Evaluation of the Shuttle/Mir Online Research Experience (S/MORE) Interactive Project

Jeanne Gasiorowski, Steven McGee, Bruce Rosen

NASA Classroom of the Future

Wheeling Jesuit University

316 Washington Avenues

Wheeling, WV 26003

Marc Siegel

NASA Ames Research Center

Mail Stop T-28H

Moffet Field, CA 94035

Abstract

The NASA Classroom of the Future conducted an evaluation of the Shuttle/Mir Online Research Experience (S/MORE). Through its Web site and email, S/MORE provides a behind-the-scenes look at life sciences research being conducted aboard the Mir station. For six months between August 1996 and January 1997, Web-based lessons, images, background information, and email messages were examined. A profile of the average educator-user was compiled through a collection of questionnaires and personal interviews. A composite picture of S/MORE users showed a white, 45-year-old female teacher with 15 years experience and above average computer skills teaching in a US public, suburban, middle school science class with access to fewer than 3 computers and modem access to the World Wide Web. Recommendations following the study include: defining the target audience, taking existing technology into consideration, keeping a Web site active for a long period of time, and increasing minority representation.

Evaluation of the Shuttle/Mir Online Research Experience (S/MORE) Interactive Project

Introduction

The NASA Classroom of the Future (COTF) conducted an evaluation of the Shuttle Mir Online Research Experience (S/MORE). S/MORE is supported by NASA's Life Science Division through its Space Life Sciences Outreach Program, the Information Infrastructure Technology and Applications Program (IITA) of NASA's Office of High Performance Computing and Communications, and by NASA Ames Research Center.

> S/MORE is a K-12 project providing a behind-the-scenes look at the life sciences research conducted in space aboard the Mir station. S/MORE focuses on the men and women doing and supporting this research. The goal is to encourage student interest in science and technology careers by portraying the NASA experts as friendly people through biographies and field journals of day-to-day activities. Students are encouraged to interact with these enthusiastic folks as a way to further engage them in the process of cutting edge research. In addition, a special activity highlights the cross-cultural nature of this US/Russian effort. (NASA, 1996)

The goal of S/MORE fits nicely into the growing use of computers and the Internet in classrooms today. Computers have become commonplace in U.S. schools. In 1994 the National Council of Teachers of Mathematics (NCTM) reported on a survey released by the International Association for the Evaluation of Education Achievement (IEA). For U.S. schools, the survey showed that

- 99% of all elementary and secondary schools have installed computers, and
- 85% of all students use computers at some time in their program. The typical U.S. high school has one computer for every 10 students; the typical elementary and middle school has one computer for every 15 students (NCTM, 1994).

Along with the increase in the number of computers available, there has been an enormous increase in Internet use in the classroom. A survey by the National Center for Education Statistics reported that, as of the fall of 1995:

- 50% of public schools had Internet access, up from 35% as of the fall of 1994, and
- although only 9% of instructional classrooms were on the Internet, this represented a three-fold increase compared to the fall of 1994, when only 3% of classrooms had access to the Internet (National Center for Education Statistics, 1995).

There has been a proliferation of sites on the World Wide Web. For example, in December 1996

the Lycos search engine reported 14,137 "relevant documents" when using *science* as a keyword and 6,001 "relevant documents" when using the word *mathematics*. Of course, not all of these sites would be appropriate for use in K-12 classrooms, but the numbers do give an indication of the volume of material currently available.

In addition to S/MORE, the NASA K-12 Internet Initiative has developed similar projects under the umbrella title "Sharing NASA." These include "Live from Mars," "Women of NASA," "Live from the Hubble Space Telescope," and "Online from Jupiter." All make use of online opportunities, and many are supplemented with television broadcasts and/or print materials. The home page for this initiative extols the benefits of online communication:

> The Internet is more than a library, a TV, or a pathway to passive information. One of its most exciting uses is as a tool of collaboration. It allows teachers and students to work together to design inquiries and explore challenges. Online are opportunities to meet and work with scientists, writers, engineers, and other professionals. For students, this helps to break down the artificial barriers between the school, the wider community, and the world of work. For teachers, it opens new paths to both professional development and school reform and restructuring (NASA, 1997).

S/MORE Project Components

Mail List

The S/MORE mail list was established in late spring 1996. Mail lists provide subscribers with periodic email messages. The number of subscribers to a list changes daily as users subscribe and unsubscribe. Although mail lists can be interactive, this one was designed to serve as a source of information and did not allow interactive user participation.

Twelve "Updates" were sent to S/MORE mail list subscribers between August 23, 1996, and January 10, 1997 (1 in August; 2 each in September, October, and December; 4 in November; and 1 in January). These contained general project information along with other topics of interest. All twelve Updates are archived on the Web site.

Web Site

The S/MORE Web site was released in late August 1996. The site’s home page described the project and contained links to such areas as Teacher’s Resources, Student Activities, and Photo Gallery. Usage was tracked between September 23, 1996, and January 30, 1997. During that period, counting software recorded over 28,000 "hits."

The S/MORE Web site consisted of 8 major subdivisions plus an area called "Featured Events" and several miscellaneous buttons which were minor to the intent of the project. Teachers were surveyed and asked to evaluate each section.

