 1997 - Learning Technologies Conference

As the Take Off! Project involves more than the WWW as an instructional tool, in the following presentation the various topics will be addressed separately, depending on the media used, whenever such a distinction is necessary, and treated as pertaining to the broad field of “distance learning technologies” instructional models where appropriate.

With the current trend in Web development, namely the inclusion of graphics, sound, animation, streamline audio, and video files, synchronous communications through chatrooms and video conferencing capabilities, the two media are no longer clearly separated, and a lot of the conclusions and observations regarding the development of the broadcast series apply to Web development as well.



Aeronautics and Aviation Science: Careers and Opportunities

1 - Different Types of Classroom Access

- Satellite access - Central feed into main library/ channel distribution to the classrooms
- Web access - Classroom - single/multiple workstations/library/computer lab/technology lab
- Satellite + Web access in same or different locations

September 1997 - Learning Technologies Conference

In addition to the access to the Web, our project had to deal with the satellite connection. There are many different network configurations for this type of access, depending upon existing infrastructure at the school, and each configuration leads to different instructional settings and somehow interacts with the use of the product. A connection available at the library leads to large audiences. With hundreds of students participating, a difficult setting for the teachers to control. A feed into the classroom with a limited number of students allows more flexibility for the teachers to set the appropriate environment.

The Web site is developed to support the broadcast series and, ideally, access to the satellite and the Web should be available in the same room (however very few schools have this kind of setup).

Given the challenges imposed by differences in access, we designed the satellite series and the Web site to be independent of one another. We provided the teachers with instructions on how to approach the differences in access through the Teachers' Resource Guide, the workshops, and using the satellite broadcast.

Special case: Integrating Internet into the broadcast series (development of the "Web Corner" for Take Off! Part II). The "ideal" set up calls for a tech lab with a satellite feed and Internet connections available for the students. Alternatively, the Web sessions can be done at a later time. To accommodate the needs of the users, the list of Web sites explored during the show was included in the Teachers' Resource Guide mailed to all registrants.



Aeronautics and Aviation Science: Careers and Opportunities

1 - Different Types of Classroom Access

-Satellite access often determines the choice between live vs. taped viewing

-Web access, namely type of connection, number and location of workstations, availability of computers and Internet accounts for the students in addition to the teachers, determines effective use of the media

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Satellite series: Live participation requires availability of satellite feed and telephone line. This set up was provided through this grant for the four demonstration sites. Across Massachusetts, the program was available at no charge to every teacher that registered for the series. However, the satellite dish might not be located at the school. Due to logistic limitations some of the teachers participating were successfully using the series on tape rather than “live” (flexibility in design).

The Web: Our Web site was originally developed in support of the broadcast series, and our original intent was to provide an additional resource to the viewers of Take Off! However, based on our analysis of the server statistics, and from the messages posted on the “Forum,” the majority of the users are not Take Off! participants. The most popular page is the “Activities” page, a list of hands-on activities organized by topic and grade level.

We are reorganizing the “Activities” page with the inclusion of illustrations and diagrams.



Aeronautics and Aviation Science: Careers and Opportunities

#2 - Types of WWW resources used in the materials

Satellite series

- A "Piloting the Web" session was included in every Take Off! broadcast. The presenter explored live a limited number of outstanding web sites related to the topic of the broadcast
- Interaction and communication with the "Career Guests" was strongly encouraged via e-mail after the broadcast
- The activity suggested for the "Weather" unit required access to meteorological data available on the web, to compare with data collected locally by the students

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Within the design and development of the satellite broadcast we incorporated the Web in different ways.

The Web as an on-line library of multimedia curriculum support products.

The enormity of the information available on the WWW is sometimes overwhelming. During the show, and following suggestions from the teachers, we selected few among the many potential sites, and explored them live. We wanted to show the teachers the resources available (we are still fighting with inertia on the part of some teachers not yet convinced of the advantages of using the Web in the classroom). In addition, we wanted to show the students how exciting some "educational" Web sites can be, and thus defy the myth "education is boring."

The Internet as a communication vehicle.

One long-term goal of our project is to get students and teachers to communicate with peers over the Web, exchanging ideas and sharing projects. We started the "initiation" process by opening a communication channel between the students and our "Career Guests," people they are already familiar with. After they get used to the media (and the writing on the computer), they will appreciate the advantages.

The Web as repository of publicly accessible scientific data.

By looking for meteorological data available on-line to compare with their own, students use the Internet as a database.



Aeronautics and Aviation Science: Careers and Opportunities

#2 - Types of WWW resources used in the materials

The Web site

The newly developed interactive “Glossary”, “History” and “Activities” pages contain embedded links to many external sites, on-line museums, archives of historical images, activities and lesson plans

The “Career Album”, featuring the “cards” of the Take Off! career guests, and the “Forum”, provide communication lines to peers and content experts.

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Three major uses of the Internet already identified for the satellite series (library, communication, and database) are mirrored in the development of the Web site.

To increase usage of communication tools at the demonstration sites, the evaluators suggested providing some Internet accounts to encourage students to use this type of communication more frequently. We are presently investigating this idea.



Aeronautics and Aviation Science: Careers and Opportunities

#3 - Different Teaching and Learning Styles

Distinction between

- a) Products developed for unmediated use
- b) Products designed to be used in a classroom with the mediation of the teacher (facilitator)

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The distinction is critical when talking about the “live” satellite broadcast. Although there is a “substitute” teacher acting on the screen, using his/her teaching style during the presentation, the effectiveness of the live feature depends upon the amount of preparation (content and instructional set-up) done by the teachers prior to the broadcast.

Even the Take Off! Web site, which is designed to support the broadcast series, addresses primarily the teachers, not the students. The Takoff! Web site requires the teachers to facilitate and supervise classroom use.

In this respect our project might differ from the other CAs.

Our job is easier as we delegate part of the responsibility to setup the instructional environment more appropriate for a particular classroom to the teachers.

Mentioned earlier were Examples of guidelines provided to the teachers on how to take advantage of the WWW in support of the broadcast, and suggested uses of the Web site itself.



Aeronautics and Aviation Science: Careers and Opportunities

#3 - Different Teaching and Learning Styles

Teaching styles and strategies

-Expository/inquisitory

-Problem-based

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A combination of different styles and approaches was used to present the content during the broadcast series.

Presenters brought their personal teaching styles and different ways to interact with the camera. The shows benefited from the variety. Some of the students asked for more presenters and more guests.

As our Web site doesn't include self-contained Web-based instructional units, but is organized as a selection of aviation and aeronautical resources, I am not sure the definition of "teaching style" or a well-defined "instructional strategy" can be identified for its design.

The decisions regarding the extent and format of the development are resource-driven.

One original solution is the development of the "Glossary" and "History" sections. Lacking time and resources to fully develop the content, we decided to support it with what is already available on the WWW. Rather than opening additional pages within our sites, we opened new "windows" into the Internet (they literally look like windows), linking to many different sites, and introducing a great diversity in "teaching styles."



Aeronautics and Aviation Science: Careers and Opportunities

4 - Teacher training in the use of our product(s)

Technology-based products require training in the use of technology first

Strategies

- Instructions for use as downloadable on-line documents
- Additional multimedia/print resources
- Workshops

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Even if training in the use of technology was not identified at the beginning as necessary, the projects were soon facing the dilemma: without adequate preparation the products could not be used effectively, even if no plan to provide training existed.

We used the live broadcasts to train the teachers, (two units for the first and one for the second series), but realized that additional support was needed.

(It was like trying to train somebody in the use of technology using that same technology to do the training).

