2002

A backwards approach to instructional design

Dirk Martin Davis

A BACKWARDS APPROACH TO INSTRUCTIONAL DESIGN

A Project

Presented to the

Faculty of

California State University,

San Bernardino

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

in

Education:

Instructional Technology

---

by

Dirk Martin Davis

September 2002

A BACKWARDS APPROACH TO INSTRUCTIONAL DESIGN

A Project

Presented to the

Faculty of

California State University,

San Bernardino

by

Dirk Martin Davis

September 2002

Approved by:

[redacted]

Amy S.C. Leh, First Reader

8-15-02

Date

[redacted]

John Ruttner, Second Reader

ABSTRACT

This paper describes a project whereby 45 K-12 educators underwent forty hours of intensive training on developing a technology integrated unit of study from a backwards design point of view. After reviewing the related literature, and the idea of "backwards design", the following topics, which are individual components of the overall process, are described at length.

1. Unit Plan
2. Using the Internet to locate resources
3. Student Samples
4. Scaffolds to support the unit
5. Teacher support materials
6. Pedagogical issues

Samples of participant's work are included, where applicable. Conclusions about the individual components are reached and recommendations about the overall process are made in both the areas of who to train, and the training process in particular.

ACKNOWLEDGMENTS

I would like to acknowledge Dr. Amy Leh and Mr. John Ruttner for their guidance, suggestions, really strong suggestions, and infinite patience.

DEDICATION

The work is dedicated to Natalie, Connor, Ellen and Annie. Thank you for your patience, understanding, and love.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER ONE

INTRODUCTION

Many experts would agree that only a small portion of teachers are effectively using technology in their teaching. Several key obstacles to the use of computers in the classroom are:

1. Limited support for integrating unfamiliar technologies into instructions (Goldberg & Richards, 1995).
2. Lack of time, knowledge and skill to successfully integrate computers into classroom activities.
3. Difficulty in developing the level of expertise needed to incorporate technology into their job (Heaton & Brown, 1995).

Tremendous improvements in technology together with ever lowering prices on hardware and software have made integrating technology into the curriculum available to most teachers. Additionally, the newer software allows even the beginning user to develop projects that once required sophisticated knowledge. But with this new found capacity educators must address their teaching practices if they are to increase their student's learning and achievement. Well trained teachers are the key to successful classroom technology integration (CEO Forum, 1997). In other words, it is teachers, not computers that are the most critical component to the integration of technology and increasing student achievement.

Purpose

Teachers are essentially designers. We design curriculum and learning experiences to meet specific purposes. We design assessments to diagnose student needs and to determine whether our goals have been achieved. Similar to other design professions, standards shape our work. More specifically we are guided by state and national standards that specify what students should know and be able to do. Unfortunately, many teachers begin with textbooks and their favorite lessons or activities, instead of targeted goals or standards. In this project I am advocating the reverse. In this project one starts with the goals or standards, and then designs the curriculum called for by those same goals and standards. It is called backward design and while seldom used by many teachers today, Ralph Tyler (1949) was describing its logic 50 years ago when he wrote: "Educational objectives become the criteria by which materials are selected, content is outlined, instructional procedures are developed, and tests and examinations are prepared..." (p. 1). "The purpose of a statement of objectives is to indicate the kinds of changes in the student to be brought about so that instructional activities can be planned and developed in a way likely to attain these objectives" (p. 45).

Project Overview

This project looks at this kind of backwards design in the hopes of eliminating at least some of the preceding dilemmas. The main goal is to describe the creation of a project-based curricular unit that effectively integrates the use of technology, all in the hopes of increasing student achievement. The participants go through the entire process from developing a unit plan, to the creation of a works cited page, student examples and evaluation tools, and other teacher support materials.

More specifically, this project describes the outline for an effective procedure for a backwards design approach as it relates to a technology integrated unit of study. I randomly selected forty K-12 teachers who professed to have basic general computer skills. During approximately forty hours of training, we covered the following topics:

1. Unit Plan
2. Using the Internet to locate resources
3. Student Samples
4. Scaffolds to support the unit
5. Teacher support materials
6. Pedagogical issues

The hope was that these teachers would leave this training with a completed technology integrated unit. Ideally, they would go back to their schools after the last day with a standards-based, technology integrated unit that they, or any other teacher, could teach with on the next school day.

Significance

While much has been written about backward design, the implications in the field of instructional technology, due to the relatively young age of the medium, are somewhat limited. However, with the onslaught of computers in this technological age, more information in this area is certainly warranted. Unfortunately, examples of step-by-step instruction just do not exist at this time. My project provides this step by step instruction in order to make teachers aware of backwards design. While this paper focused mainly on what I have done, more data on all of the most effective components in the backwards design process, as it relates to instructional technology, will ultimately only serve to better prepare students to excel in a technology dependent world.

Limitations

The main limitation of this project is the lack of objectivity in the results, summary, and conclusion sections. This limitation, I believe, results from the recruitment of the participants. In order to move through the material in the allotted time they needed to have certain prerequisite skills, that most considered to be intermediate level computer skills. The following skills were considered prerequisites due to the nature of the training which included a working knowledge of the PC, basic navigational skills on the computer, an entry level knowledge of Microsoft Office suite of programs (Excel, PowerPoint, Publisher, and Word), and an entry level knowledge of navigation on the Internet. The participants needed to be comfortable with:

Operating Systems including using Windows 95/98/2000 or NT, or Mac System 7 or 8.

General Skills to include saving, copying, deleting files to and from floppy disks and hard drives. Cutting, copying, sizing, moving text and graphics, and using drawing tools. Also copying files from a computer to a CD using a CD writer.

Word Processing Skills to include creating, editing, modifying, and merging documents with text and graphics.

Presentation Skills to include creating a presentation using multiple authoring systems. Using drawing tools to create charts and templates. Integrating graphics, video clips, and sound. Transferring images from outside sources.

Internet Skills to include logging on, sending, and receiving email and attached documents. Conducting research using search engines. Downloading and uploading documents and files via file transfer protocol.

In my district, I could not find enough qualified applicants, so I had to accept participants who lacked the prerequisite skills necessary to effectively get through the training. Consequently, I spent much of my time bringing people up to speed on prerequisite skills and their unit projects suffered. When I attempted to objectively look at their units, because they all came to the training with a different skill set, I could not easily distinguish whether or not the unit was appropriate or not. In other words there should be some sort of "relative" evaluation, or some way to determine individual performance.

Another limitation that can be identified at this time is only having one reviewer of the data. This is less of an issue due to the fact that this paper seeks to describe a process rather than to evaluate the product.

Definition of Terms

Computer Clubhouse - Computer Clubhouse is a model learning environment that was founded by The Computer Museum and MIT Media Lab.

Learning Through Collaborative Visualization Project (CoVis) - CoVis is "an integrated software environment that incorporates visualization tools for open-ended scientific investigations and communication tools for both synchronous and asynchronous collaboration" (Edelson, Pea, & Gomez, 1996, p. 161).

Computer-Supported Intentional Learning (CSILE) - CSILE is a "family of developing systems intended to support the collaborative construction of knowledge in and beyond the classroom" (Bereiter & Scardamalia, 1992, p. 41).

GATE - Gifted and Talented Education

Hypermedia - Hypermedia refers to a computer-based system that allows interactive linking of multiple format information including text, still or animated graphics, movie segments, video, and audio (Bagui, 1998, p. 10).

Jasper - Jasper is a project where students are presented with adventures that challenge them to solve real-life problems. Learners are challenged to construct knowledge, collaborate in groups, and then come to conclusions. It is all done in a modular format, so the students understand when, why, and how to use various concepts, skills, and procedures (Cognition and Technology Group at Vanderbilt, (1992).

Preservice - This term relates to those teachers who are still involved in some sort of training in the hopes of gaining a valid, non-restrictive teaching credential.

Resource - Students who need additional academic help in various subject matters.

Unit - A group of lessons that cover a particular topic with a specific scope and sequence.

WebQuests - WebQuests are inquiry-based activities in which some or all of the information that the learners interact with comes from resources on the Internet (Dodge, 1995).

CHAPTER TWO

REVIEW OF THE LITERATURE

Introduction

The literature covered in this review spans a wide range of research with one end in mind, to uncover the effective components of backward design as it relates to instructional technology. My first piece of research reveals that a substantial investment in authoring software is not necessary, and that video does not need to reach a professional standard to be effective. Next I unearth some reasons why multimedia increases learning. After that, the mystery of motivation is closely scrutinized. Lastly, training is studied, first with people who want to be teachers, then with new teachers, next with students, and lastly with experienced teachers. The central theme throughout all of this research is backward design and effective instructional technology.

End-User Satisfaction with a Low-Cost Motion Video Solution for Multimedia and Hypermedia

My first piece of research deals with end-user satisfaction with a low-cost motion video solution for multimedia and hypermedia educational software. This is important because of the increased use of computer-based education (CBE) from the elementary to university levels at a time when funding is being cut across the board. Lamont (1998) states that they are increasingly using hypermedia educational software, often involving motion video, to meet the need for flexibility, interactivity, and innovation. However, Lamont continues, the authoring of such intricate applications can be a daunting and expensive task if it is thought that their presentation must be of television quality. He concludes that if it can be shown that end users are satisfied with lower quality (and therefore lower cost) presentations, then many more lecturers may be encouraged to develop educational software.

Lamont's methods seemed to be appropriate. He used a test application, which consisted of small video (160x120 pixels in size) which was very dependent upon the power, and performance of the equipment used in the experiment. The captured sequences were of a short duration, about 20-30 seconds in length. The computers used were low powered. Half were 486 machines, and the remainders were Pentium 75s. All were connected to a conventional computer network.

