

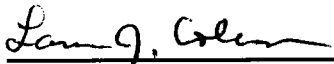
To the Graduate Council:

I am submitting herewith a dissertation written by Karen Milligan entitled "Making the Computer a Part of Teaching: A Piece of the Puzzle." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Education.



E. Dale Doak, Major Professor

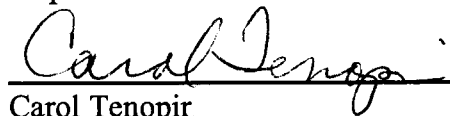
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MAKING THE COMPUTER A PART OF TEACHING:
A PIECE OF THE PUZZLE

A Dissertation
Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

Karen Little Milligan
December 1998

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ABSTRACT

This study used grounded theory methodology to develop a model of how teachers in a single, typical school made technology a part of teaching. Unlike other studies that have looked only at exemplary technology using teachers or teachers in technology rich schools, this study examined how teachers in a single elementary school with typical technology resources made technology a part of their teaching.

Eagleton school was chosen as a typical school based on its comparison to average school size and technology resources. Teacher interviews and classroom observations were completed during a single school year. The data was analyzed using the techniques of grounded theory.

For the Eagleton teachers the process of making technology a part of teaching was like fitting a new piece into the puzzle that is their classroom. There were two key concepts that propelled the teachers forward toward making the piece fit: knowledge and enjoyment. These two concepts were related to each other in a spiral fashion. As teachers increased their knowledge of the computer, they increased their acceptance and enjoyment of the computer.

Knowledge develops along a continuum from a time in which teachers are dependent on the knowledge of others to a time when they are independent learners. An important part of moving forward on the knowledge continuum is the development of a

foundation of basic knowledge. Enjoyment develops along a continuum from a time in which the computer is new and unfamiliar to teachers to a time when teachers are comfortable with and enjoy using the computer. An important part of moving forward along the enjoyment continuum is overcoming fear.

Two factors influenced this spiral movement of knowledge and enjoyment: students and resources. As a result of the process of making the computer a part of teaching the other pieces of the puzzle, such as the decisions that teachers made about time devoted to learning activities, the structure of those activities, and the management of students while they were completing the activities, changed in some way. Teachers devoted time to computer use by setting aside times for their students to experience using the computer and to meet curricular objectives. The most frequent use of the computer for most teachers with only one computer was with the whole group activity structure. Teachers also used computers with individuals during independent work time. Partners were used occasionally by teachers. Small groups were used less frequently. Teachers developed a series of routines to manage computer use. These routines fell into three types: routines to establish independent work skills, routines used during a special computer time, and routines for individual student use during independent work time.

For the Eagleton teachers, the computer is a part of their everyday lives. It is used for non-teaching tasks such as creating worksheets, calculating grades, and communicating with other teachers and staff. The shape of the computer piece of the puzzle was very similar for all the Eagleton teachers. The majority of teachers used the computer as a

supplement, an extra. They see that the computer has potential as an instructional tool. They are still struggling to find ways to make use of that potential.

Each individual teacher has begun a gradual process of fitting the computer into the puzzle, spurred on by student interest and excitement about computers and growing resources. Some teachers were progressing at a slower pace than others, but all the teachers were moving forward. No single teacher had totally refused to use the computer.

What is striking about the results of this research is that the Eagleton teachers' routines and practices when using the computer were so very similar. Unlike other studies which report typologies of teachers based on computer use, there was no clear typology of teachers found in this study. The Eagleton teachers showed few developmental changes or stages. The Eagleton teachers did not report that the computer changed their practice. There was not a move toward progressive practices. The limited developmental stages and the similarity of instructional use of the computer demonstrated the importance of context in the process of making the computer a part of teaching.

In order for the computer to bring about educational change, educators will need to consider the context. Simply introducing the computer to teachers will not bring about educational change. When we introduce technology we need to set clear pedagogical goals for what we want that technology to accomplish. Teachers should be an integral part of the decision making process for it will be the common, typical teachers who will implement any goals that are set.

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CHAPTER 1 - INTRODUCTION

Twenty-five years ago computers were large, mysterious calculating boxes tucked away in research institutions, far away from everyday life. The impact they would have on our society was mere speculation. Indeed computers have changed almost every facet of our daily lives. Computers offer a promise of change to our educational system much the same as the book changed education, by allowing storage of information over time and place (Moursund, 1992). Yet schools today remain much the same as they were in the past (David, 1991, 1994; Loveless, 1996).

The use of technology can be seen as a perfect example of the constancy and change in public schools, a part of the cycle of never ending 'fads' (Cuban, 1986). Changes come and go and yet many things remain the same. Since the early 1900's, a succession of new technologies have entered the classroom with the teacher usually being blamed for their failure to succeed. Cuban (1986, 1989) concluded that technological innovations go through a cycle of exhilaration, scientific credibility, disappointment, and blame. When a new innovation is introduced into schools there is much excitement about its potential in the general press. Scientific research then follows in an effort to back up this claim. When the studies fail to produce unequivocal support, the result is a search for who to blame.

Cuban (1986) calls the teacher the gatekeeper of innovation, for it is the teacher who must implement the innovation. Regardless of the place or method of introduction, one result that is consistently found is that the teacher is the key factor in the success or lack of success in any initiative to put computers in the classroom (Collis, 1996). Teachers understand that school organizations already have embedded within them powerful beliefs about the nature of knowledge, how students learn, and how teachers should teach (Cuban, 1989). To understand teaching it is important to understand the “complex interplay between teachers’ intentions and abilities, and the motivational and normative background in concrete and changing situations” (Carlgren & Lindblad, 1991, p.510). The way to understand how external factors influence teaching is to describe these factors from the teachers’ point of view. The teacher is a key factor in using technology to bring about positive change. Technology cannot just be installed in a school without considering the people who will use it (Carstens, 1995). Successful technology integration will be influenced much more by human factors than by technical ones.

So the teacher becomes the center of effective use of technology. It is the teacher who will lead students to become comfortable, effective users of technology. Technology is not a silver bullet or magic box that will cure all our educational ills (Means, Olson, & Singh, 1995). According to the 1995 Office of Technology Assessment (OTA) report, *Teachers and Technology*, there is relatively little research on how and why teachers use technology. “Most research about educational technology has focused on the impact of technology on students; little attention has been given to its impact on teachers”(Office of

Technology Assessment, 1995, p.51). Even in providing technology to schools our emphasis has been on student access and not teacher access (Hasselbring, 1991). The search for how teachers can use technology effectively will not yield one right answer but many. The type of research that will yield the kind of answers we need must do more than just ask if a particular approach works. Rather it will need to ask when, where, and how does technology work in real classrooms over time. More contextualized approaches to research can help educators understand the process of finding effective ways of using technology. The role of the teacher will become a critical element in these studies (Office of Technology Assessment, 1995).

Much of the research that we do have about teachers and technology focuses on a very small population of teachers - the enthusiastic, exemplary technology-using teachers (Becker, 1994; Hadley & Sheingold, 1993). Other research about technology-using teachers has come from technology rich environments where teachers have a large quantity of hardware, software, and technical support (Dwyer, 1994; Dwyer, Ringstaff, & Sandholtz, 1991; Ringstaff, Sandholtz, & Dwyer, 1991; Sandholtz, Ringstaff, & Dwyer, 1997). We know very little about how teachers in typical schools with adequate or less than adequate technology resources are making decisions about using technology in their classrooms.

RESEARCH PROBLEM

This study sought to address the need for contextualized research on teachers and technology. Unlike other studies that have looked only at exemplary technology using teachers or teachers in technology rich schools, this study examined how teachers in a single elementary school with typical technology resources (operationally defined in Chapter Three) made technology a part of their teaching. The following question and subquestions guided the investigation.

Research Question

How do teachers make technology a part of their teaching?

Research Subquestions

How does technology interact with teachers' beliefs, practices, and roles? How does technology impact interaction between teachers? How does curriculum impact teachers' integration of technology into their teaching? What personal factors influence teachers' integration of technology?

REASONS FOR RESEARCH

Many educators feel that computer technology is different from past technologies in its power to bring about educational change. One reason that computers could transform schools when earlier technologies didn't is that they have more power, versatility, portability, and are easier to use. Further, they appear at a time when there is a presence of restructuring activities. Current restructuring activities are different from those in the past because they are focusing on systemic change (David, 1991).

If technology is to bring about change, then we need to know how teachers are using technology. The teacher is both the factor that must be changed and the change agent (Loveless, 1996). One of the recommendations of the 1995 OTA report was for more research on the interaction between technology, teachers, and the instructional context. Understanding the process of adopting technology can become the basis for the development of programs, procedures, and methods that can help technology reach its potential as a catalyst for educational reform. Additionally it can provide teachers, who are learning to use technology, information about what other teachers have experienced in this process. They may be able to recognize possible obstacles to the process and make informed decisions about how they can make technology a part of their teaching (Sandholtz et al., 1997). Knowing how technology impacts teachers also has implications for how we use technology in teacher education; for teacher educators are teachers too.

METHODOLOGY

As Barbara Means (1994) concludes from her examination of technology and educational reform, there is no one right way for a teacher to use technology or for a school to adopt technology. There are multiple perspectives that must be taken into account in understanding the adoption process. One research methodology that offers a means for understanding multiple perspectives is grounded theory. "The grounded theory approach is a qualitative research method that uses a systematic set of procedures to develop an inductively derived grounded theory about a phenomenon" (Strauss & Corbin, 1990, p. 24). Grounded theory is well suited to examining process. "A major argument of

this methodology is that multiple perspectives must be systematically sought during the research inquiry” (Strauss & Corbin, 1994, p. 280).

Grounded theory was developed by Barney Glaser and Anselm Strauss (Glaser & Strauss, 1967; Strauss, 1987). A later collaborator with Anselm Strauss is Juliet Corbin (Strauss & Corbin, 1990; Strauss & Corbin, 1994). Glaser and Strauss define grounded theory as the discovery of theory from data. Grounded theory is a general methodology that is grounded in systematically gathered and organized data. Theory that is generated from data produces theory that can be easily understood and applied by laymen involved in the area to which the theory is applied. Grounded theory is a way of thinking about and conceptualizing data (Strauss & Corbin, 1994). Grounded theory can be used to explain as well as to plan a course of action. In a grounded theory study, the researcher begins with an area of interest. Explanations or theory derived from the data lead to further data collection. The researcher constantly moves between data collection and data analysis. This leads to the other name for this approach, the constant comparative method (Mann, 1993).

Where other forms of qualitative research seek to provide only rich descriptions, grounded theory strives to move beyond descriptions. Grounded theory is different from description in its use of concepts. Data are categorized and given conceptual labels which requires interpreting the data. The concepts are related to each other by statements of relationship. In other types of qualitative research, the data may be organized according to themes but these are more like summaries of words taken directly from the data (Strauss

& Corbin, 1990). Grounded theory places the emphasis on conceptual density which refers to the richness of concept development and relationships rather than on thick or rich descriptions. "Theoretical conceptualization means that grounded theory researchers are interested in patterns of action and interaction between and among various types of social units . . . They are also concerned with discovering process - not necessarily in the sense of stages or phases, but of reciprocal changes in patterns of action/interaction and in relationship with changes of conditions either internal or external to the process itself" (Strauss & Corbin, 1994, p. 278). Grounded theories are embedded in time and place.

Grounded theory techniques can be used to develop all levels of theory but most grounded theory research aims to develop substantive theory, theory that fits a specific situation and context. This is due largely to the mainly substantive interests of its practitioners rather than the nature of the methodology. There is also built into this method a mandate to strive toward verification of the developing theory (Strauss & Corbin, 1994). This verification is done throughout the course of the research.

With the use of grounded theory methodology, this study sought to develop a theory of how teachers make technology a part of their teaching at a typical school. The data comes from interviews and observations over a single school year. The result is a model of the process that individual teachers go through in making technology a part of teaching. The initial starting point for the model was the educational literature.

CHAPTER 2 - REVIEW OF THE LITERATURE

PURPOSE OF LITERATURE REVIEW

In the early presentation of grounded theory, Glaser and Strauss (1967) were concerned that the purpose of research should be to generate theory rather than to test theory. To encourage theory generation research and move away from theory verification they downplayed the role of the literature in the formulation of the research question. They encouraged researchers to ignore the literature and instead to see the potential for data in the library during data collection and analysis in the form of documents produced by people, groups, or institutions under study. In later versions of grounded theory, the role of the literature was expanded (Strauss & Corbin, 1990). In quantitative research the literature review serves as a necessary first step to identify the variables around which the research will center. In a grounded theory study, the literature serves as a place to look for possible relevant categories that will be used as a beginning point in the discovery of a grounded theory. Grounded theory seeks to explain phenomena in terms of the data itself rather than adhering to a previously designed theory. However as the theory does evolve in the data the researcher may be able to incorporate relevant elements of previous theories.

Strauss and Corbin (1990) do recognize that the researcher comes to the study with a background in the technical literature which he or she should acknowledge and use.

However they do not see a need to complete a comprehensive literature review before beginning the research. Discovery is the purpose of this research methodology and therefore all of the categories relevant to the theory cannot be known. The literature can be helpful in designing questions for interviews. It also can give the researcher ideas about where he or she might go to uncover phenomena important to the development of the theory. After the categories or variables have emerged from the data then the researcher goes back to the literature to see if other researchers have written about the topic and what they have written.

The following review of the literature seeks to serve this purpose. It was begun even before the dissertation purpose was fully developed and continued throughout the research process. The literature selected for this chapter seeks to provide an overview of the research concerning teachers and technology. It will provide the background for the initial decisions of site selection and data collection. Chapter five will look at the literature again in light of the grounded theory developed during the research process. The review will begin with an examination of the place that the computers play in the classroom today followed by a description of the instructional use of computers and factors that influence the adoption of technology. The chapter will conclude with a description of typologies of teachers adopting technology and models of technology adoption.

THE COMPUTER IN THE CLASSROOM

Howard Mehlinger (1996) provides a provocative metaphor when he compares technology integration to a volcano in Hawaii. Man can not stop the flow of lava. It continues by either burning up the obstacles in its path or simply rolling over them until it meets nature's immovable object, the ocean. A volcano changes the environment in ways that cannot be predicted and cannot be stopped. The information age is like that volcano, it will bring about change even if we don't always notice the change while it is happening. "The exact shape of future schools is unclear, but of this I am certain: schools will be unable to resist the new technology. The new technology will be used in schools because it appeals to students and may enhance learning and because the schools can offer no reasonable defense for rejecting it" (Mehlinger, 1996, p. 402).

While schools may not be able to offer a reason to reject technology, there have been many reasons proposed to accept technology. Hawkrige (1989) summarizes some of these in his article about technology adoption in schools in third world countries. He proposes social, vocational, pedagogical, and catalytic rationales for computer use.

The social rationale is concerned with the a student's place in society. Schools should prepare children for life. Therefore children should learn to use computers because they are a part of life. Computers should not be mysterious. This rationale can be seen in computer awareness classes or clubs where children learn how computers work with little hands on experience.

The vocational rationale reasons that teaching students how to use a computer will give them the skills they need to find jobs. Education involving the computer should be related to finding a job. When this rationale is being used, students will take courses in computer literacy or computer science.

This pedagogical rationale is probably the one with the most support of educators. Children should use computers because they can learn with them. Computers should become a classroom aid to be used occasionally as appropriate.

The catalytic rationale for computers propose that computers should be used as catalysts to bring about educational change. "Computers encourage students to learn by collaborating rather than competing with other students. Teachers using them adopt 'more relevant' curricula and bring educational opportunities to a larger number of children. Administrators improve the way they manage schools" (Hawkridge, 1989, p.320). This rationale describes schools as they might become if enough computers with the right kind of software are present for schools to change. No matter which rationale or combination of rationales is used the presence of computers in America's schools is increasing.

The Number of Computers in Schools

During the 1980's the number of computers increased in American schools 50 fold, from 50,000 in 1983 to roughly 2,400,000 in 1989. In a 1991 study, Henry Becker reports the results of three surveys conducted by John Hopkins Center for Social Organization of Schools (Becker, 1991a). The 1983 survey found that most schools had so few computers in relation to the number of students that students actually only spent

a fraction of their time with a computer. In this small amount of time students were probably only learning about how the computer operates and not learning academic content and skills. In the 1985 survey, computers were used mostly for enrichment or in secondary schools for computer literacy classes. They were rarely used to provide instruction. The 1989 international survey reported a consistent annual increase in the number of computers in the schools in a four year period beginning in 1985. However when compared with earlier years, 1982 - 1984, this represented a decline in the annual rate of increase (Becker, 1991a).

Technology is increasing so quickly that it is difficult to get exact figures about the number of computers in classrooms. Most of the numbers that are reported are projections. The Office of Technology Assessment, (OTA) projected that in Spring of 1995 there would be 5.8 million computers used in instruction in American schools which is a ratio of about one computer to every nine students. Seventy five percent of public schools have access to some kind of network, 35% of public schools have Internet access. Only one teacher in eight has a telephone line in the classroom. The amount of access to telecommunications networks is changing rapidly. In 1992 at least 10 to 15% of schools had at least one teacher who used electronic mail or information networks. About 20% of schools reported using some type of communications service such as National Geographic Kids Network. The extent of telecomputing activities among teachers is not well understood. It does seem to be growing rapidly but the majority of teachers in the US do not have access to telecommunications services (Office of Technology Assessment,

1995). According to the National Center for Educational Statistics the number of classrooms connected to the Internet rose from nine percent in 1995 to 16% in 1996 (Trotter, 1997).

It is estimated that the current ratio of students to computers is seven to one (Viadero, 1997). However, it is difficult to trace exactly what types of computers are included in such statistics. Research by the OTA (1995) attempted to look at types of computers present. In 1992 the typical high school had 54 computers and the typical elementary or middle school had about 25 (calculations are medians). In elementary schools 60% of machines were older 8-bit machines, 23% were intermediate level machines, and 14% were up-to-date machines. In middle schools older machines were 48%, intermediate level were 28%, and up-to-date machines were 20%. In high schools only 34% were older machines, 28% were intermediate machines and 34% were up-to-date machines. Over half the machines in American schools were older 8-bit machines, mostly Apple IIs. Most software today requires the newer machines. The result is that most of the more promising uses of technology for instruction can only be accomplished on a limited number of machines in the schools.

These figures represent national averages. There is a great difference in student to computer ratio from school to school. Schools with fewer students have more computers per student no matter what the demographics of the school. Technology use is also not consistent across grade levels and schools (Krendl & Clark, 1994). Further, these statistics do not reveal information about individual student access in the schools. Many

times low ability, poor and minority students have less access to computers at school (Office of Technology Assessment, 1995).

Student and Teacher Access to Computers

Keeping these differences in mind, there are some data about the average time students use a computer per week. This data represents only rough estimates and it varies based on who is surveyed. From a survey of computer coordinators, it is estimated that elementary school students use a computer about one hour and 45 minutes per student per week, middle school students two hours per student per week, and high school students three hours per week. When students were asked, their estimates were much different : 24 minutes by fifth graders, 38 minutes by eighth graders, and 61 minutes by eleventh graders. High school students report that computers are not used regularly in academic subjects. Nine percent of secondary students report using computers for English class, six to seven percent for math and three percent for social studies (Office of Technology Assessment, 1995).

The data about how many teachers use computers differ based on the definition of computer use. According to an National Education Association (NEA) survey of its member teachers, about 60% of teachers who have readily available access to computers use them regularly. The percentage of teachers as judged by other nationwide surveys varies depending on how computer use is defined from 25% to 75%. There are no national data about how many teachers use computers for administrative or professional development tasks (Office of Technology Assessment, 1995).

Another consideration when determining access to computers is location in the school. About one half of all computers in use in schools in 1992 were in computer labs, 35% were in classrooms, while the rest were in other places like media centers or offices. Computers in labs offer teachers the opportunity to use them with the whole class simultaneously, but it makes it more difficult to integrate technology into learning activities (Office of Technology Assessment, 1995)

These national statistics seem to tell us that the presence of computers in American schools is increasing; however access is not consistent from school to school. That access is also limited in that many of the machines are not capable of meeting the requirements of multimedia software or connecting to telecommunication networks. For many teachers and students computers play a relatively small role in classroom activities. When teachers do use technology how do they use it?

INSTRUCTIONAL USE OF COMPUTERS

Ideas About Best Practice

It is easier to assess the number of computers in schools than to assess how they are being used. One of the most interesting things about the computer is that it can be used in many different ways. Ginsburg and Zelman (1988) compare the computer to a chameleon. The same computer can be used for drill and practice, as a productivity tool, and a rich microworld. Drill and practice can promote only the memorization of basic facts and it can provide individual instruction to students who need help mastering skills in a patient way. Professional tools such as word processing, invented for secretaries, can

be used in powerful ways by children allowing them to concentrate on writing as thinking rather than the mechanics of writing. Microworlds, like LOGO, can provide students with rich problem solving experiences or be used to follow patterns provided by the teacher.

As a result of the flexibility of the computer and the rate of technological innovation, what is considered as the best use of technology constantly changes. In 1982 the prevailing wisdom from experts was that students should learn to program in BASIC because it was what came with the computer. In 1984 teachers were told to teach students to program in LOGO in order to develop thinking skills. In 1986, the best use of computers was deemed to be the use of integrated learning systems for drill and practice the rationale being to provide individualized instruction and increase test scores. In 1988, the focus was on teaching word processing so that students would use computers the way adults do. In 1990, the move was to integrate computers into the curriculum by using curriculum specific tools like history databases and science simulations. In 1992, the expert advice was to teach multimedia and hypertext programming because students learn best by creating products for an audience. This represents a push for a changed curriculum that is more process based. In 1994, the emphasis shifted again to teaching students to use the Internet and telecommunications so that they can become a part of the real world (Office of Technology Assessment, 1995).

In an attempt to research how teachers use technology, several researchers have developed ways to describe how teachers use technology. Wiske, et. al. (1988) classified computer activities as unrelated to curriculum (using technology to prepare the school

newspaper), as an add on to the curriculum, and as an integral part of the curriculum.

Barbara Means concludes from her review of the literature that there are four ways the computer is used in instruction: as a tutor, as a means of exploration, as a tool, and as a means of communication. Educational technology was first used as a tutor with the teaching machines in the 1960s. This was followed by using technology to explore ideas and concepts with problem solving and simulation software. The current trend is for the computer to be used as a tool and for communication. These two uses are different because they support student work rather than present information or center on a pre-determined content. When used this way the educational value comes from the activity planned by the teacher rather than from the technology (Means, 1994).

The use of this description of computer as tool has been criticized by some. Morton (1996b) considers the idea of computer as tool to be an unfortunate error that correlates the computer with other common tools such as the pencil. He considers a picture of the computer and pencil on the cover of a major school administrator journal as the beginning of the official misconception of computer as tool. He suggests that the comparison of computer as tool relegates it to the level of supplies. As a result computers have been put on a cost continuum by educational planners and rejected as too expensive. In the rest of our society the computer is considered to be essential, but in schools it is an add-on. This view of computer as an add-on is the result of the description of the computer as a tool. As an add-on in both time and space it can be easily rejected by teachers without understanding its capabilities. They simply choose other tools.

Brown and Henscheid (1997) take another approach to describing computer use by developing a continuum of teacher practices, which they call the Presentational, Interactive, and Generative uses of technology continuum or the PIG continuum. Presentational uses can be as simple as computer generated slides or using the WWW in a lecture. When a student asks a question then this begins to push toward interaction. Interactive uses include multimedia programs and web based interactive learning environments. The interactivity can increase in complexity from right/wrong responses to hyper links. There can be communication between students in the same class as well as between groups of students in different places via the WWW. Generative uses put multimedia and web tools in the hands of the students. Most of these types of uses require collaboration between students. They can range from participating in on-line discussions and group ware to students actually designing multimedia themselves. These uses are described as falling on a continuum because a single activity may overlap each of the uses. Students can watch a multimedia presentation (P), interact with simulations or each other (I), generate their own presentations (G), or watch a multimedia presentation to get information to make their own presentation.

There are some general tendencies that characterize each approach, such as control of content. As you move along the continuum the control changes from teacher control to student. On the Presentational end teachers have control of content, while with Interactive and Generative uses of technology the teacher may lose control of content but they gain influence over how students learn. Generative learning environments are

messier. In these uses the teacher must confront students who have entrenched expectations of teaching being presentational.

Surveys of Instructional Uses

In addition to these descriptions of the instructional uses of computers there have been several national surveys to try to assess how teachers are actually using technology. What the surveys have found is that when teachers do use computers they use them in more traditional ways. At the elementary level the overwhelming use of computers is for drill and practice and instructional games, rather than to solve problems or create products. Computer literacy and generic computer applications like word processing are used at all levels. From 1989 to 1992 there was a decline in the amount of teachers using computers to teach programming. Computers are used mostly in high schools to learn to use word processing rather than teachers having students do word processing for other academic goals (Office of Technology Assessment, 1995).

In a national telephone survey of teachers in diverse schools in different regions of the country, the most common use that teachers in this sample made of computers was outside of the classroom for professional or personal purposes (Wiske et al., 1988). Introducing computers to teachers does not necessarily mean that they will use them for instructional purposes. Two general ways of using computers in the classroom were distinguished: as the object of study and as a tool for teaching and learning subject matter in the regular curriculum. In this sample more teachers used it as a tool than as an object.

As opposed to the OTA report teachers in the study by Wiske, et. al. were as likely to use the computer for open ended problem solving as for drill and practice activities.

Exemplary Teacher Technology Use

As mentioned in Chapter One a group of teachers that have received much research interest is exemplary computer-using teachers. A national study of these teachers provides information about how this specific group of teachers are using technology in instruction. Hadley and Sheingold (1993) conducted their research in connection with the Center for Technology in Education at Bank Street College of Education, Harvard and the Educational Testing Service in Princeton, New Jersey. Their nationwide survey was conducted in 1989. Teachers were invited to participate in this survey because of their accomplishments in using technology in the classroom. Some of the participants were self-nominated. Six hundred public school teachers from grades four through twelve participated in the survey. These teachers used computers in a variety of ways, on the average 14 or 15 different uses. Ninety five percent of these teachers used text processing tools; 89% used instructional software; 87% used analytic and information tools; 84% used programming tools or authoring programs; 81% used games and simulations; 81% used graphics tools; 49% used telecommunications tools; and 25% used multimedia tools. These teachers report also that they have shifted away from the use of programming languages like BASIC and LOGO. When asked about the frequency of use of software, word processors are used 75% of the time, drill and practice software 37% of the time, and tutorial software 24% of the time. These teachers report that the most frequent use of

computers is for students to create their own products. Six in ten teachers report using this approach most weeks or every week. Fewer than one in ten report not ever using the computer to create products.