We used

- Workshops
- Additional professional development programs, like the Mass LearnPike series Telecommunicate! (a series of live broadcast programs dedicated to the use of Internet in the classroom) and the new MCET/UMass Lowell initiative, Pulling in the Net, a professional development program for in-service and pre-service teachers (Internet account, credits for rectification and graduate credits available)
- Using the kit Internet for Educators and other on-line resources from NASA
- Text-based instructions (on- and off-line)



Aeronautics and Aviation Science: Careers and Opportunities

4 - Teacher training in the use of our product

Strategies for training in the use of our products
suitable for scaling-up

- Support for technology training through independent sources
- Producing on-line, multimedia support products

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Our workshops are effective and are appreciated by the teachers, who usually asked for more Internet training. Unfortunately, given the available resources, the workshop model can be implemented only on the local scale, not on the national.

We have many additional resources for technology training, due to the nature of the Massachusetts Corp. for Ed. Telecomm., and its mission to support the national efforts in implementing the technology revolution in the schools.

Once the technology part has been taken care of, on-line documents and distance learning methods (all scaleable) can be effective.



Aeronautics and Aviation Science: Careers and Opportunities

5 - Different ways to create interactive lessons

- Interactivity on the video series
- Interactivity on the web site

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Video series: There are additional dimensions to the interactivity between students and the content when dealing with the satellite broadcast, because of the mediating presence of the presenters and the camera. The interaction between each viewer and the programs is also complicated by the classroom setting when students are interacting with one another. Of course, during a “live” broadcast the main interactive feature is provided by the two-way audiobridge connection between the studio and the sites and among the sites. Students like this type of interactivity so much that we usually extend the audiobridge connection after the end of the broadcast.

In addition to the spontaneous requests from the audience, the presenters prompt responses at specific times, for instance during the “Career Corner” interviews.

As the Take Off! program will be re-broadcast this fall, and the audiobridge feature will no longer be available, we are redirecting the requests for information to the Internet through the “Career Album” page on the Web site.

To facilitate students’ use of the “Career Album” and the “Forum” feature on the site we are exploring the possibility (there are budgetary and legal issues to consider) of providing the students with Internet accounts in addition to the ones already available to the teachers.



Aeronautics and Aviation Science: Careers and Opportunities

#6 - Meeting/Addressing National, State and Local Education Standards

Aviation and Aeronautics not part of the standard curriculum

The Take Off! series and the Standards/Curriculum
Frameworks

The Take Off! web site and the Standards/Curriculum
Frameworks

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Since high school schedules are usually organized by subject areas, there was a challenge in moving aeronautics and aviation (which are not part of the standard curriculum) from the 6-8 to the 9-12 grade level.

The only option was to use aviation-based themes to address existing National and State Educational Standards. The Massachusetts State Curriculum Frameworks present significant overlapping with the National Standards.


For the Take Off! series we included in the development team a high school science teacher who was also a trainer of teachers in innovative technology-enhanced instructional practices in the classroom. He was instrumental in identifying appropriate standards for the broadcast series, supporting the content development for the workshop, and reviewing the “Teacher’s Guide.”

For the final Take Off! kit, (production scheduled to start around November), the efforts toward the alignment with the Standards will be intensified


- Addressing “Process Standards” in the activities and the final video program through a refinement of the design
- Re-editing and completing the alignment matrix included in the Teacher’s Guide
- Developing a similar matrix for the “Activities” page on the Web

AVIATION ACADEMY 2000

Tom Schieffer, Wooddale High School



WOODDALE HIGH SCHOOL
AVIATION ACADEMY 2000 IITA K-14 PROJECT
<http://www.mecca.org/~tschieff/AVIATION/ACADEMY/>



Learning Technologies Conference
LeRC Sep. 23-25, 1997



Aviation Academy 2000 Staff

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



Wooddale Aviation Optional School Mission

Is to encourage high school students to increase their study in the field of aeronautics through the application of on-line, real-time communication and information systems, ie. the Internet, which will inspire more students to pursue post-secondary educational goals in one of the many related careers within the aviation industry such as:





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 connected to 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.



Aviation Academy 2000 Classroom Access

- Classrooms are connected in 8 node groups via a Windows NT driven 10 Base-T Ethernet LAN.
- The Aviation Lab has 25 computer nodes connected to the twelve 10 core classrooms.
- A single teacher Life R.A.F.T. is made available.
- During year 3, a RAS site will come on line for Home Bound/Parental or industry use.



Aviation Academy 2000 WWW Resources

- A not all-inclusive list used is:
 - Commercial WEB Pubs, eg. USA TODAY, etc.
 - NASA Homepage/Sites, eg. ALLSTAR, etc.
 - Educational sites, eg. Connect-tn, etc.
 - Manufacturer sites, eg. Cessna.com, etc.
 - Vendor sites, eg. Microsoft, IBM, MAC, etc.
 - Local Partnerships, eg. Douglas Aviation, etc.
 - Teleconferences, Reflectors, BBS', etc.
 - Hot E-mails & Chat Lines, Listserves, etc.



Aviation Academy 2000 Teaching and Learning Styles

- Teaching practices vary according to the teachers' individual personality and experience levels.
- One project goal was to impart a collaborative spirit where teachers would feel comfortable with relying on others to support their teaching standards.
- Teaching method changed from a lecture nature to a Facilitator/Resource manager with the addition of available technology.
- Student learning methods have changed as a result of the transition to performance based evaluations.



Aviation Academy 2000 Teaching and Learning Styles

- Learning Paths are Performance Based.
- Students are engaged in active learning.
- Activities require research, evaluation, & problem solving skills...Teamwork.
- Evaluations are weighted more towards project or object results values.
- Still required is a systemic written exam as the FINAL evaluation.



Aviation Maintenance Technology Four Year Path

	Freshman	Sophomore	Junior	Senior
1.	English 9	English 10	English 11	English 12
2.	Physical Science	Biology	Chemistry	U.S. History or Elective
3.	Algebra I	Geometry	Algebra II	Economics/ Government or Elective
4.	Aviation Orientation	Aviation Technology	Avionics/Computer Technology I	Airframes and Powerplants I at TTCCM
5.	Lifetime Wellness	World History or Geography	Avionics/Computer Technology I	Airframes and Powerplants I at TCM
6.	Fine Arts or Elective	Foreign Language or Elective	Foreign Language or Elective	Airframes and Powerplants II at TCM
Total Credits	6	6	6	6



Avionics/Computer Technology Four Year Path

	Freshman	Sophomore	Junior	Senior
1.	English 9	English 10	English 11	English 12
2.	Physical Science	Biology	Chemistry	U.S. History or Elective
3.	Algebra I	Geometry	Algebra II	Economics/ Government or Elective
4.	Aviation Orientation	Aviation Technology	Avionics/ Computer Technology I	Avionics/ Computer Technology II
5.	Lifetime Wellness	World History or Geography	Avionics/ Computer Technology I	Avionics/ Computer Technology II
6.	Fine Arts or Elective	Foreign Language or Elective	Foreign Language or Elective	Avionics/ Computer Technology III or Elective
Total Credits	6	6	6	6



Travel & Tourism Marketing Four Year Path

	Freshman	Sophomore	Junior	Senior
1.	English 9	English 10	English 11	English 12
2.	Physical Science	Biology	Chemistry	U.S. History or Elective
3.	Algebra I	Geometry	Algebra II	Economics/ Government or Elective
4.	Aviation Orientation	Aviation Technology	Travel & Tourism Marketing I	Travel & Tourism Marketing II
5.	Lifetime Wellness	World History or Geography	Government Economics or Elective	Travel & Tourism Marketing II
6.	Fine Arts or Elective	Foreign Language or Elective	Foreign Language or Elective	Elective
Total Credits	6	6	6	6



Aviation Academy 2000 Teacher Training Approach

- The approach was to develop performance based, cross-disciplined, interactive multi-media lesson plan structure.
- We now are developing Web-based instruction with the above concept using a READ - PERFORM - REPORT format.
- The LP contributor's progress was nurtured using three phases of Teacher Training.



