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ABSTRACT

This study focuses on the integration of technology into middle school science classrooms. It concerns building interest among students in science and technology and understanding the impacts of technology in student learning. Three questions are posed: (1) How does using the Internet influence student performance in science? (2) How does using the Internet influence student interest in and understanding of science and technology? and (3) How does using the Internet influence girls' interest in science and technology? One researcher's experience with integrating technology into an eighth-grade physical science class is described. A list of Web addresses for periodic tables on the Internet and the pilot and actual student interest survey questions are included. (Contains 25 references.) (YDS)

# INTEGRATING TECHNOLOGY INTO THE SCIENCE CLASSROOM

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One of the biggest challenges facing teachers today is to find ways to use technology to enhance academic achievement. In the Washington State Essential Academic Learning Requirements Technical Manual for Science, Social Studies, Arts, and Health and Fitness, the Commission on Student Learning (1996) writes:

> Technology and other forces are rapidly transforming the ways we live and work. The forces of change are also re-shaping what it means to have the knowledge and skills necessary to lead a successful life now and in the 21st Century. (p. 2)

One technological force re-shaping life today is the Internet. This powerful technology is also a tool that teachers can bring into the classroom to enhance teaching and learning.

As a requirement of my Master In Teaching (MIT) Program at Washington State University Tri-Cities, I conducted an action research project that involved the integration of technology, primarily the Internet, into a middle school science classroom. Through this study I hoped to build student interest in science and technology and to understand how using technology impacts students. I also wanted to evaluate my success at integrating technologies such as the Internet into the science classroom.

## Problem Statement

The Washington State Commission on Student Learning (1996) and the National Research Council (1996) have recognized the important role of technology in the area of science with specific requirements. For example, the Essential Academic Learning Requirements in Science state that the student will "understand the connections between science and technology" (Washington State Commission on Student Learning, 1996, p. 32). Similarly, the National Science Education Standards call for students in grades five to eight to develop "understandings about science and technology" (National Research Council, 1996, p. 161). In addition, the Washington State Technology Plan (Office of Superintendent of Public Instruction, 1997) calls for funds to integrate technology into the curriculum and to train prospective teachers how to incorporate new technology-based instructional strategies into the curriculum.

To be prepared for the global world of the 21st century all students must become comfortable with using technology. In order to facilitate this, teachers must learn how to use the technologies available to them, including the Internet. They must learn how to utilize these technologies to the benefit of their students. In other words, all teachers must decide what to do with the Internet in their classrooms.

## Theoretical Background

Technology has affected society for centuries. For example, in 1450 only about 30,000 books existed in all of continental Europe (Gates, 1996). That year Johan Gutenberg introduced the first printing press to Europe. By 1500, there were more than 9 million books, on many topics, not to mention other types of printed matter such as handbills, available in continental Europe. For the first time, the common person had access to written information. Now there was a reason to learn to read and write. People became interested in learning what was going on in other parts of the continent and in recording what was happening in their part of the world. As Bill Gates (1996) writes in *The Road Ahead*, "Books gave literacy critical mass, so you can almost say that the printing press taught us to read. The information highway will transform our culture as dramatically as Gutenberg's press did the Middle Ages" (p. 27).

Already it is difficult to interact in the world today without seeing some reference to the Internet. Web addresses are everywhere, in magazines, on books, and even on commercials. And, as Ray Schneider (1997) wrote, "Incredible as the Internet already is, it is only a shadow of things to come" (p. 14). In the October 27, 1997 *U.S. News & World Report,* 11 of the careers listed in "20 Hot Job Tracks" required science and/or technology backgrounds. Collins and Collins (1996) pointed out that in order for "our students to compete in the current global community, it is imperative that . . . educators embrace and use [the Internet] in our teaching" (p.101).

Besides the reform requirements at state and national levels there is increasing pressure from the business community and federal agencies to teach our students to learn how to use technology. According to the Tri-City Herald ("Going High-Tech," 1997) the Information Technology industry has now emerged as the country's largest manufacturer and accounts for $866 billion in revenue per year. In addition, last year the high-tech sector accounted for 6.2% of our nation's output of goods and services and employed almost 4.3 million people. This sector grew by 7.2% in the 1990's. Furthermore, high-technology workers earn wages 73% above the general private sector rate. "The role of education in providing the skilled workers that 'high-tech' requires is central to any community strategy involving the industry" (Going High-Tech, 1997, p. A6). Today most communities are doing everything possible to attract high revenue industries like Information Technology, including examining how they educate future workers.

In response to the Improving America's Schools Act of 1994 the U.S. Department of Education wrote a national long range technology plan, *Getting America's Students Ready for the 21st Century: Meeting the Technology Literacy Challenge. A Report to the Nation on Technology and Education* (1996). At the heart of the plan is the President's Technology Literacy Challenge, which urges that the nation's students be technologically literate by early in the 21st century. In a letter to Congress opening this plan, Richard Riley, Secretary of Education, (U.S. Department of Education, 1996) wrote:

> Computers are the 'new basic' of American education, and the Internet is the blackboard of the future. . . .I strongly believe that if we help all of our children to

> become technologically literate, we will give a generation of young people the skills they need to enter this new knowledge- and information-driven economy. (p. 3)

These sources provide evidence that there is a reason for students to learn how to use technology, but does it have any benefits or pitfalls for them? Can the use of the Internet help students develop other skills needed in the workplace, not just make them technologically literate? Results of a project on the Internet and literacy (Wright, 1997) suggest that Internet use has a positive affect on students in regard to literacy, but do these effects extend to the areas of science and technology?