Telecommunications Use

In another national survey, Honey and Henriquez (1993) sought to describe how teachers are using telecommunications for professional development and classroom instruction. In use for professional development, 76% of the teachers report using e-mail, 62% exchange information on bulletin boards, 51% access information relevant to students, and 49% access information about educational research. About two thirds use telecommunications for these purposes once a week or more and most do it on their own time. Forty eight percent have access to the Internet. The most highly rated reasons for using telecommunications for professional development include opportunities to communicate with other educators and share ideas, access to information that would be difficult to get otherwise, and to combat the isolation of teaching. The Internet is used by twice as many respondents for professional activities than for student learning activities. In instructional use, 41% use it for pen-pal exchanges, 34% use it for scientific data collection, 33% use it for awareness and opinion exchanges. The most frequently accessed information by students include encyclopedias, news retrieval services, weather information, and educational databases. The most highly rated reasons for using telecommunications with students include expanding student awareness of the world, accessing information that would be difficult to get otherwise, and increasing students'

analytical skills. These teachers report that one of the greatest benefits of using technology with students is technology's impacts on the higher order thinking skills of their students.

What the national surveys tell us is that computer use is on the rise, but access is inconsistent both between schools and within schools, and teachers use technology in different ways. The instructional uses proposed by experts in the field seem to have moved from an emphasis on programming to using technology for developing specific academic skills to using the computers as a tool to produce a product and to communicate with others. "Precisely because the computer is a flexible, interpretable device, the process of interpreting and reinterpreting it, of adapting to it, and adapting it to the purposes of the classroom are likely to take a long time" (Sheingold, Hawkins, & Char, 1984, p. 3). This process of developing ways to use technology in instruction can be influenced by many factors. This next section of the review will examine these factors that influence technology use by teachers.

FACTORS THAT INFLUENCE TECHNOLOGY USE

Information about conditions for technology use come from studies of effective technology use, studies examining the relationship of personal teacher traits and technology use, and from conclusions of studies providing literature reviews. Whether stated as barriers to technology use or conditions for successful technology use, there seems to be some consistency and agreement about many of these factors. These factors

include access, time, support, training, personal teacher traits, and teacher beliefs and attitudes.

Access

Having access to a computer is a logical condition to the integration of technology into teaching. Access is a key factor to teachers' acceptance and comfortable use of the computer (Thomas, Tyrrell, & Bullock, 1996). Even though there has been a substantial investment in technology, most schools still lack the basic technology infrastructure to support teaching with technology. Technology initiatives have focused on getting hardware and software for students. Many times these finances are from special one time grant and bond issues. Money for technology is not a regular part of the budget (Morton, 1996b).

Teachers have been ignored in the allocating the limited technology resources. As mentioned earlier, about half the computers in schools are older 8-bit machines that cannot make use of CD-ROM or multimedia applications (Office of Technology Assessment, 1995). The technology that schools do have is not always accessible but is located in labs. Teachers report that they have not used technology because they could not schedule computer time for their classes (Doornekamp & Carleer, 1993; Honey & Henriquez, 1993; Honey & Moeller, 1990; Office of Technology Assessment, 1995; Wiske et al., 1988). Another access problem is lack of appropriate software (Wiske et al., 1988). In a study of exemplary computer using teachers, Becker (1994) found that these

teachers taught in schools where there was an understanding of the resources required such as smaller class sizes and software acquisition.

The exemplary teachers in both the Becker (1994) and Hadley and Sheingold (1993) studies taught in more resource rich environments. For example, the schools of the exemplary teachers in the Hadley and Sheingold study were unique in the fact that the average number of computers in these schools was more than double the average number of computers in schools reported in a random survey of American schools. Hadley and Sheingold conclude that access to technology in sufficient quantity is a key factor to technology use. Saye (1994) found that a critical mass of technology must be present in a school before teachers are able to make it an integral part of teaching. While access to technology is a necessary condition for technology integration it is not been found to be a sufficient condition for technology use by teachers (Evans-Andris, 1995; Honey & Moeller, 1990; Saye, 1994; Thomas et al., 1996).

Time

The OTA report, *Teachers and Technology* (1995) considers time to be the greatest barrier to technology use. Time is mentioned as a factor in much of the literature. Most commonly lack of time is mentioned as a barrier to technology (Evans-Andris, 1995; Honey & Moeller, 1990; Office of Technology Assessment, 1995; Russek & Weinberg, 1993; Wiske et al., 1988). Teachers describe a need for time to develop or adapt instructional materials for use with technology (Wiske et al., 1988). The more complex the software the more time it takes to find ways to use it effectively, even if the

potential for greater student learning is greater than with simpler software. (Becker, 1991b)

There is also a need for shared planning time and longer class time to plan and implement interdisciplinary technology projects (Carey, 1993). For example, Sunal, Scheffler, and Sunal (1995-96) used qualitative research techniques to examine a special social studies project that involved sharing e-mail between schools across the United States. They found that the teachers' enthusiasm at the beginning of the project gradually decreased with the feeling of being overwhelmed by the organizational and time demands of the 12 week project. The teachers felt the project was valuable to their students and were pleased with the students' enthusiasm, but they did not feel that they could maintain the effort that the project demanded of their time. Only one of the 4 teachers expressed the desire to continue using telecommunications projects in her classroom even if the other teachers were not going to continue with the project. She reported that it was the enthusiasm of her students that made her want to continue.

Another way that time is discussed in the literature is the substantial investment of time a teacher must make to learn to use technology in the classroom (Honey & Henriquez, 1993; Office of Technology Assessment, 1995). Becker (1994) found that exemplary teachers spend more time at school and at home developing technology skills and lessons. Additionally male exemplary teachers spent two and a half times more time with technology than female exemplary teachers. Hadley and Sheingold (1993) concluded that learning to use technology effectively takes from three to five years.

In one study (Anderson & Harris, 1997) about teachers and technology, time was not mentioned as an important factor. This study examined use of a state educational network by teachers. Anderson and Harris found that time was not associated with network use the same way. These respondents made time for network use. They suggested that one reason for this finding may be that people may make time for use if they have a sufficient interest in its use. Teachers do have time pressures which must be taken into account in integrating technology into teaching. Technology must become a priority in decision making about time before a teacher will invest the time necessary to use technology in the classroom.

Support

Three different types of support are mentioned in the literature as being critical to successful technology integration: technical, administrative, and collegial. Teachers that were satisfied about their technology use reported having equipment support (Wiske et al., 1988). Exemplary teachers in one nation wide survey were more likely to teach in schools where there was a full time computer coordinator to provided needed technical support (Becker, 1991a). Seventy seven percent of the exemplary teachers in the Hadley and Sheingold (1993) survey reported that they had technical support at their school. Teachers need someone available to answer their questions and help solve technical problems. In a study of technology integration into elementary mathematics, teachers listed technical difficulties as one of the main barriers to implementation (Russek & Weinberg, 1993).

In addition to technical support, teachers need administrative support. Several studies consider administrative support a general condition for technology integration (Honey & Moeller, 1990; Office of Technology Assessment, 1995; Ritchie & Wiburg, 1994; Russek & Weinberg, 1993; Wiske et al., 1988). Exemplary teachers were more likely to teach in schools where there was a high amount of administrative support (Becker, 1994; Hadley & Sheingold, 1993). Computer-using teachers report that they had administrative support in a building principal to provide time and encouragement and district support that provided clear priorities around educational technology (Wiske et al., 1988).

The OTA (1995) suggests that there is a need for evaluation and assessment policies to encourage technology use by teachers. A student assessment system that relies heavily on standardized test can be a barrier to technology use. A teacher has to risk experimenting with new methods when integrating technology into the classroom. They are not sure that these methods will result in improved test scores that are required by many districts. Standardized tests do not measure the higher level thinking and communicating skills that technology helps to develop. Teachers are held immediately accountable for changes that may take time to show results (Office of Technology Assessment, 1995).

Leadership is also a crucial need if schools are going to implement technology (Cory, 1991; Kearsley & Lynch, 1992). Technology is more successfully integrated into systems that have technology leaders and systematic policies (Becker, 1992). Cory

(1991) concludes that systems that do not have a district technology leader will not achieve full integration of technology. Beasley and Sutton (1993) suggest that there need to be three levels of leadership: district, school technology coordinator, and teacher leaders. The teacher leader must be a teacher who can work effectively with other teachers to get them to try new technologies.

Colleagues are another form of support that leads to successful technology use. Teachers report that a supportive school culture is essential for integrating technology into the curriculum. Teachers who do not have a supportive culture report thinking about giving up (Zehr, 1997). Teachers are more likely to use technology in the classroom if they see it can be used to increase achievement and interest in learning. They are more likely to use it for professional activities if they see it can help them do a better job (Office of Technology Assessment, 1995). In Anderson and Harris' (1997) study of users of the state educational network, as users became part of a community of users, the more they perceived the network to be sociable, sensitive, and personal. The more they were integrated into the community of network users the more they received personal satisfaction and professional benefits from the network.

Teachers in schools with collegial interaction implemented more technology lessons than teachers in schools without such interaction (Russek & Weinberg, 1993). Exemplary computer using teachers teach in schools with a social network of computer using teachers (Becker, 1994). Subjective norms, defined as the influence that significant others specifically principals, colleagues, and the profession have on teachers behavior,

was found to be predictive of levels of computer use (Marcinkiewicz, 1994). Teachers who were using technology more strongly perceived that influential others expected them to use technology.

Training and Knowledge

Closely related to support is training and knowledge. In a survey of teachers enrolled in graduate education classes, the higher the ranking of computer expertise, the more the teachers used computers to prepare instructional materials (Chiero, 1997). From a review of literature of teacher attitudes about computers, Dupagne and Krendl (1992) conclude that the more knowledgeable about computers teachers were the more likely they were to have a positive attitude towards computers. One survey of teachers and administrators reported that the most important factor for successful integration of technology in teaching is training (Yaghi, 1996).

Teachers need training that is concerned with technical and pedagogical skills (Honey & Moeller, 1990). Teachers report that what would help them use technology better is knowledge. For some that knowledge is technical, for others there is a need for understanding what technology can do. In their study of using computers in the teaching of mathematics Thomas, Tyrrell, and Bullock (1996) found that computer experience alone did not mean that teachers had the confidence and ability to use the computer to teach students mathematics. Teachers also need knowledge about how to organize and manage their students in technology based environments. The most often cited reason for

lack of technology use in a nationwide survey was lack of specific vision of technology's potential (Wiske et al., 1988).

There is little nationwide data on technology training for teachers. Experts generally agree that if technology is to be used well at least 30% of technology money should be spent on training. A 1994 study by the Department of Education revealed that only 15% of teachers had at least 9 hours of technology training. The need for training is stronger for veteran teachers, but even young teachers who are familiar with technology don't know how to use technology in the classroom (Zehr, 1997). The OTA (1995) reports that 85% of technology money is spent on hardware and software, leaving only 15% for training. Much of this training tends to focus on mechanics, with little emphasis on pedagogical issues (Zehr, 1997). Schools that placed an emphasis on acquiring hardware were more likely to use technology as simply an end in itself. In other words students were only taught how to use the computer, but computers were not used in academic subjects (Wiske et al., 1988). Even in schools that were spending less than 10% of technology money on training, the teachers that received inservice training were more likely to use technology than teachers who did not receive training. There is a growing emphasis on training. For example, states like Florida and Texas are requiring that 30% of technology money be spent on training (Office of Technology Assessment, 1995).

Personal Teacher Traits

An additional area of research aimed at determining conditions for technology use has examined individual personality traits and their relationship to computer use. Some specific traits that have been researched include age, gender, teaching experience, computer anxiety, writing apprehension, professional specialty, teaching level, perceived technical knowledge, self confidence, and innovativeness. No significant relationship was found between age and computer use (Harris & Grandgenett, 1996; Saye, 1994). Becker (1993) found that gender was a predictor of exemplary computer use. In a survey of Australian teachers, Lee (1997) found that men as a group were more active in computing. They were more confident about using computers. They also tended to complain more about problems with computer use. The women tended to be less active. They reported lower levels of use and blamed themselves for their lack of confidence. Women were more likely to get help from external sources and often paid for computer courses from their own income. Men complained more frequently about lack of funds and hardware problems while women were more likely to report human resource problems such as support personnel too busy to help them or lack of personal knowledge. Other studies have not found significant relationships between teacher computer use and gender (Grandgenett & Harris, 1994; Harris & Grandgenett, 1996; Henry, 1993; Nash & Moroz, 1997).

Two surveys of teachers report a slight positive correlation between teaching experience and technology use (Grandgenett & Harris, 1994; Henry, 1993). In another study (Chiero, 1997) the opposite was reported, as the years of teaching experience

increased the use of the computer to prepare or analyze lesson plans and use with students decreased.

Computer anxiety has been found to be both significantly and insignificantly related to teachers' computer use (Grandgenett & Harris, 1994; Harris & Grandgenett, 1996; Morton, 1996a; Nash & Moroz, 1997). Writing apprehension was found to be significantly, negatively related to e-mail use (Grandgenett & Harris, 1994; Harris & Grandgenett, 1996). Self-confidence in computer use and innovativeness, defined as willingness to change, also have been found to have significant positive relationships to technology use by teachers (Marcinkiewicz, 1993-94, 1994, 1996; Marcinkiewicz & Regstad, 1996)

The interesting thing about these studies is that they have found few significant relationships. The relationships that have been significant are not very strong and are inconsistent. Grandgenett and Harris (1994) conclude, based on the lack of significant relationships found in their research, that personal traits are not as important as expected in determining computer use.

Teacher Beliefs

Closely related to personal teacher traits are teacher beliefs. There does seem to be a significant relationship between teacher beliefs and technology use (Office of Technology Assessment, 1995; Ritchie & Wiburg, 1994). Technology-using teachers are more student centered in their practice, while non-users are more diverse in their beliefs (Honey & Moeller, 1990; Office of Technology Assessment, 1995). What is not clear

from the literature is the direction of the relationship between teacher beliefs and technology use (Saye, 1994); do teacher beliefs influence technology use or can technology use influence teacher beliefs?

These factors all play a part in determining if and how teachers will use technology. Teachers must have access to a computer before they can use them with their students, they need time to learn to use technology, and they need support and training. All these conditions are mitigated by personal traits and beliefs. The exact presence and influence of these conditions is not consistent in the research literature. Much of this research is based on small, localized samples of teachers.

TYPES AND MODELS

One way that researchers have attempted to explain this complex relationship between computers and teachers is through the use of typologies and models. This section will first look at research that describes different types of teachers that use technology. This will be followed by a discussion of models of the adoption process by both individual teachers and schools.

Typologies of Technology Using Teachers

Exemplary Users

The most researched group of technology-using teachers are teachers that use technology effectively (Saye, 1994). Effective use is defined in several different ways but these definitions seem to share the theme of student centered. Becker, in his national survey, categorizes exemplary teachers on the basis of their response to a set of standards

that “suggest a classroom environment in which computers were both prominent in the experience of students and employed in order that students grow intellectually and not merely develop isolated skills” (Becker, 1994, p. 294). Of 516 teachers who were all to some extent using the computer in this national survey, only 45 teachers met a majority of standards. Based on this sample, the actual proportion of computer using teachers who would meet the majority of standards would be about five percent. If you include teachers who do not use the computer at all the actual level would be about three percent of teachers nationwide.

There is a group of enthusiastic users who overcome many obstacles to integrate the computer into their classrooms (Office of Technology Assessment, 1995). In his case study of technology integration at a high school known for its technology use, Carstens (1995) calls these teachers technology champions. They break down red tape and push for organizational change. These intrinsically motivated teachers provide a vision of technology use and serve as a catalyst for change. They believe strongly that using the computer increases their students’ learning. Carstens speculated that the technology champions in his case study might have actually hindered technology because they gave the illusion of widespread technology use.

Exemplary computer using teachers were also the focus in the Hadley and Sheingold study (1993), mentioned previously. They developed a typology of teachers who were considered accomplished users from their national survey. Using a cluster analysis procedure they developed five types of teachers in their sample of 600.

Enthusiastic Beginners - 25%

These teachers do not have a large amount of technical knowledge but are convinced and excited about the use of technology. They are less experienced in the number of years they have used technology. They see that technology has had an effect on the way they teach but they are still teaching the same material. They use drill and practice software more than the other groups.

Supported Integrators - 22%

These teachers come from schools with more technology using teachers and more student hours in front of a computer. They are more likely than the other groups to have a computer at home and have exceptional computer skills. They feel that technology has made a difference in the amount of time they spent with individual students. They report a change in their teaching style away from lecturing.

High School Naturals - 18%

The largest representations of male teachers and secondary teachers fall in this category. They have been teaching with computers for most of their teaching experience. The percentage of other computer using teachers in their schools is very low. They list the same impact of technology on their teaching as the other groups (a move toward student-centered teaching). They tend to use more programming software for instruction.

Unsupported Achievers - 19%

These teachers are experienced and comfortable with computers but work in systems where they feel unsupported. They tend to work in schools that are more urban, more working class, and have more minority students. They are less likely to have computers at home and their students have greater difficulty in gaining access to computers.

Struggling Aspirers - 16%

This is the least experienced and the older group of teachers. They are more likely female elementary teachers. They have a smaller range of instructional practices. They are unlikely to be self taught. These teachers see technology as an extension of a teacher-centered approach. They infrequently use computers to have students create a product.

Due to the nature of the study there was not a category for non-users. An interesting observation about this typology is that all five types are relatively close in size. There is no one group that is more predominate. Another distinctive feature of this typology is the importance of teaching situation to the individual types.

All Teachers

Honey and Moeller's Typology

Other researchers have sought to include all teachers in their attempts to describe what types of teachers use technology. In a study by Honey and Moeller (1990), 20 teachers from suburban and urban school districts were interviewed. These were experienced teachers who were both users and non-users of technology. Further the users

were teachers who had made technology an integral part of their teaching. The non-users were those who had had the same opportunities to get involved with technology but had decided not to do so. The interviews focused on four areas: general classroom practices and educational objectives, the relationship between technology and education, how they used technology in their classrooms or for non-users why they were not using technology, and classrooms of the future. They found that teachers could be grouped into four categories which are described below.

Progressive practice and successful technology integration. These teachers used progressive teaching practices such as collaboration, project-oriented work, and hands on activities. They wanted to instill a sense of curiosity in their students. They felt that students needed to be able to think for themselves. They emphasized the importance of inquiry based or discovery learning over the acquisition of facts. They viewed all students as potential learners and described themselves as learners. They describe an increase in self-confidence with experience. They no longer worried about the perfect lesson but felt free to take a chance that they could work with their students to solve problems. They believed that technology could play a vital role in education when it was used as a tool to support and enhance activities that were taking place in the classroom. They used computers in the classroom as well as in the lab. They had worked hard to integrate technology into their ongoing curriculum. They were using mostly productivity software and tended to avoid CAI and drill and practice software. The particulars of what they were doing varied by content area. They believed that technology had helped them to

make changes in their teaching, like being able to spend more time with individual students and to become more process oriented than content oriented.

These teachers' technology skills were mostly self taught. They became interested in learning to use computers for a variety of reasons: the presence of computers in their teaching situations, their students' interest, their need to constantly change their teaching practice and try new things, their own children's interest, and their own personal interest. They also reported they felt they were supported by their administrative and district personnel. The barriers to using technology they reported were: initially having to learn on their own, overcoming fear and inadequacy, hardware problems, too few computers, lack of time to develop materials, and problems with red tape.

Progressive practice and technological ambivalence. These teachers were much like the successful technology users in their teaching beliefs and educational objectives. They reported that their practices had changed over time to become more student centered. Their reluctance to use technology seem to come from a deep-seated personal ambivalence about the technology itself. This resulted from a fear of technology due to a lack of personal experience with computers, a negative first experience with technology, or the lack of technical know-how. These teachers did not have adequate examples of what technology could do. They had no idea of the kinds of software that were available in their content area.

Traditional practice and technological reluctance. These teachers employed traditional methods of following textbook lesson plans, lecture, and workbook. They placed less emphasis on learning and more emphasis on their students being about to pass school system examinations. These teachers believed that there were students who wanted to learn and those who didn't. They reported that they had experienced no significant changes in their teaching practices. They had maintained the way they had started off teaching. When they spoke about change it was about what they were required to teach or the type of students they were teaching. They were reluctant to use technology because they were afraid it would disrupt their classroom practices and alter the relationship of authority with their students. If they did use it, it should be used in the form of whole-group lessons in the lab. They also discussed a lack of time to get involved with technology. They tended to see technology as a special treat or an add-on to the curriculum rather than an enhancer of the curriculum.

Progressive practice and lack of opportunity. This was the smallest group of teachers. They were very much like the successful technology teachers in their beliefs and educational objectives. They were student centered. They reported that their teaching practices had changed over time. They had become more facilitators. They favored the use of technology but had not been involved in using computers directly because of scheduling problems and lack of available machines. As a result they had a limited understanding of what technology had to offer their classroom practices.

Honey and Moeller conclude that there is a relationship between educational goals and the ways teachers integrate technology. Educational beliefs play an important role in how teachers choose to use technology in the classroom. The successful technology teachers are highly motivated to use technology. They see themselves as learners and seek out new educational opportunities and innovations. They are secure and comfortable in their roles and willing to learn from students. They use these pedagogical beliefs to facilitate effective integration of technology into their classrooms.

The low technology teachers were a more diverse group and their relationship between their pedagogical beliefs and their integration of technology was more complex. For those teachers who held student centered beliefs, they need experience and support with technology. For those who hold more traditional beliefs, they face more barriers in integrating technology.

Evans-Andris' Typology

Another typology of teachers is based on the relationship between technology and the working styles of teachers. Teachers like other similar semi-professional workers have a high level of autonomy in the work place. As teachers make technology a part of their teaching they create computing styles to which they informally subscribe. The purpose of a study by Evans-Andris (1995) was to identify computing styles among teachers. Teachers in this study were from nine elementary schools in one metropolitan area. Computers in each of these schools had been available for at least five years and most of the computers were placed in labs. Most computers were Apple II series. Many of the

schools did have several computers that were available for classroom use. Every school had provided training to the teachers and they were expected to be in charge of instruction when the students went to the computer lab. The majority of teachers did provide their students with computer opportunities.

Evans-Andris found three computing styles among the teachers. The two most prominent styles were avoiding and embracing. In both styles teachers allowed the students to use computers. In the avoidance style the teachers avoided meaningful interaction with the machine while providing students access. After taking their students to the lab, they did things like select the drill and practice programs and grade papers while the students used the computers. There was very little planning of computer activities in this style. In the embracing style, the teachers came to the lab early, encouraged students to use computers in conjunction with a curriculum topic lesson and used the computers themselves. They were involved with students and worked with individual students at the computers in a facilitative way.

The ways that teachers scheduled computer time was a reflection of the way in which they used the computer. Those who scheduled the lab for the popular times, toward the end of the week in the afternoon, used the computer as a buffer from their regular classroom agenda. If their schedule permitted they used the lab. The teachers that used the lab during the unpopular times used the equipment as a part of regularly planned classroom activities.

Seventy percent of the teachers used drill and practice software; however the difference in the two styles can be seen in how they used it. Avoidance teachers got their students started and then did teacher activities such as grade papers. Embracing teachers also used drill and practice software but they walked around the room and were involved with their students while they were working. Teachers that were embracing also used the computer as a tool.

The third style of computing found, technical specialist, was not as common. These teachers use the computer as the focus of their lessons. They taught students how computers worked and programming. These teachers had strong computer skills. They carefully planned and scheduled computer activities. In this sense they were much like the embracing style. The distinguishing characteristic was that these teachers spent their time teaching about computers. They used technology in a curriculum that was distinct and separate from the rest of the curriculum they taught. The students showed boredom and disinterest.

Of the 72 teachers observed, Evans-Andris found that 60% used the computing style called avoidance. These teachers demonstrated avoidance behaviors. Twenty eight percent demonstrated the computing style called embracing. These teachers integrated the computer into weekly lesson plans. They assisted students that were using the computer for drill and practice. They incorporated the computer into their work routines. These were the teachers who exhibited embracing behaviors. Eight percent of the teachers were technical specialists.

Saye's Grounded Theory

Another study that offers a typology of teachers is different from others in the methodology and purpose (Saye, 1994). Saye's study, a doctoral dissertation, uses grounded theory methodology to examine what factors effect teacher adoption of technology and describes the interaction of those factors in terms of a theory of teacher computer use. His study was conducted in a single school and examined technology using teachers as well as non-technology using teachers. The school was chosen because it was considered to be a critical case, i.e., a place that had all the right conditions for successful integration of technology. It was in the middle of a technology implementation program. It was a private boarding school of 146 secondary students, many of who were considered at-risk for failure.

The differential factors that were found to effect technology use were in perceptions of teaching and learning, degree of engagement in conserving behaviors (valuing time tested methods), and comfort with uncertainty. Perceptions of teaching and learning were organized between two extremes with one extreme being serious business in which tried and true methods are favored and learning is a quiet, orderly, structured, and predictable undertaking that is a means to a goal. On the other extreme is the use of experimental methods that are playful, exciting, and fun, Teaching at this extreme values creativity and sees learning as a lifelong activity with an emphasis on critical thinking skills. These two extremes became ends of a continuum of teacher practices in which technology use was described. Teachers at one end of the continuum were called

Accidental Tourists. These teachers sought to use technology to reinforce familiar ways of doing things. Teachers at the other end were called Voyageurs. These teachers sought to experiment with new ways for looking at old problems.

Saye found the most consistency between the ways the teachers described their teaching and actual observation of their practice on the Accidental Tourist end of the continuum. One teacher wrote lecture notes on the board in full sentences, kept the class together, had very little interaction, and tests were mostly recall of questions on the worksheets. He was not observed using technology in the classroom; however he was the teacher that used the computer the most as a professional productivity tool. His tests and quizzes were word processed and his lesson plans were stored in a data base.

The teacher on the Voyageur end of the continuum differed the most from the Accidental Tourist end in the amount of student involvement. This teacher's primary means of content transmission was through student recitation. He required students to engage in complex analysis and apply principles. These differences were seen in other teachers, with Accidental Tourist teachers adhering strictly to learning as teacher centered, serious business, and Voyageur teachers believing that you could play with students ideas and questions and learn from them in a fun way.

The teacher at the Voyageur end of the continuum had students working individually and in groups on special projects that encouraged students to make videotapes and hypermedia presentations of their projects. He became more of an advisor than a dispenser of content. For this teacher the process of knowing was too complex to

be able to be passed directly from student to teacher. There was also a high degree of ambiguity present in his classroom over the long period of time that the students were working on the projects. Saye concludes that this high degree of ambiguity represents substantial tolerance for uncertainty.

Saye also examined other teachers not at the extremes of the continuum. In the teacher that was closest to the Accidental Tourist side he saw that the teacher recognized the importance of student involvement, yet in his class activities he stopped short of full involvement. Something --pressure to cover content, avoidance of controversy, conception of knowledge -- kept him toward the Accidental Tourist end of the continuum. Teachers closer to the Voyageur end of the continuum had lengthy student-centered projects; but these teachers tended to make the projects fit a prescribed format. Another teacher more toward the middle did not use group projects. Her class was teacher centered but not teacher dominated. Her lessons were more flexible and there was a social climate in the class of sharing of expertise. She used technology as a demonstration tool, much as she used manipulatives.