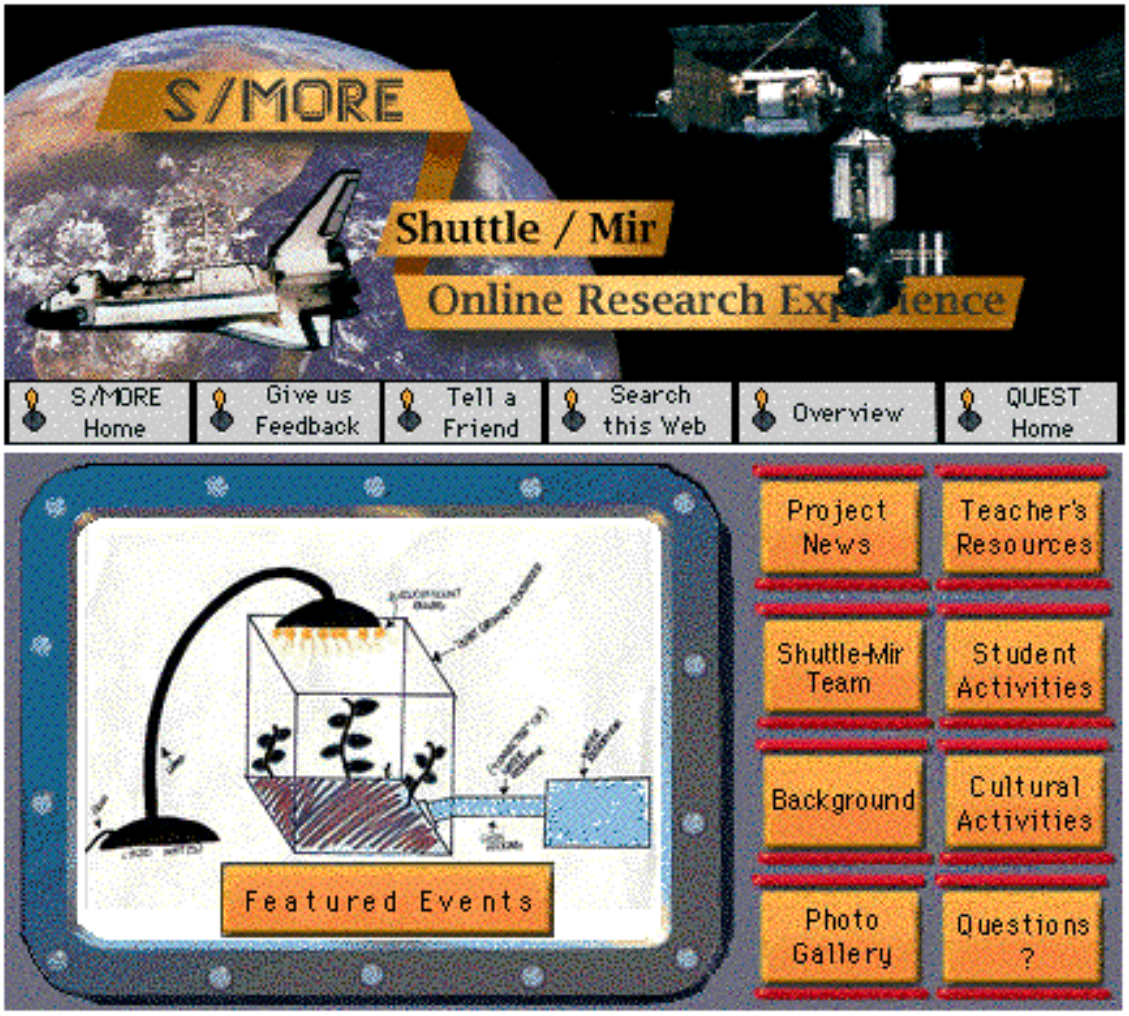

Figure 1: S/MORE Home Page

Project News consisted of a brief welcoming message, a scrollable message of short project updates, a link to the main Update archive, and a link to S/MORE related topics in the news. In general this page received a high rating, although one teacher reported that it was not updated often enough and another stated that NASA TV schedules were not posted clearly.

Teacher's Resource Center contained links to three types of classroom activities (The Great Plant Debate, Life Sciences, and Microgravity), to a glossary of terms, to a teacher discussion group, to Web chat information, to a sign up button enabling teachers to be placed on the Updates mailing list, and to a request for teachers to volunteer in the evaluation of S/MORE. This page had the highest number of hits of any of the individual pages. Several teachers reported using only portions of the materials; one high school teacher stated that some of the

activities needed modification before they could be used.

Shuttle-Mir Team provided links to biographies and journal entries from members of the team (five U.S. astronauts and eleven Russian cosmonauts who have flown on board the Mir Space Station, nine scientists and researchers, eleven experiment planners and coordinators, two engineers, a crew trainer, four student interns, and the daughter of an astronaut). There was a balanced representation of gender in this section, with 44% female and 56% male. Nineteen featured people included pictures with their biographies. A high percentage of those, 74%, were white. Several teachers praised the biographical information and journal entries. An elementary teacher stated, "This made it real to my class;" a high school teacher remarked, "Career bios are gold to us high school teachers;" and a middle school teacher reported that this page inspired students to begin writing their own daily journals.