Accompanying the movie was a questionnaire, which could be summarized as follows:

1. the time taken to start video sequences,
2. the size of the video sequence window,
3. the visual clarity of the video sequence,
4. their suitability for use in instructional software, and
5. whether or not motion video can be used to good effect generally in educational software.

The test subjects were thirty in number, fifteen males and fifteen females, and their ages ranged broadly.

The summary and conclusion, at least in this particular case, seem to go hand in hand. Consistent standard deviations among the data seem to suggest an agreement between the test subjects. Even though the subjects thought the video was slow and occupied too small a screen area, they believed the clarity was suitable for the purpose. There also seemed to be agreement that, generally speaking, lower quality video can be used to good effect in educational software applications. These results support others assertions (Skillicorn, 1996) that high quality video and hypermedia in educational software in not necessary. Even though they are able to ascertain the lower quality video's shortcomings, they were tolerant nonetheless. These results would therefore indicate that a substantial investment in authoring software is not necessary, and that video does not need to reach a professional standard to be effective.

Reasons for Increased Learning Using Multimedia

Bagui (1998) discusses the research that has shown the capabilities of multimedia environments to better store, connect, and provide access to knowledge represented as text, graphics, audio, and video to enrich student learning. It also discusses the possible reasons for this increase in learning using multimedia and suggests this success is due, in large part, to the similarities between the structures of information processing theory and multimedia. Also discussed are other reasons for an increase in learning using multimedia.

Bagui's definition of multimedia is the use of text, graphics, animation, pictures, video, and sound to present information. He then makes the connection between this type of media, the use of computers, the assumption that people enjoy multimedia, and the fact that numerous studies have shown that computer based multimedia can help people learn more quickly than conventional classroom lectures (Bosco, 1986; Fletcher, 1989, 1990; Khalili & Shashaani, 1994; Kulik, Bangert, & Williams, 1983; Kulik, Kulik, & Bangert-Drowns, 1985; Kulik, Kulik, & Cohen, 1980; Kulik, Kulik, & Schwalb, 1986; Schmidt, Weinstein, Niemie, & Walberg, 1985).

Information processing theory explains how people take in and learn information. Bagui asserts that the structures of multimedia and information processing theory account for the majority of success of learning with multimedia. According to information processing theory, humans learning system consists of four main components:

1. Sense organs, which receive impressions from the environment.
2. Short term memory, which holds limited amounts of information for a limited amount of time.
3. Long term memory, which stores large amounts of information for a longer amount of time.
4. Muscle systems, which perform motor acts such as reading and speaking.

The success of multimedia, Bagui suggests, can be attributed mainly to the dual coding aspect of information processing theory. If, "People generally remember 10% of what they read, 20 % of what they hear, 30 % of what they see, and 50% of what they hear and see", (Treichler, 1967), it is understandable why multimedia can be so successful.

Taking a further look at dual coding, and its importance to this process is critical. The individual codes, or media, that humans use to take in information, are text, voice, visuals, and imagery. Both text and voice present verbal information, either aurally or visually. Visuals support comprehension and form to meaning correspondence, while images are useful for the formation of mental representations of spatial information. Now multimedia makes it easy for us to combine these forms of media to enhance the learning process. Using more than one code during the learning process is referred to as dual coding. Najjar (1996) also suggested that dual coding can be attributed to the increase in learning through the use if multimedia. Numerous studies have shown that dual, or two or more, media improve learning better than using only one medium (Levie & Lentz, 1982; Ellis, Whitehill, & Irick, 1996; Mayer & Anderson, 1991; Shih & Alessi, 1996).

Bagui goes on to describe several other reasons for increased learning through multimedia beyond the structural similarities with information processing theory. The first is that students are better able to control their learning direction and pace with multimedia, and more specifically, hypermedia. Since hypermedia is nonlinear in structure and any of its parts can be linked to other information through buttons, users can browse through a hypermedia system in any manner they choose. This allows different viewers to view things from many different perspectives. If students are given the opportunity to view information from different perspectives, research suggests that they will develop a much fuller understanding of the relationships among the concepts (Jones, 1990; Kozma, 1991; Spiro, Couloson, & Feltovich, 1988).

Another reason Bagui suggests for this increasing learning is that multimedia, and hypermedia, allow chunking. According to information processing theory, information is processed more easily and efficiently if it is appropriately chunked. Information in hypermedia is considered chunked because the users can view the information in any order he or she chooses. Wang and Arbib (1993) also suggest that chunking may also help in the retention process.

The success of multimedia is also due to its more flexible, interactive nature than that of the traditional classroom. Multimedia is interactive because it can be responsive to learner input. Clicking on an icon results in some event related to that icon. Entering search words results in some desired feedback. This sort of interactivity appears to have a strong, positive effect on learning, and is associated with learning achievement and retention (Najjar, 1996). Multimedia is flexible in part due to the wide selections of subjects and titles and the variety of means by which information can be located. It can be used by individuals, small groups, classrooms, or whole schools.

Perhaps the most import factor that can be attributed to the success of multimedia is motivation. The motivational function of the computer in general has been considered an important factor in many instructional programs. While media alone may not motivate learning, research suggests that the intrinsic features of the computer, immediate feedback, animation, sound, and interaction are more likely to motivate students than any other known media (Yang & Chin, 1996-97). Additionally, multimedia appears to be more effective for learners with low prior knowledge and fewer prerequisite skills (Najjar, 1996).

In conclusion, there are several factors that can be attributed to the success of multimedia as outlined in Bagui's research. First and perhaps foremost are the similarities between the structures of information processing theory and multimedia and hypermedia. Other factors include, but are not limited to: it allows for the chunking of information; it is more interactive than traditional classroom lectures; it is more flexible; has richer content; and is more motivational than other forms of media.

The Effect of Being Hypermedia Designers on Elementary School Students' Motivation

Liu and Pedersen (1998) look at project based instruction and the potential to enhance learning and have an effect on elementary students' motivation and learning of design knowledge. Their findings indicate that engaging students in hypermedia could enhance their motivation, and allowing them to be hypermedia designers could support the development of design knowledge and ultimately higher order thinking skills. These skills included, specifically, planning, presentation, reflection, collaboration, task distribution, and time management. Liu and Pedersen also assert that the hypermedia design project provided an opportunity for students of different abilities to grow at their own pace cognitively, affectively, and socially.

The participants of this study were two fourth grade classes from a mid-sized city in the southwestern United

States. Nearly eighty percent of the student population was White. Of the 38 students used in this study, 13% were GATE, and 24% were resource students. Seventeen were female and 21 were male. All students had previously used computers, mostly for word processing and playing games. HyperStudio was chosen as the hypermedia authoring program used in the project. While some students had limited knowledge of HyperStudio, none had used it in any organized fashion. The lab where these students worked contained 15 Macintosh LC computers with 4 MB of disc space and 4 MB of RAM. The instructor's station had more disc space and memory. A color scanner and digital camera were also made available.

The research for this study took place during two semesters in 1996, and 1997, and in three phases. The classes involved (2) participated in this hypermedia authoring project as part of their daily 50-minute science class. The first 6 weeks consisted of an introduction to HyperStudio. Two researchers and a classroom teacher provided modeling, coaching, and scaffolding to help students learn the various features of the program including creating stacks, cards, buttons, creating fields, using drawing tools, and importing media. The purpose of this first phase was for students to acquire the technical skills and create a small HyperStudio stack.

The second phase lasted almost five weeks in which students were asked to create a HyperStudio stack as part of a "plant" unit. During this phase students were introduced to more advanced concepts in HyperStudio such as audio, animation, scanning, linking to other cards in the stack, and linking to outside locations. The researchers and teacher made the design process explicit in the following ways:

a. planning was built in as a mandatory step
b. several presentations discussing the importance of planning were given
c. different forms of peer assessment were included
d. students presented their stacks to an audience of students, peers, faculty and family
e. students worked with a teacher and university researchers during the entire process

The third phase of the process lasted another five weeks and was similar to phase two, with two main differences. The first difference was that in phase three students learned a new unit in science on oceans and were assigned to create a HyperStudio stack based on what they learned. During phases one and two the students had received help from the teacher and researchers concerning the technical aspects of HyperStudio. The second major difference was that this assistance was not given during the third and final phase. While the purpose in phase two was introduce students fully to the program and the design process, in phase three the purpose was to reinforce material from the other phases and give the students the opportunity to develop their projects independently.

While both quantitative and qualitative data was collected during this study, due to time and space limitations I will only look at the qualitative results.

The interviews with the students, coupled with their entries in their daily journals, indicate that the students liked the project very much. When asked what they liked about the project, the following responses were given

It's fun to draw and write what you've learned rather than read out of the book.

I do like using HyperStudio to learn about the oceans because it gives me more time to think about my work.

It helps me learn more and makes work easier.

I like it because you can do more visual things than just listening

It is fun. You can add things to your stack and show others what you have used. So you do not have to try to memorize a whole part. You just open your stack and there it it.

Parents also agreed that the project had indeed motivating their children, which in turn make the learning that much more fun. The overall response seemed to be that not only was the project creative and stimulating, but that it really grabbed the kids's attention. The teacher shared the same view as the parents on the students' interest.

The interview data and journal entries also make it clear that the students learned design skills by participating in this project. When asked what they learned from this project, the following comments were typical from students

> I learned how to use HyperStudio. I think I learned more about each subject that if we just read out of a book.

> I have learned a lot about the subject and how to use HyperStudio. HyperStudio can teach you stuff while you're having fun.

> Make animation. Learn many things about the computer. Different strategies to make a good card.

> I learned a lot about plants and the oceans and learned how to do animation that could show what you're talking about. I also learned how to make invisible buttons and a lot more.
>
> I learned more than just reading books and then taking tests.