Aviation Academy 2000 Teacher Training Approach TRAINING THE TEACHERS

- First Year... Teachers were taught initial computer skills, e-mail/web protocols, web navigating and searches. (TLC¹)
- National and Local curriculum standards were reviewed for aviation topics and refocused on cross-discipline applications and...
- Developed Aviation-Core Content Curriculum.



Aviation Academy 2000
Teacher Training Approach
TRAINING THE TEACHERS

- Secondly...Teachers were trained to effectively utilize the “Learning Centers” concept. (TLC²)
- They worked in year groups designing cross-disciplined lessons focused on a cooperative unit or module of instruction. (2-6 Wk Plans)
- Coordinated within disciplines to build smooth transitions into the next level of material.



Aviation Academy 2000
Teacher Training Approach
TRAINING THE TEACHERS

- By the third year... Teachers were able to focus more on the application of transferring aviation skills through Learning Collaborations. (TLC³)
- Training was focused on developing lesson plans which were now “Collaborative” which was a logical extension of the TLC² methodology.



Aviation Academy 2000 Teacher Training Approach TLC Methodology

- TLC¹:
 - Teachers Learning Computers
- TLC²:
 - Teachers Learning Centers
- TLC³:
 - Teachers Learning Collaboration



Aviation Academy 2000 Different Methods for Creating Interactive Lessons

- Poor Model: Text Base Posterboards
GoTo & Click on
- Better Model: Read information and
perform tasks for evaluation.
- Best Method: Read information, Perform a
specific task, Return to Report findings on
the web site for (teacher/peer) evaluations.



Aviation Academy 2000 Meeting/Addressing National, State, & Local Standards

- This issue was addressed earlier.
- Core Curriculum Standards were derived from National, State and Local standards.
- Aviation Curriculum Standards are being developed by an Aviation Advisory Council for submission to higher approving levels.

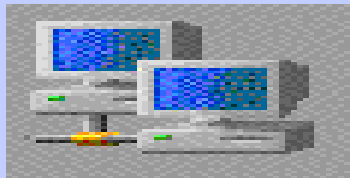


Aviation Academy 2000

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**Visit Wooddale's Homepage at: [http://
www.mecca.org/~tschieff/AVIATION/ACADEMY/](http://www.mecca.org/~tschieff/AVIATION/ACADEMY/)**



Break Out Sessions

TOPIC: CLASSROOM ACCESS

Participants

Barbara Grabowski, Michael Hornsby, Jenny Kishiyama, Mark Leon, Cesar Levy, Beth Lewandowski, Christa Peck, Ruth Peterson, Thom Pinelli

Definition

For the K-14 classroom environment four typical configuration of Internet access currently exist: classroom access, lab access, resource room access, and home access only. These access options also vary depending upon the number and type of computers available at the access point. Each option presents unique challenges for using WWW materials in the classroom.

- How does each Aeronautics CA project address Internet access issues?
- How would the project change the way it addresses access issues if it were starting now?
- What access strategies are recommended for others starting WEB projects now?

Group Discussions

Classroom access used:

PlaneMath is designed to accommodate an array of technical capabilities. Designers and developers recognize the amount of low-end hardware still being used by many and design their Web site to account for such constraints. PlaneMath can be accessed via the WWW, on an internal server, or downloaded to a Zip disk. In terms of access to the information within the program, PlaneMath recognizes limitations of disabled students and thus is compatible with adaptive hardware. This program also provides an opportunity for both on-line participation and off-line activities. Most importantly, the activities within this site can be presented as stand-alone activities or as a part of larger lessons.

ALLSTAR uses stand-alone computers, kiosks, which are placed in a central location within the school so that students have easy access to their project. This kiosk allows for flexibility; the teachers bring their students to the library or students can come to work on their own. Because of the students easy access to the kiosk, there are problems with student hacking.

Project changes and recommendations:

Product developers need to consider three aspects of classroom access: physical or technical access, content or Web site access, and computer literacy or access to skill in using the WWW for teaching. Technological access is not enough, teachers and students need to become aware of the product, know how to gain access to the product, and have the skills to use the product. Understanding what level of access the end user has enables developers to design appropriate Web sites that will be usable by the widest possible audience.

Select an audience that you know is likely to use the product and then request that they provide input during the development process.

Think about the presenting the product on kiosks, and placing these kiosks in a central, high traffic location to allow for more students access to the program simultaneously.

Create a product that can be placed on a local network or server. Using a server saves excessive deterioration of the hardware and decreases access to software for students to hack.

Products should be content rich as opposed to process rich. Content rich products will always be highly valued by classroom teachers and thus, increase motivation to locate and access the Web site.

Offer a high level of service. Identify customers' needs and design with consideration of low-end systems.

Make it possible to deliver the product in alternative formats. For example, if access to the product cannot be gained through the Internet or Intranet, then create a deliverable on a CD-ROM or Zip disk.

Provide multiple versions of the software to accommodate different levels of technological capabilities to enable access by more people.

Technological access often is not the problem, but rather the teachers' ability to find the product and implement it into their curriculum. Make sure the Web site is easy to find.

When proposing a project, consider a longer time frame for completion. Three years is not enough time to impact change in education. Three to five years is more reasonable to create a product. Prepare the school to technically accommodate the products, train the teacher, and integrate the product into the existing curriculum.

Create a dissemination plan which considers those who would make the most use of the product. This plan helps the project team focus on product requirements needed by specified audiences.

TOPIC: WWW RESOURCES

Participants

Carey Brock, Kay Brothers, Christiy Budenbender, Francesca Casella, Ben Erwin, Carol Galica, Tiffany Koszalka, Lewis Kraus, Marianne McCarthy, Tom Schieffer

Definition

The World Wide Web (WWW) contains a variety of resources including people and information that, in turn, include databases, lesson plans, projects, student activities, tools, references and links, and tutorials. Are the Aeronautics CAs considering all the potential resources that are available to offer maximum flexibility to the K-14 customers? If so, how and if not, why not? Specifically:

- What WWW resources are used in each Aeronautics CAs?
- How would the project change the ways it uses WWW resources if it were starting now?
- What WWW resource uses are recommended to other projects starting now?

Group Discussions

WWW Resources used:

The Aeronautics CA's Web sites incorporate many WWW resources. Web-based communication features such as e-mail, listservs, chatrooms, and videoconferencing are used to incorporate collaboration amongst teachers, students, and scientists. Web-based informational features such as resource links, real-time databases, activities, lesson plans, tutorials, and on-line tools are used to deliver subject matter, provide interactivity, and present instruction.

E-mail is used as a communication tool for product development, such as a vehicle for project team communications and continued construction of Web sites, and as a feature to enhance instruction, facilitating collaborative activities between students and scientists. E-mail is also used as a tool to reach out to industry partners or to ask questions in inquiry-based Web sites.

Teacher listservs are available. The primary uses of the listservs are to announce product updates and share teaching experiences related to the Aeronautics CA's products.

Chatrooms, with threaded discussion, have been provided to support teacher and parent communications with mixed results. Teachers were not using the chatrooms explaining that they already have too many places to talk to each other, including in-person, existing listservs, and e-mail. A kid's chat room with threaded discussion (for a kite activity) is being established, however, there are technical difficulties and issues related to using an open system.