Saye also looked at teachers' ideas about intelligence. He found that the teachers on the Voyageur end of the continuum held more complex conceptions about knowing, teaching, and learning. He concluded that these teachers saw learning as a highly complex activity. They designed learning tasks that were risky and ambiguous and saw this kind of activity as the only intellectually honest option. These teachers struggled with the issue of coverage vs. depth. For teachers on the Voyageur side of the continuum reducing

coverage to use methods that fit with their conception of knowledge as constructing posed coverage dilemmas. The pressure for coverage at the expense of depth that they allowed differed with different types of classes (low ability, high ability, or subject area). Teachers on the Accidental Tourist side of the scale consistently favored coverage of discrete facts. Students are knowledge consumers not knowledge constructors. They defined knowing as a simple process of mastering facts. Discovering the facts is something mysterious, best left to experts. Performance on a test was emphasized over learning.

Saye concluded that the way teachers use technology is determined by individual differences in beliefs about teaching and learning, and tolerance for uncertainty. These differences, influenced by organizational factors, form a highly complex interaction that produces highly individualized responses to technology by teachers.

Honey and McMillan's Internet Users

Honey and McMillan (1993) looked at a specific use of computers, telecommunications in their typology. This study is based on electronic interviews with 18 educators including teachers, technology coordinators, librarians, and school technology specialists from across the United States. The participants were chosen from a subset of respondents to the CTE National Telecommunications Survey who reported that they used the Internet for more than e-mail. On the basis of the data, the participants were placed into categories that described their feelings about the Internet.

Enthusiastic Beginners

This was the smallest category with two classroom teachers. These teachers had less experience with technology and had begun using the Internet because of a special project or training program. They were receiving ongoing training and support. They were working with colleagues who were also novices in technology use. They taught in schools which were investing resources in technology and supporting teachers technology use. They found the process of learning about the Internet exciting. They described the Internet as having endless possibilities for learning in classrooms. They felt that training had been crucial in their use of technology and will be important for other educators.

Evolving Understanding

Six of the participants fell into this category. They were struggling to learn how to use the Internet on their own. These teachers averaged eight years of experience with using technology. They had been using the Internet for between one and two years. They were the only Internet users at their school. They had minimal support from their schools and described themselves as self-taught. The central reason that these teachers began using the Internet were specific projects. They did not express a desire to explore the Internet. They were preoccupied with technical obstacles and struggling to develop an understanding of what the Internet is. They were faced with technical and logistical difficulties and did not have the resources to overcome these easily.

Cautiously Optimistic

This group was also made up of six educators. They were experienced with using technology in the classroom and also in using the Internet. Two were teachers, three were district technology coordinators and one was a librarian. They were experienced and largely self-taught Internet users. They were the primary Internet users in their schools and districts and frequently shared their expertise with others. They not only shared expertise but found resources for other teachers who wanted to use the Internet. They were concerned with training issues. They served as trainers to their colleagues. They were very familiar with what is available through the Internet and found the quality and usefulness of k-12 Internet resources lacking.

Experienced Enthusiasts

This group was made up of four teachers. They had a high level of experience in using technology in the classrooms. They had highly technical backgrounds or advanced degrees in technological fields. They had more experience with using the Internet than the other groups. They taught in schools that were investing in resources for technology use. They had trained other educators in Internet use both as a part of their job and on their own time. Their Internet skills were self taught. They believe that providing access to educators is crucial to getting teachers to use the Internet.

The teachers in this study who were more positive about using the Internet were working with groups and had ongoing training and support from experts and colleagues. These authors concluded that educators that use the Internet are technically sophisticated.

They work in schools that at minimum provide an adequate level of access. Even those that were described as beginners in this study when compared to the nation's teachers as a whole would be considered technologically sophisticated.

These five studies developed typologies of how teachers use technology from different perspectives and with different research methodologies. Hadley and Sheingold used a national questionnaire of exemplary computer using teachers. Honey and Moeller used interviews of users and non-users of technology in the two school districts. Evans-Andris used interviews, observations, and analysis of documents in one school district to examine how technology using and non-technology using teachers adapt technology to fit their work style. Saye spends two years as a participant observer in one school to develop a grounded theory of how individual differences interact to place teachers along a continuum of teacher beliefs and technology use. Honey and McMillan used electronic interviews of educators who responded to a national telecommunications survey. While these studies classified teachers based on situation, practice, working style, and interactions of personal factors and teacher beliefs, other studies looked at changes in teachers use of technology over a period of time. The result of this type of research are developmental models of technology adoption by both individual teachers and our educational system.

Models of Technology Adoption

One of the most consistent findings of studies about teachers and technology is a change in teaching style described by teachers who have become technology users. For example, accomplished technology using teachers in the OTA (1995) sponsored research reported that technology has changed their teaching. They expected more of students, allowed more independent work, presented more complex material, and spent less time lecturing and more time working with small groups. They reported that they see a change in their role to more of a facilitator or coach, with the students assuming more responsibility and initiative for their own learning. The majority of teachers in several descriptive studies (Kerr, 1991; Selby, Ryba, & Williams, 1994; Wiske et al., 1988), reported that technology has changed the way they taught. Hadley and Sheingold (1993) found that 88% of the teachers in their national study of exemplary computer using teachers reported that technology use made a difference in their teaching. Wiske, et al. (1988) were surprised with the extent to which teachers in their national study mentioned that it changed their practice. Teachers that use technology often changed roles outside of the classroom as well, many times becoming computer experts and technology leaders (Wiske et al., 1988). Teachers describe this change process as positive, but not easy (Kerr, 1991) and as necessary, profound, and welcome (Office of Technology Assessment, 1995). Technology using teachers not only expressed a change in their teaching practice but a change in their attitudes. Teachers reported feelings of personal

empowerment and rejuvenation. They became more willing to take risks and viewed themselves as learners again (Sandholtz, Ringstaff, & Dwyer, 1997).

Kerr (1991) found an increased use of activity centers and hands on activities and a redistribution of power and authority. Swan and Mitrani (1993) examined teacher and student interactions. An important distinction of this study is that the same teachers and students were observed in both a computer lab and a traditional classroom in two different content areas. They found that there were more student-teacher interactions in the non-computer reading classroom than the computer lab, while the reverse was true for the mathematics classroom. In both content areas there was more whole group interactions in the non-computer classrooms and more individual interactions in the computer classrooms. In the computer classrooms the interactions were initiated by the students, whereas in the non-computer classrooms the interactions were initiated by the teacher. In the non-computer classrooms, control was dominated by the teacher; however in the computer classrooms control was shared equally by students and teachers.

While these researchers make note of general trends in the effect of technology teacher practice, several researchers have developed models that more specifically describe the process of technology adoption by the educational system and individual teachers.

Adoption of Technology by the Educational System

Cuban's Cycle of Innovations

One of the most quoted writers in the field of teachers and technology is Larry Cuban. Cuban's (1986) research examined the introduction of technology to teachers since the first of the century, including film, radio, educational TV, and the computer. He proposes that adoption of a new technology follows a cycle of exhilaration, scientific creditability, disappointment, and blame.

When a new technology was introduced there was much excitement over what it would do to revolutionize education. Extraordinary claims were made. Seldom were these innovations initiated by teachers, instead most of the innovations came from foundation executives, educational administrators, and salesman.

After the technology was introduced came academic studies to prove the effectiveness of the new technology in relationship to traditional instruction. Each technology was generally proved to be as effective as a classroom teacher. There would arise complaints about logistics or technical problems with using the technology.

Surveys would reveal that teachers were not using the technology as frequently as expected. The result would be criticism of narrow minded administrators and teachers. Teachers were blamed for the failure of the technology but few researchers ever questioned the claims made by the proponents or if the technology should be introduced in the first place.

This cycle of exhilaration -- scientific creditability -- teacher bashing drew its energy from those outside of teaching who wanted to change teaching practices. Teacher reluctance was an obstacle to overcome. The craft knowledge of teachers was dismissed rather than listened to. Few researchers looked at the technology from a teacher's point of view.

While Cuban looks at the adoption of technology by teachers in general, Sheila Cory (1991) looks at the adoption process by school systems. She looks specifically at the introduction of computers into education and describes this process in a four stage model of technology adoption by schools.

Cory's Model of Technology Adoption by Schools

Stage One. The first stage is called Getting on the Bandwagon. In 1983 there was a large variety of hardware available from the Atari to the Commodore, to the TRS 80, to the Apple II Plus, but there was little educational software. The idea was that teachers would create their own software by programming in BASIC. Many teachers subscribed to computer magazines of BASIC programs and spent long hours typing them into the computer. When it was used, the most common applications were drill and practice at the elementary level and BASIC programming at the secondary level. The major topic of the computer curriculum was computer literacy. A big debate raged about whether computer literacy meant teaching BASIC or LOGO. In this stage the focus was on obtaining hardware. The assumption by the stakeholders was that if we can just get the computer into the school, students will become computer literate. All time spent on the computer is

beneficial because children are becoming computer literate. All software is considered to be equally good simply because the students are being exposed to the computer. Staff development is on the same level of training that is received when you buy a home appliance. The salesperson comes and sets up your refrigerator, tells you how to turn it off and on, and gives you a warranty card and an owners manual with all the information you will need to use your new appliance. This is exactly how the staff development was handled in this stage.

Stage Two. The second stage is the Stage of Confusions. Things seem to be moving in many directions at the same time. Hardware is still the main focus, but there is some knowledge of the benefits of certain operating systems. There is very little money available for software, but its importance is beginning to be realized. Administrators do not see a need for staff development but teachers are seeking it to the point of taking courses and attending workshops at their own expense. There is usually someone at the central office who has computer-related responsibilities tacked on to their full time job. The move from stage two to stage three is usually the result of the hiring of a full time person at the district level.

Stage 3. The third stage is the Stage of Putting it All Together. It begins with much committee work and an effort to get things organized. Hardware acquisition continues but other factors are considered important. Staff development is now seen as important for success. There is an effort to make technology an integral part of content area teaching, rather than an add-on. Word processing is taught as a skill. Teachers are able to select

software that fits what they teach and use software for primary instruction or enrichment.

Stage 4. The final stage is the Stage of Full Implementation. Cory does not believe that every school will necessarily get to this stage. Moving from the first to third stage just happens with experience. Technology is still an extra at these stages. Even at the third stage when there is some effort to link computer use to the curriculum, no major curriculum changes occur. This is what Cuban (1989) calls first-order change or change only around the edges. There is no organizational or systemic change. It is widening the highway and not building a new system of transportation. Moving to the fourth stage requires major changes in how and what we teach. "Unlike transitions from one stage to the next at the earlier stages, the focus of change from Stage 3 to Stage 4 is on curriculum and instruction, not on technology"(Cory, 1991, p.40).

Cuban's and Cory's models explain how technology is adopted from the point of view of the educational system. Other models have looked at the individual teacher's process of adopting technology.

Models of Technology Adoption by Individual Teachers

Collis' 3P Model

In this model Betty Collis (1996) describes teachers' adoption of technology as being a function of three factors: expected payoff, problems that must be overcome, and pleasure in being involved in the innovation, payoff, problems, and pleasure. How teachers see these three factors influence how and if they will adopt technology. For

example, teachers who do not feel pleasure from the innovation see the problem factor as considerably stronger and the payoff factor as weaker. They are less likely to use the computer. The profile of a teacher is determined by the strength of each of these factors. The profile of a computer enthusiast would be different from the profile of a non-enthusiast.

Doornekamp and Carleer

In a study of a computer integration program for Dutch secondary teachers in which the computers were placed in a lab, Doornekamp and Carleer (1993) observed that teacher computer use could be categorized into three levels. At the Experimental Use level, teachers take students to the computer lab and use specially selected courseware a few times. On the basis of this examination, they decide to use the courseware again. At the Supplementary Use level teachers bring students to the lab to use courseware that deals with a specific topic after they finish teaching that topic in the classroom. This was found to be the most frequent use level of teachers in the study. At the Integrated Use level, teachers have revised the curriculum. Computers are used to teach some topics and teachers teach other topics.

Marcinkiewicz and Welliver

A similar model, developed by Marcinkiewicz and Welliver (Marcinkiewicz & Welliver, 1993), is based on the Concerns Based Adoption Model (CBAM)(Hord, Rutherford, Huling-Austin, & Hall, 1987). The model of Instructional Transformation

looks even more specifically at a particular educational innovation, the computer. This model proposes 5 stages of involvement with computers:

The first stage is familiarization. In this stage the teacher becomes familiar with the computer. Following this stage is utilization in which the teacher uses the computer in teaching. In the third stage, integration, the computer becomes critical to teaching and the teacher becomes aware of a change in role. As development continues the teacher enters the fourth stage of reorientation, in which the teachers pursues, expands, and fine tunes the computer, student, teacher relationship. The final stage is evolution. In this stage the teacher seeks to learn new ways to improve instruction through the systematic implementation of the computer.

Marcinkiewicz and his colleagues developed an instrument to distinguish between two of these levels of use: utilization and integration. In a study of 138 elementary school teachers in schools where the student to computer ratio was twelve to one, the computers had been present for at least three years, and teachers had access to the computers, he found that 31% were non-users, 66% were at the utilization level and only 3% were at the integration level (Marcinkiewicz & Regstad, 1996).

Apple Classrooms of Tomorrow (ACOT)

One of the most extensive research projects concerned with teachers and technology has come from the Apple Classrooms of Tomorrow (ACOT) projects. This research was conducted over a ten year period and involved the collection of both qualitative and quantitative data. Teacher accounts of learning to use technology in ACOT

classrooms reveal that the process caused self-doubt, was subject to external influences, went in many different directions, and was exhausting. Most teachers entered the ACOT program thinking that technology would make their jobs easier and more efficient. They did not expect the change that technology brought. The change was gradual, not a revolution, but the new gradually replacing the old. Teachers' actions would sway one way and then the other. They would make changes that allowed students to be more involved in the lesson using more group work. They would doubt if the experiment was working and would return to more teacher centered, more direct instruction. The students would exert pressure, not in the form of insurrection but in their resistance to do things they old way instead of the new way, and then the teacher would risk something new again. (Sandholtz et al., 1997).

Researchers in the ACOT project found that the way in which teachers used technology in the project changed as teachers themselves changed (Sandholtz et al., 1997). The rate and direction of change was greatly influenced by teachers' beliefs, learning, roles, and practice. They developed a model of stages of adoption of technology by teachers. They found that the process was cyclical in that when teachers were introduced to a new piece of hardware or software they returned to the beginning stages and worked their way back to the later stages. The model has 5 stages.

Entry. At the beginning of the project the common tools (technology) were blackboards, text books, work books, and overhead projectors. These tools were used to support lecture, recitation, and seat work. In this stage the teachers faced problems that

are typical of first year teachers: discipline, resource management and personal frustration. The major technology focus of this stage was on technical details required to make the computers work. Concerns that teachers faced during this period are student misbehavior, the physical environment, technical problems and software management, and the dynamics of the classroom environment.

Adoption. Teachers entered this stage after the technical problems of the entry stage were under control. Teachers still faced technical problems but their concerns began to shift more to how technology is used for instruction. Typical computer based activities in this stage were primarily aimed at teaching students how to use the computers. Teachers used software that they could adapt to their instructional style of direction instruction and recitation. Teachers at this stage were able to predict problems and to develop strategies to solve them. They were no longer overwhelmed by unexpected problems and became good problem solvers. Teachers were concerned that evaluators would mark them down for messier, noisier, classrooms where children were not all doing the same thing. There was also a concern that student performance would decline because of the disruption of normal classroom operation that computers caused. However, traditional measures of student achievement showed no significant decline or improvement during this stage.

Adaptation. In this stage technology became a part of classroom practice. Lecture and seat work was still the major form of instruction but students were using computers for 30 to 40% of the day. Technology use was more frequent and purposeful.

Productivity was a major theme of this stage. Teachers no longer viewed technology as infringing on the curriculum, but rather as a support for the curriculum. They learned to use technology for their own advantage. They used databases and spreadsheets for record keeping, individualized instruction, and developed instructional materials.

Appropriation. The description of this phase is different in later research than in earlier research (Dwyer, Ringstaff, & Sandholtz, 1991). It was characterized more by change in teacher attitude than change in classroom practice. "Appropriation is the point at which an individual comes to understand technology and use it effortlessly as a tool to accomplish real work" (Sandholtz et al., 1997, p. 42). They described this as a necessary milestone that must be reached before a teacher can use technology in more creative ways. Appropriation marked the time when teachers no longer use technology to computerize their traditional practice.

Invention. In this stage teachers experimented with new ways to practice and relate to students and other teachers. There was a great increase in interdisciplinary projects. There was also an increase on the teachers part of reflection of teaching practices, an increase of questioning old patterns.

One of the findings from the ACOT research was an increase in collegiality among teachers in the project. This increase followed a pattern. At first the support was primarily emotional, providing encouragement and sharing success and failures. As teachers increased in their use of technology the collegial sharing was in the form of technical assistance. This assistance included help with classroom management issues. As

teachers began to integrate technology into their teaching more, their interactions centered on instructional issues. As teachers increased their interaction and collegiality they started to observe each other teaching rather than just sharing ideas. Very few teachers had done this previously. Certain types of collegial sharing occurred in specific stages of adoption. In the entry stage collegial sharing was mostly emotional support. In the adoption stage it included technical assistance as well as emotional support. The adaptation stage had instances of emotional support, technical assistance, and instructional sharing. In the appropriation and invention stages teachers continued to share in all the ways previously mentioned and in addition began team teaching.

Concurrent with the change in teacher practices was a change in student role. A change in role that occurred gradually was the role of student as expert. Initially this was noted with students who had technical expertise or experience. They would help the teacher learn a new software program. Teachers noted an increase in peer tutoring also. At first this was spontaneous and unplanned. Students got tired of waiting on the teacher and begin to ask each other for help. Teachers would capitalize on this and just teach a few students a new skill and these students would teach other students. This expert role spread to academic areas and students offered content information or knowledge they had developed. Students became experts to an outside audience, to others in the school, and to the community.

What these models of adoption have in common is that they seem to describe a process that begins when the computer is not considered in teaching to a time in which is a occasional part of teaching and then to a time when it changes teaching. The majority of teachers seem to be somewhere in the middle of the continuum from non-use to integration.

SUMMARY

Technology, like the Hawaiian volcano, will make its presence known in schools. What effect it will have is still to be determined. A large determining factor will be the teacher. As more teachers gain access to the computer and to the Internet they will make decisions about the way they will use technology.

A variety of researchers have offered ways to describe how teachers use computers: as unrelated to curriculum, an add on to the curriculum, or an integral part of the curriculum; as a tutor, a means of exploration, a tool, or a means of communication; and as falling on a Presentational, Interactive, and Generative use continuum. From the first introduction of the computer into the classroom what is considered as the most effective way to use it has changed from an emphasis on programming to using technology for developing academic skills to using the computer as a tool for producing a product and communicating with others. When looking at actual practice, national surveys reveal that most teachers use computers in traditional ways, such as drill and practice and instructional games, rather than as a tool to solve problems or create products. Those

teachers that do use the computer as a tool to create are considered as exemplary users in the research literature.

The pattern of computer use is influenced by several factors. Access to computers is a necessary but not sufficient condition for use. Technology takes an investment of time. Training and support are crucial to success in integrating technology. Access, time, knowledge, and support are in turn mitigated by a teacher's personal traits and beliefs, but exactly how is not sure. Understanding the importance of these factors and their exact influence is an area of weakness in the literature.

As a way to further understand the introduction of computers into classrooms, other researchers have developed typologies of teachers and models of the process. These typologies classify teachers based on situation, practice, working style, and interactions of personal factors and beliefs. There are also models that take a development point of view and offer stages of adoption for both schools and individual teachers.

The purpose of this literature review was to provide a general overview of the research on teachers and technology. The number and types of computers, the way the teachers use the computer, the factors that influence the use of computers, and the models of technology adoption served as the foundation for the methodological decisions of the following research.

CHAPTER 3 - METHODOLOGY

DATA COLLECTION AND ANALYSIS IN GROUNDED THEORY

Data Collection

Grounded theory uses the basic data collections techniques of qualitative research: interviews and observations. It is important to use different types of data because they provide different views or vantage points from which to understand the data. Glaser and Strauss calls these different views 'slices of data'. Different types of data, interviews, observations, and other documents, are not used as a test of each other, but rather to provide different ways of understanding (Glaser & Strauss, 1967).

Data Analysis

The basic process of analyzing qualitative data is called coding. Grounded theory involves very detailed coding. There are two analytic procedures that make up the process of coding in grounded theory: making comparisons and asking questions. These are the procedures that are used to conceptualize and categorize data. Conceptualizing data is different than summarizing data. Summarizing is saying what happened in a descriptive way. Conceptualizing is looking at the data for concepts. Several events can be labeled with the same concepts, for example, reading a schedule or asking questions might be labeled as information gathering. There are three major types of coding: open

coding, axial coding, and selective coding. However the boundaries between these types of coding are artificial and the three types can be done at any point in the process.

Open Coding

Open coding is the first step of grounded theory. The goal of open coding is to name and categorize the phenomenon. "During open coding the data are broken down into discrete parts, closely examined, compared for similarities and differences, and questions are asked about the phenomena as reflected in the data" (Strauss & Corbin, 1990, p. 62). The phenomena represented by a category are given a name. Category is defined as "A classification of concepts. This classification is discovered when concepts are compared one against another and appear to pertain to a similar phenomenon. Thus the concepts are grouped together under a higher order, more abstract concept called a category." (Strauss & Corbin, 1990, p. 61).

Categories have attributes called properties. Properties can vary along a continuum which is called dimensionalizing. General properties occur each time the category is found regardless of the situation, for example the general properties of color would be hue, intensity, saturation, etc. Each time a property occurs it is possible to locate it somewhere along the dimensional criteria. "Each category has several general properties, and each property varies over a dimensional continuum. In effect, this gives each occurrence of a category a separate dimensional profile. Several of these profiles can be grouped to give you a pattern. The dimensional profile represents the specific

properties of a phenomenon under a given set of conditions” (Strauss & Corbin, 1990, p.70).

In open coding the aim of sampling is to identify as many potential categories as possible. The kind of sampling associated with open coding is open sampling. “The sampling is open to those person, places, situations that will provide the greatest opportunity to gather the most relevant data about the phenomenon under investigation” (Strauss & Corbin, 1990, p. 181). The initial sampling choices are made with the idea of openness. The selection of interviewees is quite indiscriminate.

AxialCoding

Data collection and data analysis are highly interrelated and occur alternatively in grounded theory. Later data collection or theoretical sampling is driven by the early data (Mann, 1993). Theoretical sampling is sampling on the basis of concepts or categories that have been proven to be relative to the grounded theory. The idea is to find and sample incidents or events that are indicative of categories and properties. Axial coding will begin and open coding will continue. Axial coding involves making connections between categories. “In axial coding, the researcher considers the axes that might run through the categories” (Mann, 1993, p.136). It takes place across interviews or data sets. Open coding takes the data apart by putting it in categories. Axial coding puts it back together by making connections between categories.

In axial coding the researcher is looking at the codes and how they are related to each other and not the actual data. Once the researcher has asked category relating questions then he or she returns to the actual data for verification or evidence of the patterns of relationship that were found. The researcher must also look for discrepant cases or incidents when the patterns of relationship do not hold up. Discrepant cases don't disprove the grounded theory but rather add variation and depth of understanding.

The kind of sampling associated with axial coding is relational and variational sampling. "Thus sampling now focuses on uncovering and validating those relationships. You will propose statements of relationships; then while out in the field determine whether those relationships hold up" (Strauss & Corbin, 1990, p. 185). In the sampling during axial coding the goal is to try to find as many differences in the dimensions of the properties as possible. This is done purposefully by choosing a situation or person that will maximize your chances of gathering data about categories, or systematically by moving from situation to situation gathering data on a specific category.

Selective Coding

Even though grounded theory seeks to develop models that fit the context, there is no claim that the model that is developed is the only way to understand the area under study. The researcher must eventually choose a core category around which to build the model. The core category has three characteristics: it occurs frequently, it links codes together, and it explains variation in the data (Hutchinson, 1986). The next level of coding that begins after the core category is identified is selective coding. Data collection and

analysis focuses on this core category and any supporting categories needed to build the model (Mann, 1993).

Theory Verification

The process comes to completion when the theory is now checked against the data. There are four criteria for judging the applicability of a theory: fit, understanding, generality, and control. If the theory is grounded in the data then it should fit the substantive area about which it was written; it should make sense to those people in the area; it should be abstract enough to be applicable to a variety of contexts related to the area; and it should provide control or guide actions based on the theory.

THE GROUNDED THEORY RESEARCH QUESTION

The process of developing a grounded theory begins with the research question. The initial research question for a grounded theory study starts out rather broad and then becomes more focused during the research. It should be open enough to allow for discovery but narrow enough to allow the researcher to know where to look to discover theory. "The research question in a grounded theory study is a statement that identifies the phenomenon to be studied. It tells you what you specifically want to focus on and what you want to know about this subject" (Strauss & Corbin, 1990, p.38). Grounded theory questions tend to be oriented toward action and process. A special type of research question is needed to develop grounded theory. The research question or questions need to provide the flexibility and freedom to explore a phenomenon in depth. An important assumption about the phenomenon under study is that all of the concepts

pertaining to it have not yet been identified, at least not in the particular population or place or the relationships between the concepts are poorly understood or conceptually undeveloped (Strauss & Corbin, 1990).

Research Question

The research question for this study sought to examine how teachers in a single elementary school make technology a part of their teaching. The following question and subquestions guided the investigation.

How do teachers make technology a part of their teaching?

Research Subquestions

How does technology interact with teachers' beliefs, practices, and roles? How does technology impact interaction between teachers? How does curriculum impact teachers' integration of technology into their teaching? What personal factors influence teachers' integration of technology?

These questions were the beginning of the collection and analysis of the interviews, observations, documents, and literature review that comprised the data of this study.

DATA COLLECTION AND ANALYSIS IN THIS RESEARCH

Use of Technology

An important part of managing the data generated from this research was the use of technology. This study made use of technology in several ways. All field notes were transcribed from handwritten notes or audio tape to word processing files following a

standard template. All interviews were audio taped and then transcribed to a word processing file. I did all transcriptions. Both files and field notes were entered in a specialized qualitative analysis software package, NUD*IST (Non-numerical, Unstructured Data Indexing, Searching And Theorizing).

The decision to use this software was based on a review of qualitative data analysis software by Weitzman and Miles (1995). This extensive review categorizes analysis software into five categories. It provides system requirements as well as a comprehensive review and a variety of tables comparing the programs feature by feature. The category of analysis software which best fits grounded theory studies is 'code-based theory-builders'. In addition to being able to code and retrieve data, they provide other functions that are especially suited to grounded theory. For example, they allow you to not only code blocks of text but relate codes to each other in graphic form. They also allow you to annotate your data and add memos or code notes explaining your codes.

