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Web-Enhanced Instruction and Learning: Findings of a Short- and Long-Term Impact Study and Teacher Use of NASA Web Resources

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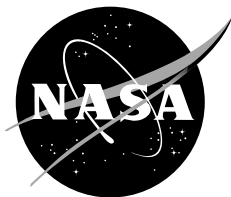
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EXECUTIVE SUMMARY

NASA has made a substantial, multimillion-dollar investment in a World Wide Web (WWW) presence and in developing Web resources for use by the educational community. Over a three-year period, the Pennsylvania State University and the NASA Dryden Flight Research Center conducted educational research investigating the most effective practices for using Web-based resources to enhance instruction in science, mathematics, technology and geography.

Many individuals contributed to this body of research to ensure input from as many stakeholders as possible regarding the issue of effective Web-based or Web-enhanced instruction. The project team conducted two working conferences in March and September 1997, (NASA Conference Publication 3358 1997 and NASA CP/1997-210722), and an analysis and needs assessment in 1998 (NASA/TP-1998-206547). The technical paper “Web-Enhanced Instruction and Learning: Findings of a Short- and Long-Term Impact Study” reports the findings of a study of a reflection tool created to help teachers merge the vast NASA Web resources with the best teaching methodologies. NASA Web-Enhanced Learning Environment Strategies (WELES) were developed, tested, revised and retested over the life of the project, from 1997 through 2000. The unique feature of the study was the broad spectrum of data collected from teachers from over 23 states in the United States and abroad.

The feedback from a variety of teachers representing different schools, grades, states, and experience levels helped us develop a textual and visual representation in the NASA WELES reflection tool and lesson planner that is easily understandable by a vast majority of K–14 educators.

The data analysis also revealed that innovations such as NASA WELES are much more successful when presented as a way to help teachers reflect on methods to enhance their current teaching and learning, instead of as a replacement for the methods, activities, and resources they currently use in their classrooms. The strategies used to facilitate NASA WELES workshops also seemed to impact teachers’ use of NASA resources in their teaching practices. Teachers who attended NASA WELES workshops that extended over a long period of time (eight months) used more NASA resources than those who attend the short term (one day to two weeks) continuous sessions.

Reflection tools such as NASA WELES can and do help teachers rethink the possibilities for creating an ideal teaching and learning environment using any of a variety of NASA Web resources to enhance science, mathematics, technology, and geography lessons. Operationalizing the integration of NASA resources into their practice through the NASA WELES lesson planner provided teachers a familiar tool, a lesson plan, with which to integrate NASA Web-based resources into lessons that actively involved students with authentic NASA content, activities, and people. This bridge between reflecting on innovations and operationalizing innovations into practice was successfully accomplished. Teachers developed a process for integrating any of thousands of NASA Web resources into their lessons rather than learning how to use one new resource.

This research has great potential to transfer beyond the educational outreach for NASA. As noted in this paper, the WELES reflection tool has migrated into graduate-level courses for educators, international educational settings, and research agendas beyond those sponsored by NASA. The true value of NASA WELES is that it helps teachers think about what they currently do well, what they are trying to do, how they plan to teach, what resources are available for teaching and learning, and how these resources can be effectively incorporated into lessons. More importantly, this encompassing framework provides teachers with prompts to think about the ultimate possibilities for teaching and learning, the vast numbers and types of resources available, and the endless ways to combine methods of teaching and NASA Web resources to make instruction exciting, motivational, and relevant to students.

PREFACE

“Web-Enhanced Instruction and Learning: Findings of a Short- and Long-Term Impact Study” represents the culmination of three years of educational research into the best practices for using World Wide Web (WWW) resources for classroom instruction. Under investigation were teachers’ attitudes about and use of Web resources, and their feedback regarding the usefulness of a tool designed to assist them in combining NASA (and other) Web resources and the best pedagogical methods for teaching science, mathematics, technology and geography.

PROJECT TEAM

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ABSTRACT

Over a three-year period, researchers and educators from the Pennsylvania State University (PSU), University Park, Pennsylvania, and the NASA Dryden Flight Research Center (DFRC), Edwards, California, worked together to analyze, develop, implement and evaluate materials and tools that enable teachers to use NASA Web resources effectively for teaching science, mathematics, technology and geography. Two conference publications and one technical paper have already been published as part of this educational research series on Web-based instruction and learning. This technical paper, “Web-Enhanced Instruction and Learning: Findings of a Short- and Long-Term Impact Study,” is the culminating report in this educational research series and is based on the final report submitted to NASA. This report describes the broad spectrum of data gathered from teachers about their experiences using NASA Web resources in the classroom. It also describes participating teachers’ responses and feedback about the use of the NASA Web-Enhanced Learning Environment Strategies reflection tool on their teaching practices. The reflection tool was designed to help teachers merge the vast array of NASA resources with the best teaching methods, taking into consideration grade levels, subject areas and teaching preferences. The teachers described their attitudes toward technology and innovation in the classroom and their experiences and perceptions as they attempted to integrate Web resources into science, mathematics, technology and geography instruction.

NOMENCLATURE

Case-based Learning Activity	Workshop activity in which the teachers were given real situations relevant to each participant’s context.
Change Theory	A study of how innovations are implemented in an organization.
DFRC	Dryden Flight Research Center, Edwards, California
Distance Education Class	A class offered in which most, if not all, of the course work was conducted virtually (through the Internet and other telecommunication means).
ID-PRISM	Represents an acronym of categories to provide a framework that supports reflection upon Instructional Design—Possibilities, Realities, Issues, Standards, and Multidimensional Perspectives created during the think tank phase of the educational research project with PSU and DFRC.
K–12	Kindergarten through twelfth grade
K–14	Kindergarten through second year of college
LaRC	Langley Research Center, Hampton, Virginia
Lesson Planner	A structured guide for teachers to use to formally write down their plans for teaching.
NASA	National Aeronautics and Space Administration

NASA Contextualized Workshop	A workshop in which NASA Web-Enhanced Learning Environment Strategies (WELES) training was included in an existing NASA workshop.
NASAWELES-specific Workshop	A workshop whose sole purpose was to train teachers about NASA WELES.
Network Elements	Capabilities of the Web that facilitate communication with other individuals. In other words, these are the types of resources that connect people electronically to enable shared interactions with experts, leaders, scientists, role models, and collaborators via e-mail, listservs, newsgroups, chat rooms, audio conferencing, and video conferencing.
Organized Sites	Teacher resources that are generally developed with a specific purpose in mind, such as to entertain, present current or historical events, provide background information, instruct or encourage hands-on activities. Categories include information, databanks, interactive events, current events, historical events, showcases, simulations and tutorials.
Pedagogy	A study of how children learn; the art of teaching; best teaching methods.
PSU	Pennsylvania State University, University Park, Pennsylvania
Reflection Tool	A structured tool to help teachers to think introspectively about their teaching.
Site Elements	Teaching resources that represent the raw materials from the World Wide Web (WWW) from which lessons can be created. Site elements include numbers, narratives, lists of references, still images, animations, video clips, sounds and tools
TAP	Teacher Ambassador Program
Teaching Methods	Specific strategies and tactics that teachers use for teaching.
Present	Teaching method in which the teacher provides instructional information through lecture, presentation, demonstration, or other “telling” activities. The teacher is in control as he or she specifically directs those students through the lesson, activity or practice session.
Guide	Teaching method in which the teacher uses inquiry activities to help students discover rules and relationships of the content. The teacher’s role shifts from presenter to activator of conversation with students. The teacher coaches by using questioning, providing context, drawing upon prior and prerequisite knowledge, giving feedback, and providing help.

Active Learning	Teaching method in which the student is mentally active and constructs meaningful and personal understanding of the content by manipulating objects or abstract concepts in the learning environment. Instructional activities such as note taking, concept mapping, graphing, and mnemonics enable students to mentally “play with” information.
Collaborative	Teaching method in which two or more peers work together on learning activities that encourage them to maintain agreement and eventually reach a shared solution. The process promotes discussion of ideas, collaborative argument, and interaction among participants especially when those participants begin the discussion with little in common.
Problem-based	Teaching method which starts with a presentation of a “real world” problem in which students are provided with instructor guidance and resource material and are encouraged to dive into the problem, construct an individual understanding, and finally find a solution. Students actively define problems and construct potential solution while teachers model, coach, support and make explicit students’ learning processes.
Role-Play	Teaching method in which activities require putting the students in the context of a problem-based story in order to learn. The students “play” authentic roles while investigating a situation, identifying gaps in their knowledge, researching information needed to solve the problem, and developing solutions. The teacher’s role is to coach.
WELES	Web-Enhanced Learning Environment Strategies (pronounced WEE-LEEs)
Frame	A lesson strategy in which a context for studying a particular topic is established.
Inform	A lesson strategy in which information about the content is conveyed to the learner during a presentation, demonstration or discussion.
Explore	A lesson strategy that is student-directed. Students investigate, manipulate and research subject areas, problems and situations.
Try	A lesson strategy in which the student practices, or tests, their newly acquired knowledge, skills or inclinations.
WWW	World Wide Web

INTRODUCTION

Over a three-year period, the Pennsylvania State University (PSU), University Park, Pennsylvania, and the NASA Dryden Flight Research Center (DFRC), Edwards, California, worked together to analyze, develop, implement and evaluate materials and tools that enable teachers to use NASA and other Web resources effectively for teaching science, mathematics, technology and geography.

The goal of the educational research project was twofold: to identify what teachers needed to effectively integrate NASA and other Web resources into classroom instruction, and to develop an effective and useful tool to help them achieve this integration. This technical publication reports the findings of a short- and long-term impact study on the tool we have named the NASA Web-Enhanced Learning Environment Strategies (WELES).

A broad spectrum of data was collected from teachers in over 23 states and abroad. Documentation from face-to-face workshops, focus groups, interviews, e-mail surveys, lesson plans and evaluation forms was utilized to present the teachers' experiences. Using these data sources, we asked teachers about their attitudes toward technology and innovations in the classroom, and their perceptions about themselves and their schools' readiness to integrate technology into classroom instruction. We asked basic demographic questions including their grade levels, subject area, and use of computers and technology for teaching. We asked open-ended questions about their current technical environment, the use of Web resources in their classrooms, barriers to using Web resources and their ideal learning environment. We collected data about their visits to NASA Web sites and evaluated the types of resources they used (and did not use).

While the percentage of respondents to our long-term impact study was less than expected, the information we received over that eight-week period and the summative data over the life of the project gave us insights about the benefits and challenges of incorporating NASA Web resources in the classroom. The data confirmed some aspects about Web use that we already knew while giving us new insights about teachers and how they use Web resources for classroom learning.

BACKGROUND

One strategic educational mission of the National Aeronautics and Space Administration (NASA) is to increase science interest of kindergarten through second year of college (K–14) students and thereby inspire them to pursue science careers. As part of this educational mission, NASA has made available to educators hundreds of thousands of NASA-mission-related Web pages. From an analysis of teacher use in 1997, Grabowski, McCarthy and Koszalka found that most teachers were 1) overwhelmed by the vast unknown of the Internet and World Wide Web (WWW) and 2) unaware of the existence of these NASA educational materials.