Videoconferencing, through a telecommunication vendor, is used by the PlaneMath project to provide teacher orientations to the use of the Web site in their classroom.

Information references and links are provided at the Aviation Academy 2000 Web site such as electronic newspapers, NASA aeronautic Web sites, partnering manufacturer's Web sites, and vendor's Web sites to access technical data, drawings, and real-time data.

Access to databases is provided to encourage students to find, manipulate, and report data. For example, students go to weather-related Web sites to compare to their local weather to weather around the world. There are also efforts underway to identify ways to make databases directly applicable to Web site activities, i.e., automatically transferring data from outside sources to the applicable activities in Aeronautics CA Web sites. This data transfer would provide a resource of real-time data directly relevant to provided activities.

Tools are linked on the front pages of LDAPS to entice teachers to enter the Web site and learn what is going on with the project. The tools are displayed in a simple layout with explanations that are easy to understand.

Tutorials for using the Web sites as well as associated software and plug-ins are available on the several of the Web sites. The tutorials are printable so teachers can have access to them in hardcopy form because of the memory issues many users have when they have to open the browsers and the application software at the same time.

Project Changes and Recommendations:

WWW resources should be chosen based on the objectives of the instruction. In other words, the most effective WWW resources should support the objectives of the instruction. Resources should not be selected only because they are available.

Maintaining a focus on overall instructional objectives helps to ensure that funding is spent to the greatest overall benefit of the project. Begin product development by incorporating the types of WWW resources that team members know and can design well. As the team builds proficiency, add new WWW resources as they help meet the project objectives.

Projects must have a clear definition of their target audience and know their technical limitations. One strategy is to pick a WWW resource to help focus attention on meeting project objectives. Once fully integrated, then choose additional resources that enhance the Web site and meet the instructional objects.

It is then important to help the teachers develop strategies to incorporate the Web site and associated resources into the classroom. If focused on the needs of the target population, others who come to the Web site and provide comments will help extend the use of the Web site to a wider group, with different perspectives. If the target audience is served well, other users will recognize it and spread the word.

Build on the project team's strengths and successes. Technology is a tool. The key focus on what needs to be accomplished. Avoid letting glitzy, new WWW technologies overshadow effectiveness and clarity of instruction.

Access technical experts and scientists effectively to support the instruction such as videoconferencing between the students and a scientist. Arrangements need to be made in advance and an ongoing relationship should be established with partners who wish to participate on a consistent basis. Relationships should be made with different community partners who have a reason to maintain

relationships after funding ends. Again, it is prudent to be mindful of experts and their constraints to participate, how well they relate to students, and their teleconferencing skills and camera presence.

It is also important to build partnerships early in the project. Networking and nurturing those partnerships will help to develop future support, provide a mechanism for teacher content and technical support, and perhaps become providers for technology for teacher home use.

Establish a budget for a staff including secretary, research, and technology support. Establish access to dedicated technical support to incorporate WWW resources. Create a balanced project team that contains graphics and Web design expertise. Writing code, designing page layouts, and incorporating WWW resources technically and effectively requires different skill sets. The blending of skills, mind sets, focus, and tasks will help guide the team to make the most effective decisions regarding use of WWW resources.

With technical support in place, the recommendations would be to incorporate two types of communications strategies over the WWW: (1) videoconferencing and chat rooms for teachers, and a (2) separate communication lines for students including E-mail or listservs. Avoid using chat lines with students. Generally, the conversations become irrelevant and off target. Videoconferencing should be used to facilitate the development of teacher technical skills at each location and to provide an orientation to the features on the Web sites. While synchronous videoconferencing has utility in terms of teacher training, it is important to keep in mind the time zones of potential users. Be cautious using synchronous and asynchronous communications over the WWW. Usage is at a lower level than anticipated and the effort expended on further development of these resources is being reconsidered. E-mail is a useful tool, but the projects should not be financially responsible for providing or maintaining e-mail accounts for teachers or students.

Using fewer resources well is more important than trying to incorporate many WWW resources just because they are available. Educators do not want to use a Web site that they cannot figure out or integrate into the classroom. Provide clean, straightforward instructions that are easy to follow. Establish information bases that clarify the uses of the Web site. Then, other options such as e-mail, chatrooms, or videoconferences can be added so that the teacher has options and directions for using the instruction their classroom. It is important to use WWW resources that make the Web site more powerful, i.e., instructionally sound and motivational, and to make it effective when the teacher or student accesses it. It is important that the teacher feels comfortable using the Web site. With whatever tool you choose, make sure you have adequate training from the beginning. Select methods and tools and then train. Once mastery is achieved, then add new tools. It is also important to develop a vehicle to share successes and solutions showing how different projects use technology differently and effectively.

Time should be allocated for training on each WWW resource used in the instruction. Training should begin at the start of the project and be an ongoing part of the development process.

Provide specific training for teachers and students on each WWW resource used in the instruction. This would include Internet communication tools, software, and hardware. The issues, e.g., costs, training, benefits, of Web access for teachers and students would need to be resolved early in the project. Also, the logistics of setting up accounts for each student so that they use it effectively and appropriately need to be planned.

Tutorials should be developed for the teachers; however, it is useful to offer them in a printable form. Another option is to use hands-on, face-to-face, or video-conferencing for training in the use of the instruction. In the video-conferencing, distance education specialists should be involved to ensure that instruction is well presented. Focus the first year of the project on teacher training and preparation. Specifically, build the teachers technical skills, motivation, and confidence in using the technology. Next, focus on developing a resource center to build comfort with technical content. Establish an arrangement for technical support with vendors at the outset. The goal is to build the school and teacher infrastructure first, then build the instruction and lesson plans, and then incorporate Internet conductivity.

Provide every teacher with a computer, Ethernet card and modem to encourage use in school and at home. Use the communication capabilities of the Web such as listservs. It will be important to develop a strategy to keep teachers involved in using the communication tools. Educate and inform teachers about the value of newsgroups, especially the K-12 newsgroups.

When using references and links select only high-quality Web sites and keep the lists to a minimum. It is important not to overwhelm the teachers and students. Also, periodically check referenced Web sites for technical and content accuracy, as well as style consistency. When referencing links or other Web sites, list Web sites by topic heading versus mass lists of information sources. References should be information centers, not hundreds of URLs.

Activities and projects should contain full explanations including: the science and engineering behind the instruction, directions for activities, questions that model scientific inquiry, and explanations about how scientists and engineers would approach the problem.

Lesson plans should spark interest in aeronautics using interactive activities and pictures and help the students learn how to learn. Teachers should be informed about the kinds of misconceptions that students form. WWW lesson plans should be structured as follows: (1) Access the lesson plans or activity Web site, (2) Read the instructions and background information, (3) Do the activity (4) Go back to Web site and record findings, (5) Compare findings and results.

When building a new database, learn how to do it, scope out the effort, develop a plan to complete the research, and design a usable database structure.

TOPIC: TEACHER TRAINING

Participants

Christiy Budenbender, Francesca Casella, Carol Galica, Jenny Kishiyama, Tiffany Koszalka, Lewis Kraus, Beth Lewandowski, Marianne McCarthy, Tom Shieffer

Definition

While the consensus of the participants is that training teachers about Internet fundamentals is not one of the responsibilities of the Aeronautics CAs training on the classroom use of the Aeronautics CA products is. Without an understanding of how to use the products, teachers will be reluctant to use them for classroom instruction. What type of training is actually being provided by the Aeronautics CAs and how is it being done? If training is not being provided by the Aeronautics CAs, what alternatives are being considered to ensure that the product will be used, and used appropriately? Specifically:

- What teacher training strategies are used by each Aeronautics CAs?
- How would the project change the way it implements teacher training if it were starting now?
- What teacher training strategies are recommended for other projects starting now?