The **Student Activities** button was linked to "Student Stumpers" in which students made riddles for others to solve, to "Science Fair" in which students submitted their ideas of good science fair projects relating to S/MORE, and to examples of student work and writing. Some elementary teachers felt that this was a bit too advanced for their students.

Background contained links to descriptions of the Mir and international cooperation in space, to additional information about life sciences and microgravity, to the glossary, and to other related Web sites. This location received high praise from teachers of all levels of students.

Cultural Activities encouraged students to establish "key-pals" with Russian students. Specific discussion topics were suggested, along with sample conversations, holiday greetings, and links to other cultural Web sites. Some teachers found this location quite valuable and reported that their students have continued their communication with "key-pals" beyond the project itself. However, the amount of Russian participation was very limited, probably due to the necessity of speaking English and to the fact that few Russian schools have Internet capability. One Russian school was very active and, despite the language difference, participated in nearly every facet of the project.

The **Photo Gallery** offered numerous links to internal and external images of the Shuttle and Mir and to Shuttle-Mir biology research on board. This location received the highest teacher rating of all the sections and was praised by teachers at all levels. Teachers noted that the images encouraged student interest in the project and that most of these images would have been difficult or impossible to obtain otherwise.

The **Questions** button contained information on how to email questions to the Shuttle-Mir team. An archive of past questions was available, along with tips for asking good questions. This location received the fewest hits, and the developers expressed disappointment in the lack of activity.

In addition to the eight main buttons, the home page contained a link to **Featured Activities**. The purpose of this area was to highlight different parts of the project such as the Great Plant Debate; Web chats; and reminders of upcoming cultural activities, Student Stumpers, and Science Fair

activities. Teachers were not asked to rate this as a specific section since the contents were included in other ratings.

Online Chats

Three types of online chats were held. Five chats with NASA experts were offered beginning at 10 a.m. Pacific time (1 p.m. Eastern) between the dates of November 13, 1996, and December 18, 1996. Participating scientists were John James (Chief Toxicologist at Johnson Space Center), Tana Hoban-Higgins (Principal Investigator, University of California in Davis), Karen Borski (Space Science Support Engineer at Johnson Space Center), Frank Salisbury (Principal Investigator on Project Greenhouse at Utah State University), and Cecilia Wigley (Safety, Reliability, and Quality Assurance Lead, NASA Ames Research Center). The chats represented a good gender mix (3 females and 2 males). Only two of these experts were pictured in the Photo Gallery, and they were both white.

There were also 6 weekly chats for home schoolers beginning at 11 a.m. Pacific time (2 p.m. Eastern) between the dates of October 23, 1996, and January 8, 1997. These forums were hosted by home schooler Gayle Remisch from London, Ontario, Canada. An additional chat was held for Net Day on October 12, 1996. Archives of the chats were placed on the Web site.

Context of the Study

The study of S/MORE addressed the following questions:

- Who used the project?
- Was the material used directly by students or was it relayed to them by the teacher?
- Did the project provide a worthwhile experience ?
- Were the Web pages and mail list messages interesting and at an appropriate reading level?
- Were online chats frequent enough and useful enough to help in maintaining interest?
- Was there increased student interest in science and technology after using the S/MORE materials?
- Did the project help students and teachers develop a better understanding of real-world issues which are part of a modern research effort?
- How was S/MORE content incorporated into the curriculum?

- How did teachers use the various project parts? For example, were the parts used separately or in conjunction with other project pieces?
- How did students view the project?
- What could be done to make this and future projects more useful?

Methods

Five sources of information were used to address these questions--mail list data, Web site data, voluntary registration, an email questionnaire, and student interviews.

Data on the number of subscribers to the mail list were collected over a period of nineteen weeks from September 1996 through January 1997. Counts were grouped by month. Duplicate addresses were deleted before counts were tallied.

Hit counts were noted for each of the Web site subdivisions across the time period beginning September 23, 1996, and ending January 30, 1997. A total of 286 individual location addresses were available on the S/MORE Web site. These were categorized, according to their URLs (Universal Resource Locators or addresses), and pages at deeper levels were counted for the top level. For example, all pages accessed through Teacher's Resources were added to the Teacher's Resources count. Log files were collected by the S/MORE Web server, and the server administrator moved the log files to the Ames ftp site, from which they were downloaded by the COTF.

On a voluntary basis, subscribers to the mail list and users of the Web site were asked to complete a simple registration form that requested basic demographic information such as name; geographical location; and whether the registrant was a teacher, a student, or "other."

From those completing the voluntary registration, K-12 teachers were identified and asked, via email, to respond to a more detailed questionnaire. Of the 105 K-12 teachers who registered, 79 were sent the questionnaire. (The remaining K-12 registrants had faulty email addresses, making it impossible to communicate with them using this method.) Forty-eight teachers responded (61% of those who were sent questionnaires), either by email or by regular mail. The questionnaire asked for input and comments in a variety of areas, including more detailed teacher demographics.

For several items on the questionnaire, teachers were asked to rate the quality of the project on a 5-point Likert scale. Respondents were not required to rate items they didn't use. Teachers were also asked to rate each of the 8 main sections of the Web site using a similar 5-point Likert scale. Other questions requested open-ended responses. The questionnaire is included in its entirety in Appendix A.