Through coursework at Washington State University I know that the work of L. S. Vygotsky and others (Biehler & Snowman, 1993) demonstrated that a constructivist approach was more beneficial to students. My own experiences as a student suggest that it also makes learning more interesting and thus increases the desire to learn and improves student performance. In writing about the potential of using technology in a constructivist classroom Strommen (1995) points out that students raised in a technology-driven world with video games, remote controls, and the like are used to an environment where they control the flow and access of information. He believes that these students are naturally more interested and involved in a classroom with technology.

A previous study of equity issues showed a potential for technology use to introduce another gender-related bias to the classroom. Do boys and girls both experience a positive influence when technology is included in the curriculum? And finally, how do teachers feel about their experiences using technology in the classroom? To find answers to some of these questions I turned to past research on the impact of technology use in the classroom.

In two related research projects Goodwin (1996) and Rogan (1996) collected data from rural teachers with no prior Internet experience who integrated it into their curriculum. Their data sources included questionnaires, interviews, discussions and teacher journals. All teachers involved in the study had an interest in the teaching of math and science. The teachers in Goodwin's study were also trained in changing the way they teach science based on theories and strategies of reform in science education. Both Goodwin and Rogan found that teachers' were frustrated while learning to use the Internet, but that they also experienced an end to feelings of isolation. Both teachers' and students' enthusiasm increased and classroom practices changed to a more student-centered approach. Goodwin also found that teachers reported improvement in students' overall performance.

Jane Hollis, in a 1995 action research project, had her students do multimedia presentations for an Oceanography project. The students shared their final presentations with the class. Based on data collected by surveys and observations, Hollis reported an increase in student interest. For example, in the month before the project there were 14 tardies while during the project there were no tardies. Students also asked to stay and work on their presentations after school several times, a rare event before the study. Hollis also reported that she felt the excitement return to her teaching.

While Wilcox and Jensen (1997) expressed concern that girls' (and minority groups') interest and achievement has been shown to decrease with increased computer use in the classroom, Walker and Rodger's 1996 research study showed the opposite. Walker and Rodger implemented the PipeLINK program to attract and retain women and girls in computer science careers. Subjects either were assigned mentors or acted as mentors, participated in labs on using the Internet, and used e-mail, bulletin boards and chat rooms. Data collected by questionnaires found that girls' interest in computers increased with more exposure. Walker and Rodger concluded that one key factor in girls' increased interest may have been the communication aspect of the Internet.

The United States Department of Education in its 1996 publication *Teaching and Learning with Educational Technology: Myths and Facts* reported that:

> [S]tudents with more extensive access to technology are more likely to learn how to organize complex information, recognize patterns, draw inferences and communicate findings . . . it is these students who exhibit superior organization and problem-solving skills, compared to students in more traditional school programs. (p. 1)

Finally, the Department of Education also reported a dramatic example of how technology can impact students' achievement in their national long-range technology plan (1996). In the late 1980's students at Christopher Columbus Middle School in Union City, New

Jersey had state tests scores that were very low, and a high absentee and dropout rate. In 1992 Bell Atlantic offered to work with the school district to demonstrate that technology could improve students' performance. Computers were installed all over the school and in students' homes. Two years after the initial installation of the computers, dropouts and absentees were near zero and students were scoring 30 points higher than the New Jersey inner city school average on standardized tests. On New Jersey's Early Warning Test students' scores were more than 10 points above the statewide average. In addition, Columbus now held the district's best attendance record for both students and faculty and the transfer rate had dropped significantly. Students were proud of their work and eager to learn. They even lined up to get in before the formal school day began.

Overall, my review of the research and literature on using technology suggested that:

1. Technology fosters interactive, self-directed learning (Goodwin, 1996; Swain, Bridges & Hresko, 1996; Wellburn, 1996) and higher order thinking skills (Goodwin, 1996; Rogan, 1996; Wellburn, 1996).

2. Technology increases student-centered learning (Goodwin, 1996; Rogan, 1996).

3. Technology improves overall student performance (Goodwin, 1996; U.S. Department of Education, 1996) and increases student interest (Hollis, 1995; Goodwin, 1996; Rogan, 1996; Strommen, 1995).

4. Technology may influence girls either by increasing their interest (Walker & Rodger, 1996),

or inhibiting their interest (Wilcox & Jensen, 1997).

5. Technology decreases teachers' feelings of isolation (Rogan, 1996; Swain, Bridges & Hresko, 1996) and increases their interest in teaching (Hollis, 1995).

## Research Questions

The research questions that guided my study were:

1. How does using the Internet influence student performance in science?
2. How does using the Internet influence student interest in and understanding of science and technology?
3. How does using the Internet influence girls' interest in science and technology?

As a corollary to these questions I wanted to determine how using the Internet influenced my teaching.

## Context and Participants

I integrated technology in the classroom for the first time during my internship experience in an eighth grade physical science class at a Southeast Washington suburban middle school. Research occurred primarily during the seven weeks (out of 13) that I had full responsibility for classroom activities. Class periods were 47 minutes long four days per week and 37 minutes long on Wednesday. Although this project was actually implemented during all six class periods, data were collected primarily from the students in the third and fourth hour class periods, referred to as the focus study classes. The third hour class was chosen because they had the lowest scores prior to beginning the project so any potential effects might be observed more easily. Fourth hour was included to bring the number of male and female subjects to a more equal number as third hour had significantly more females than males. Fourth hour also provided somewhat of a balance through a more even distribution of scores. However, students in all six class hours were studied during observations and post data from students (surveys, essays and opinions) were taken from all six classes. Evidence from these other classes was included to provide additional support in the data analysis.