Group Discussions

Teacher training provided:

Three levels of teacher training are provided in the Aviation Academy 2000 project: Teachers Learning Computers, Teachers Learning Centers, and Teachers Learning Collaboration. At the first level, teachers receive training on operating the hardware and using software, such as Microsoft PowerPoint and HTML. At the second level, teachers learn how to use the aeronautics content modules in the classroom and across curricula. At the third level, teachers focus on units being taught through collaborative activities. As part of the training they collaborate on how to use the technology effectively in the classroom.

Training should be related to the objectives of the project. Teacher training for PlaneMath was not originally a part of the project plan; however, a training component for teachers has been developed. Teachers go to a local teleconferencing vendor location to receive an orientation on PlaneMath's features. The outcome of this videoconference orientation is that new features of the Web site. Teachers are then able to adapt the use of the product in a way that is best for them and their students. The goal of the orientation is to describe the Web site and its features. It is up to the teacher to adapt the material to his or her teaching strategies and requirements.

Training for the Aeronautics and Aviation Science teachers is provided in the fundamentals of software, such as word processing, spreadsheets, and presentation packages. These are offered through professional services. Training is then provided on the use of the network and Internet. Finally, teachers are provided workshops on Aeronautics and Aviation Science products. Teachers are not screened for

prerequisite skills. The selection criteria for school participation are identified as part of the Aeronautics CAs project. Criteria include designations such as under-served schools with high percentages of minority students.

NASA's Lewis (now Glenn) Research Center offers extensive training programs for many K-12 teachers on different computer applications, including word processing, graphics and drawing packages, multimedia development, and Internet fundamentals. Content training in the areas of science, physics, and mathematics as well as specific classes in using the Internet for science are also provided.

Training is marketed through brochures and includes intensive two-week summer sessions and short 1, 2, or 4 hour sessions during the school year. School districts set up their own registrations and handle the clerical aspects of the training. Administrative support is obtained at the beginning of the training process and teachers are granted release time to attend training sessions.

In the NASA Ames Research Center Program Office training is not offered, however, based on experience with other Aeronautics CAs' projects, such as the LEGO training, it is recommended that teachers receive training in their own environments. A caution is that guidelines need to be established that prevent teachers from temporarily leaving the training to go to their classroom to deal with unrelated issues.

Project changes and recommendations:

A high priority in the beginning of the project should be to establish a technology plan. Make sure there is a strong technology plan that employs technology experts to help develop the most comprehensive technology strategies. It is also important to keep on top of industry trends for technology upgrades to ensure that projects are getting the most for their money.

Identify the extent of training required based on project objectives. At a minimum, provide an orientation to the Web site. Training in the fundamentals of technology is outside the scope of the Aeronautics CAs' projects. Other resources that specialize in fundamental skills training should be identified. Outsource the training for basic computer skills.

Bring teachers in during the grant proposal phase. Select teachers who can contribute and understand the long-term vision of project rather than ones who are only interested in satisfying their own individual needs in the classroom. Provide teachers with incentives to be involved, address technology ignorance issues, and demonstrate that the use of technology is a permanent process, not one that will fade away after a year or two.

Increase the emphasis on training to build skill and confidence with the use of the technology. In the beginning, less time should be expended on building a curriculum base, leaving more time for providing teachers with intensive up-to-date instruction. Train teachers at the beginning of the project and build their motivation to use technology in the classroom.

Identify prerequisites and selection criteria for schools and teachers early in the project. These would include hardware, software, and Internet requirements. Volunteers are not necessarily the best choice. Prime candidates are usually technology-literate teachers with experience in using computers and the

Internet. Be cautious about establishing selection criteria. Problems can include limiting or excluding the very audience the product is intended to reach.

It is also important to assess the teacher factors for using technology, such as motivation, attitude, and willingness to change teaching practices and integrate technology. It is important that teachers come to training because they want to use technology in their classrooms rather than being mandated to attend training by school administration. Teacher selection criteria should be established that specify prerequisite computer literacy levels, teacher motivation, and willingness to participate in technology projects.

Begin teacher training initiatives by asking schools if they have a technology coordinator to lead the effort and who will have the time built into his or her schedule to train other teachers. Target the technology coordinators so that they can serve as ambassadors for technology training of teachers back at their schools. Request information from the school based on a list of criteria to assess whether or not the school is ready to participate in the project's or center's technology training efforts. Criteria should include a full-time technology coordinator, willingness to use the skills and knowledge gained to help other teachers in the school, and technology that is accessible to the teachers. Require the school district to do all the clerical work associated with teacher training. While teacher selection criteria are essential, participation should be on a voluntary basis.

During the training, teachers should have time specifically to review Web sites indepth. As an alternative training method or as a follow-up to face-to-face, training projects can use videoconferencing or some other means to deliver a Web site orientation. If the Web site is designed well, i.e., provides the teacher with the information necessary to use the features and related resources, no other training may be required. No matter how straightforward the Web site seems to be to the developers, few teachers have the time to "figure out" how Web sites work or what they contain. Developers need to provide a "navigation chart" of the content as part of the orientation.

Do not assume that teachers know the hardware and how to work with students with special educational needs. Creating easily accessible and understandable notes for teachers suggesting uses of the material with special students supports their efforts.

Provide teachers with additional materials and support including questions to ask students during lessons, modeling of the product in the classroom, and templates for activities.

On-line documents and teacher lounges should be developed to encourage sharing information about the Aeronautics CAs' projects. Videoconferences and other resources should be provided to support use in the classroom. It is important to require that release time be provided for teachers to participate in these projects.

Require the school to share responsibility in implementing the training, including registering teachers, providing clerical support, and ensuring that teachers receive training in computer fundamentals. School selection criteria for participation should be established early in the project and documented from the perspectives of the project commitments and the school's commitments. This document should delineate responsibilities in terms of prerequisite requirements, expectations of the project, expectations for the school's participation, and technology configuration requirements.

As the project proceeds, assess whether the administrators and teachers support the Aeronautics CA's project. If they are, support them. If not, temporarily drop them from the Aeronautics CA's project until they are able to meet the project requirements through teacher training, release time, or investment in other project requirements.

Conduct separate training sessions for computer operation skills, software, hardware, and Internet training. Focus the classes on using the technology in the classroom with specific subject areas such as science or mathematics. Training materials need to be fully developed and integrated with different subject areas, providing perspectives into the use of technology to deliver a variety of content in the classroom. NASA products and NASA-sponsored products need to use NASA mission specific activities to enhance science, mathematics, and technology instruction.

Provide teachers with material to read before the training session to prepare them for the instruction. Start the session with an assessment of the technology level of audience and proceed with training at a level most appropriate for the audience. Establish general prerequisite knowledge such as turning on the computer, using a mouse, and opening a browser. Enlist district support and have the technology and science district staff as well as librarians or resource center personnel present at training sessions. The participation by these staff members will ensure proper post-training support. Use a "cascading" approach to training, requiring that trained teachers and support personnel return to their schools and train other teachers, sharing responsibility for technical coordination and building a support network within the school.

TOPIC: DIFFERENT TEACHING AND LEARNING STYLES

Participants

Carey Brock, Kay Brothers, Ben Erwin, Barbara Grabowski, Mike Hornsby, Christa Peck, Ruth Peterson, Thom Pinelli, Janet Storti.