After examining the reviews of all analysis software that fits in this category and downloading demo versions of software to examine, I chose NUD*IST (Richards & Richards, 1997). This program is very well known in qualitative research circles. It has a listserv dedicated to its use and is frequently mentioned on other general qualitative software analysis listservs. It is also one of only two such programs available for Macintosh computers. The other program is based on HyperCard and has fewer features than NUD*IST. This software was developed by a husband and wife team; he is a computer programmer and she is a qualitative researcher. Weitzman and Miles (1995) call

it one of the best-thought-out programs around. It allows you to search your data in many different ways and print in a variety of report types. It provides a great flexibility in coding schemes. It proved to be very beneficial in analyzing the large amount of data that was generated by this study. In addition a concept mapping software, Inspiration (Helfgott, Shankland, Stafford, & Tong, 1997), was used to develop pictorial representations of the theory used in this study.

The Research Context

This purpose of this study was to build a grounded theory of how teachers make technology a part of their teaching in a specific context. The context is bounded by site, people, and time.

Site

The School's Students and Teachers

The site was chosen to represent a typical school. The average K-5 elementary school in the United States has 471 students (U. S. Department of Education, October, 1996). The state in which the study was conducted has a pupil teacher ratio of 18 to one (U. S. Department of Education, August, 1996). This figure was derived by dividing total number of students in the state by the total number of teachers without taking into account the teaching situation of the teacher (regular classroom, special education resource room, etc.) The search for an elementary school to participate in this study was based on these figures. Schools that had between 450 to 500 students and approximately 20 to 25 teachers were sought.

In early October, 1997, an initial visit was made to the Howard County superintendent to explain the study and obtain permission to conduct the study. I chose Howard County because it was located within driving distance of my home, but I did not know any of the administrative staff or teachers. During the initial visit with the superintendent, he identified two schools in the system which met the guidelines established for 'typical-ness'. One of these school was the only 3-5 school in the system and had a population of 388. This school was rejected due to its limited range of grade levels and its smaller than average population. The other school was chosen as a closer match to the typical school and to other schools in the system. For this study this school will be called Eagleton. (Pseudonyms are used for all locations, school systems, schools, and school personal mentioned.)

Eagleton School is located inside the city limits of Morganville, a city of about 22,000. It is a part of Howard County, a county in the southeastern United States, with a population of 53,321. The per pupil expenditure in Howard County is approximately \$1,500. Per pupil expenditures in the state range from a low of \$385 to a high of \$2,275, with an average of \$1,124. The total pupil population of Howard County is 9,033. Eagleton is one of the ten K-5 elementary schools in the school system. At the beginning of the study there were 488 students enrolled. The pupil teacher ratio was 19:1. Twenty seven percent of the students in the school were enrolled in the federal free lunch program. Eight and four tenths percent of the student population were minorities. This is in line with the 5.2% minority population of the county as a whole. The school building

is five years old. It is located in a rapidly growing part of the city. It adjoins both a neighborhood of brand new homes in the \$200,000 to \$400,000 range and a low rent subsidized public housing apartment complex. The population of the school is also growing. The computer lab had to be converted to a classroom two years ago and there are no vacant rooms. There are 25 regular classroom teachers, one PE teacher, one librarian, one regular resource teacher, and one extended resource teacher. In the regular resource room students spend only a small portion of the school day, while in the extended resource room students spend a majority of the school day. There are three part time teachers who are at Eagleton 70% of the work week: speech, music, guidance. In addition there is one principal, one bookkeeper, one full time secretary, one part time secretary, and two instructional aides for the regular classroom teachers.

There are no statistics to describe the atmosphere of the typical American school. Following is a description of the atmosphere at Eagleton. The teachers described Eagleton as being a warm, friendly school with a pleasant atmosphere. It was described in a positive manner consistently by every teacher interviewed. Many said that they would not want to work anywhere else. They felt that the teachers in the school all got along well and were very close friends. There is a 'concern board' in the teacher's work room where staff write the names of friends and relatives that are sick or experiencing difficult times. The teachers described the tone set by the principal as positive, being laid back but supportive. They have good parent relationships with a large number of parent volunteers and an active parent organization that is very supportive. The school day begins with

morning announcements over the school public address system by the principal, Mr. Lindsey, which consists of an inspirational thought for the day. The school motto is, "Eagleton School, where every child is a winner".

The School's Level of Technology

Number of computers. According to the OTA report mentioned in Chapter Two the average elementary school has 25 computers, 60% of which are older 8 bit machines, 23% are intermediate level machines, and 14% are up-to-date machines. Since these figures are medians it is difficult to match exactly with the mean school size data. These figures also change constantly. Schools that had from at least 25 computers were sought. Due to the constant change in the number and types of computers present in a school, no determination of the exact type of computers was set as a requirement for school selection.

At the beginning of the school year Eagleton had a total of 52 student computers. However two weeks before data collection began eight new computers arrived, bringing the total to 60. Of these, students have access to 58. Twenty of these 58 were Apple IIe or Macintosh SE's or Classics. Four of these were broken for a total of 16 or 27% older machines with student access. These were all located in classrooms. The remaining 42 (72%) were Macintosh LC's or higher and would be considered multimedia machines. Two of these were in the library and the remaining 40 were in classrooms. After the eight new computers were delivered, all but one of the teachers had a teacher presentation station which consists of a computer, large TV monitor, a VCR, an ink jet printer, and a

laser disk player. The single teacher received a teacher presentation station after she returned from a maternity leave in late March. Two of the classrooms are designated as Special Computer Classrooms. In these rooms there are five student stations and one teacher presentation station. This percentage is in line with the state statistics which show that 20% of classrooms state wide are Special Computer Classrooms.

The school network. The multimedia computers at Eagleton are connected to a school wide network. There is one file server with a 1.5 gigabyte hard drive and 48 megabytes of RAM. It serves as a router, e-mail server, and serves applications and files. The multimedia computers are connected to the server via an ethernet network using the built in Macintosh networking software. There is an ISDN line from the school to the central office. There is one T1 line from the central office to the local state community college which provides a connection to the state educational network. This system provides each teacher access to the Internet. The world wide web is accessed through Netscape browser software.

Technology in the Howard County system. There are approximately 2000 multimedia computers and 500 other computers, mostly Apple IIe and MS-DOS machines in the school system. The elementary and middle schools are Macintosh based and the two county high schools use Windows/Intel machines. The present technology coordinator came in February of 1993. He is in charge of the media center, the teacher's center, all materials including textbooks, AV equipment, and computers. His staff has six full time technicians. There is one for each high school (1,250 and 1,300 students). The

remaining four cover four schools each. There is one technical staff for the alarm systems, the telephone systems, intercoms, scoreboards, and all other AV equipment. The school system also does all its own wiring. There is a full time technology trainer who works on an 11 month contract. There is also an assistant technology coordinator who works with computer and technology projects. The school system is large enough to receive state moneys for two technology coordinators.

The county has a five year technology plan which will take a 37% cut in budget for next year . Due to this cut the technology plan is now being revised. The plan is developed by a 14 member committee made up of administrators, representative principals from all three levels (elementary, middle, and high school), teachers from all three levels, a librarian, parents, the state representative, and a representative from the information systems department of a local industry. In the 1997-98 budget roughly 67% was spent on new equipment, maintenance, and software, 14% was spent on training, and the remaining 19% was spent on personnel.

People

After an initial visit with the school principal, all other interviews and observations were of teachers. In mid-October, 1997 I met with the teachers after school during a regularly scheduled faculty meeting. All regular classroom teachers were asked to consider participating in the study. The following week, I met with each teacher individually during his or her planning period to answer any questions, further explain the human subjects consent form, and request participation. Two of the teachers were on

maternity leave for a large part of the school year. Of the 23 remaining classroom teachers, 16 agreed to participate in the study. Demographic information about the participants is included in Table 3-1.

Time

Data collection and analysis began in late October, 1997. Interviews and observations continued throughout the school year, ending in late May, 1998. During the summer and early fall the grounded theory was presented to colleagues and participants as a part of evaluation and verification of the grounded theory.

The Researcher

In qualitative research the main data analysis tool is the researcher. Any researcher comes to fieldwork with some orienting ideas. I come with the eyes of a teacher who spent thirteen years teaching in the public schools. After receiving my masters degree in special education, I worked with gifted students in a resource setting for three years. After adding an elementary certification, I moved to the regular classroom and taught sixth grade for the remaining time that I taught. During my ninth year of teaching, I got the first computer for my classroom. I have been always interested in computers and had taken several programming languages. While learning computer skills was easy for me, learning to use the computer in my teaching was a process that constantly challenged me to re-think my beliefs about the how's and why's of teaching. I changed from a traditional teacher with a focus on teaching content to a less traditional teacher with a focus on the

Table 3-1. Teacher Demographic Information

Teacher	Years Teaching	Education	Year Received Teacher Presentation Station	Macintosh Multimedia in Classroom	Apple IIe/ Mac SE Computers in Classroom
Alisha	22	Bachelors	1995	1	1
Dorthy	15	Bachelors	1996	2	1
Felicia	18	Masters	1994	1	1
Jamie	18	Masters	1997	1	2
Jane	25	Bachelors	1994	1	1
Jeff	24	Masters	1997	2	2
John	1	Bachelors	1997	1	1 under desk
Julie	22	Masters	1995	1	1
Louise	25	Masters	1994	1	2
Nikki	3	Bachelors	1997	1	2
Sandy	5	Bachelors	1994	1	2 broken
Sherry	4	Bachelors	1997	1	1
Shirley	19	Masters	1997	1	1
Teresa	25	Masters	1995	1	0
Debbie*	21	Bachelors	1993	6	0
Betty*	25	Bachelors	1994	6	0

*Denotes Special Computer Classroom Teacher

process of learning. Indeed I returned to graduate school to find out more about how technology was changing education. Because of my experiences I believe that technology has the potential to have a great impact on teaching, bringing about major changes in basic teacher beliefs and practices. This dissertation grew from the desire to understand how different teachers make technology a part of their teaching.

Initial Data Collection

The first type of data collected included demographic information about the teachers, staff, and students of the school. In addition information about the number and location of computers was obtained. Initial interviews of all teachers who agreed to participate were conducted beginning in late October, 1997 and completed in early January, 1998. The initial ideas for interviews and observations were based on concepts from the literature and personal experience. The initial interviews questions are grouped into three areas: background information, technical knowledge, and technology and instructional practice. An interview guide can be found in Appendix A-1.

Initial Data Analysis

As the initial interviews were completed, I listened to them several times and transcribed them. During this time I kept notes of things that were mentioned repeatedly by teachers. These early things included feelings expressed by the teachers, ways and times that teachers used computers, learning about technology, people and the school, and software. All first round interview transcriptions and field notes were entered into

NUD*IST. At this point, I reviewed the literature about qualitative research and grounded theory methodology (Rubin & Rubin, 1995; Strauss & Corbin, 1990).

With the original research question and subquestions before me, I began to develop open codes and code the first interviews. The first codes included emotions, specific people, the school, learning technology, instructional uses of computers, interactions concerning computers, children, resources, problem solving, personal use, and changes. They amounted to a grouping of things that teachers mentioned often in the interviews. As the coding continued properties of the codes developed that grouped specific attributes of the categories. For example, under the code for instructional uses of computers, the properties were: amount of time the computers were used, ways teachers managed student use, use of computers in specific subjects, ideas and plans for using computers, reasons to use computers, and computer roles in instruction. As new properties for the open codes were developed then I would go back to previously coded interviews looking for instances of the property.

The NUD*IST software was crucial to this process of coding. It allowed me to code different passages of text with multiple codes. In about three seconds the software can create a report merging all instances of a single code, reporting the amount of times the code appeared and the percentage of the documents in which the code appeared. In addition it can also search data for specific words and phrases. A term that was used frequently by teachers was the word 'tool'. Seven of the 16 teachers used the word 'tool'

when talking about technology. Instances of this concept were coded under instructional uses of computers as computer role.

Continued Data Collection and Analysis

After the initial round of data collection and analysis, a second round of interviews were conducted with 10 of the 16 participants. A surprising finding after the first round of interviews was the similarity of teachers on many of the initial categories. This made choosing teachers who represented certain properties impossible. Both of the Special Computer Classroom Teachers were included in the second round. Of the one-computer classroom teachers, participants were included based on grade level and amount of time they had the computer. Two teachers from each grade level except kindergarten were included. For each grade level one teacher was included who had the computer for a year or more and one teacher was included who had gotten the computer within the last year. The kindergarten teachers were excluded from the second round because they had had their computers for only about a month at the time of the first round.

In the initial round of interviews the teachers used the concept of tool when describing how they used the computer. Specific interview questions for this round were about the ways that teachers talked about the purposes for technology and the reasons they used technology. The teachers were asked to define what they meant by teaching tool and to give examples of things that were teaching tools. They were also asked to compare technology to other tools. This second round of data collection was completed in late March. A third round of interviews was conducted in April and May to further

clarify concepts from the initial two rounds of interviews. The questions for this round asked the teachers to describe how they used technology as a teaching tool and to explain why they used technology both in general and in specific situations. Other questions in the third round of interviews came from areas from the original subquestions that seemed to be inadequately addressed in the initial round of data. They included questions about changes that teachers noted in using technology during the past year and how technology influenced teacher interactions.

In order to develop a theory that is conceptually rich it is important to use different types of data to gain different vantage points from which to understand the data. During the second and third round of interviews, 6 classroom observations and 6 meeting observations were also conducted. The classroom observations included one-computer classroom teachers and Special Computer Classroom teachers. The observations were of lessons in which the computer was used both with whole groups and with individual students. Scheduling conflicts made it difficult to find times to observe all ten teachers. These observations were written up as field notes. Video or audio tapes were not used. In addition to the interviews, classroom observations, and meeting observations other data collected included floor plans of all the participating teachers' classrooms, copies of county and school instructional planning documents, and teacher created instructional materials. All together there were 41 separate visits made to Eagleton from October until May.

During the time I spent at Eagleton I looked for ways to become a participant observer at this school. I did this to become as involved as I could in their everyday lives of these teachers. I worked with the teachers who were in charge of maintaining the school's web page. I also would help teachers who had computer problems on days that I was at the school. After the study began the teachers received a small grant from the state department of education. The purpose of this grant was to purchase copies of a multimedia development program, train teachers to use this software, and then develop both teacher and student multimedia social studies programs which would be shared through the world wide web. I worked closely with the Special Computer Classroom teachers who had been assigned the job of writing and administering the grant. Together we planned and conducted training sessions at Eagleton for a small number of the teachers at the school. In addition, five education students in a special technology mentorship class that I was teaching were placed at Eagleton to help teachers learn this multimedia program. In my interactions with the Eagleton teachers I refrained from offering suggestions for how technology could be used in teaching. I offered only to help with technical problems or demonstrate technical skills.

Theory Development and Verification

After the second and third rounds of data collection and analysis were completed, the process of developing an initial model of the process of making technology a part of teaching began. The first step of theory development was to re-examine all field notes, interviews, and other data. Literature searches on relevant topics and examination of

recent scholarly literature were conducted. Several pieces of the literature were important in developing the theory. I re-examined the works of Larry Cuban, both his research about teachers and technology (Cuban, 1986) and teachers and innovations (Cuban, 1993). In another important article, Collis' (1996) compared the introduction of the computer into schools in the 1980's with the present introduction of the Internet as a educational innovation. Of particular interest is her idea that the computer was introduced as a solution in search of a problem. An article by Morton (1996b) traced the origin of the idea of computer as tool. He argued that this concept of the computer as tool correlates the computer with other common tools such as the pencil, relegating it to the level of supplies. In the rest of our society the computer is considered to be essential, but in schools it is an add-on. This view of computer as an add-on is the result of the description of the computer as a tool. As an add-on in both time and space it can be easily rejected by teachers without understanding its capabilities. They simply choose other tools.

The next step in the development of the theory was to re-examine the current coding scheme, which by this time had grown to more than 100 codes, taking 10 pages to list and define. This list can be found in Appendix A-2. Relationships among the codes were examined and a new set of only 18 codes were developed. This list can be found in Appendix A-3. All the data was re-coded with this new set of codes. Once again the NUD*IST software made dealing with this amount of data possible. Reports were

printed for each of the codes. These reports were examined to determine the properties and their dimensions.

As a result of the re-coding process I selected computer role as the core category. As mentioned earlier a core category should occur frequently, link codes together, and explain variations in the data. The report for this code was 45 pages, more than any other codes except for management which was 48 pages. The category provided a logical link to other frequent codes such as instructional setting, management, and knowledge. The teacher's perception of computer role can be used to explain differences between teachers.

Once a core category was selected the next step was to develop a narrative explaining the relationship of the categories that make up the theory. These relationships were represented first pictorially and shared with committee members. They offered perspectives and challenged ideas that were underdeveloped. The theory was shared with some of the teachers participating in the study to see if the theory was applicable and useful for them. Based on these findings final changes were made. The study concluded in the early fall of 1998 with the final written presentation of the grounded theory.

The grounded theory that was the result of this data collection and analysis is presented in Chapter 4.

CHAPTER 4 - RESULTS

"I am trying to use them [computers] more in the classroom as a tool. I think it is overall like a big puzzle and you can say a piece of the puzzle you put together to further educate these kids."

Jeff and the other teachers at Eagleton are in the process of fitting the pieces of their classroom together. Teachers have many pieces to fit together. They have students they must manage, a state mandated curriculum, instructional tools, and a limited amount of time. Teachers must decide how much time they will devote to each learning activity, how they will structure the activity, how they will manage the students during the activity, and what tools they will use. Teachers have a variety of tools; pencil, paper, textbooks, filmstrips, and videos. Technology has always been a part of education, it is just that until recently technology was rather simple and changed slowly (Mehlinger, 1996). The computer is a new piece that teachers must fit into the puzzle. The teacher will determine the shape of this piece, where the piece will fit, how it will fit, and why it will fit. There are many ways to use a computer. How do teachers start using the computer and begin making the computer a part of their teaching? As Jeff expressed in the opening sentence, the computer is a piece of the puzzle.

As teachers are first introduced to the computer they are unsure about how it works and exactly what to do with it. Uncertainty sets the stage for the beginning of a

process of fitting the computer in the puzzle, of making the computer a part of teaching. The initial reasons for using the new tool are vague and unspecified. Teachers are amazed at the possibilities provided by the computer. As Dorothy expressed, "it is really terrific to think that you have this much at your fingertips if you know where to go for it." There is a feeling that "you need to learn technology because there are going to be more computers in the classroom in a couple of years" (Alisha). Or as John explained, "we have got a nice computer there, there ought to be someone sitting there all day." One first grade teacher reasoned that the computer should be used "even if the only thing it does is make them not nervous around computers, then it has already served its purpose because when they get older then they are not afraid to mess with computers." In short, these teachers realize that technology will be a part of the future world of these children. Felicia expresses this when she replies that she uses the computer "because it is here, and it is expensive, and I know the kids need it; I know later on their jobs are going to require this skill, so I feel obligated. I really do."

How do teachers begin the process of making the computer a part of teaching? For the Eagleton teachers there are two key concepts that propelled them forward toward making the piece fit: knowledge and enjoyment. These two concepts are related to each other in a spiral fashion. Nikki expresses this relationship when she says that "this year has been a lot easier to where I am learning more of how to use it, so the more I learn how to use it to do different things on it, then I enjoy it more." As teachers increase their knowledge of the computer, they increase their acceptance and enjoyment of the

computer. Or they can begin by increasing their acceptance and enjoyment of the computer which will increase their knowledge of the computer. The result is a spiral movement toward fitting the computer in the puzzle of classroom life.

Two factors influence this spiral movement of knowledge and enjoyment: students and resources. As a result of the process of making the computer a part of teaching the other pieces of the puzzle will change in some way. The other pieces included the decisions that teachers made about time devoted to learning activities, the structure of those activities, and the management of students while they are completing the activities,. These relationships are expressed in Figure 4-1.

In the following pages the model will be explained by looking at the factors that influence teachers to first begin the process. This will be followed by a closer examination of the knowledge and enjoyment concepts that propel the teacher forward in the process. The chapter concludes with an application of the theory for three of the teachers.

FACTORS THAT INFLUENCE THE TEACHER TO BEGIN THE PROCESS

There are many factors that will influence an individual teacher's process toward making the computer a part of teaching. These factors are grouped into two broad categories: students and resources. Students are mentioned by every teacher. More teachers mentioned the influence that students had in their decision making about using computers than any other single factor. Parents were also mentioned as influencing the decisions that teachers make about using the computer, but only briefly by three of the 16 teachers. Resources were also mentioned by all of the teachers. Many resources play a

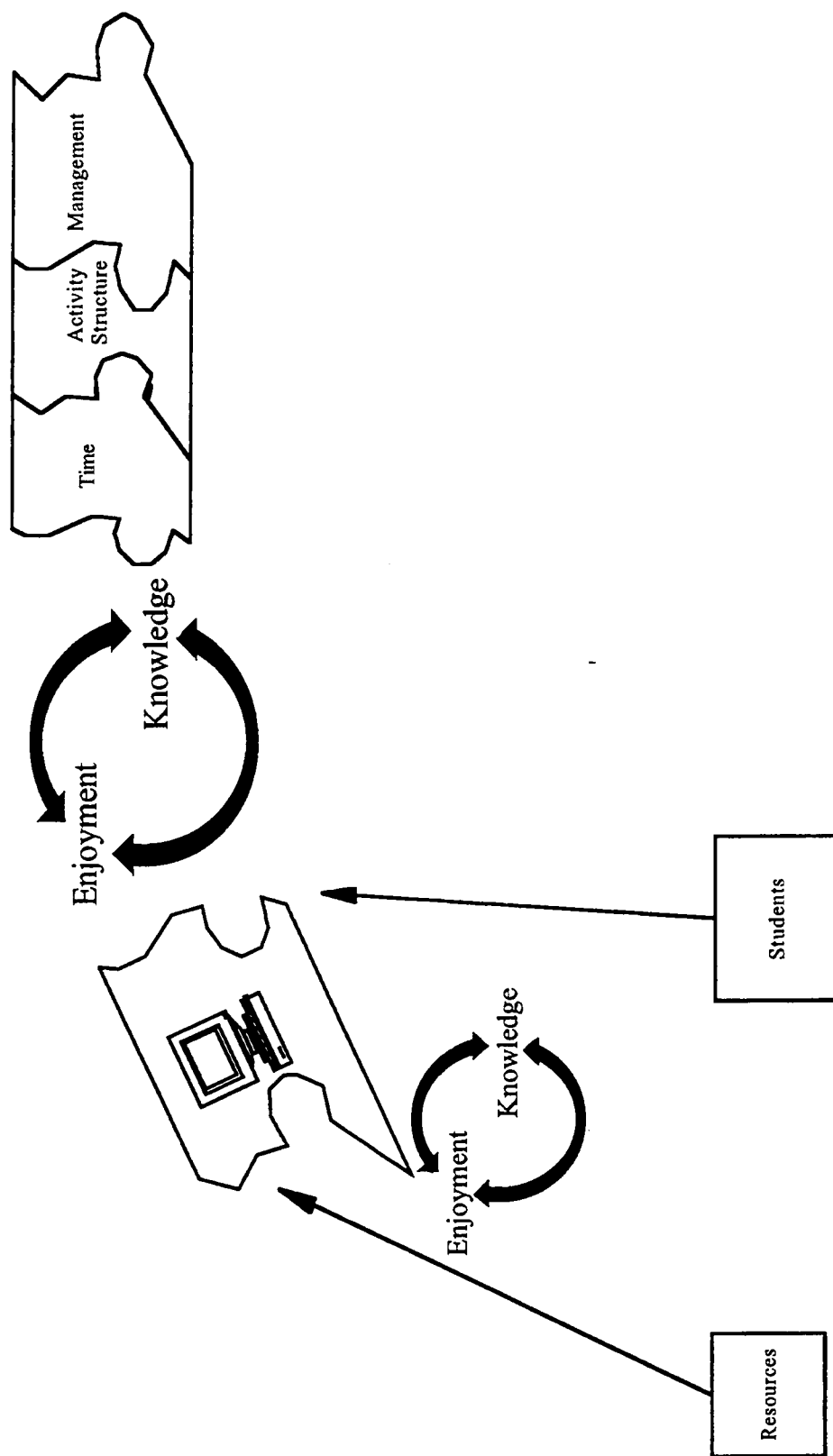


Figure 4-1. Fitting the Computer in the Puzzle

role in making the computer a part of teaching, including physical and human resources.

Figure 4-2 illustrates these factors.