The students and I were the subjects of my study. There was a total of 137 students in the six classes (69 boys and 68 girls) and 43 students in the two focus study classes (20 boys and 23 girls). There were approximately six Hispanic students, six special needs students (including Learning Disabled, Attention Deficit Disorder, Behavior Disorder, etc.) and eight chronic absentees in the focus study classes (medical and other reasons), which was representative of all six classes. All classes included a variety of achievement levels. Students who dropped or added the class in the middle of the study were excluded from the focus study data. Those with excessive absences or other incomplete data were excluded from some of the data analysis. In these cases the data group of 25 students is referred to as the selected focus group (11 boys and 14 girls). My supervisor, my field specialist, fellow members of my cohort, and my family members also participated in collection, evaluation and/or interpretation of the data.

## Implementation/Methods

Most of the students had at least seen the Internet in use. In fact, on most days my field specialist displayed a science article from the abc.com website on the television display attached to the computer. Many of the students had also had at least one technology course at school and some were also currently enrolled in another technology course. However, these courses concentrated on software uses rather than the Internet. Furthermore, many of the students and even more parents seemed apprehensive of student use of the Internet. I received several warnings from colleagues and other staff about allowing students to use the Internet. Finally, student access to computers during school hours was limited. There were two computers available in the classroom and a computer lab; however, the lab was frequently in use and the Internet access was not as friendly or timely as I had hoped. These factors caused me to take a more conservative approach to integrating the Internet and technology into the classroom.

When we began the chemistry unit I used the Internet for classroom discussions, demonstrations and displays. For example, when discussing the periodic table I used an interactive site that not only showed the standard periodic table, but also provided more information on families and individual elements by clicking on them. Other demonstrations included pictures of molecules, atomic structure and sublimation.

Through an informal survey I determined that about 85% of students had access to the Internet either at home or at a friend's house. I included a project that allowed Internet research use at home, for those with access, and at school during designated work periods (and with the television display to monitor students activities). The project involved creating a game which taught information about elements in assigned families to those playing. Students researched the families and their elements in order to create an effective game. Class time was provided for research using traditional methods and the Internet. As a corollary to this project I included extra credit projects based on the elements. These projects included a variety of choices for students, including a search on the Internet and the creation of a computer presentation or website on the elements (see Appendix A).

## Data Collection

Because of time constraints I relied on data sources that required a minimum of class time. Therefore, as data sources for my research I used the following:

1. Information on student projects and grades earned pre- and post-implementation (performance).
2. Written student surveys collected pre- and post-implementation (see Appendix B).
3. Student essays and entry tasks on the definitions of and roles of science and technology in daily life written pre-implementation and answers to guided questions collected post-implementation (see Appendix C).
4. Written student opinions/reflections taken post-implementation concerning Internet use in the classroom and at home (see Appendix B).

5. My records of observations by my field specialist, my supervisor, the school principal, and me.

6. A researcher reflection journal written throughout my internship experience.

Surveys assessed student interest in science and technology before and after the study (Hollis, 1995). The survey questions shown in Appendix B are adapted from action research studies by Hollis (1995) and Phyllis Green (1995). The first survey shown in Appendix B was piloted in class periods five and six. Minor modifications were made before use of the second version in Appendix B (modifications are shown in italics), in class periods three and four pre-implementation, and the final version in Appendix B (questions 13 to 22 were added), in all classes post-implementation. Students in all classes were asked to write essays defining science and technology, and describing the role of each in society today pre-implementation. Unfortunately, student cooperation in writing these essays was limited despite being a graded activity. However, in addition to essays, students wrote a brief entry task on a similar subject prior to implementation. This entry task was also used to assess student interest and understanding as a supplement to the essays.

Post-implementation I used a series of questions (see Appendix C) to assess understanding of the role of science and technology in daily life in place of the essay and received a better response. In order to answer the questions on the influence on girls' interest and understanding, data was separated by gender and a comparison was made. My observations and journal entries were guided by questions such as (Hollis, 1995):

1. What problems are students encountering on the Internet?

2. Are students having problems with content?

3. How much time is spent on various activities?

My field specialist, supervisor, and school principal verbally discussed their observations with me which I then recorded in my observation journal.

## Data Analysis

I used the data collected from surveys, essays, guided questions, observations, journals and students' performance to compare students' attitudes and performance before, during and after the study and to draw conclusions for each research question. For clarity, data sources for each question are shown in Table 1 and are discussed below. In the table the data sources include my conclusions to the research questions as these are relevant to my conclusions about how using the Internet influenced my teaching. The table also indicates the time period during which the data was collected.

The first research question on the influence on student performance was assessed by comparing student projects and grades from before and after the study. Further evidence for this question was provided through student reports of understanding and my own and others' observations of students' performance. Questions such as numbers 8 and 10 in Appendix B were included in surveys to help rule out the influence of other factors such as the nature of, or interest in, the content on student performance (Hollis, 1996).

The surveys, essays, and student opinions/reflections provided direct reports from the students of their interest in and understanding of science and technology, which addressed the second research question. I analyzed student surveys, essays and opinions/reflections from before and after the study in order to understand if and how student interest and understanding had changed. By examining my own and others' observations and my reflection journal I had

Table 1
Correlation of Data Sources to Research Questions and Time Collected

| | Week Collected | | | |
|---|---|---|---|---|
| Data Source | Question 1 | Question 2 | Question 3 | Corollary |
| 1. Student projects and grades | Focus only-Weeks 5, 13 | | | |
| 2. Student surveys | | Pilot-week 2<br>Focus-week 4<br>All-week 13 | Pilot-week 2<br>Focus-week 4<br>All-week 13 | |
| 3. Essays, entry task, and guided questions | | All-Week 6 | | |
| 4. Student opinions, reflections, Internet use | All-Week 13 | All-Week 13 | All-Week 13 | |
| 5. Observations recorded by researcher | Weeks 1 to 13 | Weeks 1 to 13 | Weeks 1 to 13 | Weeks 1 to 13 |

| | | | | |
|---|---|---|---|---|
| 6. Researcher reflection journal | Weeks 1 to 13 | Weeks 1 to 13 | Weeks 1 to 13 | Weeks 1 to 13 |
| 7. Conclusions to first three research questions | | | | Week 13+ |

another measure of student interest and understanding. The third question about the influence on girls' interest and understanding in science and technology was addressed by comparing the changes in girls' and boys' interest and understanding as seen in surveys, essays, opinions/reflections, and observations. Finally, I was able to examine how using the Internet influenced my teaching by analyzing my observations and journal reflections, the observations of others, and my conclusions to the three research questions.

As I reviewed the collected data I coded evidence relating to each question using letters. "P" was used to indicate evidence related to student performance, "S" indicated evidence about student interest and understanding, "G" represented evidence for or against girls' interest, and "T" represented any data on the influence on teaching. Students were coded alphanumerically to protect their identity. Data on student grades was entered into an Excel spreadsheet and averaged in a variety of ways. Numerical answers to the first seven survey questions were also analyzed in this manner. Student understanding was given a numerical rating from zero to four based on essays and entry tasks written pre-implementation and guided questions answered post-implementation. These scores were assessed in the same manner. Additional evidence from the surveys was also entered onto the spreadsheet. By looking for patterns, similarities and correlations in the data and comparing student interest and performance before and after the study I was able to reach some conclusions about the influences of using the Internet. I was also able to draw some conclusions about my success in using the Internet as a teaching tool.

As a validity check I asked others to review my findings including geology professors at Washington State University and a vice-president of a research lab. I also discussed my findings with members of my MIT cohort, my field specialist, and my supervisor to further reduce the chance of bias. Collecting data related to each question from three or more sources allowed for triangulation of the findings and helped reduce the likelihood of error in my findings when similar results were observed in two or more sources (Hollis, 1995).

The data collection and analysis techniques I used are similar to those used by the Center for Applied Special Technology (1996), Francis (1997), Goodwin (1995), Hollis (1995), Rogan (1995), and Walker & Rodger (1996), all of whom were investigating the effect of using technology on students and/or teachers.

## Results

### Influence on Student Performance in Science

I expected to see an increase in both student performance and student interest and understanding of science and technology as has been noted in previous studies (Hollis, 1995; Goodwin , 1996; Rogan, 1996; Strommen, 1995). Analysis of the data from student projects and grades, essays, entry tasks and guided questions, and student surveys provided evidence of such increases. This evidence was further supported by data from student opinions and recorded observations.

Although student grades and performance on projects were acceptable prior to implementation, there was a noticeable decline in student scores from the first to the second quarter of the school year. As shown in Table 2, from the first to the second quarter 76% of all students in the focus group and 83% of the selected focus students saw a decrease in their grade average. Furthermore, the average student score for all focus students decreased from 76% to 70% and for the selected focus students from 83% to 78% as seen in Table 3.

Post-implementation data on Tables 2 and 3 indicated that student scores showed some improvement. Although the average student score for both groups did continue to decline, it was less than the decline observed from the first to the second quarter. From second to third quarter the focus group average declined 70% to 68%, a drop of only 2% compared to the 6% drop from the first to the second quarter. The selected focus group exhibited nearly identical results with a drop of 2% from second to third quarter compared to the drop of 5% seen between the first two quarters.

Additional evidence was noted in the percentage of students whose scores declined versus those who scores rose in the third quarter (see Table 2). From the second to third quarter only 52% of all focus students and 43% of the selected focus students exhibited a drop in their grade average compared to 76% and 83%, respectively, for the same groups from the first to second quarter. These results occurred in spite of many factors distracting the students during the time of the study. These factors include the normal erratic performance of students at the middle school level compounded by the onset of spring, the realization that they would be moving onto high school the following year, and a temporary change in teachers. Furthermore, student scores improved even though observations indicated that my grading standards tended to be slightly higher than that of my field specialist.

Table 2
Comparison of Change in Student Scores for Focus and Selected Focus Students

| | % of Students | | |
|---|---|---|---|
| Time Period of Change | Improved | Declined | Unchanged |
| All Focus Students | | | |
| First to Second Quarter | 19% | 76% | 5% |
| Second to Third Quarter | 34% | 52% | 14% |
| Selected Focus Students | | | |
| First to Second Quarter | 13% | 83% | 4% |
| Second to Third Quarter | 48% | 43% | 9% |

Table 3
Comparison of Average of Student Scores by Quarter

| | Data Population | |
|---|---|---|
| Time Period | All Focus Students | Selected Focus Students |

| | | |
|---|---|---|
| First Quarter | 76% | 83% |
| Second Quarter | 70% | 78% |
| Third Quarter | 68% | 76% |

The results of the data from student grades pre and post-implementation are supported by observational evidence from all six classes. Students took more pride in their work during study implementation and paid closer attention to materials that were presented from the Internet. Both of these facts contributed to a noticeable improvement in grades. For two students, the interest generated by using the Internet resulted in completion of extra credit projects and quality work on their game projects. This improvement in performance raised their letter grades by one to two letters at the end of the third quarter.

One student, SC2B, rarely turned work in and showed little pride in the work he did turn in. This same student rarely scored below a B average on tests. After completing quality work with his partners on the game project, SC2B demonstrated even greater pride in his extra credit work that included building a website on the elements. He remarked to my field specialist that he had originally thought that the website would take him a short time, but it had actually taken hours. This student benefited through increased time on the subject we were studying that will eventually improve his test scores as well as his overall grade.

All sources of data indicated at least some improvement in student performance from pre-implementation use of the Internet in the classroom to during and post-implementation. In general, the use of the Internet did help students perform better in their science class. Based on observational evidence it is possible that the increase in performance was due to increased understanding and interest, the focus of my second research question.

Influence on Student Interest and Understanding

In assessing student understanding and interest only data from the 25 selected focus group students was used. Data from the 18 excluded students was incomplete due to surveys that were not returned or completed. The students in the selected focus group showed improvement in their understanding of science and technology from the pre-implementation essays and entry tasks to the post-implementation guided questions. An unchanged score on the scale of 0 to 4 indicated no improvement. Slight improvement was indicated by an increase of one, definite improvement by an increase of two and marked improvement by an increase of three.

Only 24% of the selected focus students showed no improvement in their understanding of science and technology. These students did not view the importance of science and technology to daily life any differently post-implementation than they did pre-implementation. However, half of this group was initially assessed at the 3 level, which indicates a good understanding pre-implementation, and half were assessed at the 1 level indicating a slight understanding pre-implementation. Of the remaining students 36% demonstrated slight improvement in understanding (10% of these had a good understanding pre-implementation), 32% had definite improvement and 8% exhibited marked improvement.

To assess student interest I analyzed the answers to statements one, two and five from the student surveys (see Appendix B). The first two statements concerned the students' enjoyment of science and learning science this year. The fifth statement directly addressed students' interest in science. As indicated in Table 4, responses from the selected focus students showed a mixture of increased and decreased interest in and enjoyment of science. There was a slight trend toward increased interest and enjoyment post-implementation. Of particular note was the increase in those who responded neutrally to the fifth statement concerning their interest in science. Neutral responses increased from 12% to 36% while all levels of agreement and disagreement with the statement decreased. This may indicate that students tended to answer in a more neutral manner on the day of the post-implementation survey. Further analysis of the student responses did indicate that the changes in student answers were usually only one level in either direction. This supported the idea that the mixed results may be attributed more to students' overall attitudes on survey days rather than a true measure of interest and enjoyment. Another possible reason for the mixed results is that students lacked true understanding of the survey questions. However, the consistency demonstrated by many students in their pre- and post-implementation survey answers indicates that this was probably not the case. Furthermore, the results obtained in my study are similar to those obtained by Hollis (1995) in a study which concerned the effect of technology on enthusiasm for science. Hollis' results were also mixed, but showed a slight trend as well.

Student interest was also assessed by looking at responses to questions designed to determine the influence of the subject matter. Students' likes and dislikes concerned activities as well as subjects. For activities, students reported greater interest in those that had included some type of Internet use than those that did not. Students also reported greater interest in the chemistry topics than the physics topics. I believe this resulted in part from use of the Internet for these topics as well as to the change in subject matter. As I taught a portion of both physics and chemistry I do not think my overall teaching style caused this difference. I base this belief in part on student responses to how they felt about the use of the Internet during class discussions.

Table 4
Comparison of Selected Focus Students' Survey Responses Pre- and Post-Implementation

| Statement Summary | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| (1) Enjoy science Pre | 8% | 32% | 40% | 8% | 12% |
| Enjoy science Post | 12% | 36% | 32% | 12% | 8% |
| (2) Enjoyed learning science Pre | 12% | 32% | 40% | 12% | 4% |
| Enjoyed learning science Post | 12% | 40% | 36% | 0% | 12% |
| (5) Science is interesting Pre | 28% | 40% | 12% | 16% | 6% |
| Science is interesting Post | 16% | 36% | 36% | 8% | 4% |
| (6) Technology is useful Pre | 44% | 16% | 20% | 16% | 4% |
| Technology is useful Post | 28% | 40% | 20% | 4% | 8% |
| (7) Science and Technology are important Pre | 36% | 24% | 24% | 8% | 8% |
| Science and Technology are important Post | 36% | 28% | 24% | 0% | 8% |

Most students reported that they liked the use of the Internet during class discussions. Of the approximately 20% who reported that they did not like use of the Internet, most wrote that they did not pay attention or did not have time. A few responded with answers such as "did not have Internet at home" or "no time" which indicated that they did not read the question clearly. Only about 5% responded that they did not understand or that they felt it was not explained. From my observations this percentage is lower than students who reported confusion when only traditional methods were used during discussions. It is my belief that student interest in the Internet during class discussions translated to increased interest in the material being discussed.

The data discussed above indicates at least some increase in student interest and understanding of science and technology. This evidence was supported by observational and journal evidence. During the pre-implementation period I noted that my students lost interest frequently and only a few ever became really involved in the topics. For the most part students complained that they had too much work, they hated the type of work, and they did not understand the material. Furthermore, despite a lack of understanding, few students requested extra help even when the offer was made repeatedly.

Observations during and post-implementation showed that an increased number of students were coming in outside of class time to use the Internet for research on their projects or for help from a teacher. Students reported that they had learned the elements and families better than other subjects during the year and that the periodic table or information on the elements was the most important thing they had learned in science this year. Student reports of the importance of this topic also suggest greater understanding of the topic and the relevance of science to daily life.

In addition, I observed that students' attention to the topics improved when the Internet was used during discussions. Students asked additional and more in depth questions on the topic. Often students would ask to see an example again or to see another example. This interest extended to their other work on the topic. For example, more students turned in one periodic table assignment than usually turned in any assignments. This assignment was explained using an Internet example and the address was provided at the students' request. Student performance on this assignment also showed improvement over performance on assignments with no Internet use.

One student demonstrated a significant increased interest in topics on the Internet. MS5B usually did not pay attention and acted in ways that often disrupted other students. During times when the Internet was used in discussions he appeared focused and actually participated in the discussion and completed in-class assignments. On a day when the students had a few minutes to complete an assignment in class he requested to read additional information on the topic on the Internet. This was especially significant for a student who never even opened his book. While evidence from some of the data sources was mixed concerning interest and understanding, other data supports the conclusion that students' interest in and understanding of science and technology did increase. In responses to the student survey statements on the usefulness of technology (statement 6) and the importance of science and technology to daily life (statement 7) a slightly greater percentage did respond with greater agreement (see Table 4). More significant was the fact that students began to ask more questions about how topics were related to their lives and to provide more examples of these relationships on their own. The results of this study do provide evidence that student interest and understanding increases with Internet use.

Influence on Girls' Interest

Because of the communication aspect of the Internet, girls' interest was expected to increase rather than be inhibited (Walker & Rodger, 1996). According to Linda Groppe, president and CEO of Girls Games, Inc., girls also like the Internet because it gives them the opportunity to explore ("Software firms," 1997). Data from student surveys and opinions, observations and journaling did not provide the strong evidence I expected for this increase. However, the data did not indicate decreased interest by girls compared to boys either.

Tables 5 and 6 show the data for student survey statements 1, 2 and 5, concerning enjoyment of and interest in science, separated by gender. Once again the data indicated mixed results which can be attributed to students' overall attitudes on the day of the survey. Boys did show a significant increase in neutral responses to the statement concerning interest in science (#5), but they also showed a significant decrease in the number reporting any level of agreement with the statement. No other significant difference in gender trends was found in the survey data.

Student opinions concerning use of the Internet indicate a potential to decrease girls' interest due to their frustrations with Internet use. Although girls were more likely to have used the Internet outside of class and to have done so on a regular basis, they also reported slightly more frustration. In addition, the only student in the focus group who reported that s/he would not like to use the Internet for more assignments was a girl. All of the boys and all other girls in this group responded enthusiastically to the idea of using the Internet more. Out of all students responding to the post-implementation survey a total of four girls and one boy reported that they would not like to use the Internet for more assignments. All of the girls cited frustration and difficulty in using the Internet as the main factor. This frustration on the part of primarily female

Table 5

Selected Focus Male Students' Survey Responses Pre- and Post-Implementation

| Statement Summary | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| (1) Enjoy science Pre | 9% | 36% | 36% | 9% | 9% |
| Enjoy science Post | 0% | 45% | 45% | 9% | 0% |
| (2) Enjoyed learning science Pre | 9% | 27% | 45% | 18% | 0% |
| Enjoyed learning science Post | 18% | 36% | 36% | 0% | 9% |
| (5) Science is interesting Pre | 27% | 45% | 9% | 18% | 0% |
| Science is interesting Post | 9% | 36% | 45% | 9% | 0% |

Table 6

Selected Focus Female Students' Survey Responses Pre- and Post-Implementation

| Statement Summary | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| (1) Enjoy science Pre | 7% | 29% | 43% | 7% | 14% |
| Enjoy science Post | 21% | 29% | 21% | 14% | 14% |
| (2) Enjoyed learning science Pre | 14% | 36% | 36% | 7% | 7% |
| Enjoyed learning science Post | 7% | 43% | 36% | 0% | 14% |
| (5) Science is interesting Pre | 29% | 36% | 14% | 14% | 7% |

| | | | | | |
|---|---|---|---|---|---|
| Science is interesting Post | 21% | 36% | 29% | 7% | 7% |

students could eventually translate to a loss of interest in the subject matter due to difficulty in using resources.

I also observed that girls were more likely to allow boys to monopolize the Internet during class time and to report that their parents restricted their Internet access at home. Girls did, however, engage in discussions using the Internet as enthusiastically as boys did. The interest level of girls was not observed to decrease due to Internet use and appeared to increase by the same amount that boys' interest increased when the Internet was used. Boys and girls were equally likely to offer to look something up on the Internet at home for a friend or project partner.

The evidence suggests that there is a potential for girls' interest in science and technology to either increase or decrease with Internet use. This could be due to changing attitudes among both genders concerning overall computer usage or to gender roles that persist in our society despite efforts to end them. Further studies are required to determine if any significant gender effects are seen when the Internet is integrated into the science classroom.

Influence on Teaching

Many of the studies I reviewed (Hollis, 1995; Goodwin, 1996; Rogan, 1996; Strommen, 1995) found that teachers reported an increased proficiency with technology as a result of using it; therefore, I expected to see an increase in my ability to use technology as a teaching tool.

Results of the first two questions indicate that my proficiency is currently adequate to justify continued use of the Internet in the classroom, but also point to room for improvement. The results of the third question concerning girls' interest indicate a need to exercise caution in using the Internet so girls are not discouraged and do not lose interest. Since student interest and performance increased, as is consistent with the literature, my techniques are acceptable; however, I do need to reassess how I involve girls in the use of the Internet as a teaching tool.

In my attempts to use the Internet in the classroom I was often frustrated. Material that related to the curriculum, especially at an appropriate grade level was difficult to find. Part of my frustration was attributable to teaching a small portion of the curriculum in the middle of the year rather than planning for my own classroom for the entire year. When I did find material that I could use I was more excited and enthusiastic about the material. I know that this helped increase student interest in the material as well.

Use of the Internet helped me in other ways as well. On several occasions I found additional information that I was able to include in my lesson. This inclusion increased my confidence in the material that I was teaching and the way that I was presenting it. I also found activities for some lessons that I was able to adapt for use in my classroom. This resource was a powerful tool in my planning. Based on my observations and journal reflections I believe that using the Internet enhanced my teaching abilities and made it possible for me to reach more of my students.

## Discussion

I believe that the results of this study have several implications for teaching. First, it provides some additional evidence of the positive influence of using the Internet and technology on student interest, achievement and understanding. This is important because as teachers we need to use whatever tools we have available to maximize student performance. We also need to prepare students for the challenges of the 21st century and there is no better way to do so than by having them use the tools of the future. Furthermore, students must be comfortable with science and technology as so much of the work of the future will be based on these areas. It is our duty as educators to prepare them in any and every way possible. Perhaps the results of this study will convince at least one other teacher to try integrating technology into his or her classroom.

This study did not provide conclusive evidence on the effect that using technology has on girls in the classroom. It did suggest a need for additional studies and caution to insure that no one, male or female, is left behind when using technology. This need for caution must also extend to special needs students and students of other cultures, who were not specifically observed in this study. As educators we must remember that our duty is to all of our students, not just the ones who respond well to our favorite, or even best, style of teaching.

This study also provides further evidence that using technology increases interest in teaching and reduces teachers' feelings of isolation. When I found resources on the Internet, I knew that other teachers had searched for and found answers to the same problems I was encountering my first time out. And, more importantly, these teachers were sharing their gained wisdom with me through the Internet. This has encouraged me to take additional courses in this area and may encourage other teachers to learn how to integrate technology in the classroom as well.

Finally, the results of this study also provide evidence to teacher preparation programs of the importance of preparing teachers to use technology in their classrooms. For nearly every other situation I encountered I felt prepared by the experiences I had in my coursework. Even the issue of discipline and classroom management, one of the most difficult for new teachers, was not uncomfortable for me. However, despite my interest in using the Internet, at times I was lost for ideas on how to use it successfully. The practice that one receives in a course in this area would have been invaluable to me in my own integration of technology in the classroom. Just as our students must learn to use technology to succeed in the world of the future, so must we in order to prepare them for that world.

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## Appendix A

### Periodic Tables on the Internet - Student Handout

Web Elements http://www.shef.ac.uk/chemistry/web-elements/main/ index-nofr.html

Periodic Table Challenge http://www.chem.uky.edu/misc/periodicquiz. html

Graphical Periodic Table http://ghs.bcsd.k12.il.us/projects/class/periodic/ 1997/

Periodic Table http://www.chem4kids.com/elements/index.html

Chemicool Periodic Table http://wild-turkey.mit.edu/Chemicool/

City Night Periodic Table http://citynight.com/periodic/periodic.html

Comic Book Periodic Table http://www.uky.edu/~holler/periodic/periodic.html

Exploratory http://www.exploratory.org.uk/plores/per_tbl/per_tbl.htm

HyperChem on the Web - Periodic Table http://tqd.advanced.org/2690/ptable/ptable.html

Carlos's Periodic Table of the Elements

http://starbase.ingress.com/~dwight/students/carlos/pages/elements/pages/periodic.htm

Periodic Table of the Elements http://www.intercorr.com/periodic/

Elements http://members.iworld.net/joo/physics/curri-sub/periodic/periodic-table.html

Los Alamos National Lab http://mwanal.lanl.gov/CST/imagemap/periodic/periodic.html

Periodic Table of the Elements http://members.aol.com/jeff555555/table/ptable.html

Pictorial Periodic Table http://chemlab.pc.maricopa.edu/periodic/periodic.html

Periodic Table of Elements on Internet http://domains.twave.net/domain/yinon/default.htm/

| | |
|---|---|
| Elementistory (Element History) | http://smallfry.dmu.ac.uk/chem/periodic/elementi.html |
| List of Periodic Tables | http://www.anachem.umu.se/cgi_bin/pointer.exe?PeriodicTables |

Appendix B

Student Science Interest Surveys

Pilot

Please rate the following statements on a scale of 1 to 5. A rating of 1 indicates that you strongly agree with the statement. A rating of 5 indicates that you strongly disagree with the statement. A rating of 3 indicates that you do not agree or disagree with the statement.

| | Strongly Agree | | | | Strongly Disagree |
|---|---|---|---|---|---|
| 1. I enjoy science. | 1 | 2 | 3 | 4 | 5 |
| 2. I have enjoyed learning science so far this year. | 1 | 2 | 3 | 4 | 5 |
| 3. I feel that I have learned a lot in science so far this year. | 1 | 2 | 3 | 4 | 5 |
| 4. Science is too hard. | 1 | 2 | 3 | 4 | 5 |
| 5. Science is interesting. | 1 | 2 | 3 | 4 | 5 |
| 6. Technology is useful. | 1 | 2 | 3 | 4 | 5 |
| 7. Science and technology are important in daily life. | 1 | 2 | 3 | 4 | 5 |

Please complete the following statements:

8. My three favorite topics in science so far this year have been

9. My three least favorite topics in science so far this year have been

10. My three favorite activities in science so far this year have been

11. My three least favorite activities in science so far this year have been

12. The most important thing I learned in science this year was:

Actual Student Science Interest Survey

Please rate the following statements on a scale of 1 to 5. A rating of 1 indicates that you strongly agree with the statement. A rating of 5 indicates that you strongly disagree with the statement. A rating of 3 indicates that you do not agree or disagree with the statement.

| | Strongly Agree | | | | Strongly Disagree |
|---|---|---|---|---|---|
| 1. I enjoy science. | 1 | 2 | 3 | 4 | 5 |
| 2. I have enjoyed learning science *this school year.* | 1 | 2 | 3 | 4 | 5 |
| 3. I feel that I have learned a lot in science *this school year.* | 1 | 2 | 3 | 4 | 5 |
| 4. *Science is hard.* | 1 | 2 | 3 | 4 | 5 |
| 5. Science is interesting. | 1 | 2 | 3 | 4 | 5 |
| 6. Technology is useful. | 1 | 2 | 3 | 4 | 5 |
| 7. Science and technology are important in daily life. | 1 | 2 | 3 | 4 | 5 |

Please complete the following statements:

8. My three favorite topics in science *so far this school year* have been

9. My three least favorite topics in science *so far this school year* have been

10. My three favorite activities in science *so far this school year* have been

11. My three least favorite activities in science *so far this school year* have been

12. The most important thing I have learned in science *so far this school year* is:

Student Science Interest Survey - April 1998

Please rate the following statements on a scale of 1 to 5. A rating of 1 indicates that you strongly agree with the statement. A rating of 5 indicates that you strongly disagree with the statement. A rating of 3 indicates that you do not agree or disagree with the statement.

| | Strongly Agree | | | | Strongly Disagree |
|---|---|---|---|---|---|
| 1. I enjoy science. | 1 | 2 | 3 | 4 | 5 |
| 2. I have enjoyed learning science this school year. | 1 | 2 | 3 | 4 | 5 |
| 3. I feel that I have learned a lot in science this school year. | 1 | 2 | 3 | 4 | 5 |
| 4. Science is hard. | 1 | 2 | 3 | 4 | 5 |
| 5. Science is interesting. | 1 | 2 | 3 | 4 | 5 |
| 6. Technology is useful. | 1 | 2 | 3 | 4 | 5 |
| 7. Science and technology are important in daily life. | 1 | 2 | 3 | 4 | 5 |

Please complete the following statements:

8. My favorite topic/topics in science so far this school year was/were

9. My least favorite topic/topics in science so this school year was/were

10. My favorite activity/activities in science so far this school year was/were

11. My least favorite activity/activities in science so far this school year was/were

12. The most important thing I have learned in science so far this school year was:

13. Did you like having some examples displayed off of the Internet during class discussions?

Yes No

Why or why not?______________________________________________

14. How often do you use a computer and/or the Internet outside of school?

a. Never (skip to question #16 )
b. Only when I have to
c. Once a month
d. Once a week
e. Almost every day

15. In what ways do you use the computer and/or Internet?

a. Programs for information
b. Programs for games
c. Chat rooms
d. E-mail
e. Search for information on the Internet
f. Typing/desk top publishing
g. Other ______________________________________________

16. Did you use the computer and/or the Internet for anything in science the school year? (circle one) Yes No

If yes, what? (Circle all that apply)

a. Information for report or project.
b. Communicate with classmates or teacher.
c. Help with homework or studying
d. To type a report or assignment
e. Other. Explain______________________________________________

17. Did you use the computer and/or the Internet for anything in classes other than science the school year?(circle one) Yes No

If yes, what? (Circle all that apply)

a. Information for report or project.
b. Communicate with classmates or teacher.
c. Help with homework or studying
d. To type a report or assignment
e. Other. Explain______________________________________________

18. When doing research and/or studying what sources (references) do you use?

a. Computer and/or Internet
b. Text
c. Reference books
d. Library
e. Parent, teacher or friend
f. Other. Explain ______________________________________________

If you used the Internet for any part of science this year please answer the following questions as completely as possible

19. What problems did you encounter while doing work on the Internet?

20. How did you feel about working on the Internet?

21. What did you learn about your topic while working on the Internet?

22. How would you feel about doing more work using the Internet?

## Appendix C

## Guided Student Questions on Science and Technology

1. Provide at least one example of how science is helpful in daily life that you have seen over the past week. (For example, knowing some science helps me understand why putting gas in the car makes it operate).

2. Provide at least one example of how technology is helpful in daily life that you have seen over the past week. (For example, technology helps me share various periodic tables and other information with students on the television screen).

3. Provide at least one example of a concept or idea you have learned since August 1997 that helped you understand something in your daily life. (For example learning about wheels and axles helped me understand how the steering wheel on a car works).

## Appendix D

## Extra Credit Possibilities

The following element projects are available for extra credit. However, no extra credit will be awarded if an individual's family project "The Family Game" is not completed or shows a lack of quality work. Extra credit must be done using one or more of the elements you were assigned.

1. Make a model of an element's structure.

2. Write a poem, story, or song about one or more of your elements.

3. Make a mobil for one or more of your elements with information from the periodic table and/or properties of the element(s).

4. Write a brief essay on the background of the discovery of one of your elements and/or the person who discovered one of your elements.

5. Make a poster for one or more of your elements, include information on the properties of the element(s). The poster must teach something about the element(s).

6. Create a comic strip about one or more elements. The comic strip must teach something about the element(s) and/or it's family.

7. Write a commercial, radio advertisement, or a print advertisement for your element(s). Include the advantages the element(s) bring to our lives.

8. Write and perform a skit about your element(s) and the family to which they belong.

9. Write a newspaper or magazine article discussing the positive and negative aspects of one of your elements in the world today.

10. Make a timeline of important events in the history of one or more of your elements.

11. Create a new product using one or more of your elements.

12. Create a computer presentation or a website about one or more of your element(s).

13. Make a map of Internet sites with information on one or more elements. Include all web addresses and printouts of the information from the websites.

14. Create a country, island, city, amusement park, or planet based on your elements (may include all elements in you family).

15. Design a research project to investigate some aspect of one or more of your elements. Include a hypothesis and the project design.

16. Make a chart of all of the elements in your family to show their differences and similarities.

17. Turn in a graphic organizer (web outline) of the information you collected for the background on your "Family Game."

18. An element/family mini-project of your choice with prior approval from Mrs. M or Mrs. A.

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