Definition

Teaching practices are varied and differ by teacher preferences, based often on what strategies teachers are comfortable with. Likewise, the classroom is being changed from a teacher-centered to a learner-centered, problem-solving environment. No one style represents a panacea for all of education, and many excellent and effective teaching strategies exist such as generative learning, anchored instruction, problem-based, collaborative learning, inquisitory, and expository strategies that can be enhanced by WWW resources. To what extent are the CAs using the various Web-Enhanced Learning Environment strategies in their projects? If they are, how are they applying them, and if not, had they considered them and dismissed them as an option? Specifically:

- What teaching and learning styles were incorporated into each Aeronautics CA product?
- What teaching and learning styles would be changed or included if the projects were started now?
- What accommodations to different teaching and learning strategies are recommended to projects starting now?

Group Discussions

Teaching and learning strategies used:

The SPARK Web site incorporates generative learning as well as anchored instruction and problem-based learning. Different teaching and learning styles are exemplified in the Web site through several content areas: the glossary, “take it and go” lessons (which have been morphed into interactive lessons), and internship experiences. Lessons and activities throughout the Web site give teachers ideas for classroom-based activities. Such lessons exemplify anchored instruction and problem-based learning.

The SHAPE learning environment focuses on generative learning, anchored instruction, problem-based learning, and expository strategies. Expository strategies are being used in two different ways: to tell teachers how to use the Web site in the teacher tutorials and to help teachers use the Web site by applying expository strategies with their entire class. In this way, SHAPE serves as a rich resource of information that can be included in their lessons.

PlaneMath is a interdisciplinary, cooperative learning Web site that focuses on problem solving strategies; students work together to solve contextualized mathematics problems.

The LDAPS Web enhanced learning environment hosts cooperative learning activities that encompass both science and engineering concepts through the use of LEGOs. The science concepts are

presented using expository and inquiry based strategies. These same strategies are evident within the presentation of engineering concepts and allow the user to become involved with several hands-on activities.

ALLSTAR teaching and learning has three levels represented. Within each level, different teaching and learning strategies have been implemented. The first level that targets younger students has many hands-on activities. Level two is intended for teacher use, and exemplifies both expository strategies and discovery learning. Level three focuses on content using inquisitory practices. Currently, the majority of the material within all levels provides text material to read.

Project changes and recommendations:

It is important to provide an opportunity to teachers to document teaching strategies they have used with the Web-based materials. This documentation enables teachers to share their knowledge with others, enhance interactivity on the Web among teachers and students, and display their accomplishments via the Web.

It is important to contextualize instruction and provide the user with options for interactive learning. Too much text is boring, and often there is no anchor. Anchoring the instruction to real problem situations of the target audience helps capture and maintain student attention. As creators of educational products, developers need to establish a link to real life for the students. If the Web site does not provide this anchor, then the teacher needs to provide the anchor off-line within the classroom instruction.

One problem teachers experienced was the feeling that incorporated narratives were too long. Besides providing an anchor, narratives should be short and concise without compromising the content.

Allow for teacher-control; it is important to provide a Web site that allows for flexibility in using different teaching and learning strategies to present instruction. Teachers have already established favored strategies in which they present material to their students. The more teachers can see how adaptable the Web site is to their teaching strategies the more likely they are to use the Web site in their classrooms.

Provide authentic interactions during instruction by facilitating content expert and student interactions.

Focus more on the interdisciplinary aspect of the subject matter. Many subject areas can be incorporated into the study of mathematics. This strategy accommodates varied teaching responsibilities by different teachers.

Include descriptions of teaching styles and case-based examples of those teaching styles within the Web site. This inclusion should enhance the teachers' overall understanding of different ways to incorporate Web sites into their lessons.

Encourage teachers to create their own lesson plans that incorporate the Web site into their own teaching style.

Students are not the only ones who have different learning styles, teachers do as well. Therefore, when teachers are taught how to use different Web enhanced learning environment strategies in their classroom, be sure to be sensitive to and teach through the teachers' learning styles.

Different teaching styles should be taught through modeling.

Hire programmers that can aid in the creation of interactive learning tools, if your goal is interactivity.

To accommodate different student learning styles, include pictorial representations, audio, and live video where appropriate. Also, account for different teaching and learning styles by making the Web site content rich and presented in a variety of ways.

Include reflection checks, review exercises, and feedback forms to help learners determine if they have been successful in learning the information on the Web sites.

In creating Web-based instruction, account for prior knowledge to make current instruction meaningful.

Consider design ideas such as screen layout to accommodate different styles of learning. Using different navigation cues can attract different user groups to the same content areas. For example, to attract teachers to one resource, the link may be labeled "Curriculum Resources" whereas, to encourage students to view this same resource it may be labeled "50 Hot Topics."

TOPIC: INTERACTIVITY

Participants

Christiy Budenbender, Kay Brothers, Carey Brock, Ben Erwin, Barbara Grabowski, Cesar Levy, Michael Hornsby, Christa Peck, Tom Scheiffer

Definition

Interactivity on the WWW does not simply mean interaction between the learner and the computer information, but rather that interaction can be viewed in the broadest sense of creating learning partners within the global WWW environment. This broad interpretation of interactivity needs to be taken into account when any WWW-enhanced learning models are created.

- How interactive are the Aeronautics CA products?
- What strategies are being incorporated to make their products interactive?
- What interactive strategies are recommended for others starting Web projects now?

Group Discussions

Interactive strategies used:

The frequent decision points within the narrative are perceived to be interactive events within SHAPE. Additionally, activities such as flight planning events are incorporated throughout and appear to be very engaging to the students.

SPARK includes lesson plan suggestions that engage learners off-line. For example, one lesson requires the students to create balsa gliders. After the gliders are made, students go back on-line and enter their data. Comparisons can be made with other students who have also entered their data and conclusions drawn based upon collective input.

Aviation Academy lessons are performance-based, cross-disciplined, interactive, multimedia lessons using a "Read-Do-Report" format. This strategy allows students to become active in their own learning as well as interacting with others. Such a process facilitates multi-leveled evaluations: students evaluate themselves, each other, and are also evaluated by the teacher.

PlaneMath provides interactive lessons on-line and off-line. Though these fourth grade, project-based lessons are not too interactive at the beginning of the Web site they have worthwhile content. The interactive activities that are present in the beginning lessons constitute off-line interactive group work. These off-line projects seem to work well for the students. It is important to remember that technology is not the only answer; worthwhile interactive events can and do take place within the classroom. To address on-line interactive lessons, PlaneMath has one lesson to date that is completed by the student on-line.

Hiring an illustrator and an animator to create animation for specific content areas has aided in the development of the interactive components of the All Star Web site. At level one, interactive activities include off-line experiments. An example of such an activity is the building of a paper glider. Shockwave animation provides step-by-step presentations of how to make a paper glider. The students can follow along or build the plane after the presentation. In this way, students have hands-on experience at the same time they are interacting with the content on-line.

LDAPS offers off-line interactive lessons which have proved to be rich and engaging learning activities for the students. Science and engineering lessons facilitate interactivity within the classroom. Science experiments encourage teachers and students to engage in dialogue and discuss what is going on in an experiment. There is also a student-material interaction taking place within the engineering lessons. Students work in small groups to create with LEGOs. These small groups come together into a large group to discuss their findings, share ideas, and pose and entertain questions from others.

Project changes and recommendations:

Interactivity is defined as occurring within the following relationships: teacher-teacher, teacher-student, teacher-material, student-student (either in class or virtually), and student-material (either in class or virtually). The essence of interactive lessons is to engage the individuals with the material presented, to consider their thinking process throughout the lesson or activity, and to enable the learners to demonstrate their knowledge through some means of communication.