Many students mentioned that they learned how to scan images, take digital pictures, make colorful backgrounds, and use clipart to enhance their stacks. Parents also agreed that their children had learned design skills. When polled about what they thought their student had learned, parents mentioned not only the science topic, but also HyperStudio, the analytical process, composition, computer skills, creating and editing, reasoning, and applying critical thinking skills.

This study seemed to find that engaging students in hypermedia authoring can indeed enhance students' motivation and support the development of design knowledge and higher order thinking skills. I would have liked to have seen samples of the instruments used to collect the qualitative data, but none were included. I did not see evidence, as the Liu and Pedersen asserted, that this hypermedia design project allowed the students to grow at their own pace cognitively, affectively, and socially.

While this may have occurred, the evidence was not clear. However, there is other research on this same topic showing the benefits of a learner-as-designer that could support this claim (Beichner, 1994; Erickson & Wilhelm, 1996; Lehrer et al., 1994; Harel, 1991; Kafai, 1996; Liu & Rutledge, 1997; McGrath et al., 1997; Orey et al., 1997; Spoehr, 1993).

Pedagogically Appropriate Integration of Informational Technology

Maeers, Browne, and Cooper (2000) describe ways in which students in a four-year education degree program learn about and with informational technology. Students learn skills and concepts related to technology and its uses and application to the classroom. Also discussed is how their faculty in-service training is being retooled in order to provide more meaningful technology experiences for students. The outlined experiment addresses the content of and responses to technology modules implemented for Faculty of Education.

Maeers, Browne, and Cooper work together in an elementary teacher education program and in the past had tried to integrate technology into their curricular areas. They concluded that the students needed much more exposure to pedagogically appropriate technology environment. They developed a template that outlined all the technology concepts and skill areas they felt that the students needed for teaching, which they wouldn't get from any of their other classes. From this they developed five modules that would be taught to students during the fall semester. They didn't stop there. The authors felt it was of vital importance that the students saw technology modeled effectively in their classes. This meant that the faculty who taught the elementary preservice teachers were encouraged to use electronic presentation software, the internet as a resource, subject area software, and email as a communication tool. The student modules are outlined below:

Module #1 - Email

Module #2 - On-line Software

Module #3 - Web site evaluation

Module #4 - Creating electronic portfolio

Module #5 - Exploring a WebQuest

The first set of modules were obviously skills-based in order to allow students and faculty to acquire the technology skills necessary to grow toward the goal of being able to use the technology in pedagogically-appropriate ways. The next series of modules will focus more on integrating technology into the classroom learning environment. Their hope is that students and faculty will plan and implement these ideas in the field-based experience during the next semester.

These authors understood that if their hope was to be realized it was important that faculty understand the content of the modules so that they could either teach the modules directly, or assist in the teaching. They organized the same basic modules for the faculty (several weeks in advance of the student module) and everyone in the department came to all sessions. The training sessions were example of non-efficient use of computer lab time. Everything went wrong from the faculty not being able to log on to their accounts, to specific web sites being down for upgrading purposes, to no internet access. Through it all they modeled good problem solving strategies, patience, humor, and everyone got a taste of a "real-life" experience.

During the faculty in-service they asked each member to report back on what occurred during the student module. Questions included;

1. What worked well?
2. Did the student understand the concepts and skills?

3. Was the instructor able to teach what need to be taught?
4. What was the instructor's role?
5. What role did the students play?

In addition to this basic questionnaire, they seemed to gather results from conversations that occurred during regular meetings, training sessions, informal conversations, program meetings, and department meetings.

Their summaries were interesting, but somewhat questionable. I thought it strange that all faculty attended all training sessions, until they suggested that maybe they wouldn't have been as interested if teaching these issues hadn't been imminent. They reported that students who had taken the training modules were using technology in the following ways.

1. Email
2. Using online curriculum
3. WebQuests
4. Familiarization with subject-specific software
5. Electronic portfolio development

Unfortunately, they didn't relate how they had arrived at these conclusions. Perhaps some of this data was the result of the questionnaire given to the faculty during the in-service. If it came from the conversations, both formal and informal, then I would have to question the results. I did agree with the way they went about conducting the training.

1. Design training for the students.
2. The faculty must become knowledgeable, so they buy into the training.
3. Train the faculty.
4. Train the students.

I also thought it appropriate that they used the cognitive apprenticeship model of learning (social constructivist theory), as described by Brown, Collins, and Duguid (1989) to form the framework for their modules. Lastly, I thought it important that skills-based modules were taught as a lead in to using technology in more pedagogically appropriate ways.

Creating a Community of Technology Users

Moving away from the "top-down" approach, let's now look at more of a "bottom-up" approach to technology training. The intent of this next project was to facilitate the implementation of computer technologies by providing elementary school students with specialized technology training in order to increase technology use in the classroom. These students would then become "experts or technology resources for their teacher and fellow students." The benefits and limitations of their approach to teacher technology development through the use of student trainers is discussed.

The purpose of this project was to design an approach to training that lessoned or eliminated the following barriers that have been identified in the literature (Gilmore, 1995; Hannafin & Saveny; 1993, Kearsley & Lynch, 1992; Ritchie & Wiburg, 1994):

1. lack of time to practice and explore available technologies
2. need for ongoing assistance
3. required changes in attitudes and pedagogical beliefs
4. need for a shift in traditional teacher's role
5. fear and confidence levels,
6. lack of relevancy of training.

By distributing the task of learning technologies across numerous participants, the negative effect of the first barrier was at the very least decreased. The second barrier was addressed by providing elementary students with expertise in technology who would then provide ongoing assistance to teachers. The third barrier would be more likely to change within a larger, more supportive community. As the students become more and more the experts, the teacher's role will shift from information provider to project manager, taking care of barrier number four. Relieving the teacher's burden to be the technology expert allows them to learn from their students and at the same time will help alleviate their fear of technology. Lastly, allowing the goals of the instruction to drive the context in which the technology is used will ensure the relevancy of the training.

The participants for this study consisted of graduate students, professors, teachers, students, and librarians. The university members were involved in the planning from the start and they did all the presenting to the teachers and the students. Initial efforts focused on the training of the students. For a half hour a week, throughout the school year, the students received instruction in using technologies for accessing information and presentation software. Every two weeks the professors met with the teachers and librarians in order to plan technology related activities for the school.

The student training was split into two sections, the first semester and the second semester. For the first semester the training activities consisted of several learning stations using various computer applications.

They included, but were not limited to, browser software, ClarisWorks, CD ROM software, and the use of digital cameras. Each station provided the students with a take home project. During the second semester the students were assigned a project during their training time which allowed them to integrate and apply the skills they had acquired during the first phase if the training. They searched for library resources using the browser, and used CD ROM resources to collect information. They typed reports and final drafts using the word processor, added original graphics created using paint programs, and created other digital images using the camera. Toward the end of the second semester, the students were introduced to HyperStudio in order to provide another means of presenting information. The students created projects on topics such as dinosaurs, fairy tales, states, and limericks.

The university members conducted a qualitative analysis of the responses to reflective statements collected from other university members, principals, and librarians. They also conducted a qualitative analysis of the questionnaires that were given to teachers and students. They were looking for general patterns in order to determine the strengths and weaknesses of the project.

The only fault I found here was that it appeared they had university members analyzing data from their own reflective statements. The article wasn't clear on this point. The reflective papers were asked to address; observations, what worked well, what could have been better, evaluate their learning, benefits, and frustrations. The questionnaires addressed benefits, limitations, student responses, and any additional impacts.

The results were somewhat mixed, but on the whole quite positive. The benefits included:

1. Teachers were more motivated to learn and use technology
2. Teachers implemented more in class
3. Students were more motivated to learn and use technology
4. Students were more self-directed learners
5. Students were more comfortable using technology
6. Students learned a new way of learning
7. Graduate students gained valuable experience
8. Librarian more confident and self-directed
9. Everyone learned the value of collaboration.

The limitations were far fewer in number, but significant nonetheless, and included:

1. Too few computers

2. Sessions with students too short

3. More personnel needed

4. More teacher involvement needed.

This study sought to implement and evaluate the effectiveness of a "bottom-up" approach to training in contract to the more traditional approach to computer training where teachers are trained in the hope that they will pass on their skills to their students. This approach trained students to go out and become part of a community of learners and distribute their expertise. The results suggest that using students as technology leaders not only transfers their skills to the classroom, but also motivates teachers to integrate technology into their classroom activities. This could be potential benefits for students, teachers, and schools.

Preparing Preservice Teachers for the Technological Classroom

Continuing in the realm of professional development, Johnson-Gentile, Lonberger, Parana, and West, A (2000) created a plan designed to integrate technology into elementary school lessons, while at the same providing valuable educational technology experience for preservice teachers. This paper was developed because nowhere is the need for college and school reform more evident than in the effective use of technology in the classroom. Though many state education boards have mandated requirements for teacher education programs to incorporate technology into their curriculum (Norvak & Berger, 1991), many preservice teachers are graduating from their perspective programs grossly unprepared (Davis, 1994). This paper addresses this issue.

This project took place at the Drew Science Magnet School in Western New York. It is a pre-K through grade eight program. Over 350 workstations serve the needs of teachers, students, and support staff. Data connectivity from all workstations is provided via a fiber-optic Ethernet network which includes file servers, mail servers, and library databases. Additionally, there is a full time connection to the Internet and students have access to their documents from any computer on campus.

Preservice teachers at Buffalo State College were required to participate in lab sessions at Drew School that introduced them to computer software and the programs used at the school. Additionally, there were several technology based assignments that were required of the preservice teachers. First, they had to create curriculum materials for lessons via the computer. Second, they had to use word processing for their lesson plans. Third, they had to access the Internet for some of the information contained in their units. Lastly, they had to produce an original unit that incorporated technology. I believe that the key element here was that the preservice teachers were able to work with this technology during and outside of class time. Not only that, but they also had student teachers, a computer resource teacher, college professors, and other teachers to mentor them. All of this allowed the preservice teachers to utilize the computers in highly creative ways.