And finally, a group of six seventh-grade students from Warwood Middle School in Wheeling, West Virginia were interviewed. The group consisted of 2 girls and 4 boys, who volunteered to

be a part of this study and used the Web site for several weeks. They accessed the Web site using Netscape Navigator on IBM machines in their home room and in their school's media center. Working in pairs, they spent 30-40 minutes daily using S/MORE. They did not subscribe to the mail list and did not participate in any of the online chats.

Results

Mail list data showed that 485 people, on an overall average, subscribed to the S/MORE list. Subscription numbers varied from month to month, with the fewest number of subscribers in the initial month of August (average 304) and the most subscribers during the month of November (average 563). Graphical representations of these and other statistics are located in Appendix C.

November was an active month for NASA in general with the launch of the Mars Pathfinder mission and shuttle mission STS-80. Neither of these events had any direct relationship to the Mir Space Station or to the S/MORE project, however it can be assumed that high media coverage of any NASA activity is likely to cause added interest in NASA education sites.

Web site hit counts showed a total of 28,585 successful hits, with the home page receiving the largest percentage of these. A high percentage of hits on the home page is not surprising since most users would enter a site through its home page. Other counts are shown in Table 1 .

A more detailed look at Web usage was taken for a random day, November 14, 1996. On that date the S/MORE site was accessed by 91 different IP (Internet Protocol) addresses. This would indicate that at least 91 individuals accessed the site. (The number may be larger since several people, in a school computer lab for example, may have the same IP address.) One hundred separate user sessions were counted for that date.

Who used the project?

A composite picture of S/MORE users showed a white, 45-year-old female teacher with 15 years experience and above-average computer skills teaching in a U.S. public, suburban, middle school science class with access to fewer than 3 IBM (or IBM compatible) computers and a modem connection to the World Wide Web.

Voluntary registrations provided part of the data used to arrive at this composite. A total of 204 users registered. Of those, 51% were teachers, 16% were students, and 32% marked the "other" category.

Of the 105 teachers who registered, 30% taught at the elementary level, 43% at the middle school level, 17% at the high school level, and 10% at college or university level.

Additional data were considered for the 95 K-12 teachers who registered. The majority (78%) taught in public school settings, with 9% in private schools, 7% in parochial schools, 4% in home schools, and 1 in a university lab school. About 50% of the K-12 teachers registering reported being in suburban areas, with the remainder about evenly split between urban and rural.

About 53% taught science, 17% taught all subjects, and 9% taught math. Other subjects taught included history, computer or technology courses, and library or resource offerings.

The vast majority (89%) of the K-12 teachers registering were from the United States. Canada, Australia, Switzerland, England, and Russia were also represented. Thirty-one states were represented with California reporting the most users (10) followed by Texas (8), and Ohio (7). Other states had 4 or fewer K-12 teacher registrants. [Note: If "student" and "other" users had been counted, 6 more states and 10 more countries would have been represented.]

Additional data were gathered from the 48 teachers who responded to the email questionnaire. Those teachers as a whole appeared to be a mature, experienced group. The average age was 45; the average length of teaching experience was over 15 years. Of the 47 who answered the computer experience question, 23% considered themselves to be "advanced," 62% considered themselves to be "above average," and 15% believed they were "average" in the area of computer experience. None considered themselves as having "below average" or "beginner" experience. This high level of computer experience was not an unexpected result since the entire project was computer-based, and novices would not likely have been involved.

All but one of the teachers responding were Caucasian; 71% were female; 29% were male. One male African American responded. Teachers were asked to indicate the gender and ethnic breakdown of their students. Among student users, gender was evenly divided. White non-Hispanic students made up 69% of those reportedly using S/MORE. The 31% minority breakdown included 16% African American, 12% Hispanic, and 2% other minorities.

Hardware availability was split, with 52% using IBM or IBM compatibles only, 35% using Macintosh computers only, and 13% using both platforms. Netscape Navigator was the browser software of choice of the vast majority who accessed the Web site. It was used by 90% of the respondents. A large percentage of the respondents (69%) relied solely on modem connections.

Forty-six respondents answered the question about the number of computers available to them. The average was 2.48 with only one teacher reporting a lab of 20 computers. Some respondents, 25%, had access to only single computers at their schools; another 12.5% relied solely on home computers. Most of the teachers (88%) accessed the Web site; 67% of those also subscribed to the mail list.

When asked how they found out about S/MORE, about 26% of the respondents used a listing of sites; another 28% found out about S/MORE while surfing the Web. Other methods included word of mouth and class assignments. Unlike other NASA online projects, S/MORE had no television component; therefore, none of the teachers learned about S/MORE through that medium.

A fairly large percentage of the users of the Web site (32%) were not directly involved in education. These users included scientists, engineers, amateur astronomers, and scout leaders.

Was the material used directly by students, or was it relayed to them by the

teacher?