Students

Students were a major influence on the Eagleton teachers' process of making the computer a part of teaching. The teachers at Eagleton are aware of the role that the computer plays in our society. Nikki noted that most of her friends in jobs other than teaching use the computer daily. They are aware of the number of their students who have home computers. Jeff mentioned his admonition to students not to become "mouse potatoes." Sandy notes that students "are in a world now that everything moves so fast, even technology they want to move fast; but they might as well grow up like that because by the time they graduate technology will be very, very advanced." Because of the prominence of the computer in our society teachers feel that students need to be able to use computers. Shirley notes that her students need computers. "They need a lot more than they are getting from me and probably most people here in this school." This general feeling that technology will be important to their students is the reason many of the teachers are willing to use computers. Three teachers that talked about not being comfortable with computers still use them because they believe that they will eventually benefit their students. Teachers also want their students to be comfortable with computers, enjoy using computers, and be excited about using computers. "Some of the kids that do not or are not interested, they just do not realize how great computers can be

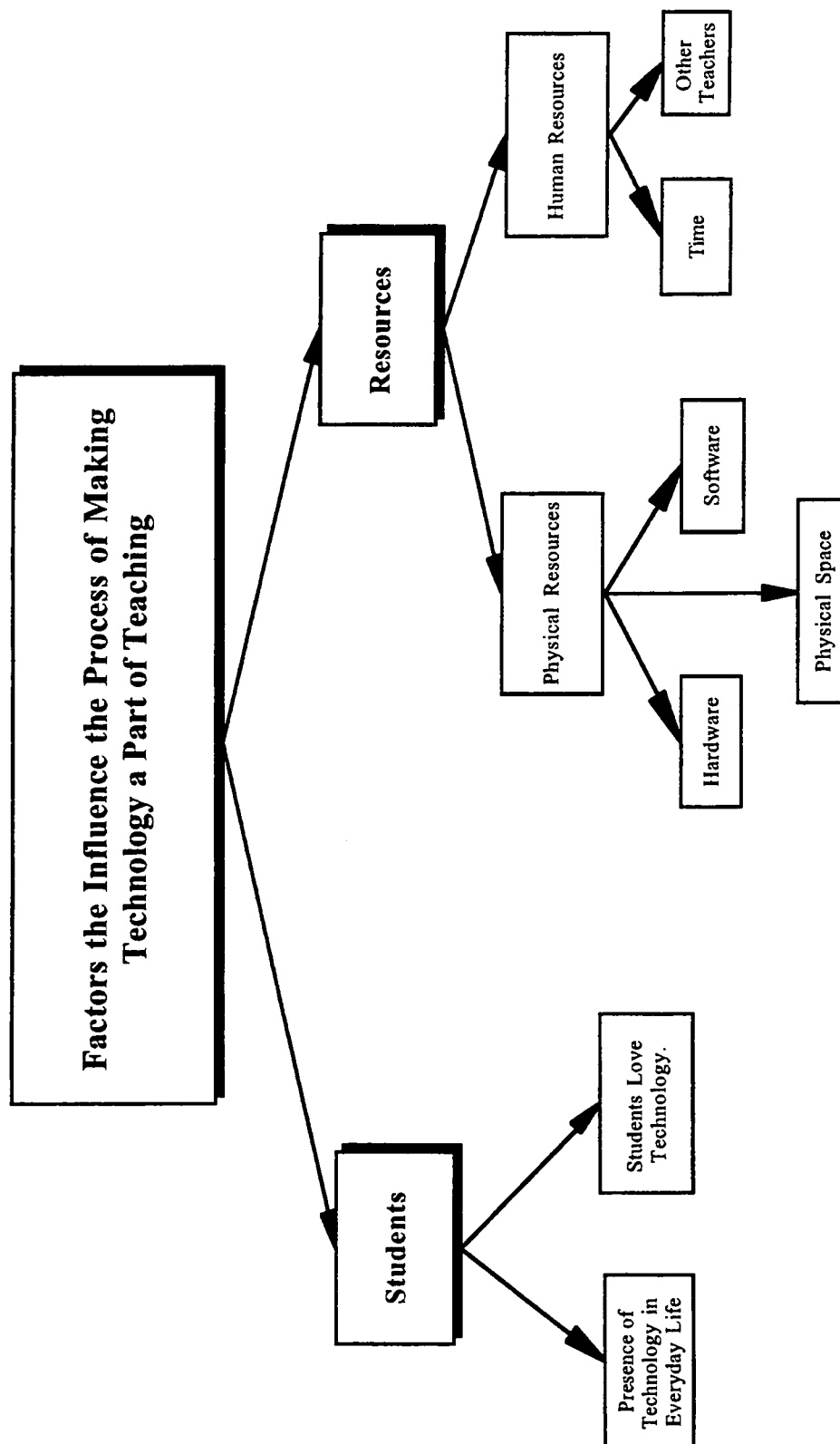


Figure 4-2. Factors That Influence the Process

and how many worlds they can take you into, you know, if you will just get started on them and enjoy" (Nikki). They express concern about students who don't have a computer at home and try to make sure that those students get to use a computer at school. Felicia expressed her desire for students not to fear the computer. "I want them to be comfortable with it, and I don't want them to feel like I did when I first started. I was not comfortable with it at all. But the more you use it, the more comfortable you get."

Teachers also express a concern about the proper use of computers with students. Dorothy wants to use technology as much as she can but not over use it. Jeff is concerned that using computers inhibit social interaction. "And you know I don't see that interaction on the computers as much. If anything I see kids who are trying to monopolize the computers and say this is mine, I don't want to share it with you." Several teachers expressed concern about using the Internet with children and were very careful when they use it to ensure that the students will not run into inappropriate material. Two teachers note that the increase use of technology has been accompanied by a decrease in reading for enjoyment.

The most common thing that teachers say about students and computers is students love computers. Several teachers related how students would sit quietly and stare at the screen saver when the computer was connected to the monitor. Teachers note that whenever they say that it is computer time the students are instantly excited no matter what they are going to do with it. The computer is seen as being very motivating for students. Teachers take advantage of this attraction of the computer to motivate

students. "It is attractive to them and as unattractive as it is to try and do some research skills, if you can say we are going to use our [computer] encyclopedia and look the things up or you can say we are going to take notes and then print them out, if you can do something like, that creates a little more of a pleasant aspect to those things" (Debbie). For Sandy the computer gets her students' attention quicker and keeps it longer. Many teachers talk about the computer as a way to make learning fun for students. They note the computer's ability to give instant feedback to students in a non-threatening way. Some teachers see it as a way of influencing students' learning in ways they can't. "Well, I like it, the kids like it, and I think it is a kind of common thing that meshes the two age levels together. And then it allows me to show them things on their level but still with animated characters and colors and cartoon figures. And sometimes they will listen to that more than they will listen to me if I did it in another direct way" (Sandy). Teresa has come to see the computer as a different channel of learning. "You used to have auditory channel of learning, visual channel of learning, this is now a technology channel of learning. It is a new way of presenting material."

Students are an important factor that influences teachers' movement toward making the computer a part of teaching. They see the computer as necessary for the students' future success. They work to ensure that students that do not have a computer at home get to use them at school. They use it to motivate students to complete unpopular tasks. They see the potential of the computer to be a different channel of learning.

Resources

In addition to the influence that students have on teachers' use of the computer, the resources available, both physical and human, influence the decisions a teacher makes about computer use. "I know if I had student stations I would use it a whole lot more; but with just the one it is kind of hard" (Julie). Physical resources include hardware (both at home and at school), software, and physical space. Human resources include time and other teachers.

Physical Resources

Hardware

Beyond the obvious observation that teachers can not use the computer if they do not have a computer, the type and amount of resources to which a teacher has access also influences the process of making the computer a part of teaching. Eagleton has two major configurations of hardware resources: one-computer classrooms and Special Computer Classrooms.

One-computer classroom. The majority of the teachers are in a one-computer classroom. These teachers have one teacher presentation station, as previously described. In addition they may have one or two older Apple IIe's that came from the dismantled lab. Nikki calls these her "baby computers." An exact list of hardware resources along with the year each teacher received those resources is found in Table 3-1. Six of the teachers that participated in the study received a teacher presentation station only this year.

All of the one-computer classroom teachers expressed a desire for more computers. They feel that to be able to use them "to teach with" they would need more. The amount of resources influences their decisions about use of time. "I have not found the right way to adjust the time so the children can come up and we can get everything else done that we need to get done" (Jane). One teacher explained that she did not spend very much time thinking about how to use the computer more because she knew that she was not likely to have any more computers. "If it happened I would take whatever training I needed and get whatever help I could. But I haven't even thought about it because it is not going to happen" (Shirley). Learning to use the computer requires a major investment of time on the part of the teacher. The teacher must also feel that it is worth the time. The presence of the physical resource influences that decision.

Special Computer Classrooms. Two teachers are designated as Special Computer Classroom Teachers, a program that began initially with state money. One of the Special Computer Classroom teachers is located on each of the two main halls in the school. The goal of this state program was that eventually all teachers would have the resources of a Special Computer Classroom. The contents of these classrooms have changed slightly over the years but they all include five student computers, one teacher computer, and various peripherals and software.

The Special Computer Classroom teachers were the first to receive the training provided by the school system. They have had the computers longer than most of the other teachers in the school. They have had more experience with having a computer.

They have become the computer experts at Eagleton in the eyes of their peers. "The Special Computer Classroom teachers that we have are real knowledgeable and if you run into a problem they will try to help you first" (Julie). The amount of computers they have has made their process of making the computer a part of teaching easier; however they still struggle with fitting the computer in the classroom. Debbie explains, "And then when I have those days like that when sometimes that student at the back is going to be left out of something, and that is the battle that I face, that I fight." It is important to both of these teachers that the computers be used.

Personal resources. Having a home computer also influences the process of integrating the computer. Teresa credited an increase in her 'comfortable-ness' with a computer this year to getting one at home. She feels less stress at home and can concentrate more on learning to use the computer. Teachers with home computers also report that they learn from their family members. Two teachers reported buying a home computer recently to help them learn to use it. They feel they have more time at home to play around and experiment without the time pressures of the school day crowding in on them. Teachers that don't have a computer at home feel that getting one would be one thing that would help them to become better computer users. "I just think that I would probably have more time to work on it and get adjusted to the programs, whereas here just with, you know during the school day, there is very little time to just play around and kind of familiarize my self with the systems that I am not sure of. I think at home I would have more leisure time to just work with it" (Sherry). One case in which a home

computer has had a lesser impact on a teacher's growth occurred when the home computer was not like the computers at school.

Software

Along with hardware resources, access to software influences the process of making the computer a part of teaching. The teachers at Eagleton have access to productivity software, such as word processors and spreadsheets, as well as specific educational programs such as mathematics drill and practice. An integrated works package runs from the hard drive of each machine. However, very little student use of word processors, spreadsheets, or databases was reported or observed.

Of the software that is available to teachers, only a small percentage of titles were mentioned frequently. Teacher knowledge of what is available ranges from teachers who know and use hardly any of the available titles to teachers who know and use a large variety of titles. Dorothy reports that before she can use the computer as a tool for learning she needs to know the software well enough to be able to access what she needs when she has a "teachable moment." Jane expresses the impact of software, "I guess we have got more software and I use it more. Because I wasn't too familiar with it at first; but the more you do anything you know you are going to do it more, become better at it. But we do have more software, so that makes a difference on how much you use it." For other teachers the amount of software has not influenced their computer use. They acknowledge that they have not taken the time to look at it. Only a few teachers report

looking for specific software to use with their students. The majority of teachers use "whatever they send me."

In the past year there has been an emphasis by the school system to purchase software. The specific titles that were chosen were selected by a committee of teachers. One teacher from each grade level from each school met to decide what software would be purchased. Each teacher was to bring in the software that they or another teacher at their school were using. This committee then decided if a particular title would be chosen and what kind of license it would have. A teacher may purchase additional software but they must either use personal funds or use part of the money they are given to purchase classroom supplies. A few teachers reported using classroom supply money, but the majority use the software provided to them by the school system. The Eagleton teachers accepted the teacher selection committee method as a good way to find appropriate software. They were grateful for the work of the committee and seem to trust the decisions the committee made. "The ones that we have, have been carefully selected by first grade teachers, a committee of first grade teachers" (Louise). They do not have to seek software to use with their students.

Only one teacher specifically expressed the idea that software was a limitation. As Debbie expressed, "Your software is a limitation, I think, because there are so many other things you could do if you had another kind of software or something. But the software that is accessible to me, a lot of it is used for review or used for introduction." The teachers at Eagleton then mostly use what is available to them. The greatest part of this

software is drill and practice software designed to be used by individual students. One of the few pieces of software that is not drill and practice is a multimedia development program. However no teacher reported using this program to allow students to create multimedia projects. Instead the most widespread use of this program is to introduce reading vocabulary words. The teachers used stacks that they and teachers from other schools in the Howard County system have developed. Six teachers created stacks for the special social studies grant the school received. All of these stacks were drill and practice stacks. The sheer amount of drill and practice software then influences the purpose that a teacher sees for using the computer. They use what they know about and since this is mostly drill and practice that is the purpose they see for the tool. The teachers feel that they "must know what is on it" in order to use the computer. To fit the computer into their teaching they must know the content of the software.

Physical Space

In addition to hardware and software, the physical space of the classroom influences the adoption process. The most obvious influence that physical space had on the Eagleton teachers is the dismantling of the lab. When Eagleton was built five years ago a room was set aside as a computer lab. It was located next to the library. Since then the school population has grown. The computer room as well as some other conference or special rooms have been taken over by classrooms. The lab was dismantled three years ago and the computers were moved to teachers' classrooms. Teachers have mixed feelings about losing the lab. They miss the children being able to go to the lab and all work on

computers at the same time. However, when asked if they would give up their teacher presentation stations to make a new lab, they would not. They note that having the computer in the classroom allows them more freedom to use it when they need it. They note that the students only had access to the computers once a week during their scheduled lab time for 30 minutes. Sandy and Dorothy feel that having the computers in the classroom provides their students more access because they can be used all day long.

Having computers in the classroom is not without its problems. Teachers are concerned with the physical arrangement of their classroom. One kindergarten teacher wondered where she would put more computers in her room if she got them. One teacher remarked that if she could have a Special Computer Classroom she would have to remove the bookshelf but would be glad to do it. The computers in the Special Computer Classrooms are lined up relatively close to each other along one wall. They are so close together that it would be difficult for more than two students to work at a computer. When asked about how this arrangement was chosen Debbie explained that the technology staff will ask you before you get the computers where you want them, but there is some limitation based on wiring restrictions about where you will be able to put them. Other teachers referred to this single line arrangement at the back of the room as the model they would use if they received more computers. The placement of computers close together in the back of the room makes a powerful non-verbal statement about the purpose of the computer in the classroom. The computers are to be used by individuals separate from activities taking place in the rows of student desks.

Human Resources

As the physical space, hardware, and software influence the process of making the computer a part of teaching, human factors also play a role in teachers' decision making process. The two Special Computer Classroom teachers are very important to the adoption of the computer at Eagleton. These teachers have become the computer resource people. While there is no official requirement for the Special Computer Classroom teachers to serve as a resource person for other teachers, they report that they have taken this on as their unofficial role. In the initial interview that I conducted with the principal he referred me to the Special Computer Classroom teachers for all information about the number and type of computers present at Eagleton. When teachers have a technical problem the first person they contact is either Debbie or Betty. These two teachers either try to fix the problem themselves or refer the problem to the county technician assigned to Eagleton.

These two teachers were mentioned in every single interview that I conducted. The faculty is very grateful for their help. Teresa sums up the faculty's feelings when she describes them, "they are excellent, very supportive, very knowledgeable, very giving of their time, so they are good." They see their role as not only providing technical help but emotional support. Debbie explains that she just tries to empathize with the teachers that are having computer problems, noting that it is easier when you have someone to be frustrated along with you. Betty relates that teachers come to her to get her approval before they do something different with their computers.

These two teachers have had only slightly more training than other teachers, yet are still acknowledged to be the computer experts. All their training has come from that provided by the school system. Betty enjoys solving computer problems. When asked why she spent so much time helping other teachers, Debbie replied,

my son would like to know the answer to that question; that is just a part of who I am, it really is. I really made myself available to them [teachers] so that they would not be frightened by that. Part of this is just my own personal lifestyle, I really feel like if I can't help anybody else, I need to be someplace else, no matter what. And I feel like with my children, my students, I am a help, but I am not only here for them. I am also here for the faculty.

These teachers spent large amounts of time working with the computer. A majority of this time was not spent on their own preparation but in helping others. For example, one of their major, time consuming projects was making sure that the Accelerated Reader program worked. This program provides students with a multiple choice test on books that they have read. It awards points for correct answers and keeps track of progress for all 500 students at Eagleton.

Other teachers have also become involved with helping with technology at Eagleton. Jane is in charge of the school's web page. Debbie and Betty work with her every month to keep the page updated. Jane has also helped teachers with computer problems. Teachers depend on each other as well as Debbie, Betty, and Jane. Teachers describe working with other teachers after school on computer projects, such as creating

multimedia presentations and customizing drill and practice programs. Louise describes these informal, after school sessions as including those teachers who are interested in the computer and enjoy working with it. The majority of their interactions center on solving technical problems. They do occasionally share ideas for using the computer in instruction. Teachers know which teachers spend time with technology and are a part of these informal learning sessions.

The teachers that participate in these after school sessions are making computer use more of a priority for their investment of time. Teachers see time as a factor that influences their use of the computer. To use the computer more Dorothy concludes that she needs either more time or more computers. Teresa sees lack of time as a major reason that she does not use the computer more. Jeff notes that using the computer takes a lot more preparation time. Most teachers have things they want to learn and do with the computer when they have the time. They report not using new software that they have received because they have had not time to sit down and "play with it."

The human resources of time and other teachers and the physical resources of hardware, software, and physical space have influenced the Eagleton teachers' progress of making the computer a part of teaching. The presence of physical and human resources, as well as their students reactions to computers become factors that influence the teacher to begin the process of making the computer a part of teaching. The computers and the software are in their classroom. There is the belief that students will need to use computers and enjoy computers.

CONCEPTS THAT PROPEL THE TEACHER FORWARD

Once the computer has entered the picture and the teacher begins to make the computer a part of teaching, knowledge and enjoyment move the teacher forward.

As shown in Figure 4-1, knowledge and enjoyment are related to each other in a spiral fashion; an increase in one leads to an increase in the other. Enjoyment and knowledge can each be described as developing along a continuum that will be described in this section.

The Enjoyment Continuum

When teachers first encounter the computer, it is new and unfamiliar. This is the case both in the area of technical skills and teaching methods. As Shirley expressed, "I feel like a fish out of water as far as using the computer goes." Other teachers expressed feelings unsuccessful and inadequate. "It makes me feel sometimes like I am inadequate as a teacher because I don't know the technology part of it. But I am learning." They describe themselves as learning to like the computer. They are also unsure about how to use the computer in teaching. Dorothy sees finding ways to use the computer with students as a problem. Jane describes not being able to work computers into her teaching. The teacher must move from a time when the computer is new and unfamiliar to a time when they are comfortable with the computer. This process is illustrated in Figure 4-3.

First Experiences

For the teachers at Eagleton their first experience with the computer was either using one either at Eagleton in the old Apple IIe computer lab or in previous educational experiences. Several of the teachers first used the computer in courses they were taking

Along the Enjoyment Continuum the teacher moves from:

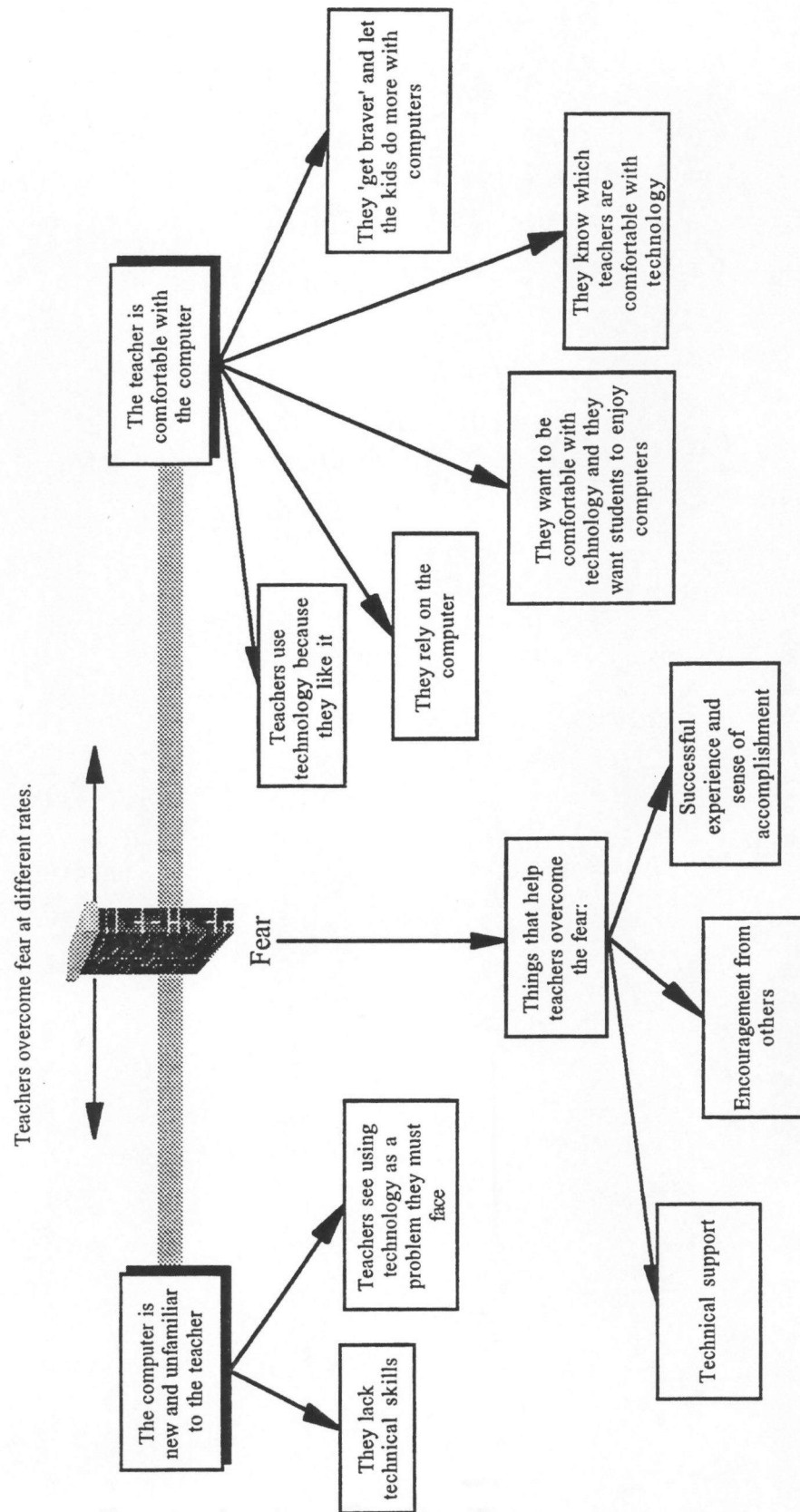


Figure 4-3. The Enjoyment Continuum

either to become a teacher or earn a higher degree. Two of the younger teachers remember using the computer in high school.

Fear

Regardless of when teachers first encountered the computer, a majority of the participants mention a feeling of fear. Julie expresses these feelings when she says, "I was afraid that I would do something wrong with it and destroy the whole thing. I guess that is everybody's major fear the first time." Alisha explains the source of her fear as not knowing which button to push next or where to go. Many of the teachers expressed the idea that fear is either something they have had or something they still have. One teacher also expressed a fear that she would lose control of the class if she used the computer with her students, while others expressed being afraid to let the students use the computer by themselves. Fear is something that teachers must overcome on the way to becoming comfortable with the computer. The rate at which teachers overcome the fear varies from teacher to teacher. Betty reports that she was hardly ever afraid, while Alisha still expresses fear about using the computer after two years experience with the computer.

Overcoming Fear

Teachers overcome fear in several ways. Technical support or technical knowledge is helpful. They learn that "they [computers] are not really all that fragile" (Louise). Nikki explains that one thing that helped her learn to not be afraid was the county computer technician's reassurance that she should not worry because he would be there

to fix it. Sandy no longer worries about having her folders arranged perfectly and color coded as they learned to do in the initial computer training. "I know that it is there and I can eventually find it I figure the worst thing I can do is to erase my hard drive or take something out, but they can put it back" (Sandy).

Encouragement from others is also an important factor in overcoming fear. This encouragement can come from both other teachers and family members. Alisha, Felicia, Debbie, and Shirley talk about the importance of family in overcoming the fear. For Debbie her husband was "her right arm" when it came to using the computer. Felicia's husband, a computer enthusiast, made special arrangements for her to take her computer home over the summer so that she could learn to enjoy using the computer. Alisha's husband encourages her to go ahead and push the button and just see what will happen.

Experiencing success is important in overcoming fear. Jane expresses the feeling of accomplishment of several teachers when she looks back at her process of learning to use the computer, "So in 3 years, I have graduated to that; I taught a computer class this summer and I am in charge of our web page, I am going to pat myself on the back, I have come a long way." Julie demonstrates this feeling of accomplishment when she relates her most memorable experience with computers as "probably the first time that I made the HyperStudio stacks and we used them; I felt really good about it because the students enjoyed it. . . . that made me feel really good." Debbie further expresses this idea, "and when you do work with it and when you do feel successful with it, it makes all the difference in the world."

Being Comfortable With The Computer

As teachers overcome fear they describe themselves as being comfortable with the computer. Debbie explains that she uses the computer more and more every year because she feels more comfortable with it. "I had that fear, I am going to tear something up. I am past that and I honestly will try just about anything." She also relates an experience of training classes in which other teachers expressed a fear of not knowing what to do next. "And I am just like, punch it, punch it. I am going to have a good time wherever I am with that and that kind of lightens things up."

The teachers who have reached this end of the continuum in which they are comfortable with the computer use the computer simply because they like it. As Jane says, "the kids like it and I like it; it is fun and challenging to me." Sandy also expresses this place on the continuum when she says, "I have got to be comfortable with it if my students are going to be comfortable with it; but it is fun for me. And I like it. And if I am motivated then it is easier for me to motivate my children in the classroom. If I didn't like it I would probably have a harder time with it, but I like it." As teachers become comfortable with the computer, they express less frustration. "I feel more confident now. I used to get easily frustrated because I really didn't understand exactly what I was doing. And, uh. . . I just feel more at ease with it now" (Sherry).

Teachers who are comfortable and enjoy computers rely heavily on the computer to get their work done. Julie uses the grading program to keep track her student's progress. Sandy uses the computer to layout the school yearbook. They wonder what

they would do without it. "I wouldn't know how to go back to teaching without it" (Sandy). Dorothy and Sandy would not be willing to give up their teacher computer to assemble a new lab. Julie and Sherry say they use it for everything. For many, turning the computer on is the first thing they do in the morning and turning it off the last thing they do in the afternoon.

Teachers who are uncomfortable with using the computer express the desire to become comfortable. Teresa sees this as an area she "needs to work on". Shirley also expresses this desire, "Oh, I would love to try it. But I don't. I am not that comfortable, like I say, I am fine as long as things don't mess up, but give me a problem and press the panic mode."

Teachers are aware of where their colleagues fit along the continuum. Jeff talks about feeling left behind when other teachers "who are doing all this HyperStudio stuff." Debbie explains that "the teacher who does more with it, the ones in the grade level that you can watch and see, just feel more comfortable." Betty explains that teachers seek her help because they know that she is not afraid. "I like playing with the problem; I like seeing if I can fix it - and it helps them and it is just a challenge to me." She notes that some teachers "are afraid and won't do anything unless they have an OK from me. And I like it. I think it is the difference between some of us. Some don't want to bother learning it, some of them are scared of it. And I just jump in there. Heaven knows Debbie and I have gotten into enough trouble going nose deep."

Not only must teachers become comfortable before they use the computer for themselves, they must be comfortable using it with their students. At first Louise was afraid to let the students touch the computer because she was worried that they would tear it up. Betty explains that she “gets braver and lets the kids do more.” Sherry and Shirley will not use the a specific piece of software with the students until they are comfortable with it.

The process of making the computer a part of teaching then depends on the teachers moving forward along the enjoyment continuum. Teachers must overcome the initial fear of using the computers both with themselves and with their students. They must become comfortable with the computer. The other key concept that parallels the enjoyment of computers is knowledge.

The Knowledge Continuum

To move forward toward adopting the computer, teachers must also develop knowledge. When teachers are first introduced to the computer they are dependent on external factors such as training courses, computer manuals, and other people. The teacher must build a foundation of knowledge on the way to becoming independent learners and computer users. This relationship is depicted in Figure 4-4.