To provide a baseline from which the preservice teachers were given a 10-item questionnaire to report on their prior experience, attitude toward, and specific skills with computers prior to this experiment. Key elements of the questionnaire are listed below:

1. Questionnaire return rate was 100%
2. 67% had computers at home
3. Almost 100% believe that technology skills were important to their careers
4. 24% had instruction relevant skills to teach access to the Internet
5. 26% could demonstrate use of software in content areas

Posttest results suggest remarkable gains in confidence regarding the same basic type of instructional skills as displayed in Table 1.

Table 1. Percent of Self Reports of Instructional Skills by Preservice Teachers in the Drew Program

	Questions	Pretest	Posttest
a.	Access the Internet to prepare a report or lesson for a class	21%	100%
b.	Demonstrate to a novice how to access the Internet to prepare a report or lesson for a class	16%	95%
c.	Access CD ROM software in my field	42%	79%
d.	Demonstrate to a novice how to access CD ROM software in my field	36%	79%
e.	Utilize the computer to create artwork or graphics	58%	89%
f.	Demonstrate to a novice how to utilize the computer to create artwork or graphics	58%	89%

The authors admitted that these results were not the product of a controlled experiment and should therefore be taken as formative and not summative evidence for the program's effectiveness. Regardless, when these results are coupled with the actual units and lessons that the preservice teachers created, I would concur that this program was indeed successful. Additionally, I believe that there were two main catalysts for the success of this program. First, the preservice teachers were given the time, inside and outside of the classroom to experiment, collaborate, share and learn. Secondly, and this is supported by numerous research (Case, Norlander, & Reagan, 1993; Stoddart, 1993), if we are to successfully meet the challenge of transforming our schools, it will take the collaborative effort of both school and university personnel.

Technology in a Constructivist Classroom

Ferguson (2001) proposes that constructivism should be a guiding philosophy in order to transform curriculum in which there is seamless technology integration. After defining constructivism, she goes on to outline some of these types of projects and give the basics of the instructional design process that combines features set forth by both Bernie Dodge and Tom March (1995).

According to Ferguson, Constructivism's central idea is that human learning is constructed, and that learners build new knowledge on the footing of previous learning. In this type of atmosphere, the learner constructs knowledge through discovery and exploration in order to solve real world problems. Learners apply current understanding to the situation at hand, note the elements in the new learning experience, recheck prior knowledge, and based on the preceding, modify there knowledge (Ernest, 1995; Fosnot, 1996; Vygotsky, 1978). While I'm not sure these authors had instructional technology in mind, the technological revolution has penetrated every area of society nonetheless. While schools have historically mirrored the values of society, with respect to technology the educational system has remained virtually unchanged. The bottom line is that our children aren't receiving the knowledge necessary to function effectively in a technological world.

If we use technology as part of this constructivist philosophy in our classrooms, our students are given some powerful tools. Computers can be used as writing tools, to complete spreadsheets or databases, for concept mapping and multimedia projects. They can be use to create Internet projects, research, as problem solvers, or to exchange information. However a person applies constructivism to the development of curriculum units Jonassen (1991), Wilson and Cole, (1991), Ernest (1995), and Honebein, (1996) have isolated a number of important design principles:

1. create real-world environments in which learning is relevant
2. focus on solving real-world problems
3. use instructors as guides
4. negotiate instructional goals with students
5. use evaluation as a self-analysis tool
6. help learners interpret multiple perspectives
7. provide multiple representations of reality
8. focus on knowledge construction

Ferguson states that while computer-based constructivists' projects can take many forms, both online and off, they do, however, all have one thing in common; they are based on a problem-solving format (49). She goes on to give the following five examples.

Computer-Supported Intentional Learning (CSILE). CSILE is a "family of developing systems intended to support the collaborative construction of knowledge in and beyond the classroom" (Bereiter & Scardamalia, (1992, p. 41). Basically, it patterns classrooms after research communities, using a collaborative environment and a communal database. This leads to much dialogue, collaboration, and therefore, the accumulation of knowledge.

Learning Through Collaborative Visualization Project (CoVis). CoVis is "an integrated software environment that incorporates visualization tools for open-ended scientific investigations and communication tools for both synchronous and asynchronous collaboration" (Edelson, Pea, & Gomez, 1996, p. 161). This project lets students participate in authentic scientific process using modified versions of the scientists' tools. Students access data, generate questions, develop plans, identify and explore data, and create artifacts.

Computer Clubhouse is a model learning environment that was founded by The Computer Museum and MIT Media Lab. They take students from under served communities and has them work with computers to develop computer-based projects of their own. Their main goal is to teach learners basic computer skills and applications. Rather than playing games, they use state of the art software to create artwork, simulations, multimedia presentations, virtual worlds, music, web sites, and robotics.

Jasper is a project where students are presented with adventures that challenge them to solve real-life problems. Learners are challenged to construct knowledge, collaborate in groups, and then come to conclusions. It is all done in a modular format, so the students understand when, why, and how to use various concepts, skills, and procedures (Cognition and Technology Group at Vanderbilt, 1992).

WebQuests are inquiry-based activities in which some or all of the information that the learners interact with comes from resources on the Internet (Dodge, 1995). Main features include questions that prompt higher level thinking, and scaffolding or prompting to facilitate critical thinking.

Regardless of the type of project chosen, Furgeson advocates a process that contains four steps.

Step One: Determine outcomes.

Step Two: Draft the project framework.

Step Three: Develop the evaluation tool.

Step Four: Design the task.

I believe that these steps can be utilized on a smaller scale for any technology integrated unit. In doing so, our students won't simply be accessing information, but understanding it to solve real world problems. Technology offers us the opportunity to make education an active process where meaning is developed base on experience. Technology offers our students the opportunity to communicate and collaborate with millions of other students, teachers, and other experts.

In the next chapter, I will describe a process that is somewhat similar to Ferguson's ideas, at least in its end product, which is the creation of a technology integrated unit.

CHAPTER THREE

METHODOLOGY

Introduction

In this chapter I will describe the process by which 45 K-12 teachers in the Colton Joint Unified School District underwent forty hours of intensive training on how to effectively create a technology integrated unit of study. During approximately forty hours of training, we covered the following topics:

1. Unit Plan
2. Using the Internet to locate resources
3. Student Samples
4. Scaffolds to support the unit
5. Teacher support materials
6. Pedagogical issues

The hope was that these teachers would leave this training with a completed technology integrated unit.

Participants

The subjects in this project were all K-12 educators. Of the 45 participants, 10 taught grades 9-12, 25 taught grades 4-6, and 10 taught grades K-3. Their experience ranged from first year teachers to teachers with up to 34 years of experience. The training took place in a computer lab over a two-week period. Each participant used the same high-end PC (Pentium IV, 1.6 GHz, 40 GB Hard Drive, 256 MB RAM) during the 40 hours of training. In order to eliminate any bias, the names were removed on all the unit materials before they were chosen for this project. In other words, we may be looking at the unit materials of any teacher K-12 who took the training. Not only will this eliminate any bias, but it will also protect the rights of the subjects, and the confidentiality of their data.

Unit Plan

The first step in this process was the creation of a unit plan. It is important to note that very few of the participants completed this plan in any particular order. The unit plan consists of the following elements:

1. Title
2. Guiding Questions - These questions should encourage higher level thinking skills in order to help them fully understand the concept. Start with one provocative, broad question. Then pose several more specific questions to guide the work of a particular unit.
3. Summary - A concise overview that includes topics to be covered, a description of the main

concepts, and a brief explanation of the activities.

4. Targeted State Framworks - A prioritized list of the state/national standards that will be addressed by the unit.

5. Student Objectives - A prioritized list of objectives that students will have mastered by the end of the unit.

6. Procedures - Describe the scope and sequence of the student activities and the approximate time needed for each.

7. Prerequisite Skills - Describe any prior conceptual knowledge and technological skills the students must have before this unit.

8. Resources - Describe any technology (hardware or software), printed materials, supplies, outside resources, etc. that will be required for this unit.

9. Accommodations for Differentiated Instruction - Describe any modified requirements, assessments, or extensions for the resource, non-native, or gifted students.

10. Assessment - Describe the context and procedures for evaluating the student learning. Examples

include, but are not limited to: interviews, observations, essays, tests, and final products.

Several components of the unit plan, due to their importance in the overall process, require more elaboration. These include the Guiding Questions, Targeted State Frameworks, and Student Objectives sections. The first of these components are the guiding questions.

Guiding Questions

Guiding Questions are a major component of the unit plan and are composed of a single broad question and several narrower, more focusing questions. The questions are designed to encourage students to use higher-level thinking skills and help them to understand the important concepts of the unit. The broad guiding question can be characterized by what it does. In other words, does it go to the center of a particular discipline? Does it recur throughout the history of a field of study? Does it raise other, perhaps more important, questions? These types of broad questions point to the core ideas of a discipline and cannot be answered satisfactory in a sentence or two. Conversely, the narrower, more focusing questions are much more subject and topic specific. Therefore they are better suited for guiding particular content and inquiry, and hopefully lead to the more subtle, broad question.

Focusing questions can be characterized by what they do. In other words, do they provide subject and topic specific pathways to the broad question? Do they have more than one "right" answer? Do they provoke and sustain student interest? Example of guiding questions appear in the following tables.

Table 2. Examples of Guiding Questions

How are problems solved?
What problem were people facing in Europe and Asia?
How were explorers solving problems?
How did explorers change the course of history in America? In California?
How did people's ideas of the world change because of exploration?
How does environment affect survival?
How do resources affect economies?
What are your state's physical features?
Which physical features of your state has affected it's development?
How have resources affected the development of states?
Who are important people in the development of your state?
How has the history of your state affected its development?
How are form and function related?
What is poetry?
What are some strategies used in poetry?
Where does inspiration come from for these poets (Shel Silverstein, Jack Prelutzky?
What is the purpose of poetry?