Only 35% of the responding teachers reported that the students themselves were using the Web site or the mail list messages. Most of the teachers (83%) reported that they accessed S/MORE information for the purpose of passing it along to their students, although 40% of those reported that their students also accessed the materials directly. Many of those passing materials along to their students were elementary teachers who felt a need to assist their students; others had limited computer/Internet access at their schools and therefore had to access the information at teacher terminals or at home and then relay the information to their students. A few teachers remarked that even though computers were available in their classrooms, their school and/or district did not allow students to access the Internet.

The small percentage of students who used the Web site or mail list directly was an area of concern. This percentage will undoubtedly increase as additional computer accessibility is possible and after "acceptable use" questions have been addressed to the satisfaction of parents and administrators.

Did the project provide a worthwhile experience?

The most highly ranked item of the questionnaire was the statement*: S/MORE was a worthwhile experience for my students.* The average score was 4.41. This would indicate that the project was indeed worthwhile. Teachers whose students had direct access to S/MORE rated the experience as more worthwhile (4.69) than teachers who only used the site themselves, either for their own background or to pass the information on to their students (4.17) ($F(1,33)=6.16$, $p<.05$)). This held true regardless of grade level.

Comments from three teachers whose students accessed the materials directly included the following:

- "I think the project helped my students see that what they are doing in class is relevant to what happens in the real world." (high school teacher)
- "Any connection to the real thing beats just reading from a dated book. The anticipation of a regular message also increases student interest." (middle school teacher)
- "This has been the most talked about project I have ever done. The kids even tell their parents about it." (elementary teacher)

Were Web pages and mail list messages interesting and at an appropriate reading level?

Two questionnaire items dealt with the interest and reading levels of the Web site. Mean score for the item *The content of the Web site was interesting to my students* was 4.08. There was no statistically significant difference in ratings based on grade level, but as a group, teachers whose

students actually had access to the Web reported a statistically significantly higher rating (4.40) than did those whose students did not have direct access (3.90) ($F(1,36)=4.93$, $p<.05$). Written comments indicated that most teachers felt the content was of interest, especially because of its timeliness. One middle school teacher felt that there was a little too much text. An elementary teacher reported that he found the organization of the site to be "somewhat confusing in that it is not as linear as it might be."

Generally, the readability of the Web site was seen as appropriate (rating 3.84). There was no statistically significant difference based on grade level or on whether or not students actually accessed the site. However, several elementary teachers reported that they needed to assist their students, and one high school teacher felt that the site was a bit elementary.

Two other items asked for similar ratings of the mail list messages. The average score for the statement *The content of the mail list was interesting to my students* was 3.83. Of those teachers who used the mail list, middle school teachers reported a statistically significantly higher rating (3.79) than did high school (3.19) or elementary teachers (3.25) for this item ($F(1,32)=5.35$, $p<.05$), whether or not their students actually had direct access to the mail list. Teachers noted that they particularly enjoyed the personal accounts that appeared in the Updates.

Generally, the readability of the mail list was seen as appropriate (rating 3.58), but high school teachers were more likely to give a high rating on that questionnaire item (4.13) than were elementary (3.01) or middle school (3.44) teachers ($F(1,30)=4.10$, $p<.05$). Several teachers commented that the Updates were too long and that they condensed them before giving them to students. One third grade teacher reported that she downloaded the Updates and then enlarged the print so her students could view the material as a group on a large screen.

Were online chats frequent enough and useful enough to help in maintaining interest?

Although the score for the usefulness of the online chats was fairly high (3.64), only 11 teachers rated this item. Those who participated had enthusiastic responses to the chats, with one teacher noting that the middle school students came in during recess just to participate. However, most teachers reported that the fact that the chats were held at a specific time during the school day made it impossible for them to participate. Posting the text of the chats on the Web site enabled those who couldn’t participate live to later read the interactions. This arrangement at least gave non-participants an opportunity to learn from the chats, even though they couldn’t take an active part.

6. Was there increased student interest in science and technology after using the S/MORE materials?

A high score of 4.33 on this question was further reflected in teacher comments. Many teachers reported that students were pursuing additional research, specifically on the Internet, after having experienced S/MORE. Others said their students extended their experience by doing additional work at home or for science fair projects. A home school teacher was particularly enthusiastic,

remarking that an Internet-based project such as this allowed her sons to participate in activities that would not have been possible otherwise. And a middle school teacher remarked that the students felt they were getting "inside information" making the science involved more "personal" to them.

Elementary teachers were more likely to give a high rating on this item (4.83) than were middle school (3.97) or high school (4.17) teachers, whether or not their students had direct access ($F(1,32)=4.00$, $p<.05$).

Did the project help students and teachers develop a better understanding of real-world issues which are part of a modern research effort?

Teachers felt that their students did develop a better understanding of real-world issues in modern research (mean rating 3.92). There was no statistically significant difference by grade level or by whether or not students had direct access to the materials. One middle school teacher noted that this was the students' "first exposure to seeing that science is alive - not dead (i.e. something that only exists in a textbook)." Several noted the team effort that is necessary, both in the classroom and in the real world of science. The site showed students that NASA is not just astronauts, and that there are many people involved in scientific efforts. One group of students remarked that they "loved knowing that even NASA scientists were having trouble growing plants. We saw scientists as real people."

How was S/MORE incorporated into the curriculum?