“Interactive” was also considered as an interaction between and among content areas. As such, consider interdisciplinary rather than content specific focus to the Web site of development of the Web site.

Consider taking a “national” approach, in that students share information with others around the nation who are working toward common educational goals. To create an interactive national Web site, use a technical expert on the team to aid in its development.

Stimulate virtual interaction within the educational community by creating a national or local event. Using content from the various Web sites for the event, teachers and students could be invited to participate and contribute to a central Web site during a specified time frame--such as a two-week period. Findings, questions, and rich dialogue could be captured so that students and teachers could interact and interpret the new information in a meaningful way.

Include on-line examples of experiments and interactive lessons for teachers, so that they can understand how to use the Web site. Within these examples, be sure to include dialogue, decision-making processes, construction tips, and potential findings.

Use a multi-sensory approach within Web sites. This approach enables many different audiences to interact with the Web sites in multiple ways.

Solid definitions, explanations, and examples should be more commonplace. However, do not allow text to dominate the Web site. Provide users with motivating animation.

If a Web site is content dense, yet has meaningful information, consider suggesting activities that provide opportunities for interaction that can be implemented within the classroom as opposed to on-line.

Include “click and see” content. Have students work in pairs and create an opportunity for them to engage in dialogue about their perceptions of the material presented on-line.

Suggest that students view the same material more than once because they may not see everything the first time. With each viewing of the same material direct the user's attention to a different aspect of the animation.

Give more responsibility to the user; allow the students to think and create their own meanings based on the given information.

Provide several versions of the same project to support various levels of technology access--for example, one version that could support CGI scripting for high-end users and an alternative that would display a text-only format for those with low-end technological capabilities.

Work at or above the pace of technology. The technology will always catch up. Write optimal lesson plans and make the technology fit the design. Let the design drive the technology rather than allow the technology to drive the design.

Hire a curriculum specialist to become part of the team. In addition, consider contacting a support consultant to address the technical issues that arise during design and development. Such support can aid in construction of Web page templates.

Hire a CGI programmer for your team. Java applications enable interactivity. With this technical expertise, highly interactive educational simulations can be created for the students. Developing these Web sites will become less complicated over time making on-line interactivity more feasible and accessible.

When using CGI scripts and Shockwave animation, measure the educational payoff versus the time it takes to program.

Animators should become team members to increase the number of animations that can be created for the Web site.

TOPIC: NATIONAL, STATE, AND LOCAL EDUCATION STANDARDS

Participants

Francesca Casella, Carol Galica, Tiffany Koszalka, Lewis Kraus, Beth Lewandowski, Marianne McCarthy, Ruth Peterson, Thom Pinelli, Janet Storti

Definition

Linking WWW products with school curriculum is a big challenge for developers. Creating that link is one very important step to the products being used. What strategies are the Aeronautics CAs using to ensure that their product will be linked to school curriculum at the national, state, and local levels? School content is also changing into a process-oriented curriculum, following the changes in the national standards. What strategies do the CAs use to follow changes in the national standards? What process strategies are they using in their projects that exemplify the new approach? Specifically:

- How do you incorporate the national, state, and local standards in your Aeronautics CA project?
- How would the project incorporate the national, state, and local standards if it were starting now?
- What methods of incorporating education standards would you recommend to projects starting now?

Group Discussions

National, state, and local standards used:

National Education Standards are embedded in the design of the broadcasts delivered in aeronautics and aviation science. The belief is that teachers are most qualified to implement state and local standards in their classroom.

Indicate how each activity meets the National Math Standards. PlaneMath's references to the National Math Standards were added to the project materials after they were identified as a need. A matrix identifying the National Math Standards as related to each of the product activities was created on the teacher page of the Web site.

The difficulty with complying to standards is related to determining whether an activity truly meets a standard and determining how to certify that it complies. After "testing or certifying" that a standard has been met through an activity, it is a "best faith" effort that the teacher uses the activity in compliance with the standard.

The issue of where to identify standards in the material remains unresolved for some projects.

Langley Research Center's Education Office is starting a new distance learning project. They have conducted a focus group with Virginia education representative regarding the use of standards. Virginia will not endorse products unless national and state education standards are clearly incorporated, i.e.,

objectives and activities are tied to specific standards. Using the standards provides products with credibility. Standards are also used to evaluate and review instructional material. Anything produced has applications to national and state standards and is referenced by the standard's numbers. This reference list is on the title page of all products.

Standards are addressed in all of the Mobile Aeronautics Education Laboratory's (MAEL) manuals. As a teacher, standards are important and provided as a guideline to curriculum. Teachers frequently rely on the curriculum development people to ensure that the curriculum or support materials meet national, state, or local standards.

In the Lewis (now Glenn) Research Center's K-12 teacher training, standards are a part of the presentations about using the computer and using aeronautics content in the classroom. The teachers had to incorporate standards, using the computer and aeronautics content into lesson plans. Most teachers started with standards and then folded in the computer and aeronautics content.

The solution to complying with the education standards, regardless of the grade level, is to consider standards at the beginning of the project during the earliest stages of product development. The standards are used to guide the product development rather than going back at the end of the project to see what standards "fit" the product.

Align with national standards first. The state standards are supposed to align with national standards and, in-turn, local districts are responsible for complying with state standards. This is the assumption that the educational book and CD-ROM publishers use to comply with education standards.

Teachers are accountable for how they meet the standards in their classrooms. The teachers want to know the key points of the instruction including the activities, materials, and how each meets the standards for which the teachers are responsible. Teachers want to know where they can integrate products into their instruction. By identifying the standards met in a given set of activities, the teacher can select activities without spending extensive time reviewing materials that may not be applicable for their classroom. Teachers also need to build in assessment strategies based on the assessment standards.

Project changes and recommendations:

Standards help teachers teach from three perspectives: concepts, applications, and processes. The process standards are as important as the content standards.

An effective way to identify the standards covered in the material is to produce a matrix of the content objectives as they relate to the standards. The NASA matrix used in the newer curriculum support products was cited as an example of a useful standards matrix.

Complying with state standards is a matter of resource allocation for the Aeronautics CAs. PlaneMath, as a nationally focused project, determined it would be inefficient to identify all fifty states' standards in relation to their product's activities. A more efficient approach was to comply with national standards. New projects should follow National Education Standards. However, if the project is localized, local standards should be applied.

We live in a world of standards. To compete successfully in a global economy, students and teachers need well-defined criteria for proficiency in science, mathematics, and technology. The national standards can be used to increase the science, mathematics, and technology literacy of students. NASA-sponsored materials are intended to enhance and support science, math, and technology education by adopting the guidelines set forth in the national standards. We must rely on local curriculum specialists and teachers to share in the responsibility of using the material and complying with state and local standards.

During the early stages of product development, secure the support of an educator or education standards expert. His or her task is to identify relevant standards and document how they correspond with the content objectives across the grade levels. Determine grade level, content objectives, and the relevant national standards including process and assessment standards, as appropriate.

Use the process standards to design a context within which students will learn the concepts and facts. Processes in the National Education Science Standards use an inquiry-based, constructivist approach.

National Education Standards form a foundation. They provide consistency and a unified set of educational goals. To achieve excellence in America's educational system, the standards provide a specific set of objectives and provide guidelines for determining at what grade levels certain content and activities should be taught.

Concluding Remarks and Recommendations

CONCLUDING REMARKS AND RECOMMENDATIONS

The September Learning Technologies Conference focused on discussions regarding ways that NASA's Aeronautics Cooperative Agreement projects did or needed to address their K-14 customers' needs. From these working sessions, several conclusions can be drawn. It is important to emphasize that the participants were candid in their discussion of issues, which resulted in rich conversations, group problem solving and important recommendations for future projects. The conclusions are listed below by topic.

Access

Access to the Internet needs to be broadly defined in order to accommodate teachers' and students' needs satisfactorily. Product developers need to consider three aspects of classroom access: physical or technical access, content or Web site access, and computer literacy or access to skill in using the WWW for teaching. Technical access is not enough, teachers and student need to be able to find NASA's resources and then incorporate them into instruction.

Although access to the Internet in school classrooms is rapidly increasing, the type and level of access varies. Developers, therefore, need to ensure that their sites accommodate an array of high to low technical capabilities, as well as different configurations of use (i.e. computer lab or single computer in the classroom).

Second, access, as defined as knowledge of the existence of, and ability to locate NASA products on the Web is considered to be a major problem. In spite of the fact that NASA products are tremendously useful to teachers, if teachers cannot find them, they are like stars shining in the daylight.

For those teachers who have limited access to Web resources due to inexperience or lack of training, having mentor teachers at school sites to provide support and modeling for teaching with Web resources is a potential solution as are district training programs.

Offering multiple versions of the product, networked access, or recommendations for use with a variety of configurations could accommodate the different types of access.

Finally, participant agreed that projects should also provide recommendations to teachers as to how students with disabilities could use their products, and whether adaptive technologies are available.

WWW Resources

The Aeronautics projects' Web sites incorporate many different types of human and information resources that are accessible through the World Wide Web. Through the Web, teachers collaborate with other teachers or experts, upgrade their content knowledge with background information, and obtain lesson plans and recommendations for teaching strategies. Teachers can also make WWW resources available to their students, and integrate either an entire site or just elements of a site in their lessons. In terms of the selection of types of Web resources, however, the project participants strongly recommended that the resources be chosen on the basis of lesson objectives and not just because of the availability of a

new technology. Participants also recommended that schools develop community partners through the Web.

Web site development recommendations spanned purpose, teams, and resource use. Participants emphasized the importance of letting the learning purpose drive the design rather than the availability of glitzy displays that may require long loading times and overshadow the effectiveness and clarity of the lessons. One way to control the design strategy is to hire a balanced development team that includes teachers, and professional graphic and Web designers. Developers should consider creating sites that use one or two capabilities well and then add options later to make the Web site more powerful for instruction. The developers were cautious about creating classroom activities that required students to use chat rooms or other synchronous conferencing capabilities. Only when linking to other sites, developers recommended was that sites be of high quality, be kept to a minimum so that users do not get lost outside of the site, and be periodically checked and updated.

Teacher Training

Conference participants asserted that teacher training can make or break a project. Effective training on the use of a project site enhances its effective use. Lack of training results in teacher frustration and abandonment of the site. Participants recommended that projects establish a technology implementation plan that involves teachers early in the product development. This technology implementation plan should include several critical on-line and off-line components: prerequisite technology configurations and support, technology literacy prerequisites, on-line teacher supports, and off-line support.

To establish this plan, it is necessary to first determine the extent of training required. Teacher selection criteria for project participation should be established that specify prerequisite computer and Web literacy levels, teacher motivation, and willingness of the teacher to participate in technology projects. For future projects, participants recommended bringing in teachers who understand the long-term vision of the project during the grant proposal phase to help develop training plan. The plan should include at least a navigation chart and an orientation to the project Web site. Since training in the fundamentals of technology is outside the scope of the NASA and the Aeronautics projects, delineating prerequisite skills clearly will also ward off disappointment in the product or project. Participants suggested providing online support that can include frequently asked questions (FAQs), questions for the developers, online documents and virtual teacher lounges.

When providing off-line support, participants stated that it was important to require the school to share in the responsibility of training. The recommendations included using technology coordinators to lead the school training effort so that there is a cascading approach to training. It was strongly urged that trainers conduct separate training sessions for computer operation skills, software, hardware, and internet training. Finally, provide materials to read prior to the training session.

Different Teaching and Learning Styles

Participants indicated that developers should provide a Web site that allows for flexibility so that teachers are able to use different teaching and learning strategies for instruction using the site. The more the teachers can adapt the Web site to their teaching style the more likely they are to use the site for instruction. The site could accommodate multiple methods of use by suggesting alternatives around

current accepted practice and by modeling. An alternative to offering recommendations is to provide space for teachers to document strategies they have used with Web-based materials to share what works with others.

Developers emphasized the importance of providing a context for instruction and options for interactive learning. A learning environment should provide a context for the instruction to motivate students to learn and maintain student attention. Providing this context could be offered on the site itself, or suggestions provided to teachers as to how they might provide that context offline.

To accommodate individual learning styles, narratives should be short and concise without compromising technical accuracy. Different learning styles may also require a different screen layout or navigation cues. Pictures, audio and video approaches provide multisensory input to learners. Content dense material can be supported with examples and animations. Reflection checks, review exercises and feedback forms to help learners assess their own learning.

Interactivity

The purpose of interactive lessons is to engage the learners with the materials presented, to stimulate their thinking throughout the lesson or activity, and to enable them to demonstrate their knowledge through some means of communication. In this working session, interactivity was defined as occurring in the following relationships: teacher and student, student and student, teacher and teacher, teacher and expert, student and expert, teacher and material and student and material.

Participants had many suggestions for enhancing learning with interactivity and developing sites that keep users engaged. Without letting text dominate, provide solid definitions, explanations and examples of how to use the Web site. Participants observed that a use of a multisensory approach (pictures, sounds, movies, animation, text) enables many different audiences to interact with the Web sites in multiple ways. Break up content dense sites by suggesting offline, classroom activities. To maximize interactive potential, provide different versions of the product to support various levels of technology access. Participants suggested having students work in pairs to create an opportunity for them to engage in dialogue about their perceptions of the Web-based material. A global approach to learning can be created with national or local events, experiments could be provided in which data are gathered off line and shared online in others who have common interests or educational goals.

In order to create and develop a highly interactive Web site, several participants suggested that the project team include a technical person capable of programming animations and interactive simulations. Including a curriculum specialist as a project team member was also suggested.

National, State, and Local Education Standards

The National Standards help teachers link resources to the three global standard perspectives: concepts, applications, and processes. Education standards provide teachers with well-defined, and unified criteria for proficiency in science, mathematics and technology, skills critical to competing in a global economy. Given that NASA-sponsored materials are intended to reflect these standards, it is critical that the connection is made overtly to activities on the Web site. Participants recommended

securing the support of an educator or education standards expert early in the product development to identify relevant standards and document how they correspond with the content objectives for the targeted grade levels. Another approach to helping teachers identify whether the Web site is relevant to their instructional goals is to create an online matrix like the NASA matrixes used in the newer NASA curriculum support products. Unless the project is localized, the connection should be made to the national standards rather than a project attempting to identify and comply with education standards from fifty states.

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.

CGI- (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.

Cascading training approach- When individuals are trained, for example in technology use, those individual return to their school and teach another group of teachers. The newly trained group of teachers would then begin training yet another group of teachers. This process continues until everyone has become trained.

DFRC- Dryden Flight Research Center, Edwards, CA

Distributed Training- Dissemination of training in a variety of ways including cascading.

Education Division Computer Aided Tracking System (EDCATS)- 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 by way of computer network, i.e., electronically. The messages are stored until the addressee accesses the system and retrieves the message.

IITA- Information Infrastructure Technology and Applications Program; a NASA component of the Federal High Performance Computing and Communications (HPCC) program. This program is being replaced by the Learning Technologies Program.

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

Intranet- A network of computers within a closed loop. For example computers networked within a classroom or school.

Kiosk- A stand alone closed computer system

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.

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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