Targeted State Frameworks

The next major component of the unit plan is the targeted state frameworks. While the content of this section may seem self evident to some, others had quite a bit of difficulty deciding which were the most important standards to address. The bottom line was that this section should contain a prioritized list of standards addressed in the unit. Examples of targeted state frameworks appear in the following table. All standards were retrieved from Content Standards for California Public Schools (http://www.cde.ca.gov/standards/).

Table 3. Examples of Targeted State Frameworks

4th Grade Social Studies
4.2 Students describe the social, political, cultural, and economic life and interactions among people of California from the pre-Columbian societies to the Spanish mission and Mexican rancho periods.
5th Grade Social Studies
5.2 Students trace the routes of early explorers and describe the early explorations of the Americas. 5.3 Students describe the cooperation and conflict that existed among the American Indians and between the Indian nations and the new settlers.
4th Grade Language Arts
Narrative Analysis of Grade-Level-Appropriate Text 3.2 Identify the main events of the plot, their causes, and the influence of each event on future actions. 3.3 Use knowledge of the situation and setting and of a character's traits and motivations to determine the causes for that character's actions.

Reading

Decoding and Word Recognition

1.3 Read aloud narrative and expository text fluently and accurately and with appropriate pacing, intonation, and expression

Technology Foundation Standards for Students

1. Basic operations and concepts
   - Students demonstrate a sound understanding of the nature and operation of technology systems.
   - Students are proficient in the use of technology.
2. Social, ethical, and human issues
   - Students practice responsible use of technology systems, information, and software.
   - Students develop positive attitudes toward technology uses that support lifelong learning, collaboration, personal pursuits, and productivity.
3. Technology productivity tools
   - Students use technology tools to enhance learning, increase productivity, and promote creativity.
   - Students use productivity tools to collaborate in constructing technology-enhanced models, prepare publications, and produce other creative works.
4. Technology communications tools
   - Students use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences.
   - Students use a variety of media and formats to communicate information and ideas effectively to multiple audiences.
5. Technology research tools

Students use technology to locate, evaluate, and collect information from a variety of sources.

Writing Strategies

Students write clear, coherent, and focused essays. The writing exhibits the students' awareness of the audience and purpose. Essays contain formal introductions, supporting evidence, and conclusions. Students progress through the stages of the writing process as needed.

Research and Technology

1.3 Use organizational features of printed text (e.g., citations, end notes, bibliographic references) to locate relevant information.

1.4 Create simple documents by using electronic media and employing organizational features (e.g., passwords, entry and pull-down menus, word searches, the thesaurus, spell checks).

Written and Oral English Language Conventions

1.0 Written and Oral English Language Conventions
Students write and speak with a command of standard English conventions appropriate to this grade level.

Listening and Speaking

1.0 Listening and Speaking Strategies
Students deliver focused, coherent presentations that convey ideas clearly and relate to the background and interests of the audience. They evaluate the content of oral communication

United States History and Geography: Making a New Nation

5.1.1. Describe how geography and climate influenced the way various nations lived and adjusted to the natural environment, including locations of villages, the distinct structures that they built, and how they obtained food, clothing, tools, and utensils.

5.4 Students understand the political, religious, social, and economic institutions that evolved in the colonial era.

5.4.1. Understand the influence of location and physical setting on the founding of the original 13 colonies, and identify on a map the locations of the colonies and of the American Indian nations already inhabiting these areas.

5.5 Students explain the causes of the American Revolution.
1. Understand how political, religious, and economic ideas and interests brought about the Revolution (e.g., resistance to imperial policy, the Stamp Act, the Townshend Acts, taxes on tea, Coercive Acts).

5.8 Students trace the colonization, immigration, and settlement patterns of the American people from 1789 to the mid-1800s, with emphasis on the role of economic incentives, effects of the physical and political geography, and transportation systems.

5.9 Students know the location of the current 50 states and the names of their capitals.

Student Objectives

Following the targeted state frameworks, the next major component of the unit plan is the student objectives; a prioritized list of objectives that students will have mastered by the end of the unit. Examples of student objectives appear in the following table.

Table 4. Examples of Student Objectives

Students will: 1. Research an explorer using various resources (books, internet, encyclopedia) 2. Develop a multimedia presentation that describes: a. Purpose for expedition(s), b. Logistics of expedition (e.g. funding sources, supplies, technology needed) c. Problems faced by explorers and subsequent solutions, d. Route of travel, e. Long term effects of expedition.
Students will... 1. Familiarize with poetry from different authors, including Jack Prelutzky and Shel Silverstein. 2. Utilize the internet to find information on these authors. 3. Create a multimedia presentation based on their interpretation of a poem.
Students will be able to: 1. Research information on State of their choice using printed, digital and internet resources. 2. Identify how the resources of their state has affected the state's history. 3. Identify various aspects of the state's history (people, places, events). 4. Organize information into a comprehensive presentation using multimedia tools. 5. Present information orally in conjunction with multimedia presentation.

Using the Internet to Locate Resources

The next step in the overall process dealt with locating resources for the unit via the Internet. This phase of the training had several key components. First, we discussed ways to ensure that the materials obtained for this project and the subsequent student projects were used appropriately under the constraints of "fair use" and all existing copyright laws. We then discussed the challenges the participants saw in trying to follow these guidelines in their classrooms. In order to facilitate this each participant listed specific guidelines that he or she could implement in a classroom to ensure that students understood and adhered to copyright and "fair use." Lastly we discussed how the different copyright rules apply when published outside of the classroom and how students' projects could be modified for posting to the Web.

The next step in the locating resources via the Internet process was for the participants to gain some understanding of using directories and Web search engines. Participants were guided to use directories when seeking general information on a broad topic, since directories are arranged by subject and usually include return links to the directory's Web site rather than the subject specific pages. Examples of directories are:

Yahoo - http://www.yahoo.com

Magellan - http://magellan.excite.com

Yahooligans - http://www.yahooligans.com

Some additional tips for using directories were also given. These included selections from broad categories and then narrow the search, search on broad keywords, and try different directories as results may vary greatly from one directory to another.

If specific information was desired, and the participants knew the appropriate title, phrase, or technical terms, then they were directed to use a search engine or a meta search engine. Search engines continually visit Web sites and update Web pages. Search engines are best used to locate specific information such as a document or image rather than a general subject. Examples of search engines include:

Alta Vista - http://altavista.com

Excite - http://www.excite.com

Google - www.google.com

If the participants wanted to search multiple databases simultaneously, they were directed to use a meta search engine, since it retrieves results from various databases and gives one consolidated report. Examples of meta search engines include:

Dogpile - http://www.dogpile.com

Metacrawler - http://www.metacrawler.com

Also covered in this part of the training was narrowing a search using Boolean logic. If participants end up with too many choices, or even the wrong results from a search, some search engines allow the use of Boolean logic. Boolean logic consist of three operators AND, OR, and NOT. AND requires all terms to appear in a result. OR retrieves results with either terms. NOT excludes certain terms. Other search engines allow the designation of the most important words within a search by a + (plus sign) or a - (minus sign). A + (plus sign) is used immediately before the most important words, and a - (minus sign) is used immediately before a word to exclude it. If an exact phrase is the object of a search, it should be enclosed in quotation marks. Lastly, if the participants wanted their search to include a variety of spellings, they were directed to enter the first part of the keyword followed by an * (an asterisk).

Following the Internet resources portion of the training, and to ensure that copyright laws were followed, we covered the creation of a works cited page. In other words, a list of references needed to be established as images, sounds, and text were discovered and saved. Depending on their preferences, participants could create a simple list of Internet resources or a formal Works Cited page. Examples of Works Cited pages appear in the following table.

Table 5. Examples of Works Cited Pages

Sir Francis Drake Works Cited
http://www.mcn.org/2/oseeler/voy.htm
http://www.mcn.org/2/oseeler/drake.htm
http://www.global-travel.co.uk/drake.htm
http://www.springfield.k12.il.us/schools/springfield/eliz/SirFrancisDrake.html
http://sirfrancisdrakehistory.net/
http://tqjunior.thinkquest.org/4034/drake.html
http://www.whalecove.com/drake2.html
Poetry Unit Works Cited
Click the text descriptions (usually in gray fields) to enter your own Works Cited information.
Random House Resource Center
http://www.randomhouse.com/teachers/rc/rc_ab_jpr.html
Biography of Jack Prelutsky. It includes a picture of him
Shel Silverstein
http://www.ncteamericancollection.org/litmap/silverstein_shel_il.htm
Biography of Shel Silverstein
Shelly Silverstein
http://www.tamagawa.ac.jp/sisetu/kyouken/se/2000/shell.html
Biography of Shel Silverstein
Children's Haiku Garden
http://www.tecnet.or.jp/~haiku/index.html
Haikus written by children in USA, Japan and Canada.

Works Cited

State Information

50 States

http://50states.com/

Information about each state including dates, symbols and history.

Net State

http://www.netstate.com/states/index.html

Symbols, almanac, news people, etc on all 50 states

Name_of_site

http://www.theus50.com/

The US50 is an extensive guide to history, outdoors, tourism, events and attractions for the fifty states.

State Homepage

www.state.(postal abbreviation).us

If you enter the postal code of your state (e.g. CA for California), you will be taken to the homepage of that state

California Department of Education

http://www.cde.ca.gov/standards/

Content Standards for California Public Schools Kindergarten Through Grande Twelve

Enlightened Images Photography

http://www.enlightphoto.com

Stock Photography and Fine Art Photo Gallery of Coastlines, Shorelines, and Ocean scenes

Next the participants were given several hours for the actual searching of the Internet sites that would serve as the resources for their particular unit. They saved the URLs within their Favorites for later citing in their Works Cited documents. The last item covered in this section, and only for those participants who need the remediation, was the saving of images, sounds, and video from a Web site to their local machines. Most were familiar with this process.