Incorporating S/MORE into the curriculum was done in a variety of ways. Several teachers reported using the materials solely for background information or as supplements to existing curriculum. Others used the materials more. The content appeared to be appropriate for high school or middle school science classes. Several upper level teachers reported using the plant experiments; many used the materials in a multidisciplinary approach that included writing components and student presentations. Creative elementary teachers also used S/MORE extensively, incorporating biographies, plant growth, satellites, and space exploration in general.

Data taken from the random date (November 14, 1996) indicated that online access was quite short. The average amount of time per user session was 6 minutes, 10 seconds, with the maximum 1 hour, 14 minutes and the minimum 2 seconds. The median amount of time per user session was 1 minute, 32 seconds. Very short usage time might indicate access by someone browsing the Web and not interested in the S/MORE project. It might also indicate teachers accessing a page, printing its contents for later classroom use, and then quickly leaving the site. This would be a likely scenario for participants who subscribe to an online service that charges them by length of time used. As schools gain more access to the Internet and allow students to use the materials, average online time may increase.

A closer look at the hit counts as they relate to teacher ratings can give an additional indication of how materials were used. These are summarized in the chart below:

	28,585 Successful Hits		Mean
Main Pages	**% of Total Hits**	**Reported Use**	**Teacher Rating**
Home Page	32.19%		
Teacher's Resources	11.38%	77%	4.19
Shuttle-Mir Team	10.01%	79%	4.03
Student Activities	8.30%	71%	3.94
Photo Gallery	6.29%	71%	4.24
Project News	4.50%	77%	3.84
Background	3.85%	79%	4.13
Cultural Activities	3.62%	54%	3.31
Questions	1.30%	58%	3.43
Featured Events	10.41%	19%	
Other	8.15%		
Totals	100.00%		

[Note: Featured Events hits primarily related to the Great Plant Debate.]

Table 1: Percentage of use and ratings of quality for Web Site sections

The chart shows the 8 major subdivisions in order of use as determined by hits. Teacher's Resources received the most hits, and Questions received the least. Those teachers who reported a rating from 1 to 5 were counted as having used a particular section and were counted in the Reported Use column. Those responding with "0" or not responding at all were considered to have not used a section; these "0" and blank responses were then ignored. The Mean Teacher

Rating column shows the mean rating given by responding teachers.

The highest positive correlation was between Reported Use and Mean Teacher Rating (0.87)--the higher the Reported Use, the higher the Mean Teacher Rating. There was no statistically significant difference among teachers at different grade levels.

It was interesting to note that although only 19% of the teachers reported having participated in the Great Plant Debate, the Featured Events portion of the Web site (which focused on the Great Plant Debate) received the second highest number of hits for a specific site. This might indicate that there was high awareness of and/or interest in this event, despite low actual participation.

Of course a hit count does not reflect the length of time spent on a particular page or its perceived quality. For this reason, a location should not be judged solely on the number of hits it receives. Actual user ratings should carry more weight.

How did teachers use the various project parts? For example, were parts used separately or in conjunction with other project pieces?

Only 18 teachers responded to this question. The majority reported using the parts together and noted that this enabled students to see a main idea presented in different ways.

In addition to the featured Great Plant Debate, two sets of activities were included on the Web site--Life Sciences and Microgravity lessons. Fifteen teachers responded that they used the Life Sciences lessons. A few responded that they had not yet used these lessons but planned to use them later in the school year. Most of those who reported using the lessons grew wheat seeds or did the gray water activity. Very few teachers reported using the Microgravity lessons, but several noted that they would be using them later in the school year. Several teachers wrote that they appreciated having simple, inexpensive experiments that could easily be duplicated in their classrooms.

One questionnaire item focused specifically on the Great Plant Debate activity, in which students were to develop a design for growing plants in the weightless environment of a space station. (A copy of the first Web page describing that activity is located in Appendix E.) Only a few schools participated, but those who did were quite enthusiastic about it. One teacher praised the fact that ideas could be shared with other schools by using the Internet and expressed a desire for more such activities. The Great Plant Debate activity was the subject of a newspaper article featuring elementary students at the Louisiana State University Laboratory School. The teacher involved chose this project for her presentation at the National Science Teachers Association Conference. Several teachers noted that they planned to use the activity at a future time. Reasons for not participating fell into four general categories:

- There was not enough time, or the event timing didn’t fit into an already tight pre-Christmas schedule.
- The school had inadequate access to computers for student use.

- The content was seen as inappropriate to the course and/or grade level.
- There were difficulties with the project itself (e.g., some of the lesson plans needed revision, and the project deadline was postponed due to lack of initial involvement).

These comments indicate that plenty of advance notice should be given to teachers when developers plan an activity that will last an extended period of time. Tight school schedules and lack of adequate technology can be at least partially worked around by creative teachers if they are given sufficient advance planning time.

A close look at the Web site activity on November 14 showed that 26% of users accessed only the home page. Of the remaining 74%, the average number of different sections visited, not counting the home page itself, was 2.2. This low number would indicate that users tended to focus on a few areas of interest at a time. Since November 14 was well into the time period during which S/MORE was available, it was assumed that frequent users would already have been familiar with the different sections and would have known where their interests were located. The sections visited by the largest number of users on that day were Teacher's Resources (34%), Featured Events (32%), Student Activities (29%), and Photo Gallery (29%). The high percentage of hits on Featured Events (which usually focused on the great Plant Debate) is a further indication of interest in that area.