Recognizing a significant need, the NASA Dryden Flight Research Center (DFRC), Edwards, California, funded a three-year educational research project through a NASA Learning Technologies Project to create a strategy to address these two problems. This project capitalized on the findings of a think tank whose purpose was to reflect on the components needed in the design of electronic classrooms and to conduct an analysis and needs assessment of technology use in the United States kindergarten through twelfth grade (K–12) educational system. The results of these activities and a series of pilot tests contributed to the creation of the NASA Web-Enhanced Learning Environment Strategies (NASA WELES) reflection tool and lesson planner.

Results of the Think Tank

Purpose and Methods

The think tank project was launched when the Education Officer at NASA DFRC challenged the Pennsylvania State University (PSU), University Park, Pennsylvania, team with exploring the literature, instructional design models and tactics, and advances in technology to reflect on and identify components needed for an ideal electronic classroom. This think tank was conducted as part of an advanced graduate level instructional design course during which one NASA DFRC education program manager, nine graduate students, and one PSU professor worked through the task together for 15 weeks.

Findings

Encouraging teachers to think about the use of innovative technologies can lead to increases in their skill and knowledge of incorporating technology into their teaching practices (Pultorak, 1996; Putnam, 1991). Recent books and articles are full of definitions of the ideal electronic classroom, prescriptions for how to use electronic resources, and descriptions of the effects of such resources on learning, attitude, and changes in pedagogy. Yet very little literature focuses on the mental processes involved in designing these electronic classrooms that ultimately facilitate the enhancement of instruction or the types of tools that can help guide teachers through the thinking processes considering the possibilities, realities, and issues of creating electronic teaching and learning environments. These complex factors were distilled into five categories to help teachers do just that.

The resulting Instructional Design—Possibilities, Realities, Issues, Standards, and Multidimensional Perspectives (ID-PRISM) reflection tool represents an acronym of categories to provide a framework that supports reflection upon those categories as they are associated with creating an electronic classroom. As required in effective reflection tools, ID-PRISM prompts teachers to think about strategies they currently use that they believe exemplify good teaching and learning. Then, they are prompted to reflect on the endless possibilities for creating an ideal classroom supported with electronic resources.

Thus, teachers are tasked with considering the multidimensional nature of the educational environment, namely educational and instructional design principles, learner-psychological attributes, and environmental and technological conditions (Koszalka, Grabowski, & McCarthy, 1999).

Results of the Analysis and Needs Assessment

Purpose and Methods

To address the second issue of awareness and use of NASA Web resources in the classroom, it was important to establish some understanding about:

- the contemporary educational context, that is, the administrative and technology infrastructure and teacher characteristics
- school content including curriculum guidance, support and resources available and existing NASA Web resources
- school processes, including best teaching practices, applied contemporary learning theory and methods of teaching integration.

The needs assessment, therefore, was organized around these three themes and was conducted by a 16-member team: three NASA educators, two faculty members, one lead research assistant, nine doctoral and master's students enrolled in the instructional systems program, and one Internet industry expert.

Findings

The technology infrastructure was and continues to be changing dramatically, with teacher access growing exponentially. Teachers' skills however, were not keeping up with the change in access. Training was focused on using technology, as opposed to integrating resources into lessons. Teachers also perceived that it takes too much time and requires major changes in teaching to use the Internet in the classroom. Lastly, in terms of context, we found that administrators were critical factors in the successful use of the Web in the school. Teachers with administrative support were more likely to adopt the Internet in their classroom.

The WWW offers NASA scientists one very convenient dissemination mechanism for extending NASA missions into the K-14 educational community. NASA personnel have responded by publishing a vast amount of information on the Web. In November of 1998, there were 291,470 Web pages with the nasa.gov domain name in existence (Marianne McCarthy, personal communication, November 1998). The content of these NASA Web resources, however, was not always teacher-friendly or school-relevant. To enable the teacher to use the entire site, a "translation" to school use was needed. The organization of NASA resources on the Web suffered from the general malaise of all Internet resources; Web sites were not created and posted with a systematic, teacher-friendly organizational structure in mind, nor had they necessarily been created for that purpose. In order to find these resources, the teachers must be very strategic and purposeful in their search techniques. Teachers have indicated that random searching results in frustratingly few usable hits.

To reach the highest proportion of the 3.2 million teachers in the U.S, the strategy that was developed needed to be flexible enough to accommodate the differences between, and complexities of, the classroom environment. When considered appropriately, many factors that appear to impede the use of the Internet in the classroom can actually enable the use of NASA Web resources in effective and innovative ways. Two such factors include the locus of access to the Web and the use of multiple teaching strategies. Teachers who have direct access to the Web in their classroom, in a computer lab setting, in the library, in the teacher's lounge, in the administrative areas of the school, or at home can all use NASA Web resources. Teachers who use a variety of teaching strategies including the more traditional teacher-centered presentation and guiding strategies and the more learner-centered strategies of active learning, collaborative learning, problem-based learning, and role playing can also use the vast resources created by NASA.

Given that the thousands of nasa.gov Web sites that exist can be used by the teachers in multiple ways as noted above, the following two scenarios exemplify the two extremes of a continuum of Internet use. In scenario 1, the teacher directs fifth grade students in the school lab to review the information and complete the interactive activities on the "Build Your Own Aircraft" Web site about understanding the principles of flight. The entire site is used in the manner in which it was designed to engage students. In scenario 2, the teacher teaches a lesson on flight dynamics and uses a variety of hands-on activities to create flying objects and demonstrate the principles of flight. She *enhances* the lesson by showing the students, through a liquid crystal display (LCD) projector, the animation of the four forces of flight in the "Build Your Own Aircraft" Web site. In this way, she frames the lesson on aircraft design at the beginning to promote curiosity about why objects are able to fly. In the first scenario, the teacher uses a NASA site "as is" in a computer lab. In the second, the teacher is selective about which elements from the NASA site are relevant to her own goals of the lesson, and shows them to her class with her one computer displayed to all.

Conclusions

Based on the input from this analysis, we have reached the following conclusions regarding needs of teachers for using the Internet in their classroom.

First, teachers need to have administrative support for the most widely implemented use of the Web in the classroom. Second, teachers need a tool that would help them integrate Internet resources smoothly into current teaching practices. This tool needs to focus on Web integration strategies rather than on general technology training.

Therefore, we concluded that although we cannot increase administrative support, we could create a teacher integration tool to conceptualize Web resources similar to the way teachers currently think about resources in general. By using this framework, teachers could be more strategic in their searching. To this end, Web resources were characterized into two main types: others (human) and informational resources available through the Internet network and Internet sites. These human and informational resources were then subdivided into types of each, e.g. industry experts, peers, pictures, sounds, data.

In a similar vein, the analysis led us to identify and categorize six contemporary teaching methods and six Internet access configurations for teachers. The full Analysis and Needs Assessment Report is also available for further reference (Grabowski, McCarthy, and Koszalka, 1997).

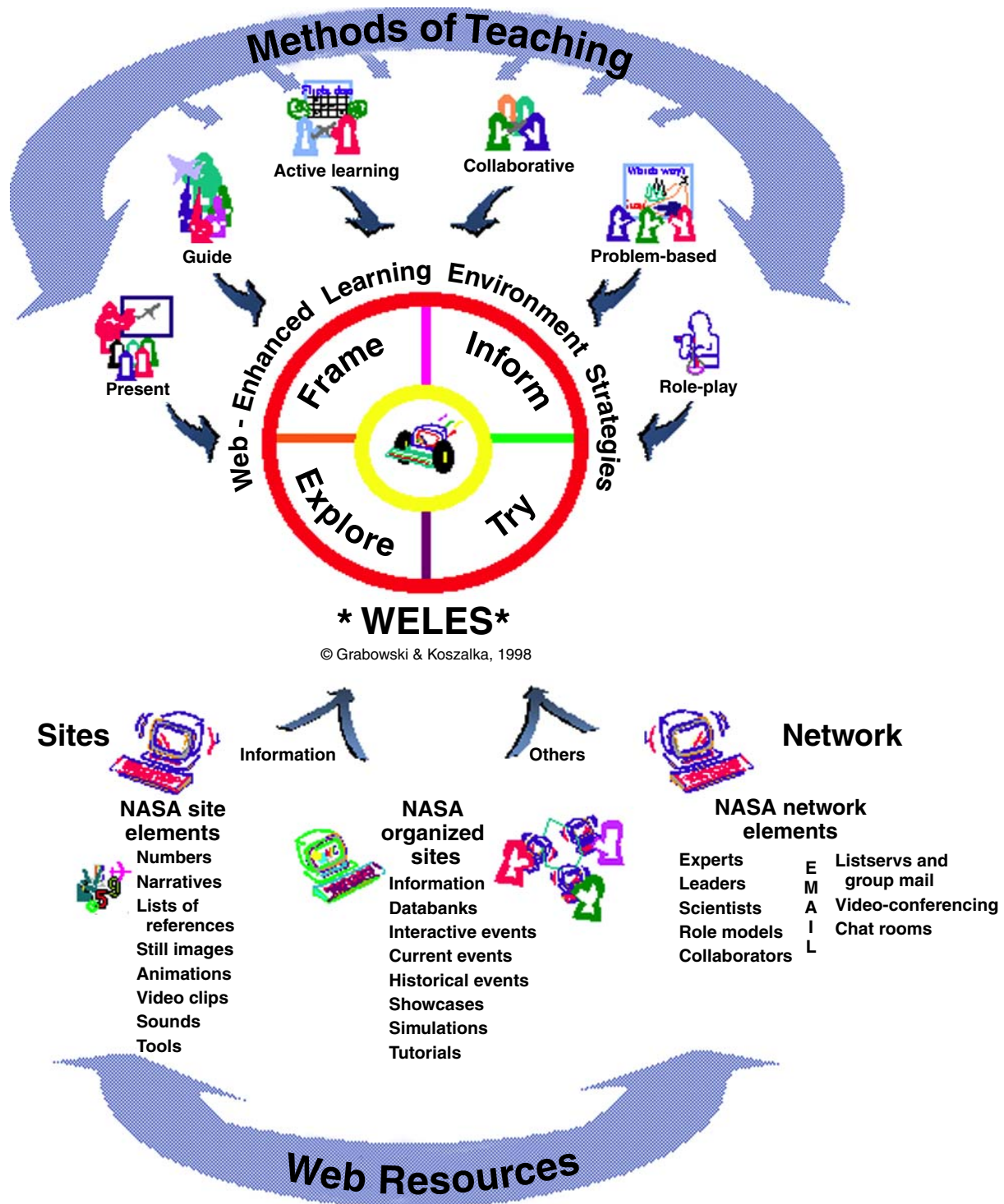
The Making of Web-Enhanced Learning Environment Strategies (NASA WELES)

Based on the data from the think tank and the Analysis and Needs Assessment, the team created the NASA Web-Enhanced Learning Environment Strategies (NASA WELES) as an organizational framework to assist K–14 teachers to plan, search for, find and use NASA Web resources to enhance their lessons. The NASA WELES reflection tool is shown in Figure 1.

This figure provides an overview of the conceptual interrelationship between teaching methodology and WWW resources. The lower portion of Figure 1 provides the teachers with a road map through the myriad of resources available on the Web. The upper portion identifies six methods of teaching that the current educational research literature cites as the most optimal teaching strategies. The resulting four central WELES follow a typical lesson sequence: framing a lesson, informing learners, providing for content exploration by the learner, and allowing learners to try out newly acquired skills, knowledge, and inclinations. Teachers can often see from this overview, a broader conception of how the Web can be used for classroom teaching.

Figures 2 and 3 present the lesson planner, which was developed next as a practical tool for teachers to use when actually planning a specific lesson. The planner steps the teachers through the thinking process to ensure that they consider all available teaching options for using the vast resources on the WWW.

It is important to note that the resulting design took into consideration our beliefs about teaching and the use of Web resources, our understanding of changing pedagogy, changing realities of classroom access, change research, and extensive feedback from teachers.



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Figure 1. NASA WELES reflection tool.

WELES LESSON PLANNER

Subject

Science

Mathematics

Technology

Geography

Social Studies

Language Arts

Teaching methods

Present

Guide

Active learning

Collaborative

Problem-based

Role play

NASA Web

NASA site elements

Numbers

Narratives

List of references

Still images

Animations

Video clips

Sounds

Tools

NASA organized sites

Information

Databanks

Interactive events

Current events

Historical events

Showcases

Simulations

Tutorials

NASA network elements

Experts

Leaders

Scientists

Role models

Collaborators

Web-enhanced lesson

Grade: _____

Lesson: _____

Lesson objective(s): _____

National standard(s): _____

NASA mission context: _____

Lesson activities

• _____

• _____

• _____

• _____

• _____

WELES

Figure 2. Page 1 of the NASA WELES lesson planner.

NASA WELES LESSON PLANNER

NASA Web Resource Worksheet

Lesson activity	Resources required	Web resources found

030473

Figure 3. Page 2 of the NASA WELES lesson planner.

Beliefs about Teaching and the Use of Web Resources

We held the following four beliefs and assumptions related to contemporary methods of teaching with WWW resources.

- By taking a broad perspective of the WWW and the types of resources it contains, the model would be more useful to the teacher.
- WWW resources have the potential to be used to enhance lessons more often than as a public space for publishing home pages or teacher-developed lessons.
- Teachers were already teaching using contemporary and effective methods of teaching in a manner that engages learners with as many resources as they can gather together, but were challenged by the latter.
- WWW resources were useful for one or more lesson strategies, or for the lesson as a whole. Web resources should empower teachers to re-purpose sites to meet their everyday needs, rather than have teachers re-purpose their own lessons to conform to the Web.

Understanding Changing Pedagogy and the Realities of the Classroom

We felt that the model needed to include both traditional and contemporary teaching methods to reach the greatest number of teachers. Traditional teaching methods included the *Present*, *Guide*, and *Active Learning* methods in which the teacher is in more direct control, reflective of a behavioristic and cognitive pedagogy. We then included *Role-play*, *Problem-based* and *Collaborative* learning in which the teacher plays less of a direct role, as reflective of a more constructivistic pedagogy.

While not represented in figure 2, NASA WELES also provided advice to teachers in an accompanying manual that took into consideration six different computer/Internet access configurations. We emphasized that if the teacher only had access at home, or in an administrative area, there were also ways for him or her to use this resource. Primarily, the teacher uses the resource as a planning tool for a vast number of lesson plans and resources that he or she could print and bring into the classroom. Of course, for those who have lab access, one computer with or without a display panel, or multiple configurations directly in the classroom, there are more options for Internet integration.

Applying Research on Change Theory

Theories on teacher adoption of technology innovations greatly influenced the design of NASA WELES. Research suggests that those teachers at ease with technology quickly migrated toward more sophisticated and challenging lessons incorporating new technology-enhanced resources and methods (Geyer, 1997). Encouraging teachers to *reflect* on lessons, activities, and strategies they were familiar with and that have worked well in the past helped them adopt new technologies (Shön, 1983; Canning, 1991). By using an existing repertoire of successful assignments, projects, and activities from their tool kit, teachers had enough familiarity with old procedures to ensure a successful instructional outcome when applying new technologies. Continuing to experiment with Web technologies in steps encouraged teachers to include Web resources as a regular and continuing part of instruction rather than as rare, anecdotal experiences. The first step is to encourage teachers to think about successful instruction, current resources, and how technology can be comfortably integrated into those successful lessons.

This process of reflection allows for the building of logic and movement toward change (Senger, 1998). NASA WELES was designed to introduce Web technology innovations through methods and terms with which the teachers were already familiar, and had experienced success. It was important that the model guided teachers slowly since they were more likely to incorporate innovations a little at a time until they became comfortable with the innovation.

Feedback from Teachers

Lastly and most importantly, the NASA WELES reflection tool and lesson planner were forged and shaped by teacher feedback over a three-year period. We offered eight NASA-sponsored workshops attended by 164 teachers in the United States, five PSU graduate courses attended by 93 teachers, and one Assumption College Thonburi-sponsored international workshop attended by 118 Thai teachers. In each case, we were interested in whether the tool was effective in its ability to help teachers think strategically about the Web and about the use of NASA Web resources in their classroom, enough so that they would use them in their teaching. After each session, we considered all of the feedback, and revised the model accordingly.

The following reports were written which summarized the feedback we received. Their full reports are available in the project final report (Grabowski & Koszalka, 2000).

1. NASA WELES Workshop Summary: NASA Langley Research Center (LaRC), Hampton, Virginia — July, 1997
2. NASA WELES Workshop Summary: NASA DFRC — July/August, 1997
3. Summary of Web-Enhanced Learning Environment Strategies Workshops — October–December, 1998: Keppel, Altoona¹, Lewisburg, and Altoona²
4. Web-Enhanced Learning Environment Strategies: Dole Middle School, Hawaii Workshop Findings
5. Initial Summary Report of Followup Data on NASA WELES Workshops — NASA DFRC and Keystone

Feedback from NASA Education and Instructional Design Leaders

In addition to the feedback from teachers, two NASA education leaders provided comments about the evolving model. In each case, comments referred to the need to simplify the model and make it very practical in terms of what teachers were likely to use. These suggestions were collected during frequent meetings over the course of the three years, and incorporated as they were given.

Eight instructional design leaders representing six universities (PSU, Florida State, Syracuse University, Purdue, University of Colorado at Denver, and Iowa State University) were asked to review the NASA WELES model. Each reviewer was asked to respond to eight questions regarding the appropriateness of the strategies, attributes of the Web, components of the network, components of sites, networks, site elements, and configured sites, six NASA WELES, and the model in general.

Overall, a majority of the respondents indicated that the NASA WELES categories and model in general are representative. The reviewers suggested several additions to the categories, such as an assessment, “ask-a” Web resources, and explore/research/synthesize teaching pedagogies. Two respondents requested clarity or definitions of some of the items, such as Active Learning; two respondents had indicated that there could be overlap among some of the categories. One respondent brought up an interesting comment about capturing traditional teaching strategies as compared to providing a venue for exposure to different pedagogy.

One of the instructional design leaders was queried extensively in a face-to-face interview, and as a result of this discussion, we realized that *model* was not the appropriate term to be using, and began referring to this product as a reflection *tool*.

Results: The Changes in NASA WELES

The WELES reflection tool and lesson planner evolved over the three years of this project. Each version was enhanced to reflect new insights on learning technologies, learning theories and teaching practices. Feedback from leading educational and technology experts as well as teachers who participated in the eight teacher workshops was also used to clarify and enhance NASA WELES materials. As a result, there were ten versions created over the three-year period each representing revisions based on this feedback.

NASA WELES began as a conceptual drawing of the attributes of the Internet, e.g., networks and information resources, and instructional implementation models including six methods of teaching and learning, e.g. inquisitory presentation, expository presentation, generative learning, collaborative instruction, problem-based learning, and anchored instruction. In the middle of the model was a box labeled *Use the Web* that represented the idea of teachers merging the attributes of the Internet and the teaching and learning strategies they use in their classrooms. As our understanding of the use of Internet resources for teaching and learning, practices of applying learning theory in the classroom, teacher-acceptable terminology, and teacher training grew we evolved the graphical representation, descriptions, supporting materials, and training methods. We used our evolving understanding to enhance NASA WELES materials to best support teacher integration of NASA Web resources into science, mathematics, technology, and geography lessons. The final version was dramatically different from the first box-and-line representation. Contemporary teaching methods were added to the top of the model (*Present, Guide, Active learning, Collaborative, Problem-based, and Role-play*). The parts of a lesson (*Frame, Inform, Explore, and Try*) were reflected in the center. The classification of NASA Web resources for enhancing lessons (site elements, organized sites and network elements) was listed on the bottom. The last version also had a very well developed handbook to accompany the lesson planner and reflection tool.

RESEARCH METHODOLOGY

To investigate the effectiveness and impact of the NASA WELES reflection tool and lesson planner, we utilized several levels of evaluation: formative evaluation, short-term and long-term impact studies, and NASA WELES validation. We collected data about teachers' initial perceptions of the various models and tools immediately following the workshop. To assess short-term impact, we tracked teacher use of NASA WELES for an eight-week period following the workshop. Finally, during April 1999, we

surveyed participants who attended workshops from July 1997 through March 1999. Long-term impact, therefore, was defined by length of time from NASA WELES workshop participation to the mailing of the survey. This length of time spanned from one to 21 months: NASA DFRC — 21 months, Keystone Central School District — 13 months, Keppel Union School District—six months, Pennsylvania Series — four months, and Dole Middle School — one month.

Research Questions

Our research questions were divided into two areas: general and specific. In general, we were interested in determining the effectiveness and usefulness of the NASA WELES reflection tool. Specifically, we were interested in patterns of NASA Web resource use by NASA WELES trained K–12 teachers after being exposed to the NASA WELES.

General Research Question: Effectiveness and Usefulness of the NASA WELES Reflection Tool

1. Is the NASA WELES reflection tool comprehensible, relevant, or useful as an organizing tool for teachers to think about incorporating NASA Web materials in their classroom?

Specific Research Questions: Patterns of NASA Web Resource Use by NASA WELES-Trained K–12 Teachers

1. Do teachers use NASA Web resources after being exposed to NASA WELES?
2. Which school subjects do NASA WELES-trained teachers enhance with NASA Web resources and with which teaching methods?
3. Which types of NASA Web resources (e.g. images, interactive events, or scientists) do NASA WELES-trained teachers use?
4. Are there differences in NASA Web resource use between participants who attended the NASA contextualized workshops and those who attended the NASA WELES-specific ones? Specifically, are they different in terms of frequency of Web integration, type of NASA resources integrated, teaching strategies employed, or area of school content selected for NASA Web resource use?
5. What do NASA WELES-trained teachers like best about NASA resources, and what would they change?

Subjects

Included in this study were 164 teachers and administrators who attended the eight NASA-sponsored workshops between July 1997 and March 1999. Each of the 164 attendees was asked to complete the post-workshop evaluation.

Of those 164 teachers and administrators, 87 were asked to complete a followup log of Web use in the classroom. Sixteen teachers submitted logs, representing 17 percent of the population. Either during or after the NASA WELES workshops, these teachers submitted 107 lesson plans.

Of the 135 teachers attending the workshops, 94 supplied e-mail contact information. Three messages were returned as undeliverable. Of the 91 surveys, we received 13 responses, despite repeated requests, representing a 14 percent response rate as shown in table 1.

Table 1. Number of subjects by workshop and type of participation in the study.

Nasa-Funded Workshop	Formative evaluation/ number of attendees	Lesson plan creation		Short-term followup responses	Long-term followup responses
		FE	STF		
1. NEWEST: NASA LaRC—July, 1997	Yes N = 26	Yes		No	No
2. Teacher Ambassador Program: NASA DFRC—July, 1997 *Teacher Ambassador program Credit Course follow-on:—1998 (unfunded <i>extension</i> to TAP)	Yes N = 3 N = 16	Yes		No	No Yes N = 4
3. Keystone Central School District NASA WELES Workshop: Lock Haven Pennsylvania—March, 1998	No N = 17		Yes	Yes N = 8	Yes N = 4
4. Keppel Union School District NASA WELES Workshop: Lancaster, CA—October, 1998	Yes N = 12	No	No	Yes N = 2	Yes N = 0
5. Altoona School District—1: Altoona, Pennsylvania—December, 1998	Yes N = 28		Yes	Yes N = 2	Yes N = 0
6. Lewisburg School District: Lewisburg, Pennsylvania—December, 1998	Yes N = 19		Yes	Yes N = 2	Yes N = 0
7. Altoona School District—2: Altoona, Pennsylvania—December, 1998	Yes N = 18		Yes	Yes N = 2	Yes N = 0
8. Dole Middle School: Honolulu, HI—March, 1999	Yes N = 25		Yes	No	Yes N = 5
Total	164	DFRC = 47 LaRC = 17 PA = 30 HI = 13		16–17%	13–14%

While data were not collected specifically for use in this NASA-funded project, feedback and input from non-NASA-funded events influenced the conceptual evolution of the NASA WELES handbook, reflection tool and lesson planner. This input was provided by 118 Thai participants in an international workshop, plus 93 in-service and pre-service teachers attending five offerings of “Internet in the Classroom,” a distance education graduate class in which NASA WELES were presented. Since 16 of these same teachers also participated in the NASA Dryden workshop, only 77 are included in the total shown in table 2.

Table 2. Number of workshop participants in unfunded sessions.

Unfunded workshops and courses	Number of participants	Comments
4 sections of “Internet in the Classroom” graduate class: PSU — fall 1997; spring, summer, fall 1998; and spring 1999	77	Distance Education Class 37 additional lesson plans submitted
Assumption College, Thonburi Workshops: Thailand, March 1998	118	International Workshop
Subtotal	195	
Grand Total exposed to NASA WELES	359	

Demographics of Teachers

Table 3 presents a descriptive breakdown of the demographics of the 164 participants in the various NASA WELES workshops showing the level of representation by grade level, teaching experience, computer and Web use, subject areas taught, and geographic location. Of those 164 attendees, 154 could be classified definitely as classroom teachers.

As can be seen from this table, there was about equal representation between elementary and middle school teachers, but many more than high school teachers. Subject areas spanned most school subjects from science to the arts. While the different levels of experience were represented, the majority of the teachers had more than eight years in the classroom, with only nine teachers having less than two years experience. The participants came from various geographical areas of the U.S. The researchers intended to mitigate regional biases by attempting to involve as much geographic diversity as possible. Twenty-three states spanning from Hawaii to Maine and Minnesota to Florida were represented in the study.

Table 3. Teacher demographics.

Total number of teachers	<u>Grade level</u>			<u>Teaching experience</u>				Use computers	Use Web for	Subject area	States represented
	K-4	5-8	9-12	< 2 yrs	2 to 5 yrs	5 to 8 yrs	+ 8 yrs	for lessons	lessons	represented	represented
NASA LaRC 26	17	9	0	0	2	3	21	19	1	Science, math, social studies, language arts, art/music, generalist	FL, KY, MA, MD, ME, NC, NY, OH, PA, SC, TN, VA
NASA DFRC 19	7	7	5	0	6	5	8	17	17	Science, math, technology, social studies, generalist	AK, ID, MN, MT, ND, OR, SD, WA, WI
CA Keppel Union School = 12	3	8	0	2	2	1	7	11	8	Science, math, generalist	CA
PA 82 KCS D = 17 Alt1 = 28 Lewisbr = 19 Alt2 = 18	42	27	10	5	10	13	53	48	39	Science, math, technology, social studies, language arts, generalist	PA
HI Dole Middle School = 25	0	11	8	2	4	5	14	24	18	Science, math, social studies, generalist	HI
Total 164	69	62	23	9	24	27	103	119	83		23 states

* Note: Totals do not sum to 164 because some participants did not answer all questions.

Treatments

Eight different in-service workshops were offered to the participants. These workshops can be classified into two major types: NASA Contextualized and NASA WELES-specific workshops.

In the two NASA Contextualized workshops, NASA WELES training was included in an existing NASA workshop, in this case, NASA Education Workshop for Elementary Science Teachers (NEWEST), held at NASA LaRC, and the DFRC Teacher Ambassador Program (TAP). Both of the NASA Contextualized workshops were held in July 1997. In the contextualized workshops, teachers were immersed in NASA science content, during which we added training covering the NASA WELES.

In the six NASA WELES-specific workshops, training was held at school district locations in California, Pennsylvania and Hawaii with no additional NASA science-specific content presented. The primary focus of the WELES-specific workshops held in 1998–99 was to learn about the NASA WELES reflection tool and how to use it to think about integrating NASA Web materials effectively and broadly in the teachers’ classroom curricula. Table 4 presents the characteristics of the eight NASA WELES workshops.

Table 4. Characteristics of the eight NASA WELES Workshops.

Workshop	Type	Length	Time of day/year	NASA WELES version	Compensation	Activities
NASA LaRC	Contextualized	12 hours/ 8 1.5-hr sessions over two-week period	End of day/ summer	1 st	No	Discussion of teaching methodology and lab activities on use of the Internet
NASA DFRC	Contextualized	16 hours/ 2 consecutive days	All-day, summer	2 nd	No	Discussion of teaching methodology and lab activities on use of the Internet
PA: KCSD	NASA WELES-specific	6 hours/ 2 sessions 1 week apart	Evening/ During the school year	4 th	IU credit	Exemplified teaching methods, Internet activities, search strategies
CA: Keppel	NASA WELES-specific	8 hours/ 2 sessions consecutive days	During school day and school year	8 th	Release time by substitute	Case-based learning, 9-step lesson planning, NASA mission sites, Internet activities, search strategies
PA: Alt1	NASA WELES-specific	8 hours 2 4-hr sessions	Evening/ During school year	9 th	\$50 honorarium	Case-based learning, 9-step lesson planning, NASA mission sites, Internet activities, search strategies
PA: Lwsbrg	NASA WELES-specific	6 hours 1 session	Saturday, during school year	9 th	\$50 honorarium	Case-based learning, 9-step lesson planning, NASA mission sites, Internet activities, search strategies
PA: Alt2	NASA WELES-specific	6 hours 1 session	Saturday, during school year	9 th	\$50 honorarium	Case-based learning, 9-step lesson planning, NASA mission sites, Internet activities, search strategies
HI: Dole	NASA WELES-specific	8 hours 2 consecutive days		10 th	No	Case-based learning, stories, analogies, electronic classroom, and bookmarking, embedded Internet activities

Procedures

Participants in the NASA WELES workshops were identified using various means. For the NASA Contextualized workshops, we were invited to add the NASA WELES training to previously

scheduled NASA summer workshops. For the NASA WELES-specific workshops, administrators were contacted in Pennsylvania and California to solicit participation by the school district. Once agreeing to participate, the school district itself publicized the workshop and invited participation. In Hawaii, contacts were made with the Hawaii Space Grant Officer who, in turn, contacted one specific school. We were not involved in the selection of any of the specific teachers other than to request that they had or would have Internet access.

NASA provided the location for offering the contextualized workshops, while the school districts supplied the lab and lecture areas for the NASA WELES-specific workshops. Once the teachers were identified and the location arranged the workshops were scheduled and offered. At the beginning of each workshop, we explained the purpose of our research and the procedures for collecting data, including any expectations for followup. Participants were asked to complete a consent form approved by the PSU Office of Regulatory Compliance.

Selected pre-assessment measurement instruments appropriate to each workshop were administered next, followed by the instruction as described in the previous section. At the conclusion of all but one workshop, participants were asked to complete a post-workshop evaluation instrument to provide us with formative evaluation on both the NASA WELES reflection tool and workshop strategies. In five of the workshops, teachers were given logbooks or weekly journals and instructions on how to keep track of their use of the Web over the subsequent eight weeks. Teachers were asked to send these books or journals weekly to a central office whose staff sent them collectively to us. Receipt of the logbooks and journals were tallied and teachers who did not return their forms were e-mailed or eventually called.

After the March 1998 Keystone Central School District workshop, the teachers were contacted for a taped, face-to-face or telephone interview. Volunteer teachers were interviewed both as a group and individually to gather their thoughts about the NASA WELES reflection tool, the workshop's impact on their teaching with NASA Web resources, and any additional ideas they wanted to share on the NASA WELES materials or approach.

In the eight-month exposure to the NASA WELES in a graduate class following the NASA Dryden workshop, instead of keeping track of their Web use, teachers were asked to create NASA WELES lessons related to the subject's heritage.

In April 1999, a long-term followup survey was sent via e-mail to 91 participants to assess NASA Web resource use.

Lesson Plan Submissions

During the LaRC and DFRC NASA WELES workshops, lesson plans were created by groups of teachers.

The teachers from the DFRC NASA WELES workshop continued to create NASA WELES lessons that integrated science, mathematics, technology, geography and Native American culture during the eight-month distance education class.

Teachers from the Keystone Central School District were not required to complete lesson plans during the eight weeks of logging Web use in their classrooms, however, a few had submitted outlines of lessons with their log books.

The California and remaining Pennsylvania teachers were asked to submit lesson plans as part of their weekly journal.

The Hawaii teachers also created lesson plans during the NASA WELES workshop.

NASA WELES Content Validation Procedures

Acknowledged academic experts who apply theory to practice in the fields of instructional design, technology, technology integration, teaching methodology and K–12 education validated the NASA WELES reflection tool. Experts were identified from the literature based on their expertise in these areas. Each was contacted to enlist their participation. If they agreed, they were sent a validation packet, which included the validation instruments and the approved *use of human subjects* consent form. Once they completed the consent form, these experts were asked to validate the strategies, components, terminology, and overall framework inherent in the NASA WELES reflection tool. Each reviewer was provided with a copy of the NASA WELES graphic representation and the accompanying booklet describing the components and framework for presenting NASA WELES to teachers. They were also given a validation instrument that prompted “yes” and “no” responses to each section of the NASA WELES reflection tool. Reviewers were also asked to comment on the terminology used in the model and how they might modify or otherwise change the model to better represent current classroom pedagogy, components of the Internet, and best practices for integrating pedagogy and Internet technology in teaching and learning practices.

Measurement Instruments and Other Data Sources

Measurement instruments were administered throughout the NASA WELES project to collect data about the teachers who participated in the NASA WELES workshops. Pre-assessment measurement instruments were designed to collect baseline data on the teachers’ attitudes, preferences, classroom practices, and thoughts regarding the integration of Web resources into their existing teaching environments. Measurement instruments were also designed to collect formative feedback on the NASA WELES reflection tool and workshops, specifically assessing the comprehensiveness, relevance, or usefulness of NASA WELES as an organization and reflection tool for teachers and the effectiveness of the workshops in presenting the NASA WELES reflection tool. Finally, instruments were designed to collect data for an eight-week period immediately following the workshop, and in a one-time survey administered in April 1999. The purpose of the short- and long-term followup instruments was to assess teacher use of NASA Web resources after being exposed to NASA WELES.

Pre-assessment Instruments

The pre-assessment instrument included several sections: attitude survey, school readiness assessment, demographic and background information, and a section on teacher use of Web technology in the classroom.

Teachers' attitudes toward a new innovation can be predictive of their choice to use or not use an innovation such as NASA Web resources in their classrooms. The first section of the survey administered to teachers at the beginning of each NASA WELES workshop was a *Teachers' Attitude Toward the Use of Web Resources in Their Classroom* (Koszalka, 1998) instrument. The instrument consisted of several questions focusing on teachers' beliefs, feelings, and intent to use Web resources in their teaching that culminated in an overall attitude score. Cronbach's alpha internal reliability was found to be 0.91.

The second section of the instrument included a series of questions on the teachers' assessment of their schools' readiness to integrate Web resources into their classrooms. The questions were drawn from the items in NASA Technical Publication 1998-206547, *Web-Based Learning and Instruction: Analysis and Needs Assessment* (Grabowski, McCarthy, and Koszalka, 1998).

The next section of the survey solicited demographic and background information on the participating teachers. This included information on their grade level, teaching experiences, subject area, and use of computers and Internet technology for teaching.

Finally, a series of open-ended questions were included that asked teachers about their current technology environment, uses of resources in their classrooms, barriers to using Web resources, and their ideal learning environment.

During the later workshops, beginning in October 1998, a series of worksheets were used to gather data on methods of teaching, use of resources, Internet access, and lesson component strategies. These instruments were developed as informational tools for the NASA WELES handbook as well as a means for collecting this information during the workshop.

Formative Evaluation Instruments

During the workshops the teachers were asked to assess the NASA WELES reflection tool presented and the effectiveness of the workshop. Formative evaluation data were collected on the use of terminology and graphic representation of the tool and lesson planner as well as the presentations and activities used during the workshops and followup session. The formative evaluation instruments were modified as the workshops were enhanced.

Short-term Followup Instruments

Daily teacher logbooks and weekly journals were designed to gather data about how teachers used NASA Web resources in their classrooms following the workshops. The logs were slightly different given the different versions of NASA WELES used with each group of teachers.

The teacher logbooks used by the Pennsylvania teachers from Keystone Central School were composed of both checkboxes and open-ended questions. Teachers were asked to record how many lessons were covered each day, how many lessons incorporated Web resources, and detailed information on any one lesson that used Web resources and one that did not. For each lesson the teacher checked a box indicating the methods of teaching used, location of computers used, who used the Web resources, which types of Web resources were used, how they were used, who developed the lesson, and how successful the lesson was. The open-ended questions asked teachers to describe lesson procedures, key NASA sites visited, and non-Web NASA materials that were used during the lesson. Teachers were also

asked to comment on the successes experienced when using Web resources, the obstacles encountered, and what they would do differently in the lesson. The teachers completed the logs for one practice week and eight additional weeks following the NASA WELES workshop.

The weekly journals used by the California and other Pennsylvania teachers were also composed of both checkboxes and open-ended questions. The checkboxes solicited specific feedback on the frequency of using resources in each of the four components of a lesson, e.g., Frame, Inform, Explore, and Try, the specific types of resources used in the lesson including site elements, network elements, and organized sites; and the methods of teaching. The open-ended questions asked teachers to describe their biggest successes and challenges in the lessons. Teachers were also provided a NASA WELES lesson planner and asked to provide a record of one lesson each week in which they integrated NASA Web resources into their teaching. These teachers were also asked to complete the weekly journals for eight weeks following the NASA WELES workshop.

Group and individual debriefing interview protocols were written to gather final feedback and teacher thoughts on the NASA WELES reflection tool, the workshop's impact on their teaching with NASA Web resources, and any additional ideas teachers wanted to share on the NASA WELES materials or approach.

Long-term Followup Instrument

The long-term followup questionnaire was designed to measure whether exposure to NASA WELES had an effect on teachers' use of NASA Web resources. The questionnaire consisted of six questions. One question was asked to determine if teachers had prior knowledge of NASA resources before participating in the NASA WELES workshop. The remaining questions asked about their use of NASA Web resources, that is, which sites and type, which subject areas, what they liked best about the sites and what they would change about them.

NASA WELES Validation Instrument

The NASA WELES validation instrument was designed to validate the strategies, components, terminology, and overall framework inherent in the NASA WELES reflection tool. It consisted of the NASA WELES graphic representation and an accompanying booklet describing the components and framework for presenting NASA WELES to teachers. The questions prompted "yes" and "no" responses to each section of the NASA WELES reflection tool and comments about the terminology used. A section was included for recommendations for modification or changes to the model to better represent current classroom pedagogy, components of the Internet, and best practices for integrating pedagogy and Internet technology in teaching and learning practices.

Lesson Plan Submissions

Another source of data regarding the use of the NASA WELES as an effective tool to assist teachers in their lesson planning and use of NASA Web resources were the actual lessons teachers wrote during and after the workshops. We felt that a teacher's ability to create NASA Web-enhanced lesson plans was an indicator of the usefulness of the tool. Lesson plans were examined for their use of Web resources to enhance their lessons. The lesson plans that were created during the NASA WELES workshop included objectives, descriptions of overall student tasks, Web preparation and specific sites, descriptions of Web

activities assigned to students and lesson procedures. Each lesson plan incorporated NASA resources and conformed to one of the six methods of teaching.

The lesson plans that were created by the eight-month graduate class following the NASA DFRC workshop included 13 parts. These parts included grade level, lesson title, time required to teach the lesson, subject area links e.g., geography, Native American culture, NASA aeronautics, education standards, lesson purpose and objectives, activity content, preparation and procedures, materials required, followup activities, and NASA Web sites. Teachers also identified the type of teaching method(s) used, additional content required to teach the lesson, information on non-Web NASA resources incorporated into the lessons, and applicable worksheets and diagrams.

Lesson outlines included in the logbooks included lesson titles, objectives, procedures, and links to Web resources.

The lesson plans collected from the weekly journals were written using the NASA WELES lesson planner and included grade level, subject area, teaching strategies, lesson objectives, links to national education standards, information on the NASA mission context, lesson activities by NASA WELES, and NASA Web resources.

Finally, a source of many NASA WELES lesson plans was the group of teachers who participated in the PSU graduate-level distance education using “Internet in the Classroom.” The lesson plans included a lesson title, grade level, subject, objectives, links to educational standards, lesson components and activities, links to Web resources, and additional notes on preparing for or conducting the lesson.

Analysis of the Data

The purpose of the formative, short-term, and long-term evaluation, NASA WELES validation and the lesson plans was to determine whether we had accomplished the goal of designing an effective and useful tool to help K–12 teachers integrate NASA Web resources in their classrooms. Data were analyzed to answer one general research question about the effectiveness and usefulness of the NASA WELES reflection tool and five specific questions about patterns of NASA WELES-trained teacher use of NASA Web resources in their K–12 lessons.

Effectiveness and Usefulness of the NASA WELES Reflection Tool

The general research question was:

1. Is the NASA WELES reflection tool comprehensible, relevant, or useful as an organizing tool for teachers to think about incorporating NASA Web materials in their classroom?

Table 5 relates the general research question to sources of data for analysis.

Table 5. Data sources for the general research question.

General research questions	Formative Evaluation		Short-term followup			Long-term followup		Validation
	End of session	Teacher logbook	Weekly journal	Lesson plans	Interview	E-mail survey	Validation instrument	
Is the NASA WELES reflection tool comprehensible, relevant, useful?	X			X			X	

Patterns of NASA Web Resource Use by NASA WELES-Trained K–12 Teachers

The specific research questions referring to the patterns of NASA Web resource use were:

1. Do teachers use NASA Web resources after being exposed to NASA WELES?
2. Which school subjects do NASA WELES-trained teachers enhance with NASA Web resources and with which teaching methods?
3. Which types of NASA Web resources (e.g. images, interactive events, or scientists) do NASA WELES-trained teachers use?
4. Are there differences in patterns of NASA Web resource use between participants who attended the NASA Contextualized workshops and those that attended the NASA WELES-specific ones? Specifically, are they different in terms of the frequency of Web integration, type of NASA resources integrated, teaching strategies employed, or area of school content selected for NASA Web resource use?
5. What do NASA WELES-trained teachers like best about NASA resources, and what would they change?

Table 6 relates these specific research questions to the sources of data for analysis.

Table 6. Data sources for each specific research question.

Specific research questions	Formative Evaluation	Short term followup				Long term followup	Validation
	End of session	Teacher logbook	Weekly journal	Lesson plans	Interview	E-mail survey	Validation instrument
Do teachers use NASA Web resources after being exposed to NASA WELES?				X	X	X	
Which school subjects/methods do teachers enhance with NASA Web resources?		X	X	X		X	
Which types of NASA Web resources do teachers use?		X	X	X	X	X	
Are there differences between teachers who attended workshops embedded in NASA workshops and those who attend NASA WELES-unique workshops?		X	X	X	X	X	
What do teachers like best about NASA resources and what would they change?					X	X	

FINDINGS

Effectiveness and Usefulness of the NASA WELES Reflection Tool

One general question directed our research. The findings are presented by this general research question.

1. Is the NASA WELES reflection tool comprehensible, relevant, or useful as an organizing tool for teachers to think about incorporating NASA Web materials in their classroom?

During the formative evaluation of our initial version of NASA WELES, called *Use the Web*, teachers were fairly neutral and provided us with essential feedback to make the later versions much

more teacher-friendly. Comments on their ratings focused on the need for more computer training rather than information on teaching strategies, better links to curriculum, and ‘real’ applications and examples for teaching. The strengths of the model were the well-designed plans, organization, and its ability to expose teachers to the features of the Web. When asked about NASA WELES model enhancements teachers generally commented that it needed better graphics, the terms needed better explanations, and the model needed to be better related to teaching curriculums.

The teachers indicated that the strengths of the model were being able to see a visual representation of the different components and how they relate, the classification of different components of the Web, and that the model (reflection tool) demonstrates how teaching and the Web tie together.

Many comments focused on NASA WELES as a useful tool for “opening doors” to the use of the Web, providing additional ways to think about the Web, maximizing effectiveness, and providing a focal point to begin to enhance lessons. Several of the teachers commented that the NASA WELES material helped to make lesson planning more effective and provided many helpful suggestions on how to integrate NASA Web resources into their curriculum.

NASA WELES terminology for Web resources was useful to the teachers. One commented that the categories were helpful in breaking the Web down into manageable parts and several others indicated that the categories were very easy to relate to, and made them more comfortable with the Web. Several had commented that the categories and terminology made Web searching easier and would help them make better use of their planning and teaching time.

Most of the teachers commented that the list of teaching methods was appropriate and well-rounded. Some commented that the list of teaching methods was not new, while others commented that it was a refreshing review and reminder of strategies they had not used in a while.

The teachers thought that the categories used to describe the resources available on the Web could easily be related to and were useful in thinking about Web resources. Several indicated that they liked the categories and now realized the importance of understanding the types of resources available and matching the types of Web resources to the types of activities they plan in their classrooms.

Teachers indicated that the NASA WELES lesson planner was succinct and useful, especially for novice teachers and for helping experienced teachers organize their thoughts about using NASA Web resources in their lessons.

Teacher interview comments indicated that the early version of the NASA WELES reflection tool provided them with Web integration ideas, guidelines that used understandable terminology, references that helped extend their classroom and lesson ideas, and clarifications on methods of teaching with Web resources.

Overall, a majority of the respondents to the validation tool indicated that the NASA WELES categories and model in general are representative. All had agreed that the strategies cited in the model — *Present*, *Guide*, *Role-play*, *Active learning*, *Collaborative*, and *Problem-based learning* — applied to today’s teaching practices. However, two of the reviewers suggested adding assessment, while three of the reviewers suggested adding clarification and further definition of the teaching strategies.

Conclusions

As an overall summary of the findings for the general research question, a majority of the teachers indicated that the language of the early versions of NASA WELES was not quite comprehensible to them without explanation. However, teachers indicated that the terminology and language of the model became more comprehensible and relevant in subsequent versions of the NASA WELES reflection tool as it emerged over time.

Teachers also indicated that from the beginning the NASA WELES reflection tool was useful in helping them to reflect and think about a variety of uses of NASA Web resources to enhance their teaching and learning environments. Many comments throughout the subsequent versions indicated that NASA WELES helped teachers organize their thoughts about the types of Web resources available and their approaches to lesson planning using Web resources.

The experts indicated that the NASA WELES reflection tool was representative of the methods of teaching, Web resources, and learning strategies used in the classroom. They recommended that some of the categories be adjusted to account for emerging pedagogy and Web resources and include further explanations of NASA WELES as the merging of pedagogy and Web resources.

Overall, although there were a few teachers who questioned the relevance of the NASA WELES tools, a majority indicated that they provided a useful and relevant approach to harnessing the vast number of NASA Web resources for specific uses in the many different methods they use for teaching in their classrooms.

Patterns of NASA Web Resource Use by NASA WELES-Trained K–12 Teachers

Five specific research questions directed our research. The findings are presented by these specific research questions.

1. Do teachers use NASA Web Resources after being exposed to NASA WELES?

Forty-five of the 107 lesson plans were selected from the NASA DFRC TAP participants for analysis. The 16 participants who took the follow-on credited course in which they were not required to use NASA resources wrote these lesson plans. Teachers expected to practice the principles from the NASA WELES workshops, including the use of NASA resources, wrote the others. We felt that these 45 lesson plans, therefore, represented the least biased sample of the total lesson plans written. By analyzing these lesson plans, it is evident that these participants were not only aware of the existence of NASA sites, but used them in their lesson plans. Twenty-five, or 56 percent of these lessons submitted, included some NASA sites. One lesson plan was submitted that included NASA materials that were not Web-based.

From the group and individual interviews, it was evident that this sample of teachers increased their use of Web resources in general. One teacher stated, “I tried to use more. The log increased my frequency of Web resource use. It increased the number of assignments I give that require Internet resources.” Two teachers indicated that they felt that use of Web resources was important because it “provides applications and ideas [and takes them] beyond the walls of the classroom to a world of possibilities” and it “increases my terminology and interest.” While NASA sites were not specifically mentioned in these responses, other data sources included NASA sites in the list of Web resources that teachers had used during this study.

In the long-term followup e-mail survey, eight of the 13 teachers responded that they did not know about NASA Web resources prior to attending the NASA WELES workshop. Five responded that they were aware of NASA Web resources; four indicated that they had used NASA Web resources in their classrooms previously. This pattern continues to be consistent with other teachers with whom we have contact.

After being exposed to the NASA WELES, nine teachers indicated that they now used NASA Web sites. One indicated that she was on sabbatical but planned to use NASA resources when she returned to teaching. Only two of the teachers, not on sabbatical, did not use NASA Web sites at all.

Conclusions

Based on the data from all of the sources, we can conclude that teachers increase their use of Web resources in general after being exposed to NASA WELES. Based on specific instances included in the lesson plans and the e-mail survey, teachers exposed to NASA WELES are also more likely to use NASA Web resources in their classroom.

Note: Due to low response rates of the e-mail surveys, conclusions from the data must be considered cautiously. The trends noted for those who responded were encouraging. However, those who do not use technology often may be less likely to respond to such surveys than people who use technology resources regularly. Thus, without data from a larger sample of all those involved the research findings cannot be generalized to the greater population of K–14 educators.

2. Which school subjects do NASA WELES-trained teachers enhance with NASA Web resources and with which teaching methods?

Eight teachers from Keystone Central School District representing 7th grade science, 3rd, 4th, and 10th grade mathematics, and 3rd, 4th, and 6th grade generalists submitted logbook data for a nine-week period. Over these nine weeks, 40 instances of Web use were noted, of which eight specific NASA sites were used.

An examination of the weekly journals for teaching methods revealed that the *Explore* strategy was the NASA WELES strategy used the most, with 41 instances, and *Try* was used the least, with 17 instances. The *Frame* and *Inform* strategies were used a similar number of times, with 32 and 34 instances, respectively.

In addition, the teachers used only five of the six teaching methods. The method teachers most often used was *Active learning*, and not used at all was *Role-play*. *Collaborative learning* and *Problem-based learning*, the two most difficult teaching methodologies, were only used four and three times, respectively.

Examining the lessons submitted by the NASA DFRC, NASA LaRC, Pennsylvania and Hawaii teachers, and additional lesson plans submitted by students in the PSU distance education courses exposed to NASA WELES, it is evident that Web materials in general were incorporated in seven different subject areas. These subject areas listed in the order of most to least number of times they were included: science, mathematics, social studies (culture, history, and social science combined), technology, geography, language arts, and art.

NASA DFRC lesson plans were analyzed for the number of lesson plans that used NASA Web resources. The four content areas with the highest percentage of NASA Web resource use include art, mathematics, technology and science. Overall, 44 percent of the lessons submitted included some NASA Web resource.

From analyzing the lesson plans created, one can note that teachers have incorporated Web resources using a variety of different methods of teaching predominantly while using present strategies and active or generative learning.

Many lessons incorporate Web resources for more than just searching. For example, Web resources are used in half of the lessons to frame activities or excite and motivate students. The Web resources are used to give student specific information and as sources of information for students to develop projects, share ideas and data with others, and manipulate concepts through simulations and tools. Most work on the Web is supplemented with offline activities.

Teachers were asked in a group interview about which new strategies they had tried and would continue to use. Included in the methods that they mentioned were collaboration, expository presentations, and an interest in exploring all the strategies a little more than they had before exposure to the WELES reflection tool.

In an e-mail followup survey, nine teachers indicated that they used NASA Web sites in science classes, two used them in mathematics classes, four in technology classes, two in a geography class, and one in an aviation class. One indicated that she was on sabbatical but planned to use NASA resources when she returned to teaching. Some teachers used NASA resources to teach multiple subjects. Two of the teachers, not on sabbatical, did not use NASA Web sites at all.

Conclusions

The data from the logbooks, weekly journals, lesson plans and e-mail followup survey all indicate that NASA Web resources can be and are used in at least eight content areas: science, mathematics, social studies, technology, geography, language arts and art.

In terms of teaching methods and use of the various NASA WELES, data from the weekly journals and lesson plan analysis, indicate that all four of the NASA WELES strategies, *Frame*, *Inform*, *Explore* and *Try* hold possibility for being taught with NASA Web resources. Methods employed, however, showed a different pattern, with *Active learning* methods being most used with NASA Web resources. *Collaborative* learning and *Problem-based* learning are being used but only minimally. The purpose of the reflection tool is to encourage teachers to consider using a variety of Web resources with a variety of teaching methods, and at the same time reach out to teachers with methods that they are already comfortable with. The data suggest a few adventurous teachers, but also they suggest that more concentrated effort be placed on ways to raise the consciousness level of teachers to the more innovative teaching methods with some of the more innovative Web resources.

Interview data suggest that NASA WELES has the possibility of encouraging new methods of teaching, with 35 percent of those teachers indicating that they are doing something differently.

3. Which types of NASA Web resources (e.g. images, interactive events, or scientists) do NASA WELES-trained teachers use?

By examining the teacher logbook from the Keystone Central School District, two different types of NASA Web resources were noted as being used: images/pictures/information and lesson plans. Five instances were noted for the images and three for lesson plans. These were taken from six specifically noted sites. By examining the weekly journals from the California and remaining Pennsylvania Schools, we noted 19 different types of resources in 276 instances of use over the eight-week period. Information, narratives, still images and animations were selected the most. Network elements were selected only minimally. This is consistent with the fact that teachers used collaborative teaching methods only minimally as well. It must be pointed out, however that it is not evident from the data that we collected if these were specifically NASA sites or sites in general.

When asked in interviews about the types of Web resources that they had used during this study, the teachers responded with 14 types. These included Netscape, lesson plans, lists of resources, plug-ins, simulations, calculators, and databases, lists of other teachers, NASA sites, scholastic news site, mathematics and visual projects, *Ask* sites, and projects. While these responses did not include specific NASA sites, we did not ask for specific sites in this question. Other responses from other instruments noted many NASA sites that were used. It is highly likely, therefore, that many of these noted in the interviews were NASA sites.

In an e-mail followup survey with regard to which NASA sites they were using, most participants provided general descriptions of the sites they have used to teach. These included: nasa.gov, SR-71, weather, space, atmosphere, airplane ground school, airplane construction, geology tracking, JPL, planets, NASA control panel, how machines work, Galileo, Mars Pathfinder and links. Some also indicated that they have used too many to list or many others.

When asked which types of Web resources they were using, ten indicated that they used images, nine used number or picture databases, six used NASA lesson plans, nine used general NASA information sites, and two have communicated with NASA people. Two have been involved with NASA interactive student project sites, one has used NASA tutorials, and no one indicated using any other types of NASA Web resources.

Conclusions

From the data, we can conclude that NASA WELES-trained teachers use a variety of Web resources. At the beginning of the project, fewer numbers of types of Web resources were reported, with many more resources reported later on. A pattern showing little use of network Web elements was consistent even with the final e-mail survey. Weekly journals showed only five instances of network element use, and only two in the final e-mail survey. These results indicate that teachers may again gravitate to those resources with which they are most familiar, and not try out new opportunities to connect their classroom with outside others. They may also reveal a suspected increased level of complexity and probability of technical problems.

4. Are there differences in NASA Web resource use between participants who attended the NASA Contextualized workshops and those that attended the NASA WELES-specific ones? Specifically, are they different in terms of the frequency of Web integration, type of NASA resources integrated, teaching strategies employed, or area of school content selected for NASA Web resource use?

A comparison can be made between the lesson plans from the NASA Contextualized workshop held at NASA DFRC and the Keystone Central School District logbooks, and the weekly journals from the NASA WELES-specific workshops completed by Keppel Union School District and the three other Pennsylvania Schools. Interview data were only collected from the NASA WELES-specific workshop.

From the interview data representing the NASA WELES-specific workshop, 12 types of resources were listed along with two different teaching methods. Three respondents included four specific strategies, while three indicated their use of multiple strategies.

In the e-mail followup survey, the teachers in the contextualized workshops reported using NASA Web resources more frequently and using more types of resources in more topics than those in the WELES-specific workshop. There were also some interesting patterns in the types of resources used. For example, many more teachers from the contextualized workshop were using the information-based resources, e.g. images, animation, and lesson plans rather than people resources, e.g. NASA scientists and experts. As compared to the WELES-specific workshop teachers, these teachers also used a variety of NASA sites as well as other science Web resources. Teachers commented that they have used teacher strategies with these Web resources that they had not regularly used in the past. One teacher who primarily used *Present* strategies stated that she began to use more *Problem-based* learning and *Collaborative* learning methods in her class. Another teacher who was primarily using *Active learning* methods admitted to using more *Present* methods because of the interesting materials on the Web and lack of access for all students.

Conclusions

An important conclusion regarding diffusion of the reflection tool is that the more contextualized the workshop describing NASA WELES is within a specific topic, the more likely the Web will be used to teach that specific topic. If one's goal is to enhance science teaching with NASA resources, our recommendation is to introduce NASA WELES in an existing NASA teacher workshop. If one's goal were to enhance teaching in general without regard to resources, methodology, or school subject, then a more generic workshop would be appropriate. A second very important conclusion, is that followup is important, but not in the form of a listserv. The workshop that extended over the eight-month period of time had a greater impact on teacher use of NASA Web resources, than those who attended a short-term continuous session.

5. What do NASA WELES-trained teachers like best about NASA resources, and what would they change?

When asked about what Web resources in general offered to the teachers in the classroom, teachers noted ten different characteristics. These included enhanced communication, lesson plans, ideas for lessons, alternate research resources, access to other information, updated information, a means for

students to reach beyond the classroom, enriched text, and opportunities to motivate students and make them explorers.

In the e-mail followup survey teachers were asked specifically about NASA Web resources. To this question, teachers gave eight positive responses. They indicated that they thought that the NASA Web resources increased student interest, provided information not easily obtained otherwise, provided beautiful graphics, were interesting, provided cutting-edge information, were vast and informative, contained current science events, and were useful for teaching. One teacher stated that she was able to find information that all of her students (grades 2–6) could understand and that they really enjoyed the interactive sites. One also mentioned that she most liked bringing scientists and experts into the classroom through the NASA Web sites.

Teachers indicated that to improve NASA Web resources, they would like descriptions of specific sites with specific addresses to get to the specific information or that there should be an easily accessible catalog of NASA Web resources.

Conclusions

Teachers like NASA Web resources. They cite motivational, content, quality, currency and usefulness to themselves and their students as their reasoning.

Consistent with what we heard and continue to hear from teachers is that they would like to see an easy means to determine what NASA resources exist and how to access them.

CONCLUSIONS

The results of our three-year effort lead us to conclude that the NASA WELES lesson planner and reflection tool make an important contribution to helping teachers think about Web resources, especially NASA Web resources, and how those resources can be integrated into their classroom teaching.

Conclusions about the WELES Reflection Tool and Lesson Planner

Terminology and Graphic Representation

Working with educators and teachers, as with any member of a profession, requires using the language of that practice. Using text and graphic representation that do not represent “teacher speak” affects teachers’ level of comfort with innovative ideas and new resources. For example, many of the NASA WELES workshop teachers understood the concepts we used when describing the Internet attributes and methods of teaching, however often stumbled with the terminology we used in the earlier versions of the NASA WELES reflection tool and lesson planner. Working with a variety of teachers, from different schools, grades, states, and experience levels helped us develop text and visual representation in the NASA WELES reflection tool and lesson planner that is easily understandable to the largest possible percentage of the nation’s 3.2 million practicing teachers. Thus, the text and graphic representations of NASA WELES are familiar to and can be easily understood by a vast majority of K–14 educators because they helped us craft the language of the tool.

Enhancement Rather Than Replacement of Teaching Practices

Teachers, especially those who have been teaching many years, are masters of their classrooms. They know their classroom environment, teaching preferences, and students. When helping teachers integrate new ideas and strategies into their teaching, such as the work done with NASA WELES, it is important to acknowledge that the methods, strategies, and resources they currently use in their classrooms are appropriate.

Innovations such as NASA WELES are much more successful when presented as a way to help teachers reflect on enhancing their current teaching and learning, not as a replacement for the methods, activities, and resources they currently use in their classrooms.

Seeing the Possibilities, Reflection to Practice

Past research has demonstrated that the possibilities for technology use in the classroom extend far beyond the individualized drill-and-practice and entertainment scenarios of the past. Many teachers still hold to the ideas that the Internet is simply a giant entertainment or search tool, it is dangerous for kids, and it is often an unproductive class resource because of the possibilities for distraction from class work. Helping teachers to see the relationships between the way they teach and the many different types of NASA resources available, including information, interactive events, and human, helps them think about the possibilities for enhancing their teaching and learning environments. Giving teachers an Internet resource to use rather than a framework like NASA WELES is like the old proverb, *giving a hungry man a fish to eat will feed him for a day ... teaching him how to catch fish will feed him for a lifetime*. Reflection tools such as NASA WELES can and do help teachers rethink the possibilities for creating an ideal teaching and learning environment using any of a wide variety of NASA and other Web resources to enhance science, mathematics, technology, and geography lessons.

Operationalizing the integration of NASA resources into their practice through the NASA WELES lesson planner provided teachers a familiar tool, a lesson plan, with which to integrate NASA Web-based resources into lessons that actively involved students with authentic NASA content, activities, and people. This bridge between reflecting on innovations and operationalizing innovations into practice was successfully accomplished using the NASA WELES framework. Thus, exposure to the NASA WELES reflection tool encouraged teachers to think about the possibilities for teaching and learning while the NASA WELES lesson planner aided them in developing new and enhancing existing lessons that did indeed incorporate such resources in their practices. Teachers developed a process for integrating any of thousands of NASA Web resources into their lessons rather than learning how to use just one new resource.

Making the Exotic Familiar and the Familiar Exotic

Shön (1983) warns, “As practice becomes more repetitive and routine, and as knowing-in-practice becomes increasingly tacit and spontaneous, the practitioner may miss important opportunities to think about what he is doing” (p.6). Geyer (1997) found that encouraging teachers to think about lessons, activities, and strategies that worked well in the past helps them adopt new technologies. By using an existing repertoire of successful assignments, projects, and activities from their tool kit, teachers have enough familiarity with old procedures to ensure a successful instructional outcome using new

technologies. Yet, the first step is to encourage teachers to think about successful instruction and how technology can be comfortably integrated into those successful lessons.

Conclusions of the Impact Study

Teachers indicated that the NASA WELES reflection tool, from the beginning, was useful in helping them to reflect and think about a variety of uses of NASA Web resources to enhance their teaching and learning environments. Many comments throughout the subsequent versions indicated that NASA WELES helped teachers organize their thoughts about the types of Web resources available and their approaches to lesson planning using Web resources.

Based on the data from all of the sources, we can conclude that teachers use Web resources in general after being exposed to NASA WELES. Based on specific instances included in the lesson plans and the e-mail survey, teachers exposed to NASA WELES are more likely to use NASA Web resources in their classroom.

The data from the logbooks, weekly journals, lesson plans and e-mail followup survey all indicate that NASA Web resources can be and are used in at least eight content areas: science, mathematics, social studies, technology, geography, language arts and art. Examining the lessons submitted by the NASA DFRC, NASA LaRC, Pennsylvania and Hawaii teachers, and additional lesson plans submitted by students in the PSU distance education courses exposed to NASA WELES, it is evident that Web materials in general were incorporated in seven different subject areas. These subject areas listed in the order of most to least number of times they were included: science, mathematics, social studies (culture, history, and social science combined), technology, geography, language arts, art, and aviation.

From the data, we can conclude that NASA WELES-trained teachers use a variety of Web resources. At the beginning of the project, fewer numbers of types of Web resources were reported, with many more resources reported later on. A pattern showing little use of network Web elements was consistent even with the final e-mail survey. Weekly journals showed only five instances of network use, and only two in the final e-mail survey. These results indicate that teachers may again gravitate to those resources with which they are most familiar, and not try out new opportunities to connect their classroom with outside others.

If one's goal is to enhance science teaching with NASA resources, our recommendation is to introduce NASA WELES in an existing NASA teacher workshop. If one's goal were to enhance teaching in general without regard to resources, methodology, or school subject, then a more generic workshop would be appropriate. A second very important conclusion, is that followup is important, but not in the form of a listserv. The workshop that extended over the eight-month period of time had a greater impact on teacher use of NASA Web resources, than those who attended a short term continuous session.

Next, teachers like NASA Web resources. They cite motivational, content, quality, currency and usefulness to themselves and their students as their reasoning.

Finally, and consistent with what we heard and continue to hear from teachers is that they would like to see an easy means to determine what NASA resources exist and how to access them.

In conclusion, NASA WELES helps teachers think about what they currently do well, what they are trying to do, how they plan to teach, what resources are available for teaching and learning, and how these resources can be effectively incorporated into lessons. More importantly, this encompassing framework provides teachers with prompts to think about the ultimate possibilities for teaching and learning, vast numbers and types of resources available, and endless number of ways to combine methods of teaching and NASA Web resources to make instruction exciting, motivational, and relevant to students. Teachers are prompted to think about integrating new and different types of resources into their familiar practices while considering how to enhance their existing practices whether they are in the form of projecting pictures from the Internet, encouraging student exploration of a site, or collaborating with NASA scientists.

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PRESENTATIONS AND PUBLICATIONS

Over the course of the three years of funding, the PSU/NASA staff presented at conferences, published documents and papers, and conducted workshops and courses about NASA WELES. Eighteen professional presentations were made at local, national, and international organizations. The project produced 22 publications, including two NASA published documents, eight project-specific documents, two Conference Proceedings, one refereed journal article, and six project research reports. Eight NASA contract-funded workshops and seven non-NASA-contracted graduate classes, and one conference were held during which NASA WELES was taught. Finally, non-project writers highlighted the NASA work at PSU by publishing four other articles.