Student Samples

The next topic covered in the overall process was the creation of a student samples (multimedia, publication, and web site). During this activity participants were directed to pretend to be a student in their own classroom and create a student presentation that would become a component of the entire unit. The presentation should still be language, content, and age appropriate, and participants should ensure that it meets all of their targeted student learning objectives. Before the participants were left to create their student projects, they all had a chance to view numerous sample student presentations created by other teachers.

After continually reminding the participants that they were creating these samples as if they were a student, I covered several aspects of creating presentations from planning to saving options. In planning the content I had them list their ideas while considering the students and content they would be working with. Also, as they were planning the content and developing the presentations, I reminded them to make sure and think about how the targeted student learning objectives would be met. Next I had them use a storyboard to plan their content and layout. Again I reminded them to think about how their targeted student learning objectives would be met. One way I had participants focus on content is to create an outline, either in Word or in the outline view of PowerPoint, before they start working with any presentation authoring software. After this had been achieved, and the content was appropriate, I then focused on enhancing the presentations. The following components were covered:

Adding a Background Design

Adding Graphics from Clip Art

Adding Graphics from the Internet

Adding Music from a CD

Inserting a Movie or Sound

Printing Slides for Handouts

Saving in Different Formats

Saving as a Web Page

Working with Existing Text Frames

Connecting and Disconnecting Text Frames

Adding Text Frames

Changing Graphics

Entering Captions for Graphics

Deleting Extra Pages

Saving in Different Formats

Adding Text Frames

Creating a Table

Creating Hyperlinks

Creating Links to the Intenet

Using the Hot Spot Tool

Linking to a File

Linking to PowerPoint presentation

Using the Design Checker

Adding Sound and Video

While all these design features were covered, I stressed that each feature should enhance the content, as too many images, sounds, or animations could distract from the overall presentation. I also reminded the participants to follow all copyright laws, include source citations, and be sure to save their work often.

The last step in the student samples process is the creation of a tool to assess student learning. During this step, the participants created an evaluation tool for assessing their students' learning. I asked the participants to consider the following questions when planning their assessment tool:

Content: Does the content support the presentation's targeted objectives with content specific criteria?

Accuracy: Are there mistakes in spelling and grammar? Is the information accurate, complete, current and meaningful?

Design & Layout: Is the presentation layout and slide order logical and aesthetically pleasing? Is the design consistent? Does the design reinforce the content? Is the text easy to read? Is the background coordinated with the text and graphics? Are any tables properly formatted? Do all links follow a uniform format. Do all links work?

Cooperation: Do all group members show respect for and communicate with other members of the group?

General: Does the assessment effectively measure whether or not students have met the targeted learning objectives? Does the assessment contain topic specific criteria to aid the students?

Examples of different assessment tools are included in the following tables.

Table 6. Examples of Multimedia Assessments

Explorers Presentation

SCORING GUIDE **Multimedia Presentation**

Student ______________________________ Date ________________

	TOTAL VALUE	PEER EVAL	SELF EVAL	SCORE	TEACHER NOTES
CONTENT					
Overall depth of information	10				
Background of Explorer	10				
Purpose/Means of expedition	10				
Summary of expedition	10				
Long-term impact of discoveries	10				
Maps/Visuals of voyage	10				
CREATION OF SLIDES					
Opening Slide with Title/Name	5				
Minimum of 4 slides	5				
Uses transitions	5				
ORGANIZATION					
Spelling and Grammar	10				
Slides are logically presented	5				
Presentation is visually attractive	10				
TOTAL POINTS	100				
Grade					

Poetry Unit

SCORING GUIDE **Multimedia Presentation**

Student ______________________________ Date ______________

	TOTAL VALUE	PEER EVAL	TEACHER EVAL
CONTENT			
Excerpts from the poem	10		
Accurate graphical representations of the poem	10		
Biography of the author	10		
Read fluently	10		
Read with clear diction, pitch, tempo, and tone	10		
CREATION OF SLIDES			
Opening Slide with Title	5		
Minimum of 4 slides	5		
Uses transitions	5		
Uses animations	5		
ORGANIZATION			
Spelling and Grammar	10		
Slides are logically presented	5		
Presentation is visually attractive	10		
Printed Version: 6 slides/page	5		
TOTAL POINTS	100		
GRADE			

States Unit

SCORING GUIDE **Multimedia Presentation**

Student ______________________________ Date ________________

	TOTAL VALUE	PEER EVAL	TEACHER EVAL
CONTENT			
• Describes state accurately	10		
• Includes pertinent information	10		
• Aspects of state clear and concise	10		
• History/geography/resources of state well defined	10		
• Demonstrates understanding	10		
CREATION OF SLIDES			
• Opening Slide with Title	5		
• Minimum of 4 slides	5		
• Uses transitions	5		
• Uses animations	5		
ORGANIZATION			
• Spelling and Grammar	10		
• Slides are logically presented	5		
• Presentation is visually attractive	10		
• Printed Version: 6 slides/page	5		
TOTAL POINTS	100		
GRADE			

Table 7. Examples of Publication Assessments

States Unit
SCORING GUIDE **Newsletter**

Student ____________________________ Date ________________

	TOTAL VALUE	PEER EVAL	TEACHER EVAL
CONTENT			
• Describes state accurately	10		
• Includes pertinent information	10		
• Aspects of state clear and concise	10		
• History/geography/resources of state well defined	10		
• Demonstrates understanding	10		
CREATION OF NEWSLETTER			
• Title	5		
• Minimum of 3 articles	5		
• Incorporates graphics	5		
• Uses color effectively	5		
ORGANIZATION			
• Spelling and Grammar	10		
• Articles are logically presented	5		
• Presentation is visually attractive	10		
• Printed Version: 1 Page	5		
TOTAL POINTS	100		
GRADE			

Poetry Unit

SCORING GUIDE **Publication**

Student ______________________________ Date ______________

	TOTAL VALUE	PEER EVAL	TEACHER EVAL
CONTENT			
• Author's biography	10		
• The poem clearly shows the chosen poetry terms	15		
• At least two poetry terms	10		
• At least three other works by the same author	10		
LAYOUT			
• Title	5		
• Appropriate headings	10		
• Graphics support text	5		
• Space used appropriately and effectively	5		
• *Easy to read*	5		
• poem	5		
ORGANIZATION			
• Spelling	10		
• Grammar	10		
• Presentation is visually attractive	10		
TOTAL POINTS	100		
GRADE			

Explorers Presentation

SCORING GUIDE **Newsletter Presentation**

Student ______________________________ Date ______________

	TOTAL VALUE	PEER EVAL	SELF EVAL	SCORE	TEACHER NOTES
CONTENT					
• Overall depth of information	10				
• Background of Explorer	10				
• Purpose/Means of expedition	10				
• Summary of expedition	10				
• Long-term impact of discoveries	10				
• Maps/Visuals of voyage	10				
CREATION OF NEWSLETTER					
• Exciting article titles	5				
• Clear layout and design	10				
ORGANIZATION					
• Spelling and Grammar	10				
• Articles are logically presented	5				
• Presentation is visually attractive	10				
TOTAL POINTS	100				
GRADE					

Table 8. Examples of Web Site Assessments

Explorers Presentation
SCORING GUIDE Web Page

Student ______________________________ Date ______________

	TOTAL VALUE	PEER EVAL	SELF EVAL	SCORE
CONTENT				
• Overall depth of information	10			
• Background of Explorer	10			
• Purpose/Means of expedition	10			
• Summary of expedition	10			
• Long-term impact of discoveries	10			
• Maps/Visuals of voyage	10			
CREATION OF WEBSITE				
• Clear navigation options	5			
• Clear layout and design	10			
ORGANIZATION				
• Spelling and Grammar	10			
• Information is logically presented	5			
• Presentation is visually attractive	10			
TOTAL POINTS	100			
GRADE				

Poetry Unit
SCORING GUIDE Web Page

Student ______________________________ Date ______________

	TOTAL VALUE	PEER EVAL	TEACHER EVAL
CONTENT			
• Overview/purpose	5		
• Poems (at least two)	10		
• Poetry vocabulary (min. 2 terms)	20		
• Poems relate to the vocabulary	20		
• Relevant graphics	5		
LAYOUT			
• Navigation buttons/bar	5		
• Section headings	5		
• Logical links	5		
• Easy to read text and graphics	5		
• Coordinated colors and backgrounds	5		
ORGANIZATION			
• Spelling and grammar	15		
TOTAL POINTS	100		
GRADE			

State Unit

SCORING GUIDE Web Page

Student ______________________________ Date ______________

	TOTAL VALUE	PEER EVAL	TEACHER EVAL
CONTENT			
• Overview/purpose	5		
• Pertinent Information	20		
• Related information such as links	5		
• Relevant graphics	5		
• Geographic vocabulary	20		
LAYOUT			
• Navigation buttons/bar	5		
• Section headings	5		
• Logical links	5		
• Easy to read text and graphics	5		
• Coordinated colors and backgrounds	5		
ORGANIZATION			
• Spelling and grammar	20		
TOTAL POINTS	100		
GRADE			

Scaffolds to Support the Unit

From student samples we moved next to the creation of scaffolds to support the unit. During this activity participants creating documents, templates, and forms that support their unit and served as scaffolds for their students. In explaining this activity I told the participants that we were creating these scaffolds to guide the students' learning. It is the structure we give to them in order to help them organize and support their learning. Initially, the students use these organizational tools that we have provided for them. Later, after gaining some experience, students learn to create their own tools and become more independent learners. For examples of scaffolds to support units, see the following table:

Table 9. Examples of Scaffolds to Support Units

Student name ____________________

Write your author's information on this sheet.

Author ____

Where was he born?

When was he born?

What is he famous for?

Three interesting facts about him are:

1.
2.
3.

This author has also written:

1.
2.
3.
4.
5.

	Earth	Mercury	Venus	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
Mass (10^{24} kg)	5.9736								
Volume (10^{10} km3)	108.321								
Density (kg/m^3)	5515								
Radius (km)	6378.1								
Average Temperature (K)	288								
Atmospheric Pressure									
Atmospheric Composition	78%N_2, 20% O_2								
Orbit (days)	365.25								
Length of Day (hours)	24								
Distance from Sun (AU)	1								
Number of Moons	1								
Planetary Rings Yes/No	No								

Teacher Support Materials

The next to last topic covered in this process was basically a culmination of ideas for using multimedia, Web sites, and publications for teacher support materials.

During this discussion I tried only to facilitate the sharing of ideas. The participants themselves came up with the vast majority of these ideas that are listed below.

Multimedia Use for Teacher Support

Creating lessons for student absences and remediation

Creating presentations to existing Web sites

Creating presentations from existing lecture notes

Creating autobiographical presentation to show at start of year

Creating presentation templates for different assignments

Creating an Open House presentation

Creating a presentation to introduce another unit

Web Site Use for Teacher Support

Give students and parents access from home to resources via Web site

Creating a Web site to introduce course/class to parents and students

Creating a class Web site with homework, schedules, and calendars

Creating a Web site to publish exceptional student work

Creating Web site templates for different assignments

Creating a Web site to provide resources such as links to homework assistance, search engines, and research

Adding email link for parents to your Web site to facilitate parent/teacher communication

Publication Use for Teacher Support

Send home a newsletter/brochure of the course/class including rules/procedures

Create publications reporting about field trips or special events

Create publication templates for different assignments

Create a Student of the Month brochure

Create project/unit overview brochures

Create class books or even yearbooks

Pedagogical Issues

The last topic covered in this process was that of pedagogical issues. This was basically spending 15-25 minutes daily discussing issues related to the integration of technology into our existing curriculum. Out of these discussions came some very difficult questions, not all of which we had easy answers for. While the results were unanticipated, they were nevertheless viewed in a positive manner. The following is a list of questions generated during these discussions.

How do we provide students with access to Internet information on computers that are not connected to the Internet?

How can schools provide opportunities to increase computer access for those students who do not have access to a computer at home?

How do we, as teachers, ensure that our students focus on content rather than "bells and whistles" when they use multimedia authoring software?

How do we manage, store, and transfer our students' files so that they can locate, access, and edit them regardless of operating system or program software?

How do we protect our students when they use the Internet?

How can our students use e-mail and the Internet to communicate safely with students and other experts?

How can we support the diverse needs of our students when using computers in the classroom?

How can we encourage and increase our female students' interest in technology?

How do we, as teachers, arrange student time on the computer to ensure equal access?

How can we ensure that everyone within a group is engaged and contributing to the group's project?

How can we best manage student use of computers in a lab setting?

Now many of these questions were answered among the participants which was the effect I was after. First of all, I did not want them to think of me as the only expert and them unable to come up with answers or solutions. Secondly, I did not want them to think that my solutions were the only viable solutions. So I let them direct the discussion as much as possible and only jumped in when they appeared to be bogged down or stuck on a particular point.

After the last day of training I copied all units to a CD and made copies of the CD to give to all participants. This was helpful as all participants left the training with at least 15 completed technology integrated units that they, or any other teacher, could begin teaching with on the next school day.

Professional Reflection

Each participant created a technology integrated unit of study, admittedly with varying degrees of success. Every participant created a unit plan with student learning objectives that were aligned, more or less, with state standards. Each participant created a student sample of a multimedia presentation, publication, and Web site.

All participants created a works cited page and an assessment tool for each particular component of their unit. In addition to looking at the individual components of each unit, and to determine the overall quality of the unit, I asked myself the following questions;

Is the proposed technology use engaging, age appropriate, and beneficial to student learning?

Is the technology advocated integral to the success of the unit?

Does the student sample show a clear relationship between the use of technology and student learning?

Does this unit require students to interpret, evaluate, theorize, and synthesize information?

Are the targeted learning objectives clearly defined?

Does the student sample address the guiding questions?

Are the learning objectives clearly aligned with current state frameworks?

Does the unit plan have accommodations to support a diverse group of learners?

Is the unit plan a well developed guideline for implementation?

Could the unit plan be modified for a variety of classrooms?

Does the unit include instruments for authentic assessment?

Is there a clear relationship between the learning objectives and the assessments?

This project looked at a backwards design process in order to create a project-based curricular unit that effectively integrates the use of technology, all in the hopes of increasing student achievement. The units were created, and they did effectively integrate the use of technology, to varying degrees. Did they in fact, or will they, increase student achievement? That question has yet to be answered. But what is clear is that there is a need for more research in this area. The participants in this project did go through the entire process from developing a unit plan, to the creation of a works cited page, student examples and evaluation tools, and other teacher support materials during the approximately forty hours of training. They covered the following topics:

1. Unit Plan
2. Using the Internet to locate resources
3. Student Samples
4. Scaffolds to support the unit
5. Teacher support materials
6. Pedagogical issues

These teachers did leave this training with a completed technology integrated unit. Ideally, they can now go back to their schools with a standards-based, technology integrated unit that they, or any other teacher, are able to teach with on the next school day.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

There seemed to be some disagreement about which components of the training, and maybe the process, are the most valuable. I am not sure that any one set of components are correct, but the process of backwards design has proved valuable.

The unit plan was the critical element to this whole process. Without it as a guideline, the participants would have been much more confused and much less directed. I'm not sure that it must look like the template we used, but for the end result to be an effective technology integrated unit, it needs to contain, at a minimum, the curriculum framing questions, the targeted state frameworks, the student learning objectives, procedures, and accommodations for differentiated instruction. Giving thought to these components is essential to the overall process, if the desired outcome is an effective, technology integrated unit of study.

Using the Internet to locate resources was a highly valuable component to the training. Many of the participants were familiar with basic search techniques but very few had ever even been introduced to Boolean logic and or truncation. One way to minimize training time might be to offer this component in an earlier session, as it would prove useful even to individuals who may not be interested in this type of training. If covered before this the unit training, it might minimize the time required for this process by 1-3 hours. I want to stress that the vast majority of participants found it very useful, so if the participants had not received some sort of using the Internet to locate resources training, I would definitely not omit it.

The student samples were certainly less important than the unit plan, but necessary nonetheless. For this particular project, since the participants were not experienced computer users, we created three student samples; one multimedia presentation, one publication, and one Web site. Once a person is familiar with these different formats, only one might be necessary for a particular unit. This would be one way to minimize the time needed for this type of training by only looking at creating samples in one medium. This would minimize the training by approximately 6-10 hours, especially if the Web site medium is not used as this was usually the most difficult medium for the participants and certainly the most time intensive. For this particular project, we used Microsoft Publisher as our Web site authoring program. If a program with a higher learning curve is used, it might add additional time to the training.

Unlike the additional student samples, the scaffolds to support the unit seem to be entirely necessary. Usually, even with non-technology type units, teachers create these scaffolding items as organizational tools to guide student's learning. This is the structure given to students to help them get organized. For example, the following documents could all be considered scaffolds; concept maps, checklists, study guides, all assessment tools, any pre-formatted documents or templates, and organizational charts or templates. Initially, students use scaffolds provided by teachers. Ultimately, students will move from modifying existing scaffolds to fit their needs, to creating their own scaffolds as needed. Without exception, all participants seemed to feel that this was a very important component to the training, and the process of creating a technology integrated unit of study as a whole.

Unlike student support, the teacher support materials component received mixed reviews from the participants, although I believe it to be entirely necessary and highly useful. Many of the participants felt that the ideas generated from this component of the training to be intuitive, and that the time spent in this discussion could have been better spent working on another component of their project. I disagree. These ideas that the group generated seem intuitive once they have been brought forward and discussed, but I sincerely doubt that most of the participants would have given them much thought, much less implemented them, without this discussion. This line of thinking would be difficult to track, and nearly impossible to prove. But it has been my experience that, many times, without the discussion of how this might work for me, the idea goes undisclosed and thus not implemented.

If the teacher support materials component received less than stellar reviews from the participants, the pedagogical issues component was only slightly better received. I found this interesting. When these questions were first posed to the participants as a whole group, very few, if any of them, had any answers at all. Many of the participants commented that they would have rather spent the time working on their projects (one of the student samples) than going over issues related to doing their projects. It seems that this may have been another function of the participants not having the prerequisite skills needed upon arrival. Many of them felt pressure to complete the student samples in the allotted time, and very few of them accomplished this. Without the stress of being on a deadline that they were not going to be able to meet, I believe they would have seen the value in the pedagogical issues component. For a list of those questions, please see Teacher Support Materials in Chapter 3.

Recommendations

Recommendations for incorporating this project would probably vary from site to site. For the majority of school sites, much consideration needs to be given to the prerequisite skills needed to undergo a project of this type. After assessing potential candidates' skills, I would suggest intensive training to ensure a particular skill set before attempting a project of this magnitude. In other words, there needs to be some general computer skills, such as navigation, word processing, and presentation knowledge in place before this type of training would be most successful. I would also look carefully at who to train at a particular site. One way might be to train the majority of a staff in general computer applications, ensuring the necessary beginning skill set, while those who already possess the prerequisite skills begin this type of technology integration training. Since sending all staff members to a forty hour training is not feasible for many sites, sending qualified representatives from different grade levels or different tracks, in year round schools, seems to work well.

As far as the training itself is concerned, I believe it is valuable and necessary in its entirety. There are some previously discussed time saving features (see Conclusions) that might be incorporated, but I believe the basic process needs to be presented in its entirety. If we are going to face the technological challenges before us, we need to begin by focusing on the standards. The standards that govern our students' achievement, and our educators' abilities need to be addressed now!

REFERENCES

Bagui, S. (1998). Reasons for increased learning using multimedia. Journal of Educational Multimedia and Hypermedia, 7(1), 3-18.

Beichner, R. J. (1994). Multimedia editing to promote science learning. Journal of Educational Multimedia and Hypermedia, 3(1), 55-70.

Bereiter, C., & Scardamalie, M. (1992). Two models of classroom learning using a communal database. In S. Dijkstra (Ed.), Instructional models in computer-based learning environments (pp. 47-71). Berlin: Springer-Verlag.

Bosco, J. (1986). An analysis of evaluations of interactive video. Educational Technology, 25, 7-16.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. Educational Researcher, 18(1), 32-42.

Case, C. W., Norlander, K. A., & Reagan, T. G. (1993). Cultural transformation in an urban professional development center: Policy implications for school-university collaboration. Educational Policy, 7(1), 40-60.

CEO Forum. (1997). School technology and readiness: From pillars to progress. Washington, DC: CEO Forum on Education and Technology.

Cognition and Technology Group at Vanderbilt. (1992). The Jasper experiment: An exploration of issues in learning and instructional design. Educational Technology Research and Development, 40(1), 65-80.

Content Standards for California Public Schools. Retrieved June 1, 2001. http:// www.cde.ca.gov/standards/.

Davis, N. (1994). Practicing what we preach: New technology models for teacher preparation. Proceedings of the National Educational Computing Conference (pp. 78-80). Boston, MA:

Dodge, B. J. (1995). Webquests: A structure for active learning on the World Wide Web. The Distance Educator, 1(2), 167-210.

Edelson, D., Pea, R., & Gomex, L. (1996). Constructivism in the collaboration. In B. G. Wilson (Ed), Constructivist learning environment: Case studies in instructional design (pp. 151-164). Englewood Cliff, ND: Educational Technology.

Ellis, J. A., Whitehill, B. V., & Irick, C. (1996). The effects of explanations and pictures on learning, retention, and transfer of a procedural assembly task. Contemporary Educational Psychology, 21, 129-148.

Erickson, J., & Wilhelm, J. (1996). Building a community of designers. Paper presented at the annual conference of American Educational Research Association (AERA), New York.

Ernest, P. (1995). The one and the many. In L. Steffe & J. Gale (Eds.). Constructivism in education (pp. 459-486). Hillsdale, NJ: Lawerence Erlbaum.

Ferguson, D. (2001). Technology in a Constructivist Classroom. Information Technology in Childhood Education Annual, 45-56.

Fletcher, D. (1989). The effectiveness and cost of interactive videodisc instruction. Machine-Mediated Learning, 3, 361-385.

Fletcher, D. (1990). The effectiveness and cost of interactive videodisc instruction in defense training and education (IDA Paper P-2372). Alexandria, VA: Institute for Defense Analyses.

Fosnot, C. (1996). Constructivism: A Psychological theory of learning. In C. Fosnot (Ed.) Constructivism: theory, perspectives, and practice (pp. 8-33). New York: Teachers College.

Gilmore, A.M. (1995). Turning teacher on to computers: Evaluation of a teacher development program. Journal of Research on Computing in Education, 27, 251-269.

Goldberg, B., & Richards, J. (1995). Leveraging technology for reform: Changing schools and communities into learning organizations. Educational Technology, 35(5), 5-16.

Hannafin, R. K., & Savenye, W. C. (1993). Technology in the classroom: The teachers' new role and resistance to it. Educational Technology, 33(6), 26-31.

Harel, I. (1991). Children designers. Norwood, NJ: Ablex Publishing.

Heaton, S., & Brown, J. M. (1995). Staff perceptions of incentives and hurdles to the use of technology. Computers in Libraries, 15, 28-31.

Honebein, P. (1996). Seven goals for the design of constructivist learning environments. In B. Wilson (Ed.), Constructivist learning environments (pp. 17-24). NJ: Educational Technology.

Hruskocy, C., Cennamo, K., Ertmer, P., & Johnson, T. (2000). Creating a community of technology users: Students become technology experts for teachers and peers. Journal of Technology and Teacher Education, 8(1), 69-84.

International Society for Technology in Education. Retrieved June 1,2001. http:// http://www.iste.org/standards/ncate/found.html.

Johnson-Gentile, K., Lonberger, R., Parana, J., & West, A. (2000). Preparing preservice teachers for the technological classroom: School-college partnership. Journal of Technology and Teacher Education, 8(2), 97-109.

Jonassen, D. (1991). Evaluating constructivist learning. Educational Technology, 36(9), 28-33.

Jones, A. J. (1990). To criss-cross in every direction or, why hypermedia work. Academic Computing, 4(4), 20-21, 30.

Kafai, Y. B. (1996). Learning design by making games: Children's development of design strategies in the creation of a complex computational artifiact. In Y. B. Kafai & M. Resnick (Eds.), Constructionism in practice. Mahwah, NJ: Lawrence Erlbaum.

Kearsley, G., & Lynch, W. (1992) Educational leadership in the age of technology: The new skills. Journal of Research on Computing in Education, 25, 50-59.

Khalili, A., & Shashaani, L. (1994). The effectiveness of computer application: A meta-analysis. Journal of Research on Computing in Education, 27, 48-61.

Kozma, R. B. (1991). Learning with media. Review of Educational Research, 61(2), 179-211.

Kulik, J. A., Bangert, R. L., & Williams, G. W. (1983). Effects of computer-based teaching on secondary school students. Journal of Educational Psychology, 75, 19-26.

Kulik, J. A., Kulik, C. C., & Bangert-Drowns, R. L. (1985). Effects of computer-based teaching on elementary school students. Computers in Human Behavior, 1, 59-74.

Kulik, J. A., Kulik, C. C., & Cohen, P. A. (1980). Effectiveness of computer-based college teaching: A meta-analysis of findings. Review of Education Research, 50, 525-544.

Kulik, C. C., Kulik, J. A., & Schwalb, B. J. (1986). The effectiveness of computer-based adult education: A meta-analysis. Journal of Educational Computing Research, 2, 235-252.

Lamont, C. (1998). End-user satisfaction with a low-cost motion video solution for multimedia and hypermedia educational software. Journal of Educational Multimedia and Hypermedia, 7(2/3), 109-122.

Lehrer, R., Erickson, J., & Connell, T. (1993). Learning by designing hypermedia documents. Computers in the Schools, 10(1/2), 227-254.

Levie, W. H., & Lentz, R. (1982). Effects of text illustrations: A review of research. Educational Communication and Technology Journal, 30, 195-232.

Liu, M., & Rutledge, K. (1997). The effect of a learner as multimedia designer environment on at-risk high school students' motivation and learning of design knowledge. Journal of Educational Computing Research, 16(2), 145-177.

March, T. (1995). Working the web for education. [Online]. Available: http://www.ozline.com/learning/theory.html

Maeers, M., Browne, N., & Cooper, E. (2000). Pedagogically appropriate integration of informational technology in an elementary preservice teacher education program. Journal of Technology and Teacher Education, 8(3), 219-229.

Mayer, R. E., & Anderson, R. B. (1991). Animations need narrations: An experimental test of a dual-coding hypothesis. Journal of Educational Psychology, 83, 484-490.

McGrath, K., Cumaranatunge, C., Ji, M., Chen, H., Broce, W., & Wright, K., (1997). Multimedia science projects: Seven case studies. Journal of Research on Computing in Education, 30(1), 18-37.

Najjar, L. J. (1996). Multimedia information and learning. Journal of Educational Multimedia and Hypermedia, 5(2), 179-201.

Novak, D. I., & Berger, C. F. (1991). Integrating technology into preservice education: Michigan's Response. Computer in the Schools, 8(1 2/3), 89-100.

Orey, M., Fan, H., Scott, E., Thuma, T., Robertshaw, B., Hogle, J., & Tzeng, S. (1997). Stories about children and teachers as they create multimedia documents in a university influenced small city and a large inner city. Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.

Ritchie, D., & Wiburg, K. (1994). Educational variables influencing technology integration. Journal of Technology and Teacher Education, 2, 143-153.

Schmidt, M., Weinstein, T., Niemei, R., & Walberg, H.J. (1985). Computer-assisted instruction with exceptional children. Journal of Special Education, 9, 493-502.

Shih, Y. F., & Alessi, S. M. (1996). Effects of text versus voice on learning in multimedia courseware. Journal of Educational Multimedia and Hypermedia, 5(2), 203-218.

Spiro, R., Couloson, R., & Feltovich, P. (1988). Cognitive flexibility theory: Advanced knowledge acquisition in structured domains. Proceedings of the Tenth Annual Conference of the Cognitive Science Society, 375-383.

Spoehr, K.T. (1993). Profiles of hypermedia authors: How students learn by doing. Paper presented at the annual meeting of the American Educational Research Association, Atlanta, GA.

Stoddart, T. (1993). The professional development school: Building bridges between cultures. Educational Policy, 7(1), 5-23.

Treichler, D. G. (1967). Are you missing the boat in training aid? Film and A-V Communication, 1, 14-16.

Tyler, R. W. (1949). Basic principles of curriculum and instruction. Chicago: University of Chicago Press.

Vygotsky, L. (1978). Mind in society: The development of higher psychological processes. Boston: Harvard University.

Wilson, B., & Cole, P. (1991). A review of cognitive teaching models. Educational Technology Research and Development, 39(4), 47-64.