How did students view the project?

To gain direct input to this question, six middle school students were interviewed. The students agreed that they most enjoyed the Photo Gallery section of the Web site, specifically pictures that showed space images. Despite the fact that only two of the students listed science as their favorite subject, all agreed that using S/MORE was a worthwhile experience and that it helped them to understand what scientists do. Five of the six reported that using S/MORE increased their interest in science. They liked the student activities, but found the "Student Stumpers" to be "hard" and the plant experiment "hard to understand."

All six of the students interviewed reported that the best part of their science class was when they were able to do hands-on activities, so it was unfortunate that they didn't feel able to do the Great Plant Debate. One stated "Science is really neat. This year we started doing labs the third day of class! Last year (with a different teacher) I think we only did one lab the whole year."

The teacher reported that one of the male students had been very unmotivated in class. However, when he found that he could become a part of this project, he was the first student to return a parental permission form and stated that he was "excited to get a message from NASA."

Recommendations

Define the target audience.

Grade level differences posed problems for many of the teachers. It may be advantageous to select a target grade level for a specific project and then plan all activities to meet appropriate needs, abilities, and reading levels of that group. In this case, the composite user was at the middle school level. Targeting middle school, for example, would have enabled developers to focus on specific science and math standards that are stressed at that level. Creative teachers could still adapt the materials to meet their students' needs but would know at the outset whether or not a project was designed with them in mind. Alternatively, one project could have different components for different grade levels, with recommended grade levels clearly marked, but this would make a project much more difficult to develop.

Consider existing technology.

This study indicated that currently most teachers have only modem access to the Web, which suggests that designers should use only a limited number of large graphics (which are time consuming to download). A text-only version of at least the home page and thumbnail images (that can be selected for expanded views if desired) would also help teachers with slow connections.

The number of computers available within the classroom was limited, with few teachers having access to entire labs. This would suggest that activities that could be done in groups or offline are preferable to those that would require a computer per student.

Keep Web site active.

Many of the K-12 teachers mentioned that they intended to use S/MORE materials in the future. This would suggest that the current Web site be left active, with some modification to remove time-sensitive references. A comprehensive listing or matrix of NASA educational sites including content summaries, grade level appropriateness, and related NASA missions would also be of use to teachers as they make their year-long curriculum plans.

Increase minority representation.

Although there was a good gender mix among the scientists, researchers, and astronauts represented, the percentage of minorities was too low. Only one minority teacher participated in the survey, and the percentage of minority students using the materials was 31%. Highlighting the roles that women, minorities, and persons with disabilities have in NASA may attract additional minority teachers in addition to providing valuable role models for students.

Post shorter, more frequent mail list messages.

Shorter, more frequent messages would keep the project up to date without overwhelming young readers. Essentially the same amount of preparation would be involved, but smaller bits of information would appear less intimidating, and more frequent messages would keep the project on users' minds.

Vary times for live Web chats.

Varying times for live Web chat activities would enable additional teachers and students to become active participants. This is especially true when a project has an international focus and when many participants have access to computers or to the Internet only during limited time periods. As additional classrooms become equipped with computers and Internet connectivity, this should become less of a problem. However, at the present time most schools have not reached this level, so flexible timing is still essential for high participation.

Encourage a wider base of chat participants.

Developers should be aware of the fact that, although a Web site may be intended for K-12 use, it may be seen by a wide variety of other interested people. The ease of access to the World Wide Web enables extremely wide dissemination to an extremely wide spectrum of users. This broad cross-section of usership has no direct implications for the developers, but it could possibly lead to a wider base from which to draw Web chat participants. Perhaps the interested scientists and engineers could be encouraged to add a few words from their areas of expertise or answer questions from a slightly different viewpoint.

Pretest key experiments.

A few teachers reported having trouble performing some of the suggested experiments. Using test groups of teachers and students to preview materials before they are posted would help eliminate unclear instructions and/or basic design problems. Experienced teachers would probably volunteer to become a part of a NASA test team, and their students could be lured by the incentive of providing important input to NASA.

Require users to register.

Mandatory registration, while perhaps a mild deterrent, would allow for more accurate usage data and could provide a valuable database of teachers who could be asked to pretest materials for future projects. Although counting software can provide statistics, in many cases these data are inconclusive or misleading.

Conclusion

The use of Internet-supported curriculum supplements was enthusiastically praised by respondents to the questionnaire. Although many schools currently lack sufficient technology to make the Internet an efficient method of dissemination, the statistics indicate that technology accessibility is increasing rapidly and is being embraced by teachers at all levels, suggesting that curriculum supporters such as NASA should continue to provide cutting edge projects like S/MORE.

Overall, the S/MORE project was well done and well received. It conveyed a wealth of information, aroused student interest in science, and effectively portrayed scientists as actual

people in attainable positions.

Acknowledgments

This paper is based on an earlier evaluation report submitted to NASA Ames Research Center. The authors would like to thank Dorothy Frew and Frank Withrow for their helpful comments on drafts of this paper. The authors would also like to thank Alan Federman for his assistance is collecting Web-site data from NASA Ames. The NASA Classroom of the Future is funded through a cooperative agreement with NASA (NCCW-0012). The S/MORE project was supported by the NASA Ames Research Center.