Dependent On The Knowledge Of Others

“I just don’t feel like I have the knowledge to fix it if goes wrong. I don’t want to start trying a lot of things because I am afraid that I will just make it worse” (Shirley). These words provide a picture of teachers on the dependent end of the continuum. Their

Along the Knowledge Continuum the teacher moves from:

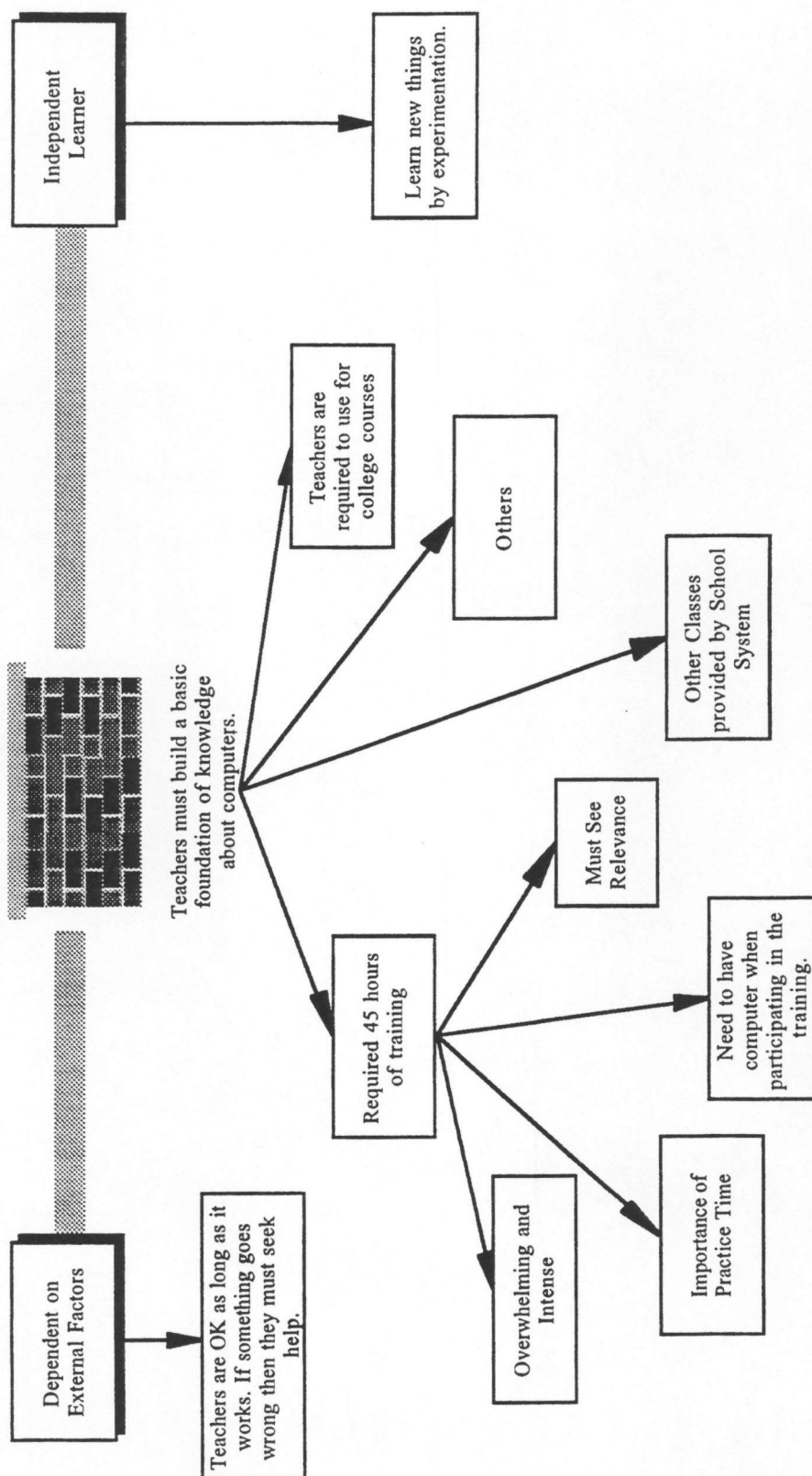


Figure 4-4. The Knowledge Continuum

knowledge of the computer is so limited that they must seek outside sources of help. This lack of knowledge is frustrating for these teachers. They get easily confused. Teachers see some level of knowledge as a basic requirement of computer use. "I think you have to have some knowledge, you have to have some or you are just whistling in the dark. And you have to be familiar enough with the knowledge you have to use it" (Debbie). This is the beginning of a process of what one teacher compared to a foundation. "Because first you have to be grounded in it, you know you have to have a good foundation of what you are doing. And after I got that, that was probably last year, and this year I am fine tuning everything" (Sandy).

The Basic Foundation

The teachers at Eagleton build this foundation in several different ways. The most common means are the training sessions provided by the school system, things learned in higher education experiences, and other people.

Training Provided by the School System

Required 45 hour course. Howard County provides two opportunities of computer training for teachers. The first opportunity is a required 45 hour training course. This course must be taken by every teacher who receives a teacher presentation station. Teachers do not receive pay for attending this course; however, they do receive a year's worth of inservice credit. Principals are not required to take the course. This course has been offered many different ways. Some of the teachers completed the training in 2 weeks during the summer. Others, including the teachers presently taking the course, attended 15

three hour sessions that met once a week after school. It is the goal of Howard County that every teacher will take this course and have a teacher presentation station in the classroom. The majority of the course focuses on technical skills. Teachers learn operating system basics, how to work with the file protection system, how to use an integrated works package, the world wide web, and the e-mail program. They also learn how to project their computer to the large screen monitor which allows for whole group presentations. A few of the teachers mentioned that there was some limited discussion of how to use the computer with children.

As Sandy described this course, it helped her to be more comfortable with having the computer; "it was like you had earned it." All the teachers at Eagleton except one had completed this course by the time this study was completed. Eight teachers were taking it in the fall as the study began. The remaining teacher could not participate in the course until the summer since she was on maternity leave.

The majority of teachers expressed mixed feelings about this course. They were grateful for the opportunity to have the training so easily available to them. They felt the technology staff are knowledgeable and helpful. However they also report being overwhelmed by the course. The teachers that took the course in the summer talked about the amount of content packed into such a short time. The teachers who took the course during the regular school year mentioned the intensity of the weekly sessions and the length of the teaching day on the days of the sessions. One teacher expressed these mixed feelings with this statement: "it is the worst part of my week, I go for three hours right

after school to a training class and it is good stuff and I am learning a lot, but it is just. . . . three hours.”

Not having a computer on which to practice is the most common criticism of the training mentioned by the teachers. They talk about forgetting what they covered in the training since they could not come back and immediately use it. In previous years teachers did not have a computer to practice the things discussed in the class until after they completed the training. They saw this as a great barrier to their getting what they needed from the course. Most teachers now receive their computer during training but due to purchasing procedures they do not always arrive until after the training has already begun.

In discussing the content of the course several of the teachers describe some of the course content as not being relevant. “You know there is some stuff that won't apply to me, but I am sure that it will apply to the upper grade teachers, like spreadsheets and stuff” (Jamie). They are unsure how they will use some of the things that they have learned. This may be due to the fact that teachers are not separated by teaching level. Secondary teachers take the same training at the same time as kindergarten teachers. One of the kindergarten teachers in this study expressed this concern when she explained that since she did not give grades, learning about spreadsheets was not something that was relevant to her or her students. The point here is not to decide what is relevant for a computer training course for teachers but to note that several of the teachers did not perceive all of the course content to be relevant to their teaching situation.

Other training courses. In addition to the required 45 hours the school system provides shorter three hour training sessions on specific subjects. These sessions are taught by the county technology staff as well as other teachers in the county. The teachers receive \$15 or inservice credit for attending these courses. Content of the courses includes multimedia development, the grading program, a lesson planning software, and a course on teaching in a one-computer classroom. A majority of the teachers mentioned taking these courses. Some had taken them before they had a teacher presentation station. They may also take a course several times until they feel they have sufficient knowledge to use the skill.

Learning from Higher Education Experiences

Six of the teachers had experience with the computer in higher education. Some of these teachers had special courses in instructional technology. These had varying levels of success. The important contribution that these experiences in higher education made did not seem to be in courses aimed at educational computing, but rather in the experience of having to use the computer to complete course assignments. "Most of my learning came from classes where I had to go print out a paper and I had to go in and change the font. And most of the stuff was just classes where I had to use the computer" (John).

Learning from Others

When asked what they do when they encounter a problem, the majority of the teachers say that the first thing they do is ask other teachers. For example a group of three teachers work on the school web page. Even though there was a formal training

session, they talk about what they have learned together in accomplishing this task. Other teachers formed informal groups to learn a specific skill or conquer a specific problem. Debbie and Betty have spent much time in conquering the Accelerated Reader program that runs on the school server. They have spent countless hours on the phone with Accelerated Reader technical support staff. They have also learned how to customize the program by adding books not included in the original program. Louise talks about working after school with other teachers and losing track of time.

Another source of knowledge and learning for quite a few of the teachers is their families. These teachers related experiences of husbands and children making special trips to Eagleton to help them solve a problem or learn a new skill. For Debbie her husband was her "right arm". This parallels the enjoyment continuum where family members encouraged the teachers to just try it and learn to like it. Shirley's describes how her son comes after school and helps her practice the computer activity that she plans to use the next day.

Independent Learner

These experiences help develop in the Eagleton teachers a foundation of knowledge that is necessary for moving to the independent learner end of the continuum. At this end of the continuum most knowledge is gained through experimentation. As with the enjoyment continuum, reaching this end of the continuum is a goal of all of the teachers. Dorothy explains that to use the computer she needs to "get familiar with everything so I can go right to it and pull it up."

For Jane learning is now easier because she is knowledgeable. Sandy explains how learning a new program was easier because she saw it as similar to a program that she already knew. "So I would get myself in and out of stuff rather quickly because I knew that, my background." For these teachers the most common way to learn is by playing around and experimenting. They are knowledgeable and comfortable with using a computer. As the result of their spiral movement of increased knowledge and increased enjoyment, the pieces of the puzzle of their classroom change.

FACTORS THAT ARE INFLUENCED BY THE PROCESS OF MAKING THE COMPUTER A PART OF TEACHING

As teachers increase their enjoyment and knowledge of the computer they shape the computer piece of the puzzle of their classroom. The result of this process can be seen in the time devoted to using the computer, the activity structure that is used in instruction, and management of computer use. Figure 4-5 summarizes these factors.

Time Devoted To Using The Computer

Time is a precious resource in any classroom. One of the major tasks of the teacher is making decisions about how time will be used. At Eagleton time is devoted to computer use in one of two ways. In some instances the time devoted to the computer is used to meet the objectives of the state mandated curriculum, i.e., content objectives of specific subject areas. In other instances time is set aside just to allow the students to experience using the computer.

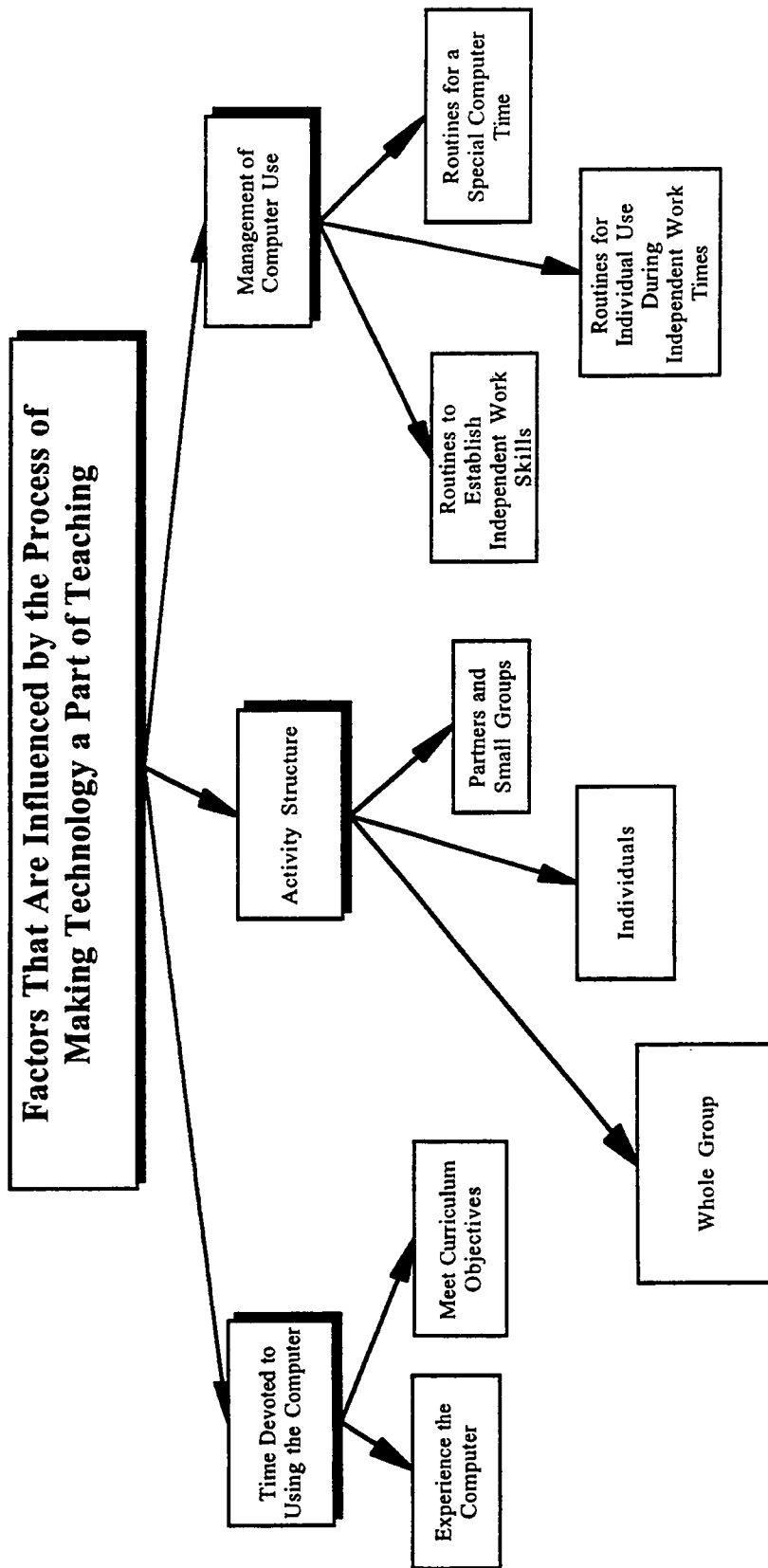


Figure 4-5. Factors That Are Influenced by the Process of Making Technology a Part of Teaching

Time to Experience Using the Computer

An example of this later instance is the fifth grade's use of the computer during study hall. The students in the fifth grade rotate to a different teacher for each subject. These teachers have set aside 30 minutes every day in which the students stay with their homeroom group. This a special time that these teachers have set aside to use the computers with their students. "After lunch we come back into the classroom and I usually read to them a book while they are doing study hall and we take turns on the computer. If they have finished everything then we do center time, which is the computer. So then after the computer they can go read in the library [a corner of the room] or they come over here and finish their work in the learning center or they can go listen to their reading story on the stereo or they can play math safari or there are little games they can play over there for their centers" (Nikki). The students are allowed to choose the programs that they want to use on most days for the fifth grade teachers. Occasionally this computer time is used for a specific project. For example the students used the word processor to type up a book report they had written. Each student made a card to give his or her mother on Mother's Day in another project. The kindergarten teachers also use the computer during a special time like the fifth grade teachers. An important part of the day in kindergarten is play time. The kindergarten teachers set up the computers in their rooms as one of the play time areas. The fourth grade teachers have also developed a way of scheduling to allow students to be exposed to the computer. Friday mornings are set aside as a special enrichment time. Debbie, the Special Computer

Classroom teacher, teaches this grade. Every other fourth grade class rotates to her classroom where she teaches specific computer skills. The other fourth grade teachers each develop a special enrichment activity to do during this period. For example, one teacher does current events and Weekly Readers during this time.

Time to Meet Curriculum Objectives

The other way that time is devoted to using the computer is to meet curriculum goals. There are a variety of ways that teachers have developed to meet content objectives. It is used as an information source. "Use it as a textbook, [it provides] more not necessarily adequate information because the textbook has a lot of general things, I am thinking of specifically Internet stuff, your textbook does not have the current information and sometimes it just doesn't even have the beginnings of that information; like I want to know what the weather today is in Atlanta, the textbook is not going to help me with that" (Debbie). Teachers also use the computer to enhance their whole group presentations. Nikki uses the computer to help her students visualize concepts. For example, she uses the computer with the whole group to watch a quick time video from the electronic encyclopedia to help her students understand the job the heart does in the circulatory system. Jane uses the Internet to take her students on virtual field trips. She accessed the White House web page in her unit on Washington, D. C. Another very popular way that the computer is used is to enhance the presentation of information is through the use of teacher developed multimedia stacks to introduce the reading vocabulary words. These stacks have been created by teachers at Eagleton as well as other

teachers in the Howard County System. They use the words for the stories from the basal reading series. "I just think that technology is just a little more, in my classroom my thinking is, it is kind of a sparkle" (Debbie). Jane feels that using the computer adds to her instruction and makes her a better teacher.

Another use of the computer that these teachers developed independently is that of blackboard. In order to take advantage of the motivating force of the computer, Nikki just decided that if she put the end of the day reminders on the computer using a word processing file with a large font size the students would pay more attention. This was successful with her students and so she started using it in this way with her science vocabulary words. Debbie also describes using the computer in this fashion. Dorothy learned to use a multimedia development program during the year and began using it to teach word families by making the stem of the word a different color.

The computer is also used by teachers as a time filler. "Anytime I have spare time I slip that in, that is one of those jiffy type things that I can put on" (Louise). Betty uses it "when she has a few extra minutes to stick in between classes." Dorothy uses the computer when eight of her students are out of the classroom for speech. The remaining students use the computers and other electronic learning games. Sandy uses it when the daily schedule is altered due to a special activity. She feels that students who are easily upset by different scheduling do better when the schedule is filled with a computer activity.

Teachers see their students' inability to type as a barrier to using word processing. A decision has been made at the school system level to provide keyboarding software for use by middle school students. In spite of this unpopular decision, some teachers have made special arrangements to teach their students keyboarding skills. Two first grade teachers worked one summer to get local businesses to donate broken keyboards so that students could actually use a keyboard to experience typing. They purchased keyboarding software. They use this software as a whole group activity in which one student works with the computer projected to the class and the other class members follow along on their own keyboards.

Similar to word processing, e-mail is used mostly by teachers with occasional student use. Only two teachers mentioned using databases and spreadsheets, and that was for teacher tasks rather than with their students. Electronic encyclopedias are used by both teachers and students.

As mentioned earlier, the majority of the software that teachers have available to them is drill and practice software. The teachers at Eagleton in turn see the computer as a way for students to practice skills they are teaching in the classroom. Teachers sometimes allow their students to have free choice of the software they have. Jeff calls this free lancing. Others sometimes limit the choices to a particular section of a particular piece of software. Teachers may use software to reinforce an area of weakness. Sandy makes sure that her English as a second language students use the reading programs rather than the math software because she feels this is an area they need to improve.

Activity Structures

Teachers devote time to the computer through the use of whole group, small group, and individual student activity structures. The most frequent use of the computer for most teachers with only one computer is with the whole group activity structure. Julie explains that the major reason she uses the computer in this way is her lack of hardware. Using only one computer with small groups and individuals is much more challenging. Teachers use computers with individuals during independent work time. The Special Computer Classroom teachers use this structure more than the one-computer classroom teachers. Partners are also used occasionally by teachers. This is true especially with software that is setup as a game with two players. Small groups are used less frequently.

Management Of Computer Use

Managing a Limited Resource

The teachers at Eagleton have developed a variety of ways to manage the limited computer resources which are shared by both teacher and student. Sandy relates an incident in which her students ask her if it is teacher's turn or kid's turn. Julie reports her concern about students accessing her files before she let her students use the computer. A file protection system has been helpful in dealing with these access issues. Most teachers allow students to use the teacher presentation station regularly.

The ways that teachers manage the computer are not part of formal plans of these teachers.

The majority of the time I just pick it up. But I have had it in my mind, maybe I haven't written it down, but I have had it my mind that I will do it. But maybe it is not a part of my written lesson plan but I know up here (points to head) what I am going to do (Jane).

Teachers do make preparations to use the computer. They get familiar with the software. Dorothy sees the need to be familiar with every aspect of the software that she has so that she "can go right to it and pull it up and have it right there on the screen waiting." Other teachers also report what they do before they use a piece of software. "I take it home and I go through the processes of it and see how can I change it. Is it manipulative? Can I manipulate it to where. . to meet my needs for the children. And then, if I can then I go into it and do it" (Louise). Some teachers will also introduce a new piece of software by using it with kids who stay for the late bus and "explore it with the students."

Classroom Routines

Aside from whole group use of the computer during teaching presentations, teachers that use the computer with small groups and individual students have developed a series of routines. These routines fall into three types: routines to establish independent work skills, routines used during a special computer time, and routines for individual student use during independent work time.

Routines to Establish Independence

The Eagleton teachers have developed several methods to allow students to use the computer independently. One method is to teach the students computer skills in a whole group setting with the computer projected on to the monitor. This method is used by one-computer classroom teachers and Special Computer Classroom teachers. For the teachers with only one computer, the teaching consists of introducing students to a particular piece of software. Sandy uses a new piece of software with the whole group first because, "they learn from each other; and if one makes a mistake, or even if I make a mistake they can learn through mistakes of how to get in and out of a program." In these classrooms the only computer skills that are taught to the whole group are specific to the software that is used rather than operating system skills. The Special Computer Classroom teachers also teach computer skills, but in addition to particular software skills they teach students operating system basics. Their students can log on to the computer by themselves and select the piece of software they want.

Another routine that teachers use to develop independent work skills is the use of student helpers. This method takes advantage of the expertise of their students. Selected students become helpers. For example, Teresa assigned two of her more knowledgeable students to be computer leaders, solve computer problems, and teach other students how to use the computer. Several of the teachers use the each-one-teach-one technique. The teacher teaches one student who teaches the next student and then the process repeats. In some cases, if a student is already familiar with a piece of software a student will not only

teach other students but will also teach the teacher the ins and outs of that particular piece of software.

Routines for a Special Computer Time

Teachers have developed routines for setting aside time during the day for computer use. The simplest of these types of routines used by the majority of teachers is to use the computer during a free time. One such time is during afternoon bus call. For example Dorothy made arrangements with the parents of two of her special needs children to stay during this bus time so that they can use the computers. She feels this has been very successful and reports learning gains made by these students. Another time when the computer is used by teachers is time in which some of their students are participating in special pull out programs such as resource and speech. Several teachers use this time to set up learning centers. Other teachers also set up learning centers but do them at a time when all the students are present. During the learning center times one or two of the learning centers that the teacher sets up are computers. Louise uses centers every Friday afternoon. Other things that serve as centers are electronic learning games, a center with a book on tape and recorder and headphones, a free reading corner, and an art activity. Sandy also uses the computer in a learning center with things such as math manipulatives and art activities. Movement through the centers varies with the teacher and with activity. For Sandy students rotate in groups from center to center after a specific period of time noted by a timer. Jamie allows free movement from center to center but puts a limit to the number of students allowed at any one center at one time.

The learning center special computer time is used by the one-computer classroom teachers and not the Special Computer Classroom teachers. The Special Computer Classroom teachers use the computer with individual students and have developed individual turn taking routines.

Routines for Use During Independent Work Time

Teachers have also developed routines for individual student use during independent work time. These routines can be categorized as systematic and non-systematic, and teacher controlled or independent. An example of a non-systematic system is to allow the first student who asks to use the computer. A little more systematic is to allow the students who finish their work first to go to the computer. Other teachers develop routines that make sure that each student has equal access to the computer. In these classrooms the students go in alphabetical order or in "row order," the order of their seat in the classroom. The Special Computer Classroom teachers have also developed a routine for individual turn taking. For these teachers each student is assigned to a computer, with four or five students at a computer. Student one goes to the computer and when he finishes he gets the next student. This is repeated until all four or five students assigned to that computer have had their turn at the computer.

Individual turn taking can also be categorized as independent or under teacher control. In the teacher control situation the teacher informs the student when it is his turn and when his turn is complete. In the independent routine students move back and forth from the computer to their seats based on a pre-determined format. For example the first

student on the list goes to the computer and sets a timer. When his time is up he gets the next student on the list without dependence on the teacher.

The routines that the Eagleton teachers have developed create the picture puzzle that is their classroom. These routines reveal how the teachers have shaped the piece of the puzzle that is the computer. They are very similar to other classroom routines. For example learning centers, having student helpers, and going in row order are routines common to many classrooms.

APPLICATION OF THE GROUNDED THEORY

General Overview

For the Eagleton teachers, the computer is a part of their everyday lives. The Howard County School System has a general goal to make technology a part of education. Eagleton school made using the computer a part of their school improvement plan. The computer is a common sight in the classroom. It is used for non-teaching tasks such as creating worksheets, calculating grades, and communicating with other teachers and staff. It has become a part of the daily work routine for teachers. It used in instruction to enhance whole group presentations, find information, and practice individual skills.

Each individual teacher has begun a gradual process of fitting the computer into the puzzle, spurred on by student interest and excitement about computers and growing resources. Teachers are learning to like the computer and overcome their fear. They are building their knowledge. As their knowledge increases, they become more comfortable with the computer, and they learn more about it. Some are progressing at a slower pace

than others, but all the teachers are moving forward. No single teacher that participated in the study has totally refused to use the computer.

The Eagleton teachers want to be able to "teach with the computer." They want to use the computer more. As Teresa explains, the more she has learned about the computer and increased her feeling of 'comfortable-ness,' the computer is "coming to have its rightful place." As they move forward, teachers want more computers. They also want more time to develop ways to use it with their students. They want to use it to meet curriculum goals, they are still struggling with how to do that.

As a result of these influences, the shape of the computer piece of the puzzle is very similar for all the Eagleton teachers. The majority of the software they use has been designed for individual students to use to practice skills. They search for ways to make effective use of this kind of software. They have established individual turn taking routines. Occasionally teachers will use productivity software with the students to create products. The things the students create are common school tasks such as book reports and art projects. At the present time the majority of teachers use the computer as a supplement, an extra. They see that the computer has potential as an instructional tool, they are still struggling to find ways to make use of that potential. The teachers at Eagleton have only begun to shape the computer piece of the puzzle.

Purpose of Case Studies

In order to see how the grounded theory can be used to explain the process of making the computer a part of teaching for the Eagleton teachers, the next section will apply the theory in case studies of three of the Eagleton teachers. The three teachers were selected to serve as examples of teachers at different points in the process. Shirley and Sandy are one-computer classroom teachers. Shirley has had one year experience with a teacher presentation station in her classroom. She serves as an example of a teacher who is just beginning the process of making the computer a part of her teaching. Sandy serves as an example of a one-computer teacher who has had four years of experience in the process. Betty, the final case study, is a Special Computer Classroom teacher and an experienced computer user. Each case study will follow the outline used in the presentation of the theory.

Shirley

Shirley has 19 years teaching experience, all in Howard County. She chose to teach at Eagleton so that her children could attend this school. She describes Eagleton as a warm, friendly, "back to the basics" school. She has an elementary education teaching certificate and received her Masters degree in 1996.

Factors That Influence The Teacher To Begin The Process

Students

"I think the kids need it [the computer]. They need a lot more then they are getting from me and probably most people here in this school." Students influence Shirley's use of the computer in her classroom. Not only does she believe they need it she also recognizes that students enjoy it. "They like it. It is fun for them."

Resources

Shirley has one Apple IIe which she calls her "ancient computer." She received her teacher presentation station in the spring of 1997. However the computer she received did not work properly. It had just been returned to her after being "rebuilt" on the day of the first interview in November. The computer problems she has had with her machine caused her to conclude, "I think I just got the lemon if you want to know the truth, because the other people who got this same model haven't had a problem." She was anxious to get everything to work so that she could use it. As the year progress there were no more problems with her computer. When asked about how it was working later in the year, she replied, "actually, it kind of works now; I have learned to get in, I can get into Netscape one way now. And I have finally gotten it hooked up to the TV monitor, which is really wonderful." The problems with her computer influenced her use of software. "They have bought us all kinds of software. I haven't used a lot of it. Like I say I have had too many problems with this particular computer."

Physical resources were the biggest factor in Shirley's decision making about using the computer with her students. "The computer is a tool, but you know when you have just got one decent computer in the classroom. . . . if we had it set up like some of the other classrooms, it could be a great tool."

Like all the other teachers, Shirley mentioned the role that the Special Computer Classroom teachers played at Eagleton. She reports her computer problems to Debbie and she contacts the technicians. Shirley has not noted a change in teacher interactions. She does not consider herself one of the teachers who is involved with technology. "It hasn't made any change for me. Some of them that are really involved in this it probably has made a change, but it hasn't for me."

Concepts That Propel The Teacher Forward

The Enjoyment Continuum

The computer is new and unfamiliar to Shirley. "I feel like a fish out of water, because this is all new to me, I haven't been using it that long." She describes her first experiences with the computer as frustrating. She depends on her children to help her when she is working at home and even at school.

I have two teenagers and I am still to this day at home yelling for them to come and help me. I . . . the most frustrating. . . I guess I am afraid to try things. If I run into a glitch I am afraid to try to get myself out and afraid I am going to loose everything. I mean my middle school-er will come over here in the afternoon and I will say, this is what I plan to do tomorrow, tell me what do I need to do.

Shirley is in the process of overcoming her fear. "Oh, I would love to try it. But I don't. I am not that comfortable, like I say, I am fine as long as things don't miss up, but give me a problem and press the panic mode."

The Knowledge Continuum

For Shirley the relationship between the enjoyment and knowledge continuum is expressed in this statement,

I think, you know even with the training they have given us, I don't have the technical knowledge. . . all this. . . I don't know. . . I just don't feel like I have the knowledge to fix it, if it goes wrong. I don't want to start trying a lot of things because I am afraid that I will just make it worse.

Shirley completed the required 45 hour training course in the spring of the previous school year (1997). She did not have a computer until the course had already begun. The computer she did receive was plagued with technical problems. "It would have been a lot more helpful if I had had the computer. I did have the computer towards the end of the class, but if I had had the computer from day one I think it would have helped a lot."

Shirley has not taken any of the other courses provided by the school system. She did plan to take one in the summer.

Shirley did use the computer in the course work for her recent Masters degree. "I am still learning to use the computer and when I got my Masters, that really made me learn a lot about the computer we have at home, which is IBM, which is not what this is."

Shirley's place on the enjoyment and knowledge continua are illustrated in Figure 4-6. Shirley still feels uncomfortable with the computer at times. She has built some knowledge but needs to develop trouble shooting skills.

Factors That Are Influenced By The Process Of Making The Computer A Part Of Teaching

Shirley represents a teacher who is at the beginning of the enjoyment and knowledge spiral. She is not afraid of using the computer as long as there are no problems or error messages. She sees her lack of technical knowledge, especially the ability to trouble shoot problems as a barrier to using the computer. As a result Shirley makes only limited use of the computer in her classroom.

Time Devoted To Using The Computer

Shirley devotes time to using the computer in a special time set aside to experience the computer and to meet curriculum objectives. On Fridays, her students participate in a special enrichment time. One of the enrichment sessions is computer literacy. This session is led by another teacher. She uses the computer as the reading lesson on Fridays instead of the basal reading series.

I do plan to use it, well I probably don't plan as well as I should to use it. I have found that it is real effective, we use it more on Fridays then anything else. Fridays are sort of a kick back day anyway and we use it for Weekly Reader [world wide web site] it is wonderful, for current events it is great.

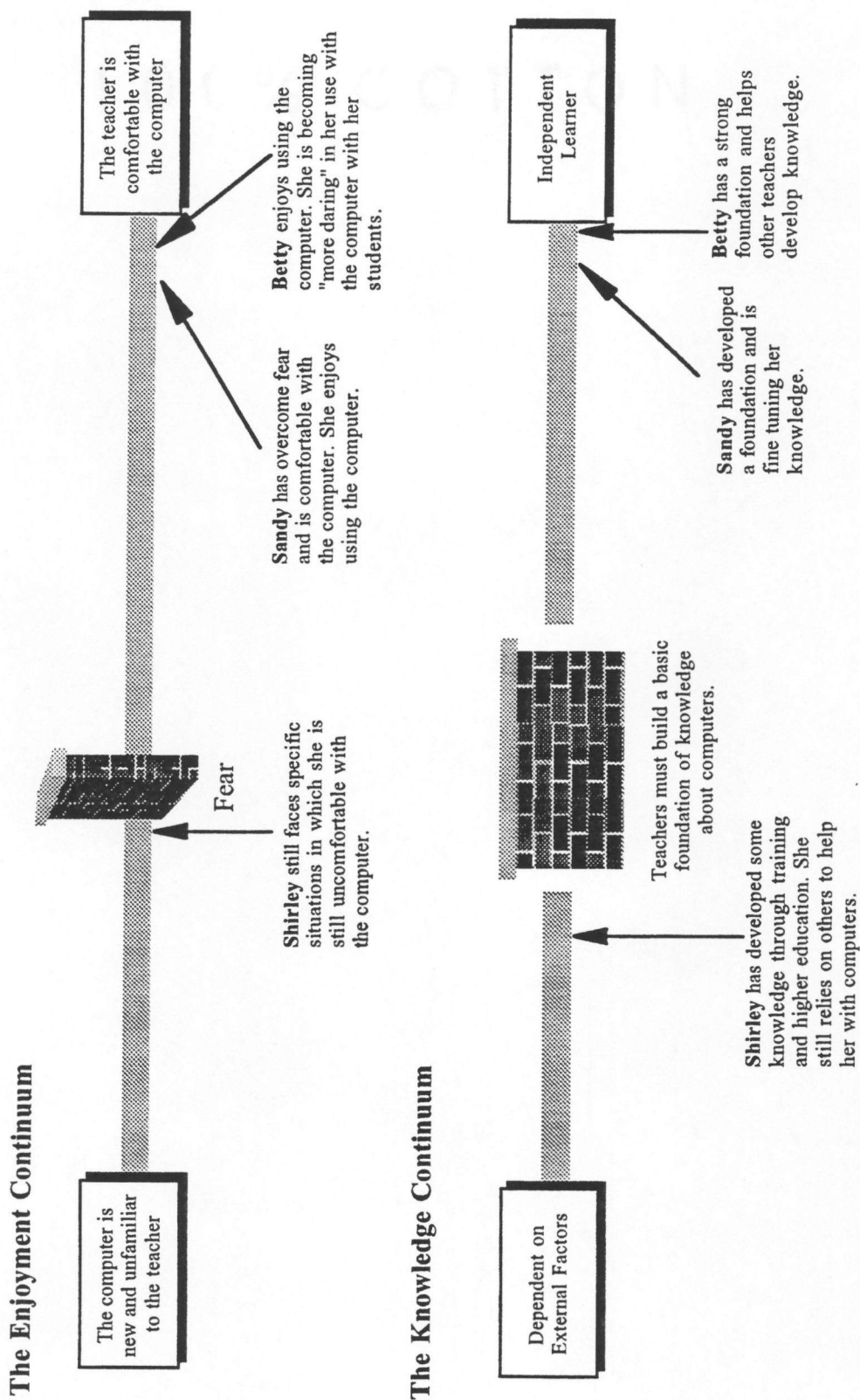


Figure 4-6. Teachers' Places on the Enjoyment and Knowledge Continua

Another way that Shirley uses the computer in her reading lesson is to introduce the vocabulary for each story with a multimedia presentation. These presentations have been developed by other teachers in the Howard County school system are shared via the world wide web.

Activity Structures

After learning to connect her computer to the large monitor in the middle of the year, the majority of the time Shirley uses the computer with the whole group. She does not use the computer with individual students. She does mention that she occasionally uses the computer with a small group of children to locate information in the electronic encyclopedia.

Management Of Computer Use

“Oh I think that I would definitely use it more if I had more. You are talking to a handicapped person here.” For Shirley the limited availability and the unreliability of her computer resources has contributed to her limited use of the computer. Other than use with the whole group she has not developed any particular classroom routines.

Shirley uses the computer with her students because she believes that they need it. She has only limited computer resources. She is only beginning to overcome her fear and develop a foundation of knowledge. As a result, Shirley makes only limited use of the computer in her classroom. The majority of the time she uses the computer with the whole group to supplement and enrich her regular instruction.

Sandy

Sandy has four years of teaching experience all at Eagleton school. She holds elementary education certification with a Bachelors degree. She describes Eagleton as a school with a wonderful positive atmosphere where the teachers work together and the principal is very supportive. She received her teacher presentation station her second year of teaching.

Factors That Influence The Teacher To Begin The Process

Students

"I think we are going at a new computerized era of time and I think we would be not benefiting our children if we didn't have it." Sandy uses the computer with her students to prepare them for their future. She wants all her students to be comfortable with the computer. "And the children who don't even have a computer at home and that kind of thing, it just gets them familiar with what is going on. Because I think that our culture is going to change to have more of that."

Sandy is aware of the motivation that the computer can bring to her students and takes advantage of that in her teaching.

But my kids like it so much, when I say it is computer time, I mean they just [shows excitement with gestures], you know, they just really, really, like it. It doesn't matter what I do with them, from Tommy Time Turtle to Storybook Weaver to Internet Crayola web site, it doesn't matter which avenue I go to as long as we are on the computer.

Her students' reactions are an important factor in her use of the computer. "I guess it is because they are so motivated it motivates me to use it more for them."

Resources

Sandy also teaches in a one-computer classroom. In addition to the teacher presentation station she has two Apple IIe computers. Unfortunately those spent most of the year on the shelf because they were broken. Sandy was one of the first groups of teachers to get the teacher presentation station. "So the first year was just mainly the Special Computer Classroom Teachers. Then I got it the next year that they offered it to so many. And we had to draw straws to see who would get it in your room. And I got to go to the training."

Sandy uses the computer a lot at both home and school. She uses the Internet to research ideas, the word processor and graphics programs to create letters, and e-mail to contact other teachers. She knows what software is available on the school's server. "So they are getting more [software] for us, what we need, after we tell them what we are using."

Sandy works with teachers after school hours with the computer. She worked with Debbie to develop a multimedia presentation for her students. She spends time using the computer to design artwork for special school projects.

Even though Sandy uses the computer a lot with her students and for herself, resources also play an important role in how she uses the computer.

You can be benefited with one, but I think it would be more suited to the children if you had like one for every four anyway. And it would be really nice if you had one for each student, but that is not possible, right now. But with one, it is just hard unless we do a group activity, a group game or something,

Concepts That Propel The Teacher Forward

The Enjoyment Continuum

Sandy was one of the two teachers who remembered using technology before college. "But I like it and as a child I remember, that was when we were first having like the Odyssey and stuff like that and that was really, really neat to me." Sandy did not experience fear as strongly as some of the other teachers.

When I first got it [the teacher presentation station] I thought everything just had to be in here and here and here. And they were teaching us how to color code our folders and put everything in alphabetical order. And if it is there and I know that it is there, I can eventually find it. So I don't really worry about it like I used to. She trusts the technical support personnel to be able to deal with any problem she might have. "I figure the worst thing I can do is to erase my hard drive or take a thing out and they [technical support] can put it back on."

Sandy is very comfortable with the computer and really enjoys using it. "But it is fun for me. And I like it. And if I am motivated then it is easier for me to motivate my children in the classroom." She would not be willing to give up a computer in her classroom to create a lab, "just because I am so attached to it." She notes that her

enjoyment of the computer affects her use of the computer. "If I didn't like it, I would probably have a harder time with it; but I like it."

The Knowledge Continuum

Just as Sandy has become comfortable and enjoys the computer, she has developed a foundation of knowledge and has become an independent learner. "Because first you have to be grounded in it, you know have to have a good foundation of what you are doing. And after I got that, that was probably last year. And this year I am fine tuning everything." She felt that the training provided by the system contributed to her becoming comfortable with the computer. "Well we have the training. And that really helped a lot, because you felt more comfortable having this in your classroom. You kind of earned it, so to speak." She learns things by doing.

When I learn something, and I am the type of student that I have to do it myself, I am a doer. And if I see it that is fine, but I don't really learn it until I get to do it myself. So if I can come back from a training session and incorporate that right then, then I will more than likely learn that. So the things that I have incorporated, then I know, I know well. But the things that I can't incorporate right now, come a little harder to me.

Sandy relates an experience that demonstrates her foundation of knowledge. Because she was very familiar with a particular graphics program she was able to learn a new multimedia development program rather easily. "So I just applied all of that [what I

knew about one program] to making that [a multimedia presentation]. So I would get myself in and out of stuff rather quickly because I knew that, my background.”

Figure 4-6 illustrates Sandy’s place on the enjoyment and knowledge continua. She is very comfortable with the computer and really enjoys using it in a variety of ways. She describes herself as fine tuning her foundation of knowledge. She can transfer things that she has learned about one type of software to learning a new piece of software.

Factors That Are Influenced By The Process Of Making The Computer A Part Of

Teaching

Time Devoted To Using The Computer

Sandy uses the computer with her students on a regular basis. “Wednesday afternoons we always do because we have a morning break and we don't have an afternoon break. So it sort of gets them together in the afternoon. And then we try to do it at least 30 minutes every other day together on the computer doing something.” While Sandy does want her children to experience using the computer, she does not set aside a special time to teach computer skills or just to use the computer. Sandy devotes time to the computer to meet curriculum objectives. For example, she explains how she uses the computer with specific students.

Some days I will say now you can choose if you want, in this program you can choose which level you want or which thing you want. And if it is my Spanish, I have two Hispanics, if it is them then I primarily want them on the English, because they are really good at math. Both of them are really stronger in that area.

So I always put them on that with a game of some sort, so they are still getting to play. And then I have got two that are a little bit weaker in math, so I may want them. . . . So some of them I do pick for them but the other ones I just generally give them a choice of usually reading or math.

For Sandy the time devoted to using the computer provides students with another way of learning a skill.

Then just as another outlet, if they haven't got it by any of those means, then I can put them on the computer and as a review for some and then it just clicks with others on technology. So sometimes that is my means of connecting with all my children. Because some will just not get it until it is put on the screen. So it seems like, if I do hands on and I do independent practice and I do technology, all of those blended together that makes my lesson. That way I can feel like I have taught it completely.

Sandy also devotes time to the computer to meet other types of student needs. She uses the computer with students who might need a little extra encouragement. For example she told of one of her student's whose mother was in the hospital. "She could not concentrate on anything. So I said the Living Books [computer software] needs you for about 10 minutes. So I pulled her over to the computer and did that." She uses the computer when there is an unexpected change in the schedule. "At that point technology always seems to be a better substitute."

Activity Structures

Sandy uses the computer in whole group presentations, small groups, partners, and with individual students. She regularly uses the computer with the whole group. "I mean we do computer, but we do some many things on the computer that they really don't know what I am going to do when we get over there to circle time." She makes use of activity centers with small groups. For example, groups of four students will rotate between the computer, a table with math manipulatives, an art activity, and a table of electronic learning games. Individual students also use the computer during seatwork time.

Management Of Computer Use

Managing a Limited Resource. Sandy has developed a variety of ways to manage the limited computer resources she has. The computer is shared by Sandy and her students.

They [the students] know like if a [e-mail] message comes on the screen, they know that ding and I try to turn it down, but they will say, oh you have a message. And one time we were waiting for Mr. Lindsey [the Eagleton principal] to e-mail us about our popcorn party, and they said, oh, he called back. So they think that it is like a telephone in the computer, so they will say OK, it is your turn. So I get a turn like everybody else on the computer.

The computer is not a part of Sandy's formal lesson plans. "The computer is really not in my lesson plans, but it is just whenever something else goes shorter or longer or whatever I need to put it in, that is when I put it in." She does spend time preparing to

use the computer. "If I don't know about them [software programs], I have to sit down with them and go over them myself before I know how to do it with my children."

Classroom Routines. Sandy has developed several routines to use the computer with her students. One routine that she uses to allow her students to use the computer independently is to introduce a new piece of software with the whole group first. "They learn from each other. And if one makes a mistake, or even if I make a mistake they can learn through mistakes of how to get in and out of a program."

Learning centers are a routine that Sandy uses regularly to provide an opportunity for her students to use the computer.

We work in centers so we get more one on one so that there is just 4 in a group, then we switch and every 15 minutes they switch. Another time maybe just the blue table switches, half the class that they are scheduled to work over there, then they switch. Because I will have a math manipulative that I want them to do and then they switch with the computer. Or I want them to read in small group with me and then work with math manipulatives and then go to the computer and then we switch. So we do a lot of things like that.

Sandy has also developed routines for use during independent work time. The computer is used a lot during these times. "Well it is on from the time I get here in the morning until the time I leave. So just whenever I have children that are finished." Sandy has arranged her computer so that the monitor is facing the front of the classroom, "so I can see what program they are on, how they are doing."

Her routine for use during independent work has changed over time. She does have a systematic way of ensuring that students go to the computer, but this system is not known to the children.

One year I did [have a system known to the children] and they didn't do their work well that morning, because they knew whenever they got finished then it was their turn. So now I just pick randomly like who's handwriting is really neat and who is taking their time. And then when they get finished I pick someone else. So it is kind of a reward of who gets to be on it, as who has done their work. And then some children are never going to get their work finished ahead enough time to work on it, so then they will just do it another time. So every child does get to be on it.

Sandy uses the computer to prepare her students for the future. She is concerned about the students that don't have a computer at home and tries to make sure that all of her students get to use the computer. While Sandy uses the teacher presentation station that she has a great deal, she would like to have more computers in her room. She uses a variety of software for herself and with her students. Sandy is comfortable with and enjoys using the computer. She has a good foundation of knowledge, which she is now "fine tuning." She uses the computer a great deal with her students to meet curriculum goals in whole group, small group, and individual activities. She has developed a variety of routines to manage computer use. Sandy represents an experienced one-computer classroom teacher.

Betty

Betty has 25 years teaching experience, all at Eagleton. Betty grew up in Morganville and attended Howard county public schools. She has a Bachelors degree plus graduate course work at local institutions. She received her teacher presentation station in 1994 and has been a Special Computer Classroom for two years. Betty describes Eagleton as a good school with good teachers.

Factors That Influence The Teacher To Begin The Process

Students

Betty uses the computer because "I think it is fun and I love them; so I want the kids to be excited about them and I just have all kinds of programs that I would like for my kids to use. I guess it is just because I am a computer nut." She contributes her students' improved reading and spelling scores to computer use. She believes that it enhances her teaching. "With the big screen you can explain it more, I mean you can put it on the chalkboard, but they can see it, they see it moving up here. I just feel like it is a big part of it." Unlike other teachers she does not mention the need to use computers with students to prepare them for the future.

Resources

In addition to the teacher presentation station, Betty has five student computers. Betty was one of the first teachers to get a Macintosh computer in her room. This Macintosh was obtained through a program sponsored by a local grocery store where students collected receipts that could be traded in for a computer. The computers in

Betty's room are lined up across the back wall of her classroom. There are very close together with one chair in front of each computer.

Betty uses a wide variety of software. "Most of it comes off of the file server. But a few of the programs I have purchased myself and a some of the programs I have made myself like HyperStudio stacks." She uses the spelling program with her students everyday. She has replaced the words that were built into the program with the words from her basal spelling series. She also makes great use of the math program that runs from the server.

Betty is recognized as the computer expert by other teachers at Eagleton, offering technical support and encouragement. She spends a lot of time after school working with teachers on the computer. She and Debbie manage several programs that run from the server. She helps Jane and Debbie maintain the school's web page.

Even though Betty does spend a lot of time with the computer, most of that time is spent doing things for others. She sees lack of time as a barrier to developing more ways to use the computer with her children. "Time, I just haven't had time to sit down and develop the programs."

Time and resources set the stage for how Betty will use the computer with her students. She would like to have more time to develop computer activities for her students. She would like to have more resources. In her ideal computer classroom, "Each student would have their own computer. . . . and then let them help create programs

and type up worksheets and do more, I guess like portfolio stuff that they could type up themselves and put in.”

Concepts That Propel The Teacher Forward

The Enjoyment Continuum

Betty's first experience with a computer was with the Apple IIe at school. She doesn't mention being afraid, instead she describes herself as becoming “more daring.” She does talk about the fear that other teachers experience. “Some of them are scared of the computers and they don't want to . . . they are afraid that they are going to mess them up. And so they won't do anything unless they have an OK from me. I just go, go for it. I think, well they are indestructible, I just go for it.”

An important factor in her progress is her work with Debbie, the other Special Computer Classroom teacher. “I think I would be more cautious, but when I have got her and she has got me, we just go in and do it. But together, buddy you can really get brave. Heaven knows Debbie and I have gotten into enough trouble going nose deep.”

Betty really enjoys the computer. She describes herself as a “computer nut.” She relates her feelings about creating her first multimedia presentation. “I love it. Just watching it in front of you, just knowing that you are creating something like that.” Betty uses the computer so much that “to me it is just part of my teaching. I don't think I could teach without it, I would have to retire.”

The Knowledge Continuum

In addition to her great enjoyment of the computer, Betty has a good foundation of computer knowledge and is an independent learner. She has taken the 45 hour training and several of the extra training sessions provided by the school system. She has led training sessions for other teachers at Eagleton. She has not taken any computer or educational technology course in any of her formal higher education experiences. She is an independent learner. "That is how I learn, just sit down and do. I mean I have been in control panels, probably where I shouldn't ever be, just trying to figure it out if I can't get it to work. So you just get in there and play with it."

Betty represents a teacher who is very comfortable with the computer. She describes herself as "computer nut" and enjoys the computer. She is recognized as a computer expert at Eagleton. Her place on the enjoyment and knowledge continua are illustrated in Figure 4-6.

Factors That Are Influenced By The Process Of Making The Computer A Part Of Teaching

Time Devoted To Using The Computer

"Mr. Lindsey [the Eagleton principal] came in and said, every time I come in here they are on those computers, I said what are they for?" Betty makes regular, daily use of the computers.

Everybody does spelling, everybody does math, everybody does reading, and everybody is doing Storybook Weaver. They go at least, and sometimes they do social studies when I have a stack, they go anywhere from 4 to 5 times a day. I'd say they [each student] spend about an hour to an hour and a half a day on the computer.

The time she devotes to using the computer is to meet curriculum objectives. Time in her curriculum is a major determining factor for how she will use the computer. "Just basically what we are studying and if I have something to go with it. Just like central office bought us Sammy's Science House. But right now there is nothing in Sammy that we are studying. Right now I haven't used it."

Betty describes the computer as being similar to textbook. "This is just a technology textbook. It is a high tech book. That is the way I feel like. I feel like it is not only enrichment, but you can get some basics from it."

Activity Structures

The majority of time Betty uses the computer either with individuals or the whole group. She uses the computer with the whole group "very often, very often. I just do it for all kinds of stuff. And like if you just have one copy of a program you can do it with the whole class easier than 20 kids going to one computer." Betty uses the computer with the whole group whenever she uses the Internet. She does not allow individual students to use the Internet.

Betty also uses the computer extensively with individual students. The students use a spelling and math program each day that keeps track of their progress. She notes that she is not using the computer as much with small groups or partners as she did last year. "This year it has just been more individual. One thing is, I lost my splitters that have two earphones. so that is one reason is why I haven't done it[use the computer in small groups]."

Management Of Computer Use

Even though Betty teaches in a Special Computer Classroom with more resources she still must manage computer use. Betty starts using the computer the first day of school. The routines that she has developed are so much a part of classroom life that she has forgotten how she developed them.

I just did. I don't know. Every year it just seems to be easier. They just seem to pick up on it when you tell them. OK these four people are on these this computer, this year it is five people on this computer, and you just notify the person. And, OK, sometimes I come in and say, OK, we go down the line or up the line. Or, and this one thing that I didn't do this year, I usually have their names on the computer, not only on the screen saver but on a little sheet of paper and they can see. But this year, I don't know, this year is buzzing by. I just haven't done it.

When the students enter Betty's room each morning they move to the computers and begin their work. When one child finishes, another child moves to the computer. There is very little teacher intervention. There is a definite system in place and the students all know the system.

In order to achieve this system Betty spends time at the first of the year introducing the computer to her students in a whole group setting. She will project the computer to the large monitor and demonstrate how to use a particular piece of software. After the students have worked on that software for several days, then she will repeat the process with another piece of software. Another routine that she uses is student helpers. "I have trainers." She selects students who seem to "catch on real quick" to help other students.

Betty enjoys using the computer and serves as one of the computer experts at Eagleton. She uses the computer for teacher jobs. She is familiar with the sites for teachers on the Internet. She spends a great deal of time working on the computers at Eagleton. The computer is a normal part of her classroom life.

These case studies conclude the presentation of the grounded theory. The final chapter will examine this model grounded in the data from Eagleton with the findings of other research and make suggestions for further research.

CHAPTER 5 - SUMMARY, DISCUSSION, AND IMPLICATIONS

SUMMARY

"I am just a common teacher, you know; and it is like, if I can do it you can do it" (Debbie). The purpose of this study was to understand how common teachers in common schools make technology a part of their teaching. It sought to understand the importance of the context on the process of introducing the computer into teaching by developing a grounded theory of the process in a single common school.

The average size of an elementary school in the United States is 471 students. Eagleton had 488 students (U. S. Department of Education, October, 1996). The estimated student to computer ratio in the United States is seven to one (Viadero, 1997). The ratio of students to computers at Eagleton was eight to one. The Eagleton teachers described their school as being a warm, friendly school where the students come first. They considered each other to be good friends.

For the teachers at Eagleton making the computer a part of teaching was like fitting together the pieces of a puzzle. The reasons for computer use offered by the Eagleton teachers followed the social, vocational, and pedagogical rationales offered by Hawkrigde (1989). They used the computer in their classroom because technology was something that is a part of the everyday lives of their students. They believed that their students will need to know how to use a computer to get a job. They believed that

computers could help their students learn. They also saw how students seemed to enjoy the computer and wanted to take advantage of this enjoyment in their teaching.

In addition to the influence of students, the process of making the computer a part of teaching was influenced by the physical and human resources that were present in the context. The physical resources include hardware, software and physical space. All the computers from a computer lab were moved into the classrooms. There were two configurations of hardware at Eagleton: one-computer classrooms and Special Computer Classrooms. All of the teachers except for two were in one computer classrooms. The software the Eagleton teachers used was mostly drill and practice. It was chosen by grade level committees of teachers from across the school system.

The human resources important in the adoption process were time and other teachers. Teachers must invest a substantial amount of time in the adoption process. They must spend their own time if they are going to use the computer. The presence of support in the form of other teachers was important to the process of making the computer a part of teaching. The first place that teachers went for help was other teachers, especially the Special Computer Classroom teachers who offered both technical support and encouragement.

The influence of students and resources set the stage for the process of making technology a part of teaching. Knowledge and enjoyment propelled the teacher forward in the process. These two concepts were related to each other in a spiral fashion; an increase

in one led to an increase in the other. Enjoyment and knowledge can each be described as developing along a continuum.

Teachers must move from a time when the computer is new and unfamiliar to a time when they are comfortable using the computer and enjoy using it. In order to become comfortable with using the computer the teacher must overcome fear. Technical support and encouragement from other teachers and family members were important in helping teachers overcome fear. As teachers overcame the fear of using computers for teacher tasks and with their students, they described themselves as being comfortable with the computer. They now began to enjoy using the computer. They used the computer because they and their students liked it. Teachers that were not comfortable expressed a desire to become comfortable using the computer. Teachers were aware of where other teachers fit along this continuum. They knew which teachers were comfortable with the computer.

Knowledge also propelled the teacher toward making technology a part of teaching. At the beginning end of the knowledge continuum the teacher is dependent on external factors to acquire knowledge, such as training courses, computer manuals, and other people. As teachers moved forward along the knowledge continuum, they became independent learners. Becoming an independent learner required that the teacher build a foundation of knowledge. This foundation was acquired through the training provided by the school system, things learned in higher education experiences, and other people, both teachers and family members. At the independent learner end of the continuum most

knowledge was gained through experimentation. As a result of this spiral movement of increasing knowledge and enjoyment, the teacher fit the computer into teaching.

The resulting picture of the classroom that the teachers made as they shaped the computer piece of the puzzle can be seen in the class time devoted to using the computer, the activity structures that were used in instruction, and the way the computer was managed. Teachers at Eagleton devoted class time to computer used either in a special time set aside to experience using the computer or during regular instructional activities to meet content objectives of specific subject areas.

The most frequent use of the computer with students was with a whole group activity structure. Teachers used computers with individuals during independent work time. Partners were used occasionally and small groups were used less frequently. Instructional use of the computer was not a part of formal plans written by teachers. Instead they used the computer when they felt it would help them. They did think about computer use and spent time becoming familiar with software; it was just not a part of their written plans.

The teachers developed a variety of routines to manage the limited computer resources which were shared by both teacher and student. These routines fell into three types: routines to establish independent work skills, routines used during a special computer time, and routines for individual student use during independent work time. Independent work skills routines included introducing a new piece of software to the whole group first and teaching one student to serve as teacher for the next student.

Routines for special computer times included using the computer during bus call and setting up a special learning center time in which the computer was one of the learning centers. Routines for use during independent work time included systematic and non-systematic turn taking by students.

The computer was a part of the everyday lives of the teachers at Eagleton. The teachers had begun a gradual process of making the computer a part of teaching, spurred on by student interest and excitement about computers and growing resources. They were learning to like the computer and overcome their fear. They were building a foundation of knowledge. They wanted to be able to "teach with the computer."

As a result of these influences, the shape of the computer piece of the puzzle was very similar for the Eagleton teachers. The majority of the software which they use was designed for individual skill development. They searched for ways to make effective use of this kind of software. They established individual turn taking routines. Occasionally teachers used productivity software with the students to create products, such as book reports and art projects. At the present time the majority of teachers use technology as a supplement, an extra. They are still searching for ways to make use of the potential that the computer offers education. The teachers at Eagleton have only begun to shape the computer piece of the puzzle.

DISCUSSION

What is striking about the results of this research is that the Eagleton teachers' routines and practices when using the computer were so very similar. While the teachers did differ in the amount of computer use, they expressed similar beliefs about the importance of the computer for their students' future. A large portion of the literature, reported in Chapter Two, is concerned with the differences between teachers. Researchers described the differences between teachers through the use of typologies and developmental models of the technology adoption process. Unlike other studies which report typologies of teachers (Evans-Andris, 1995; Hadley & Sheingold, 1993; Honey & Henriquez, 1993; Honey & Moeller, 1990; Saye, 1994) , there were no clear typologies of teachers at Eagleton.

When compared to research that use developmental models to describe the differences between teachers, the Eagleton teachers showed fewer developmental changes. The Eagleton teachers did not report that technology changed their practice in the ways teachers in other studies have reported (Hadley & Sheingold, 1993; Kerr, 1991; Office of Technology Assessment, 1995; Sandholtz, Ringstaff, & Dwyer, 1997; Selby, Ryba, & Williams, 1994; Swan & Mitrani, 1993; Wiske et al., 1988). There was not a move toward progressive practices. The majority of instructional use of computers was to supplement and reinforce and not to create products. The following section will compare the Eagleton teachers to the developmental models reported in Chapter Two.

The Doornekamp and Carleer (1993) model proposes three levels of development: experimental, supplemental, and integrated use. A few of the Eagleton teachers would fall into the experimental use level. For these teachers the computer is still new and unfamiliar and they are dependent on external factors for their knowledge. The majority of the Eagleton teachers would fall into the supplemental use stage. They use the computer to supplement and reinforce whole group instruction. None of the teachers were at the integrated use level in which technology changes curriculum and teaching practices.

Marcinkiewicz and Welliver (1993) propose five stages of development. As with the Doornekamp and Carleer model, the Eagleton teachers are in the beginning stages. A few teachers again would be in the initial stage of familiarization, with the majority in the utilization stage. There were no Eagleton teachers who were in the later three stages of development in which technology is critical to teaching, teacher roles change, and new methods of instruction are sought.

Similarly when compared to the ACOT developmental model, a few teachers were in the entry stage where the focus is on mastering technical details. The majority of the Eagleton teachers were in the adoption stage. They have developed a foundation of technical knowledge and overcome their fear. They are now concerned with pedagogical issues. They use software that they can adapt to fit direct instruction. Only the Special Computer Classroom teachers have moved to the adaptation stage in which the computer is used 30 to 40 percent of the day with recitation and seatwork remaining the major form

of instruction. None of the teachers were at the appropriation or integration stage of this model.

The limited developmental stages and the similarity of instructional use of the computer demonstrate the importance of context in the process of making the computer a part of teaching. The Howard County School System has provided the Eagleton teachers with hardware, software, and training. However the focus of the training is on technical rather than pedagogical issues. The Howard County School System has not provided pedagogical goals.

When looking back over the past 15 years of computers in education, Betty Collis (1996) concluded that the computer is a solution in search of a problem. Computers are introduced into schools because of the perception of the importance of the computer to society rather than as a means to solve a problem. In the absence of clear pedagogical goals the Eagleton teachers are using technology to solve problems they see in their everyday lives.

Cuban (1986) concluded that teachers used earlier technologies such as radio, film, and instructional televisions to solve teacher defined problems. The Eagleton teachers are asking what a computer can help them do better. Except for the Special Computer Classroom teachers, the Eagleton teachers have only one multimedia computer to use with twenty students and the ability to project the computer to the whole class. Consequently the teachers are using technology to improve and enhance whole group recitations and to motivate students.

The Eagleton teachers have access to limited types of software. Instead of open-ended problem solving and simulation software they have close-ended individual skill developmental software. They are searching for ways to use technology to individualize instruction, but find this difficult with only one computer. They see technology as a tool much like the other tools, the chalkboard, the textbook, the overhead, and manipulatives.

The greatest influence the context has is the teachers' relationship with each other. Other teachers are the main source of technical help and pedagogical strategies. The only models of using the computer with students are the ones already present in the context. The Eagleton teachers are motivated to use technology because they believe that it will make them a better teacher and benefit their students. As a result the Eagleton teachers are using the computer in ways that will help them become better at doing the job they are doing.

IMPLICATIONS

In order for the computer to be more than a solution in search of a problem teachers need more than just technical skills. Training that deals with pedagogical issues is important. This training should provide pedagogical models for the teachers to experience. Training should be focused on specific issues that teachers see as relevant to their practice. It should help teachers feel comfortable with the computer and lead them toward becoming independent learners. Teachers need to see that investing time in using the computer will pay off in their own situation. They need to see how using the computer will help them do a better job.

Simply introducing the computer to teachers will not bring about educational change. If we want technology to aid educational reform then we must make educational reform our goal. After the ACOT researchers noticed that teachers were beginning to question their beliefs about teaching and learning, the research staff actively encouraged teachers to develop ways of using technology to build knowledge, communicate, collaborate, and develop multimedia compositions with their students (Sandholtz et al., 1997). Teacher reflection was encouraged through the research requirement that participating teachers keep journals and turn in weekly reports. Pedagogical issues were an important part of the context in the ACOT classrooms.

Further research that looks at the importance of the context on the process of adopting computers is needed. Schools differ greatly in the computer resources they have available. A concerted effort to examine the process of making the computer a part of teaching in schools with different amounts of resources will further explain the role that resources play in the process. The teachers at Eagleton school were given computers without clear goals for their use or specific pedagogical techniques. A study in a school in which pedagogical goals were present offers the possibility of further understanding the impact of context on process of making the computer a part of teaching.

When we introduce technology then we need to have goals for what we want technology to accomplish pedagogically. In deciding what these goals should be teachers need to be an integral part of the decision making process. It will be the common teachers that implement the goals that are set. The resources they have and their beliefs about

technology's benefits to students will motivate how they learn and enjoy using the computer and ultimately how they fit the computer piece of the puzzle into their classroom.

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APPENDICES

Appendix A-1

Interview Guide for Initial Teacher Interviews

I. Background Information

How long have you been teaching school?

What is your educational background?

Describe the schools in which you have taught.

Describe this present school.

II. Technical Knowledge

Describe what you have to do to use a computer for yourself.

Describe what you have to do to use a computer with your students.

Describe your knowledge about computers.

Describe the first time you used a computer

Describe your most memorable experience with computers.

How have you learned to use a computer?

What kind of technical support do you have at school?

Do teachers at this school share ideas? How?

III. Technology and Instructional Practice

How often do you use technology in your teaching.

Think about a typical week. Describe the ways you use computers.

Has the way you used the computer changed over time? How?

How do you decide when and how to use computers with your students?

What is the most important thing that you do as a teacher?

How would you describe what a teacher does?

Appendix A-2

Initial Round Data Codes

FREE NODES

(F 1) *//Free Nodes/Emotions*

Definition: Words used that describe feelings

The children of this node are:

- (F 1 1) *//Free Nodes/Emotions/fear*
- (F 1 2) *//Free Nodes/Emotions/unafraid*
- (F 1 3) *//Free Nodes/Emotions/desire to conquer*
- (F 1 4) *//Free Nodes/Emotions/confused*
- (F 1 5) *//Free Nodes/Emotions/frustrated*
- (F 1 6) *//Free Nodes/Emotions/overwhelmed*
- (F 1 7) *//Free Nodes/Emotions/defeated*
- (F 1 8) *//Free Nodes/Emotions/inadequate*
- (F 1 9) *//Free Nodes/Emotions/Stress*
- (F 1 10) *//Free Nodes/Emotions/Excitement*
- (F 1 11) *//Free Nodes/Emotions/comfortable*
- (F 1 12) *//Free Nodes/Emotions/insecure*
- (F 1 13) *//Free Nodes/Emotions/successful*
- (F 1 14) *//Free Nodes/Emotions/enjoyment - includes liking and not liking*
- (F 1 15) *//Free Nodes/Emotions/Love*
- (F 1 16) *//Free Nodes/Emotions/Embarrassed*

(F 2) *//Free Nodes/People*

The children of this node are:

- (F 2 1) *//Free Nodes/People/Principal*
- (F 2 2) *//Free Nodes/People/Tech Coordinator*

- (F 2 2 1) //Free Nodes/People/Tech Coordinator/Stan
- (F 2 3) //Free Nodes/People/Parent
- (F 2 4) //Free Nodes/People/SCC Teacher
- (F 2 5) //Free Nodes/People/Teacher

INDEXED NODES

(1) /Learning Technology -*How teachers learn to use technology*

- (1 1) /Learning Technology/Training - *Receiving Formal Instruction*
 - (1 1 1) /Learning Technology/Training/School Provided by *district*
 - (1 1 1 1) /Learning Technology/Training/School Provided/45 hours
 - (1 1 1 2) /Learning Technology/Training/School Provided/Other
System Training
 - (1 1 2) /Learning Technology/Training/Resources *available for training*
 - (1 1 3) /Learning Technology/Training/Feelings *as a result of the training*
 - (1 1 4) /Learning Technology/Training/Higher Ed *learning due to college
course*
- (1 2) /Learning Technology/Experimentation - *learning by playing around, hands
on, trial & error*
- (1 3) /Learning Technology/Others - *learning by working with others*
 - (1 3 1) /Learning Technology/Others/Family - *getting help from other
family members*
- (1 4) /Learning Technology/Reading - *learning by reading about it*
- (1 5) /Learning Technology/Desire -*expressing a desire to learn technology*
- (1 6) /Learning Technology/Reasons -*reasons to learn technology*
- (1 7) /Learning Technology/Conference - *learning by going to conferences*
- (1 8) /Learning Technology/Knowledge -*the teachers perceived level of their own
tech skills*
- (1 9) /Learning Technology/Practice - *the need to practice computer skills*

(2) /Instructional Use of Computers -Issues teachers face in using technology

(2 1) /Instructional Use of Computers/Computer Role -*role it plays in instruction and ideas about working this out. Also include when teachers talk about using it as a teaching tool.*

(2 1 2) /Instructional Use of Computers/Computer Role/Enrichment

(2 1 3) /Instructional Use of Computers/Computer Role/Reward

(2 1 4) /Instructional Use of Computers/Computer Role/Info. Source

(2 1 5) /Instructional Use of Computers/Computer Role/Difficult -
*difficulties teacher have in
determining what they should do with
computers*

(2 1 6) /Instructional Use of Computers/Computer Role/Supplement -

(2 1 7) /Instructional Use of Computers/Computer Role/Reinforcement

(2 2) /Instructional Use of Computers/Reasons to Use - *or not to use*

(2 2 1) /Instructional Use of Computers/Reasons to Use/Exposure - *to
expose children to technology*

(2 2 2) /Instructional Use of Computers/Reasons to Use/Utilize Resources
- to use this costly, valuable resource

(2 2 3) /Instructional Use of Computers/Reasons to Use/Required

(2 2 4) /Instructional Use of Computers/Reasons to Use/Motivation -
motivate students or because they are fun

(2 3) /Instructional Use of Computers/Vision - *goals and ideas that teachers have
about ways to use technology*

(2 4) /Instructional Use of Computers/Management *managing the use of
technology*

(2 4 1) /Instructional Use of Computers/Management/Scheduling

(2 4 1 1) /Instructional Use of Computers /Management
/Scheduling /Curriculum

(2 4 1 2) /Instructional Use of Computers /Management
/Scheduling /Time

(2 4 1 2 1) /Instructional Use of Computers/ Management/
Scheduling/Time/Afternoon - *using it during
bus call*

(2 4 1 2 2) /Instructional Use of Computers/ Management
/Scheduling/ Time/Finished - *use when work
is finished*

- (2 4 1 2 3) /Instructional Use of Computers/ Management/
Scheduling/ Time/Special time
a special time is found to use computers
- (2 4 2) /Instructional Use of Computers/Management/Control - *what
students will do when they are
at the computer*
- (2 4 2 1) /Instructional Use of Computers /Management /Control
/Student - *which students will
use the computer*
- (2 4 3)/Instructional Use of Computers/Management/Plan- *planning how
tech will be used*
- (2 5) /Instructional Use of Computers/Amount
- (2 6) /Instructional Use of Computers/Curriculum - *relationship to curriculum in
general*
 - (2 6 1) /Instructional Use of Computers/Curriculum/Reading
 - (2 6 2) /Instructional Use of Computers/Curriculum/Math
 - (2 6 3) /Instructional Use of Computers/Curriculum/Spelling
 - (2 6 4) /Instructional Use of Computers/Curriculum/Science
 - (2 6 5) /Instructional Use of Computers/Curriculum/Social Studies
- (2 7) /Instructional Use of Computers/Location - *where computers are located in
the school*
 - (2 7 1) /Instructional Use of Computers/Location/Lab
 - (2 7 2) /Instructional Use of Computers/Location/Classroom
- (2 8) /Instructional Use of Computers/Ways to Use
 - (2 8 1) /Instructional Use of Computers/Ways to Use/Whole group
 - (2 8 2) /Instructional Use of Computers/Ways to Use/Individual
 - (2 8 3) /Instructional Use of Computers/Ways to Use/Tool
 - (2 8 4) /Instructional Use of Computers/Ways to Use/Small Group
 - (2 8 5) /Instructional Use of Computers/Ways to Use/Partner
 - (2 8 6) /Instructional Use of Computers/Ways to Use/Drill
 - (2 8 7) /Instructional Use of Computers/Ways to Use/Playing - *use of the
term play or playing when describing how students use the
computer.*

(2 8 8) /Instructional Use of Computers/Ways to Use/Catch Up - *using it to help students are behind, either because of absences or developmental disabilities.*

(2 8 9) /Instructional Use of Computers/Ways to Use/Games-Learning - *distinguishes between using games for playing or using games as learning activities*

(2 8 10) /Instructional Use of Computers/Ways to Use/Internet

(2 8 10 1) /Instructional Use of Computers/Ways to Use /Internet /AUP

(2 9) /Instructional Use of Computers/Teaching Computer Skills

(2 10) /Instructional Use of Computers/Feelings-*Feelings about how they use the computer in the classroom*

(3) /Interactions - between teachers about technology

(3 1) /Interactions/Computer Bug -*desire for others to learn about technology*

(3 2) /Interactions/Teacher Support - *interactions that have to do with providing or finding support*

(3 2 1) /Interactions/Teacher Support/Provider - *emotional*

(3 2 2) /Interactions/Teacher Support/Technical Provider -*technical know how*

(3 3) /Interactions/Collaboration

(3 4) /Interactions/Knowledge - *perceived knowledge of others*

(3 5) /Interactions/References - *references to how other teachers use technology*

(3 6) /Interactions/Decision Making - *interaction involving making decisions about technology*

(3 7) /Interactions/Companionship

(3 8) /Interactions/Other Teachers

(4) /School

(4 1) /School/Location - *physical descriptions*

(4 2) /School/Atmosphere

(4 2 1) /School/Atmosphere/Pleasant

(4 2 2) /School/Atmosphere/Positive

(4 2 3) /School/Atmosphere/Family

(4 2 4) /School/Atmosphere/Christian

(4 3) /School/Quality

(4 4) /School/Image

(4 5) /School/Demographics

(4 6) /School/Children Come First

(5)/Children - *ideas and attitudes about children and the use of technology*

(5 1) /Children/Knowledge - *perceived technical knowledge and ability of children*

(5 3) /Children/Home Access - *effect of having a computer at home*

(5 4) /Children/Attitude - *children's attitude and reaction toward computers*

(5 5) /Children/Types - *types of children who use the computer*

(5 6) /Children/Age

(6) /Resources - *what resources are there and how are they allocated*

(6 1) /Resources/Allocation

(6 2) /Resources/Obtaining - *getting the resources that are there*

(6 2 1) /Resources/Obtaining/Grants

(6 3) /Resources/Sources

(6 3 1) /Resources/Sources/system

(6 3 2) /Resources/Sources/school

(6 3 3) /Resources/Sources/personal

(6 3 3 1) /Resources/Sources/personal/Home - *access to a
computer at home*

(6 3 3 2) /Resources/Sources/personal/Time - *Time teachers must
spend on technology*

(6 3 4) /Resources/Sources/Principal

(6 4) /Resources/Sharing

(6 5) /Resources/Software

(6 5 1) /Resources/Software/Acquisition

(6 5 2) /Resources/Software/Manuals

(6 6) /Resources/Needs - *things teachers want or need*

(6 7) /Resources/Unused - *computers that are broken or not being used*

(7) /Problem Solving - *dealing with problems that arise because of technology*

(7 1)/Problem Solving/Asking Others

(7 1 1)/Problem Solving/Asking Others/teachers at this school

(7 1 2)/Problem Solving/Asking Others/teachers at other schools

(7 1 3)/Problem Solving/Asking Others/county tech personnel

(7 2)/Problem Solving/Reading Manuals

(7 3)/Problem Solving/sense of humor

(7 4)/Problem Solving/planning - *dealing with technology when it doesn't work*

(7 5)/Problem Solving/Fearless - *not being afraid to ask questions to find a way to solve a problem*

(7 6)/Problem Solving/Acceptance - *accepting that there are going to be problems and not letting that bother you*

(8) /Personal Use - *ways teachers use technology for themselves*

(8 1)/Personal Use/Amount

(8 2)/Personal Use/Create Instructional Materials

(8 3)/Personal Use/Teacher chores

(8 4)/Personal Use/E-Mail

(8 5)/Personal Use/Internet

(9) /Changes - *in how teachers have used technology*

(9 1)/Changes/Amount

(9 2)/Changes/Feelings - *changes in their feelings about technology*

(9 3)/Changes/No Change

(9 4)/Changes/Technology - *changed because the way the computer has changed.*

(10)/General Teaching - *Things that teacher do in their teaching without technology*

(10 1) /General Teaching/Whole group

(10 1 1) /General Teaching/Whole group/Lecture recitation

(10 2) /General Teaching/Small Group

(10 2 1) /General Teaching/Small Group/Cooperative Learning

(10 2 2) /General Teaching/Small Group/Learning Centers

(10 2 3) /General Teaching/Small Group/Individual

(10 3) /General Teaching/Hands On

(10 4) /General Teaching/Research

(10 5) /General Teaching/Projects

(10 6) /General Teaching/Involvement

(11) /Teacher Role - *Ideas about the role of the teacher*

(11 1) /Teacher Role /Emotional - *to help students cope with problems; provide support*

(11 2) /Teacher Role /Content - *to help students learn content*

(11 3) /Teacher Role /Independent - *teacher is in control in her classroom, independent of others*

(11 4) /Teacher Role /Reasons - *reasons and rewards for teaching.*

(11 5) /Teacher Role /Expert - *knows more about a subject than his students*

Appendix A-3

Second Round Data Codes

- (20 1)/**School** - *References to Eagleton and the general atmosphere to school; includes references to types of students and parents*
- (20 2)/**Teacher Role** - *References to the role of the teacher; the job of the teacher*
- (20 3)/**Computer Role** - *General references to the role of the computer in teaching*
 (20 3 1)/Computer Role/Tool - *Includes references to the metaphor of technology as a tool*
 (20 3 2)/Computer Role/Rationale - *Ideas about the reasons to use technology*
- (20 4)/**Instructional Setting** - *Describes how teachers use computers in instruction*
 (20 4 1)/Instructional Setting/Structure - *References to the activity structures that are used in the classroom; whole group, small group, individual*
 (20 4 2)/Instructional Setting/Where - *The physical location of the computer; includes feelings about the computers in the classroom or in the lab.*
 (20 4 3)/Instructional Setting/Internet - *References to using the Internet with students*
- (20 5)/**Management** - *General ideas about managing or organizing the use of technology*
 (20 5 1)/Management/Routines - *Routines that teachers develop to manage the use of technology in the classroom*
 (20 5 2)/Management/Plans - *Includes ideas about planning to use the computer in instruction.*
 (20 5 3)/Management/Control - *Includes ideas about when, how, and which students will use the computer*
 (20 5 4)/Management/Vision - *Includes ideas and goals that teachers have about using technology in the future*
- (20 6)/**Students** - *Mentions of students including their reactions, computer knowledge, and their influence on technology use*
- (20 7)/**Parents** - *Includes teachers ideas about how parents feel about their technology use and their influence on the teacher*
- (20 8)/**Time** - *Includes mention of time spent by the teacher*
- (20 9)/**Other Technology** - *Description of technology other than the computer*

- (20 10)/**Software** - *References to software in general*
 (20 10 1)/Software/Specific - *Mention of specific type of software or specific software program*
 (20 10 2)/Software/Selection - *Includes ideas about how software is selected or obtained*
- (20 11)/**Personal Use** - *References to how the teacher uses the computer other than direct instruction*
- (20 12)/**Teacher Feelings** - *References to how teachers feel about using the computer, such as enjoyment, excitement, fear*
- (20 13)/**Knowledge** - *References to teacher's knowledge of the computer*
 (20 13 1)/Knowledge/Learning - *Includes references to learning to use the computer*
 (20 13 2)/Knowledge/Level - *Teachers perception of their knowledge and computer skills, the knowledge of other teachers, and feelings about their knowledge level*
- (20 14)/**Curriculum** - *References to the curriculum in general and the relationship between the computer and the curriculum*
 (20 14 1)/Curriculum/General
 (20 14 2)/Curriculum/Specific Subject
 (20 14 3)/Curriculum/Computer Skills - *Mention of teaching students specific computer skills*
- (20 15)/**Changes** - *Includes references to changes in feelings or computer use*
- (20 16)/**System** - *Mention of anything the system provides like tech personnel and expectations of administrators*
- (20 17)/**Interactions** - *Descriptions of how teachers interact in relation to technology; includes interactions between teachers and teacher and principal*
- (20 18)/**Resources** - *References to resources*
 (20 18 1)/Resources/Personal - *References to personal computer resources at home and also personal resources spent for school*
 (20 18 2)/Resources/Classroom - *References to resources that teachers have in their classroom (provided by school)*
 (20 18 3)/Resources/Feelings - *Feelings teachers have about the resources they have and the resources they want*

VITA

Karen Milligan attended schools in the public school systems of Sweetwater, Tennessee and Monroe County, where she graduated from Sweetwater High School in 1975. She attended Carson-Newman College earning a Bachelor of Arts in Psychology in 1978. She then entered the Masters program at the University of Tennessee, Knoxville, earning a Masters of Science in Special Education in 1981. She taught in the Jefferson County School System in Tennessee in from 1980 until 1994. In July of 1994 she returned to the University of Tennessee, Knoxville to pursue the Doctorate of Philosophy in Education. The doctoral degree was completed in December 1998.

Karen began teaching in the teacher education department at Carson-Newman College in 1996. She currently teaches educational technology to preservice teachers.