PROFESSIONAL PRESENTATIONS

Date	Type	Conference	Title	
Feb-98	Presentation	AECT/St. Louis	Using effective Web-based materials in the classroom	Grabowski, Koszalka, and McCarthy
Feb-98	Presentation	AECT/St. Louis	Through the ID-PRISM: Reflecting on instructional design for electronic classrooms	Grabowski, McCarthy, Koszalka, and Hernandez
Mar-98	Presentation	Thailand	World WideWeb-Enhanced Learning: An Exciting and a Challenging Way of Instruction	Grabowski
Apr-98	Presentation	Penn State Univ.	Web-Enhanced Learning Environment Strategies: The WELES applied to Microscopy!	Grabowski
Apr-98	Presentation	Penn State Univ.	Web-Enhanced Learning Environment Strategies: More Than Just Web-Page Development	Grabowski
Jun-98	Presentation	LTP	Web-Enhanced Learning Environment Strategies *WELES* update	McCarthy, Grabowski, and Koszalka
Jul-98	Presentation	INET/ Geneva, Switzerland	Web-Based Instruction and Learning: Analysis and Needs Assessment Summary	McCarthy, Grabowski, and Koszalka
Jul-98	Presentation	INET/ Geneva, Switzerland	Web-Enhanced Learning Environment Strategies for Classroom Teachers	Grabowski, Koszalka, and McCarthy
Aug-98	Presentation	Syracuse Univ.	Entering the New Millennium doing "WELES!"	Grabowski
Feb-99	Presentation	AECT/Houston	Guidelines for sharing lesson plans over the Web	Moore, Koszalka, and Breman
Feb-99	Presentation	AECT/Houston	Web-Based Instruction and Learning: Analysis and Needs Assessment	McCarthy, Grabowski, and Koszalka
Feb-99	Presentation	CoSN/ Washington D.C.	ID-PRISM: Reflecting on the Electronic Classroom	Koszalka, Grabowski, and McCarthy
Feb-99	Presentation	CoSN/ Washington D.C.	Web-based Instruction & Learning: Analysis and Needs Assessment	McCarthy, Grabowski, and Koszalka
Feb-99	Presentation	CoSN/ Washington D.C.	Web-Enhanced Learning Environment Strategies: Integrating Web resources into your classroom	Grabowski, Koszalka, and McCarthy
May-99	Presentation	LTP	Research Findings of the NASA Dryden Flight Research Center Learning Technologies Project	McCarthy and Grabowski
Nov-99	Presentation	P-AECT/ Harrisburg, PA	What do the kids think? A study of resource use in middle school classrooms	Koszalka
Feb-00	Presentation	AECT/ Long Beach, CA	Web-Enhanced Learning Environment Strategies: Integrating NASA Web resources into science instruction	Koszalka, Grabowski, and McCarthy
Feb-00	Presentation	AECT/ Long Beach, CA	The Validation of a Measurement Instrument: Teachers' Attitudes Towards The Use of Web Resources in the Classroom, Across Two Cultures	Koszalka, Prichavudhi, and Grabowski

AECT = Association of Educational Communication Technology; CoSN = Consortium of School Networking;
 IADIS = International Association for the Development of Information Society; INET = Internet Society;
 LTP = NASA Learning Technologies Project; P-AECT = Pennsylvania AECT

PROFESSIONAL PRESENTATIONS, CONTINUED

Published Refereed Conference Proceedings				
Date	Type	Conference	Title	
2000	2000 Conference Proceedings	AECT (Sponsored by Research and Theory)	Web-Enhanced Learning Environment Strategies: Integrating NASA Web Resources into Science Instruction	Koszalka, T., Grabowski, B., and McCarthy, M.
2001	2000 Denver Conference Proceedings– Research and Theory edition	AECT	The Relationship between the Types of Resources Used in Science Classrooms and Middle School Student' Interest in Science Careers: An Exploratory Analysis	Koszalka, T.
2002	2001 Atlanta Conference Proceedings– Research and Theory edition, vol. 2, pp. 338–334	AECT	Kids As Airborne Mission Scientists (KaAMS): Designing Problem-Based Learning To Inspire Kids	Koszalka, T., Kim, Y., and Grabowski, B.
2002	2001 Atlanta Conference Proceedings– Research and Theory edition, vol. 1, pp. 173–177	AECT	Integrating Assessment and Research Strategies On a Large Development and Research Project: Kids As Airborne Mission Scientists (KaAMS)	Koszalka, T. and Grabowski, B.
2002	2002 Lisbon, Portugal Conference Proceedings	IADIS International Conference WWW/ Internet 2002	Helping educators harvest internet resources: The development of technology integration support tools	Grabowski, B. and Koszalka, T.
2002	2002 Conference Proceedings, pp. 2117–2121	Society for Information Technology and Teacher Education	Relationships between the use of web resources and student interests in science: Support for technology integration decision-making	Koszalka, T.

AECT = Association of Educational Communication Technology; CoSN = Consortium of School Networking;
IADIS = International Association for the Development of Information Society; INET = Internet Society;
LTP = NASA Learning Technologies Project; P-AECT = Pennsylvania AECT

WORKSHOPS

Date	Type	Location	Title	Facilitators
Mar-97		NASA	What Works and What Doesn't: NASA; Dryden Cooperative Agreement Development Teams	Grabowski, McCarthy, Hernandez, and Koszalka
Jul-97	Workshop	Langley NEWEST	Web Enhanced Learning Environment Strategies	Grabowski and Koszalka
Aug-97	Workshop	Dryden Teacher Ambassadors	Web Enhanced Learning Environment Strategies	Grabowski and Koszalka
Aug-97	Graduate class	Penn State Univ.	Internet in the Classroom	Peck
Mar-98	Workshop	Keystone Central School, PA	Web Enhanced Learning Environment Strategies	Grabowski and Koszalka
Mar-98	Graduate class	Penn State Univ.	Designing WELES for Science, Mathematics, and Technology Educators of Native Americans	Koszalka
Mar-98	Workshop	Thailand	Web Enhanced Learning Environment Strategies	Grabowski
Jun-98	Graduate class	Penn State Univ.	Internet in the Classroom	Grabowski
Aug-98	Graduate class	Penn State Univ.	Internet in the Classroom	Grabowski
Oct-98	Workshop	Keppel, CA	Web Enhanced Learning Environment Strategies	Grabowski
Nov-98	Workshop	Altoona, PA	Web Enhanced Learning Environment	Grabowski and Koszalka
Dec-98	Workshop	Lewisburg, PA	Web Enhanced Learning Environment Strategies	Grabowski and Koszalka
Dec-98	Workshop	Altoona, PA	Web Enhanced Learning Environment Strategies	Grabowski and Koszalka
Jan-99	Graduate class	Penn State Univ.	Internet in the Classroom	Grabowski
Mar-99	Workshop	Dole Middle School, HI	Integrating Web Resources into your Classroom using – WELES	Grabowski and Koszalka
Jul-99	Workshop	Blacklick Valley, PA	Web Enhanced Learning Environment Strategies	Koszalka
Sep-99	Graduate class	Penn State Univ.	Internet in the Classroom	Koszalka
Jan-00	Graduate class	Penn State Univ.	Internet in the Classroom	Koszalka

PROJECT PUBLICATIONS

Year	Type	Title	Authorship
1997		The world wide web as a medium of instruction: What works and what doesn't	McCarthy, Grabowski, Hernandez, Koszalka, and Duke
1997		Web Enhanced Learning Environment Strategies	Grabowski, Koszalka, and McCarthy
1997	Teaching Guide, versions 1–2	WELES teaching guide	Grabowski, Koszalka, and McCarthy
1997 fa	Penn State INSYS Program Newsletter	PSU and NASA Dryden Join Forces	Koszalka
1998 fa	Penn State INSYS Program Newsletter	WELES showcased at International Conference	Koszalka
1998 sp	Penn State INSYS Program Newsletter	PSU & NASA Dryden Flight Research Center: Research with Local Teachers	Koszalka
1998	Handbook, versions 4–8	Web Enhanced Learning Environment Strategies Handbooks and Reflection Tool	Grabowski, Koszalka, and McCarthy
1998	Lesson Planner, version 1	Web Enhanced Learning Environment Strategies Lesson Planner	Grabowski, Koszalka, and McCarthy
1998	Teaching Guide, versions 3–4	WELES teaching guide	Grabowski, Koszalka, and McCarthy
1998	NASA TP 1998 206547	Web-based Instruction and Learning: Analysis and Needs Assessment	McCarthy and Grabowski
1998	INET Conference Proceedings	Web-based Instruction and Learning: Analysis and Needs Assessment	McCarthy, Grabowski, and Koszalka
1998	INET Conference Proceedings	Web-Enhanced Learning Environment Strategies for Classroom Teachers	Grabowski, Koszalka, and McCarthy
1999	Handbook, versions 9–11	Web Enhanced Learning Environment Strategies Handbooks and Reflection Tool	Grabowski, Koszalka, and McCarthy
1999	Lesson Planner, version 2	Web Enhanced Learning Environment Strategies Lesson Planner	Grabowski, Koszalka, and McCarthy
1999	Teaching Guide, versions 5–7	WELES teaching guide	Grabowski, Koszalka, and McCarthy
1999	Journal of Educational and Information Technologies	Sharing lesson Plans Over the World Wide Web: Important Components	Koszalka, Breman, and Moore
1999	Research Report	WELES Workshop Summary: Dole Middle School — March 1999	Koszalka, Grabowski, and McCarthy
1999	Research Report	WELES Workshop Summary: Lancaster CA, Altoona PA, Lewisburg PA — Oct.–Dec. 1998	Grabowski, Koszalka, and McCarthy
1999	Research Report	WELES Workshop Summary: Keystone Central School District — March 1998	Koszalka, Grabowski, and McCarthy
1999	Research Report	WELES Workshop Summary: Dryden	Grabowski, Koszalka, and McCarthy
1999	Research Report	WELES Workshop Summary: Langley	Grabowski, Koszalka, and McCarthy
1999	Research Report	Change History and Teacher Exposure to WELES Report	Grabowski, Koszalka, and McCarthy

PROJECT PUBLICATIONS, CONTINUED

(Published Refereed Journal Publications)			
Year	Type	Title	Authorship
2002	American Educational Research Association, New Orleans, LA. ERIC #IR021174	Designing problem-based learning lesson plan structures for middle school teachers: Using NASA missions to inspire Kids as Airborne Mission Scientists (KaAMS)	Koszalka, T., Grabowski, B., and Kim, Y.
2002	American Educational Research Association, New Orleans, LA. ERIC #IR021176	Predictive relationships among science classroom resources and middle school student interest in science careers: An exploratory analysis	Koszalka, T.
2003	<i>Evaluation in Program Planning: Special Issue: Evaluation of Educational Technology: International Perspectives</i> , 26(2), 203–213.	Combining Assessment and Research Strategies On Large Educational Technology Development Projects: Possibilities Exemplified through Kids as Airborne Mission Scientists (KaAMS)	Koszalka, T. and Grabowski, B.
2003	<i>Journal of Technology and Teacher Education</i> , 11(3), 349–378.	Reflection Through the IDPRISM: A Teacher Planning Tool to Transform Classrooms into Web-Enhanced Learning Environments	Koszalka, T., Grabowski, B., and McCarthy, M.

PUBLICATIONS BY OTHERS ABOUT THE WELES PROJECT

Year	Type	Title	Authorship
Apr-97	The Dryden NASA X-Press	Conference looks at Web and Education	McMacken
Nov-97	Focal Points: PSU College of Education Newsletter	NASA and the College of Education: A Break-through Partnership	Blaum
Nov-97	NASA DFRC News Release 97-47	Penn State, NASA form Hi-Tech education partnership	NASA Public Affairs Office
Dec-97	Centre Daily Times Newspaper	The Internet is here to stay: Penn State Insys teacher sees huge opportunities in 'net resources	Cheng

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