References

National Aeronautics and Space Administration (Ed.). (1996-copyright). *S/MORE* [Homepage of Shuttle-Mir Online Research Experience], [Online]. Available: http://quest.arc.nasa.gov/smore/ [1997, June 25].

National Aeronautics and Space Administration (Ed.). (1997, June 6-last update) *The Internet in the classroom: Online interactive projects* [Homepage of The Internet in the Classroom], [Online]. Available: http://quest.arc.nasa.gov/interactive/ [1997, June 25].

National Council of Teachers of Mathematics, *NCTM News Bulletin*, March 1994, p. 9.

National Center for Education Statistics, *Survey on Advanced Telecommunications in U.S. Public Elementary and Secondary Schools, 1995*, February 1996, p. 3.

Appendix A

Part I. For each of the following questions, please type an "X" (without quotes) after each appropriate response.

1. S/MORE materials were used (mark all that apply)

    By students:

    By the teacher to pass along to students:

    By the teacher for background/knowledge:

    Other (please specify):

2. Did you use:

    The web site:

The "updates-sm" mail-list:

Both:

3. Number of computers used (please type a number):

4. Type of computer hardware

IBM/Compatible:

Macintosh:

Other (please specify):

5. Type of World Wide Web browser

Netscape Navigator:

Internet Explorer:

Mosaic:

Other (please specify):

I didn’t use the web site:

6. Internet access:

Modem:

Direct Connection:

Other (please specify):

7. Computer setup:

Computer lab:

Multiple computers within the classroom:

One computer within the classroom:

Other (please specify):

Part II. Please respond by typing a number after each of the following statements.

The key is:

5 strongly agree

4 agree

3 neutral

2 disagree

1 strongly disagree

0 no comment/didn't use

We encourage additional comments to each statement.

8. The content of the S/MORE web site was interesting to my students:

Comments:

9. The content of the "updates-sm" mail-list was interesting to my students:

Comments:

10. The readability of the S/MORE web site was appropriate for my students:

Comments:

11. The readability of the "updates-sm" mail-list was appropriate for my students:

Comments:

12. The online chats were useful:

Comments:

13. The online chats were frequent enough:

Comments:

14. My students displayed increased interest in science and technology as a result of the S/MORE project:

Please describe:

15. S/MORE helped my students develop a better understanding of real-world issues that are part of a modern research effort:

Please describe:

16. S/MORE was a worthwhile experience for my students:

Comment:

Part III. For the next section, please type your response following each question.

17. How did you find out about S/MORE?

18. Have you used other NASA educational web sites (such as the Passport to Knowledge - Live from Mars)? If so, which sites have you used?

19. Did you use S/MORE with students?

If yes:

A. Total number of students who used S/MORE:

B. Number of males:

C. Number of females:

D. Number of white, non-Hispanic students:

E. Number of minority students:

F. Number of African-American students:

G. Number of Hispanic students:

H. Number of Native American students:

20. Please estimate the average number of hours each student spent using the S/MORE web site:

Comments:

21. Did the students work at separate computers individually or did they work in teams?

22. If your students worked in teams, please describe the number of students per team and how the teams were established.

23. Describe how you incorporated S/MORE into your curriculum.

24. What can be done to make this and future online projects more useful?

Part IV. The S/MORE home page lists 8 major subdivisions (shown below). Please rate the usefulness of each subdivision by typing a number after each.

The key is:

5 extremely useful

4 very useful

3 useful

2 not very useful

1 not at all useful

0 no comment/didn't use

We encourage additional comments about each subdivision.

25. Project News:

Comments:

26. Teacher's Resources:

Comments:

27. Shuttle-Mir Team:

Comments:

28. Student Activities:

Comments:

29. Background:

Comments:

30. Cultural Activities:

Comments:

31. Photo Gallery:

Comments:

32. Questions:

Comments:

33. Did you use the various parts separately or in conjunction with other project parts? Please describe.

34. Did you use any of the Life Sciences lessons

If so, which one(s) and how did you use it/them?

35. Did you use any of the Microgravity lessons?

If so, which one(s) and how did you use it/them?

The developers of this Web site anticipated that there would be much interest in the featured "Great Plant Debate." However, few schools seem to be participating in that activity.

36. Did you participate in the "Great Plant Debate?"

If not, why not?

Part V. When preparing a report such as this, it is very valuable to have specific personal experiences or comments, both positive and negative. Please add any other words of wisdom or suggestions or stories that you think would enhance this report. (If you would prefer to relay these by phone, please type your phone number and the best time to contact you.)

37. Other comments/experiences/etc.:

Part VI. The following personal questions are optional. However, your answers will help us to understand our audience better, so we ask that you complete them. Responses will be recorded only by Questionnaire Number, so your anonymity will be preserved at all times.

38. Gender:

39. Ethnic Background:

40. Age:

41. Number of Years of Teaching Experience:

42. Computer Experience (type an "X" after the best choice below)

Advanced:

Above Average:

Average:

Below Average:

Beginner: