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Models of Professional Development for Teachers: Factors Influencing Technology Implementation in Elementary Schools.

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MODELS OF PROFESSIONAL DEVELOPMENT FOR TEACHERS:
FACTORS INFLUENCING TECHNOLOGY
IMPLEMENTATION IN ELEMENTARY SCHOOLS

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Educational Leadership
Research and Counseling

by

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B.S., Louisiana State University, 1954
M.E., Louisiana State University, 1980
May 2000
DEDICATION

I dedicate this dissertation to my mother, Doris Wax Hill, my father, Harry Leighton Hill, and my husband, Robert Franklin Catchings. Thank you for your encouragement, patience, and continued support for the long journey. Special thanks to my daughter, Caroline, for her loving support.
ACKNOWLEDGMENTS

I wish to express heartfelt thanks to my chairperson and friend, Dr. Kim MacGregor, for her advice, encouragement, and continued support. Also, I wish to express special thanks to Dr. Earl Cheek for mentoring me through the years. Many thanks go to the rest of my committee for their suggestions and advice, Dr. Charles Teddlie, Dr. Dianne Taylor and Dr. Chad Ellett.
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ABSTRACT

This qualitative multiple case study explored factors which contribute to the implementation of technology in elementary schools. This research had a phenomenological focus because there was a concentration on the structure and essence of the experiences of the teachers and leaders in the phenomenon, the implementation of technology in the school. The four schools chosen for the study were judged to have outstanding technology implementation by state technology leaders and a researcher screening process. They were selected because the researcher determined that these cases were the ones from which the most could be learned. These particular schools had ample technology resources and the teachers demonstrated pedagogical expertise in the selection and integration of appropriate technology in the instructional process. Data were collected through descriptive observations, open-ended interviews, a teacher questionnaire and the examination of documents and artifacts.

Findings from the data analysis revealed the importance of several factors which contributed to school-wide implementation of technology. These included a community of leadership, in-school programs of professional development, a comprehensive school-based technology plan, and positive teacher attitudes toward the appropriate use of technology. A community of leadership within the school was found to be the cornerstone of successful implementation. Strong administrative support for the acquisition of resources and encouragement of teacher
experimentation was present. Additional support was provided by teacher-leaders and/or technology specialists who mentored their colleagues. Strong professional development programs conducted at the schools using equipment and software available to the teachers was found to be a more effective approach to teacher training. Teacher participation in the establishment of goals for the sessions and the clear application of the newly learned knowledge to help them meet curricular goals was evident. All of the schools had detailed technology plans that provided clear goals and time lines for achieving them. Included among the goals were short and long term objectives for the purchase of hardware and software, guidelines for on-going professional development, and the involvement of parents, the community, and business partners. The implications of these factors are discussed in the context of the implementation of technology in elementary schools.
CHAPTER 1
INTRODUCTION

During the last ten years the use of computer-based technology in education has significantly increased. In 1994, $2.4 billion was spent on educational technology in kindergarten through 12th grade, and some $6 billion in higher education (Jones & Paolucci, 1999). Although computers have been present in classrooms for more than twenty years, progress toward implementation of the technology remains limited (Mellon, 1999; Becker, 1994, 1999; OTA, 1995; NCES, 1999). A recent survey conducted by the National Center for Educational Statistics (NCES, 1999) found that less than 20% of current teachers reported feeling well prepared to integrate new technologies into classroom instruction. Today many administrators, teachers, and parents realize the potential of computers to make teaching and learning more extensive, more authentic, and more interesting. At the same time, employers expect schools to prepare students to use technology. Despite the current interest in applying technology to the instructional process and substantial expenditures on acquiring technology, the actual utilization of these resources is minimal and unsophisticated. Faculty have been reluctant to adopt computers and revise their pedagogy (Dusick, 1998).

Glennan & Melmed (1996) tracked computer use in the public schools in this country. In 1983 there was approximately one computer for each 125 students in public schools. In 1994 schools spent the 2.4 billion dollars on computer technology. In 1998 there was an average of one computer for each nine students in public schools. As the supply of
computers available in elementary schools increases, it would seem that we are making steady progress in the diffusion of this technological innovation. However, availability is not necessarily a predictor of optimal use. Despite the rapid growth of computers in schools, research suggests that the average school still makes limited use of computers. Researcher Jane Healy (1999) invited to observe in the flagship technology elementary school of a school district, reported difficulty finding students using computers. She found many expensive computers idle because teachers had not learned to incorporate them into their daily lessons. There are relatively few instances of schoolwide implementation of technology, and only 5% of teachers are considered to be exemplary computer-using teachers (Becker, 1994; Mitra, 1998).

Schoolwide technology implementation involves the integration of technology into the curriculum, use of technology as a process-oriented approach to enable students to reach curricular objectives already in place, a child-centered approach to learning, authentic technology extensions beyond the classroom, and project-based learning across disciplines with planned collaborative activities integrated with technology (Eib & Mehlinger, 1998, Becker, 1999; Moersch, 1995). Researchers believe (Jones & Paolucci, 1999; MacArthur & Malouf, 1991) the most effective use of computers in schools depends on teachers merging computer activities with their educational goals and curricula. There are many instructional uses of computers and related technology in classrooms today (Mitra, 1998). Teachers can use the computer as a smart chalkboard, mini laboratory, or demonstration tool. It can be a
student resource like an encyclopedia, globe, dictionary or thesaurus. Young historians can look up information in a database containing information about a country they are studying; students can create handouts for a presentation; student editors can use it to design a class publication; small groups can use it to perform experiments; groups can create multimedia presentations to culminate a unit; and students and teachers can collaborate in compiling multimedia assessment portfolios.

One of the most efficacious uses of a computer in the elementary classroom is to accomplish an authentic task. To help students learn to think analytically and solve complex problems, computer tools such as word processors, databases, spreadsheets, simulations, and graphics, need to be available when students are engaged in the processes, not a half hour or a day later (Knapp & Glenn, 1996). Effective computer-assisted instruction may take place with only one computer in a classroom while instruction which accomplishes little may take place in a classroom with 5 computers or a lab with 35 computers (Becker, 1999). Diffusion history (Rogers, 1995) tells us that extraneous use of an innovation does not insure its continual and progressive use. It must become an integral part of the work of the group adopting it.

Impetus to Implement Technology

The emphasis on the implementation of computer technology in our schools has been brought about through two major influences: (1) the importance of information technology in the workplace and the belief that the skills required to succeed in future workplaces will be greatly different from those resulting from the curriculum that currently controls
schools and (2) the growing body of research in the cognitive field that suggests that students learn and better retain what they learn when engaged in "authentic" learning tasks such as small groups of students carrying out real life projects using computer and network software tools and databases (Paolucci, 1998; Healy, 1999; Glennan & Melmed, 1996).

Federal, state and local officials are spearheading this infusion of technology to prepare students for the future as we witness the invasion of the computer into every facet of life. The federal and state governments as well as private institutions have invested not only funds but also time, energy, and concern. Most district, state, and national educational planning groups have considered the integration of technology as a top priority. A study conducted by the Northwest Regional Laboratories for Research and Development reported that the implementation of educational technology was one of the six top issues considered in school planning (Roberts, 1996). The U. S. Department of Education has installed an Office of Educational Technology that is recommending strategies for integrating technology into America's public schools. The NEA (National Education Association, 1995) has included a number of references to the use of technology in their resolutions. The NEA has resolved that education employees should have access to technology for managing and advancing instruction; that employees must be involved in planning, materials selection, implementation and evaluation of technology utilization; and that training should be provided for education employees in the use of technologies and their application to instruction. The infusion of
technology should occur as a component of a broader effort of schools to improve the learning of all children (Dede, 1998; Glennan & Melmed, 1996).

School Organization and Instructional Reform

To meet the challenge of providing for the educational needs of students in the new millennium, it is important that educators develop methods of implementing technology use in our classrooms. School districts around the country are accepting this challenge by installing computers in elementary and secondary classrooms, and finally including training for teachers. Innovations in the classroom do not take place rapidly. A spirit of cooperative learning and teachers' willingness to become risk takers will increase the level of inclusion of technology at all levels of teaching and learning (Halpin, 1999; Meltzer, 1996). The infusion of computer technology into K-12 schools may be just the impetus needed to begin making changes in schools that are so desperately needed in areas of curriculum, school organizational structure, and teaching practices. The implementation of technology means more than the acquisition of hardware and software. It brings with it corresponding changes in organizational life, often including new work relationships, different teaching practices, new incentives, and different roles for teachers (Casson et al., 1997). The effort to restructure education in schools across the United States has generated proposals and plans for reform of the entire education system. Virtually every proposal or plan includes educational technology as one of the major vehicles for implementing change (Ely, 1996).
For years the organizational structure of our schools has remained basically the same, and the traditional role of teaching was perpetuated by this accepted organizational structure (Knapp & Glenn, 1996). This organizational structure incorporates isolated classroom settings; a curriculum that emphasizes mastery of skills and concepts through divided subject areas with a designated time allotment; assessment that focuses on short answer and essay tests that emphasize the ability to recall information; and technologies such as pencils and paper, chalkboards, textbooks, manipulatives and other resources that help students develop basic skills, concepts, and generalizations (Knapp & Glenn, 1996). In a careful study of schools, John Goodlad (1984) found that in these schools with traditional organizational structure, the teacher's primary roles are that of presenting information, providing exercises for students to practice skills and memorize facts, concepts or generalizations, and evaluating students' ability to remember the information.

Research by cognitive psychologists (Linn, 1986; Brown, Collins, & Duguid, 1989) brings into question traditional instructional pedagogy. The research suggests that learners develop understandings based on their own experiences and observations. Students learn not by listening to information presented by others, but by actively manipulating and synthesizing information so that it complements and expands existing understandings. Students can be guided to find and organize information in unique and different ways, to critically analyze it, and to relate the information to their own knowledge and skills. The
organizational structure of schools can change to enable classrooms to be multipurpose rooms where learners can engage in research and problem solving activities that extend into all subject areas. The curriculum can promote student inquiry by engaging students in solving real problems with emphasis on cooperation. New technologies can be used which can support research, analysis, problem-solving, and communication more effectively than the traditional resources.

**Constructivist Learning Theory**

Of the three broad theoretical perspectives most prevalent in educational circles today, behavioral, information processing, and constructivist, the constructivist learning theory seems to be the one which contributes most to the development of thinking skills and also to which technology can make an important contribution (Newby et al., 1996; Halpin, 1999). Constructivism represents a collection of theories which include generative learning (Wittrock, 1990), discovery learning (Bruner, 1961), and situated learning (Brown, Collins, & Duguid, 1989).

Advocates of constructivism believe that learning is the discovery and transformation of information and that situations and social activities shape understanding. Individuals actively construct knowledge by working to solve realistic problems, usually in collaboration with others (Jonassen, Peck & Wilson, 1999; Halpin, 1999). Constructivist oriented teachers often use authentic tasks in the classroom that are ordinary practices of the field under study, enabling students to become aware of the relevancy and meaningfulness of what they are learning (Newmann, 1991). The role of the teacher changes from
information provider, sequencer of information, and test creator to guide, supporter, task designer and creator of information-rich environments in which students think, explore, and construct meaning (Nicaise & Barnes, 1996).

A 1995 study by Means & Olson focused on the manner in which technology fosters the introduction of constructivist teaching practices. They found that technology aided instruction to move in a constructivist direction by:

1. adding to students' perceptions that their work is authentic and important
2. increasing the complexity with which students can accommodate successfully
3. substantially enhancing student motivation and self-esteem
4. illuminating the need for long blocks of instructional time
5. effectuating greater collaboration in which students helped their peers and sometimes their teachers
6. moving teachers toward a coaching and advisory role
7. increasing collaboration among teachers

In a constructivist perspective supported by technology, students learn by constructing their own knowledge through inquiry, experience, teachers, books, software programs, the internet, and many other resources. Teachers engage students in activities that require them to think critically, solve problems, and seek answers to their own questions. Teachers serve as model learners, mentors, coaches, and resources.
The curriculum promotes student inquiry, and is designed to engage students in solving real problems that extend into all subject areas.

Importance of Professional Development

In an effort to determine what impels teachers to use computers in their teaching, researchers have studied the diffusion of this innovation since its inception. Teacher computer efficacy (Murphy, Coover & Owen, 1988), cognitive style (Howard and Howard, 1994), locus of control (Rose and Medway, 1981), teachers' pedagogical orientation (Ritchie & Wiburg, 1994), administrative support (Ritchie & Wiburg, 1994), availability of hardware and software (Becker, 1991, 1994, 1999), in-service teacher training (Becker, 1994; Macmillan et al., 1997; Schrum, 1999), peer support (Vockell, Jancich, and Sweeney, 1994, Joyce & Showers, 1995, Witmer, 1998), teacher concerns (Schrum, 1993, 1997, 1999) and many other variables have been investigated as possible factors which cause teachers to use or not use computers in their classrooms. Professional development, one of the most important factors, needs further study.

While professional development is one of the reasons most often cited as affecting the use of technology, a broader ground for failure may be the absence of attention to social organizational features and contexts in which the professional development is attempted. Becker (1994) found that teachers need access to people from whom they can learn if they are to successfully incorporate a new and complex resource like computer software into their teaching practice. Those giving help could be a technology specialist assigned to the school or a community of computer-using teachers within the school who work together and share
their findings with others. Learning how to operate a computer may require only a minimum of training for teachers, but preparation for using the computer to the best advantage in the classroom instructional program requires diligent effort and understanding of both curriculum and instruction (Foliart & Lemlech, 1989; Schrum, 1999). Principals are in a position to establish and maintain a school climate which facilitates collegiality — teachers talking to each other, working together on materials, and engaging in peer teaching (Little, 1982; Hargreaves & Dawe, 1990).

**Rationale**

Governments at the national, state and local levels have recognized the introduction of computer technology as a source of school improvement. Large amounts of money have been spent and are continuing to be spent in purchasing hardware and software for public schools. Becker (1994, 1999) asserts that we need a new model of research in order to build a knowledge base that will tell us under what conditions and circumstances we can expect computers to be effectively utilized. His findings indicate that computers enhance teaching practices which focus on writing, problem solving, and inquiry- and discovery-based learning. It is necessary to determine factors which influence technology implementation and make this information available to school systems, administrators and teachers. Computer technology, implemented properly, could have a major positive impact on the educational system (OTA, 1995).
Panyan, et al., (1994) developed a Technology Integration Enhancement (TIE) model in which they measured the level of technology integration in elementary schools, then provided well-designed staff development to teachers based on this level and the teachers' concerns and then followed with another measure of technology integration. The major premise of the study was that change is a process and that teachers will successfully adopt appropriate technologies if their current concerns and use levels are recognized and respected. It is evident that staff development that is relevant to teachers' practice and expertise had a positive effect on teachers' efforts to implement technology in their schools. If professional development programs which help teachers to implement technology can be developed, then studying well planned and developed programs in schools that have successfully implemented technology will help others to do the same.

Rapidly changing world events, changing social institutions, and new workplace demands raise doubts about whether our schools can meet the needs of the Information Age (Bruer, 1994). Some advocates of change believe that reforms are needed because the needs of the Information Age are radically different from those of the Industrial Age for which our present model of education was developed. Perhaps the infusion of technology will represent a step and provide a vehicle for making changes in schools. It is important to make it possible for changes to take place in all schools, not just in a few select schools. The Southern Technology Council asserts that what educational
professionals need more than anything else is practical examples of how to change drawn from the experiences of people like themselves (Casson et al., 1997). This study will provide practical examples of how some schools have implemented technology and have established professional development programs for their teachers.

Most research on the use of computers in schools has been quantitative in nature, utilizing self-report, survey methodologies. Both Evans-Andris (1995) and Panyan, et al. (1994) found that survey data were not accurate due to confusions that teachers have concerning technology use. Qualitative research data is needed to provide thick, rich descriptions (Geertz, 1973) of technology implementation in elementary schools to provide models from which others can learn. This study was designed to provide this qualitative research data.

Problem Statement

Despite the current interest in applying technology to the instructional and administrative processes and substantial expenditures on acquiring technology, the actual utilization of these resources in schools is minimal and unsophisticated (Becker, 1999; Mellon, 1999; NCES, 1999). Although there have been many studies to determine if teachers are using technology in their classrooms, only a few studies have tried to determine how the implementation of technology can be fostered (Panyan et al., 1994). With all the studies and documentation available, research on why and how the use of technology is effective in education remains minimal and the necessity for accurate and meaningful research to ensure the appropriate use of technology in
education is urgent (Charp, 1998). Technology will never be fully integrated if it depends upon each teacher, acting alone on his or her own conception of how technology should be used. Through a collaborative process, administrators, teachers, parents, and students need to develop a vision of what they hope to accomplish together (Eib & Mehlinger, 1998). Information about the successful implementation of technology in schools and the most efficacious methods of instructing teachers in its use will enable educators to establish effective instructional programs supported by appropriate technology implementation.

Purpose

The purpose of this study was to discover factors which facilitate elementary teachers' ability and inclination to use computers and other related technologies routinely across subject areas as they strive to further a child-centered learning environment. To do this, a mixed method multi-case study of the process of technology implementation in four elementary schools was conducted with a focus on understanding the experiences of the participants. A "thick, rich description" (Geertz, 1973) of this implementation in each school has been provided. Particular attention was given to the professional development and instructional support for technology given to the teachers and how this is reflected in the classrooms. The description and analysis of the technology vision and implementation in these schools provides information to educators who are in the process of establishing technology use in their schools. The insight provided into the experiences of the participants will help others to understand the factors influencing technology implementation.
Research Questions

The following questions have been formulated to guide this outlier study in elementary schools encompassing both the process and product of technology implementation. Given the strong qualitative nature of this mixed method study, questions have been refined along the way, and added as needed. An important point made by Stringfield (1994) about positive outlier studies such as this one is that the efficiency of outlier studies can be increased by the up-front positing of plausible hypotheses. Huberman and Miles (1984) and Yin (1989) make the point that qualitative and case study researchers need not restrict themselves to constantly discovering "grounded theory". The more researchers posit explicit relationships among process and outcomes before going into the field, the more nearly standardized observations can become and the more precision can be asserted into observations and interviews.

Therefore deriving from the literature the importance of professional development in previous studies, questions two, three, and four concerning professional development were constructed before the research began. Questions one, five, and six emerged as the study progressed and the themes of collegial support, types of resources, and teachers' perceptions of implementation were appearing to have a strong influence on technology implementation in these schools.

1. What kinds of collegial support or collaborations foster technology implementation?

2. How are professional development opportunities in technology organized and offered in these schools?
3. What is the content of the professional development sessions and what kinds of activities are required?

4. What are the teachers' attitudes toward professional development sessions in technology?

5. How do schools organize technology resources and implement technology in the curriculum?

6. What perceptions do teachers have concerning technology implementation?

Definition of Terms

1. **Technology** is the application of science; it is a technical method of achieving a practical purpose. Educational technology is applying scientific knowledge about human learning to the practical tasks of teaching and learning (Heinich, Molenda, & Russell, 1999).

2. **Diffusion** is dissemination; spreading freely; the wide dispersment of something. As used in this dissertation, diffusion is a special type of communication by which information about an innovation is communicated or dispersed through certain channels over time among the members of a social system (Rogers, 1995).

3. **Innovation** is the introduction of something new; a new idea, method, or device. In this dissertation innovation is synonymous with new educational technologies (computer hardware and software).

4. **Technology Implementation** is the use of computer and related technologies to assist instruction in various ways by a majority of teachers in a school.
5. **Integration of Technology into the Curriculum** is defined as the blending of technology with the following curriculum elements: (1) across subjects of content, concepts and skills; (2) with teaching and grouping methods; (3) of time components; and (4) with the classroom management system. Equity of use across students' gender, socio-economic status, and ability level is apparent.

6. **Authentic Learning** is learning brought about by learning activities representative of the real world such as the literacy behavior of the community and workplace.

7. The **community of leadership** are the stakeholders in the education of students. The formal leader, the principal, facilitates the community of leadership but is joined and supported by teachers, parents, students, school staff, and involved community and business leaders. Membership in the community of leadership requires that each participant contribute his/her expertise to the organization. The community of leadership's interests are as follows: (1) organizational-managing the school, (2) governance - directing the school, and (3) instructional - framing, implementing, and assessing a quality academic program (Maurer & Davidson, 1998). As used in this study, the community of leadership manages changes in instructional
technology through the influence of its own instructional experts. For example, the teacher who has knowledge about word processing and process writing assumes a role of expert, while the principal who does not have a foundation in language and literacy becomes an able follower. If that same principal has expertise in mathematics education, then she assumes the expert role in incorporating spreadsheet applications into the elementary school curriculum, while the process writing expert assumes the follower role (Maurer & Davidson, 1998).

Assumptions

1. Interpretation and meaning must be understood within the cultural context.

2. Truth cannot be constructed or understood in its entirety outside of its social and cultural context.

3. Reality is multiple, interrelated, and may be divergent.

4. The power of language mediates the experience and the experienced.

5. Teachers know why they do or do not use technology in the classroom.

6. Teachers were truthful about their feelings, beliefs, and ideas.

Limitations

1. With regard to data collection, behaviors were described not measured; the sample was intensive rather than extensive; and the data resulted in the discovery of some of the research questions.
2. The schools under study were representative of urban southern schools chosen from an area within driving distance of Baton Rouge.

3. Some of the data were based on questionnaires which required the teachers to provide self-reported responses.
CHAPTER II
LITERATURE REVIEW

The central premise of this review is to look at the literature concerning aspects of teaching, teachers, schools, professional development, technology, and the interrelationship among these factors. Of relevance to a study of technology implementation is the conjecture that technology is successful in maintaining and improving student learning. Therefore, there will first be a consideration of literature concerning the effects of computer use on achieving curriculum goals. Included in this section on technology and learning will be literature concerning technology applications to literacy, math, social studies, and science.

Because many forms of interactive technology have only recently been introduced in the majority of elementary schools, there will follow an overview of research on the adoption of an innovation. Following this will be an examination of literature concerning professional development for teachers since this seems to encompass many of the factors that influence technology use. Finally, there will be an examination of research conducted on the integration of technology into the elementary school curriculum since this is seen by experts to be the most effective use of technology in the elementary school (Becker, 1999; Schrum, 1999; Panyan, 1994; Moersch, 1995; Marcinkiewicz, 1994; OTA, 1995).

Technology and Learning

Questions about the effectiveness of technology for teaching and learning continue as education officials struggle with readying schools
for the 21st century. Research shows that new technology-based teaching models result in at least four kinds of improvements in educational outcomes: increased learner motivation, advanced topics mastered, students acting as experts do, and better outcomes on standardized tests (Dede, 1998).

Technologies are valuable in assisting learners in the creation of knowledge and skills in interdisciplinary activities. These technologies can support research, analysis, problem-solving, and communication processes more optimally than the traditional resources (Knapp & Glenn, 1996). Technology can facilitate the understanding of complex concepts through simulations or microworlds. Use of these applications in science and social studies has made possible graphic and interactive representations of processes and concepts that are very difficult for students to visualize (Matray, 1997). Technology software in the form of word processors, spreadsheets, data bases, and other organizational tools help students store, reorganize, consolidate, and share information. Construction of computer databases, spreadsheets, concept maps, and hypermedia authoring systems all require thinking skills (Jonassen, Carr, & Yueh, 1998). Multimedia software allows students to organize their learning into a captivating form to teach others while consolidating their own learning. As one begins to understand the manifold nature of learning and the benefits technologies bring to the classroom, the deficiencies of traditional learning and instruction become evident (Perkins, 1992).
Early research on the effectiveness of technology focused on media comparisons. Media-comparison studies were those in which one type of instructional delivery medium was pitted against another such as computer versus teacher. Clark (1983, 1994) cautions that studies comparing student achievement with one medium over another will inevitably confound the medium with the method of instruction. Observed changes in learning can be caused not by the medium but by an uncontrolled aspect of the content or instructional strategy. For example, Gardner, Simmons, and Simpson (1992) found when a commercial CAI package on weather was used as a supplement to hands-on learning activities for third graders, the students learned more effectively than when the same activities were used without CAI. It could be argued that a rival hypothesis for this media-comparison study is that greater effort was invested in the development of the CAI program than in either the hands-on or text-based instruction, resulting in more effective instruction for the students who used CAI (Weller, 1996). It could also be argued that the effects were attributable to the Hawthorne effect, an increase in effort because of the motivating effect of receiving special attention (Harris & Hodges, 1995).

The studies selected for inclusion in this section pertain to technology applications which provide learning opportunities that other media do not. Research conducted in the areas of literacy, math, social studies, and science will be considered.
Literacy

Literacy refers to the distinctly different yet complementary sets of complex skills and abilities involved in reading and writing applied in a social context (Harris & Hodges, 1995). In the elementary school, this encompasses skills and abilities needed for reading, writing, listening, and speaking. The research on the effects of computer word processing on writing is difficult to interpret because it is influenced by so many factors in its context; there are such a diversity of research designs; and there are such differences in research findings (Bangert-Drowns, 1993). Word processing may be considered a storage device for student work (Perkins, 1992), or an educational tool similar to a pencil or pen. Factors which influence writing include the writer's preferred writing and revising strategies, keyboarding skill, prior computer experiences, the teacher's goals and strategies, the social organization of the learning context, and the school and community culture. Research designs that have been used to study the effects of computer word processing on writing include individual case studies, classroom case studies, surveys of student attitudes, alternating designs (where writers alternate between using the pen and the computer to compose), and comparative designs (where one group of writers using word processors is compared with another group writing by hand).

Despite the limitations of the studies, reviewer Cochran-Smith et al. (1991) cited these general propositions that were justified by the literature: (1) in instructional contexts, students make more revisions when writing with a word processing program than they do when
writing with paper and pencil; (2) students using word processing tend to write longer texts than students using paper and pencil; (3) students produce neater and more error-free texts when writing with word processing; (4) word processing alone does not improve the quality of students' writing; (5) students generally have favorable attitudes toward writing with a word processing program.

Besides the ease of writing and revising that word processing on the computer brings, writing with a computer program can also mean greater creativity. In a literacy study to determine the effects of electronic paint/word processing programs on students' verbal and visual literacy, Catchings and MacGregor (1998) found that these programs complemented and extended creative writing skills. The researchers discovered that the pictures drawn by the electronic paint program were more creative than pictures drawn with crayons or markers and the stories written about the paint program pictures were longer and more interesting.

A computer program which bridges the gap between writing and reading uses writing as a step to reading with kindergartners and first graders. The Writing to Read program was used in a study (Rogier, Owens, & Patty, 1999) which focused on kindergarten and grade one students. This program is used in one of the schools in the present study. The Writing to Read (IBM) program is a computer-based instructional system designed to develop the writing and reading skills of kindergarten and first grade students. The computer aids in this process because children do not mind taking a risk with a computer
because erasing is easy, rewriting does not take as long and the final copy is attractive and easy to read. When children's writing is not limited by their ability to print and spell, the length of fluency and literary quality of their work increases (Phenix and Hammon, 1984).

Writing samples from forty first grade students (treatment and control) scored by reading teachers from other schools and students' scores on the post test from the Writing to Read (WTR) program were used to determine results. Test scores showed that the WTR group did significantly better than the control group on vocabulary. The results from the students' stories as evaluated by the reading teachers indicated the WTR group scored significantly higher than the control group in the areas of content/creativity, mechanics, and language.

A reading study (Talley, Lancy & Lee, 1997) examined the effects of computer storybook programs on preschool children's emergent literacy. There were 73 children participating in the study, divided into experimental, control, and well-read-to control groups. The Print Awareness Test, Concepts About Print, and a popular wordless picture book were used to assess the children's emerging literacy level. Results indicated that the use of computer storybooks in a preschool setting appeared to have a very positive effect and may significantly influence the emergent reading skills of those children who are not as well-read-to before entering school. In reading research (Matthew, 1997) designed to study the impact of electronic text on the reading comprehension of third-grade students, the researcher reports that the results suggest that the reader's comprehension can be increased by electronic texts.
Moore-Hart (1995) examined the effects of a hypermedia reading program on fourth and fifth grade students' vocabulary development; reading and writing performance; and attitudes toward writing, culture, and computers. A hypermedia computer program is a sophisticated branching program that allows the user to move among or relate text, graphics, and sound data in new patterns in any desired order (Harris & Hodges, 1995). The researcher used comparison groups to examine whether students using the computer program and a multicultural literacy program would increase their reading comprehension, vocabulary, and attitudes more than groups of students using either the multicultural literacy program or traditional reading programs. Descriptively examining the mean scores and gain scores of the three groups revealed that the students using the multicultural literacy program with the computer program outperformed the other two groups in reading performance and vocabulary development.

Research on spelling instruction suggests that students should be taught to spell using individualized spelling lists targeted toward their immediate needs. Computer programs are capable of drawing on large databases of words, of pretesting learners to identify their appropriate levels, of adjusting the difficulty of the words presented on the basis of actual student performances, of tracking words missed, and of providing individualized skill tests and retention tests on a regularly scheduled basis. Because of their ability to incorporate sound and graphics, computer programs can provide more learning options than many other instructional strategies.
The researchers in this study (Cates & Goodling, 1997) created two instructional spelling programs, each having its own predominant, but not necessarily exclusive, instructional paradigm. One program was based on a behaviorist-visual paradigm, and one program was based on a cognitivist-phonological paradigm. While the researchers actually expected the students using the computer-based instructional spelling program with the cognitivist-phonological approach to outperform the students using the more traditional behaviorist-visual computer-based program, this did not happen. Both treatment groups improved their spelling performance significantly. The results appear to support the efficacy and efficiency of well designed computer-based instructional spelling programs.

Because of the large number of good language arts programs, it is easy to integrate computer use into literacy activities. Programs are available for writing, vocabulary, spelling, grammar, and reading, including reference tools. The computer is an effective tool for motivating and reinforcing the necessary literacy skills (Sharp, 1999).

**Mathematics**

In analyzing present computer use in mathematics in light of the standards published by the National Council of Teachers of Mathematics (NCTM, 1989, 1991, 1995), McCoy (1996) finds computer use beneficial in realizing those standards. McCoy maintains the underlying philosophy of the standards is constructivism, with students learning mathematics by active involvement with mathematical models that allow them to internally construct their own understandings and concepts. This
translates to less drill and practice and increased interaction with a variety of models of mathematical concepts. Computational skill is de-emphasized and use of calculators and computers is encouraged. Computers play an important role because they can provide a variety of rich experiences that allow students to be actively involved with mathematics.

There are several roles that computers can assume to provide these experiences; one such role is a learner role as students work with reasoning to "teach" the computer with programming. Students are creating mathematics when they write programs and the computer provides immediate feedback. Most of the research studies on programming involve Logo (Campbell, Fein, & Schwartz, 1991; Clements, 1991), but a few studies have used other programming languages. Of the top ten Mathematics Logo programming studies (McCoy, 1996), eight of the studies (Campbell, Fein, & Schwartz, 1991; Clements, 1991; Clements & Battista, 1989; Clements & Battista, 1990; Harel, 1990; Lehrer, Randle, & Sancilio, 1988; Nastasi, Clements & Battista, 1990; and Ortiz & MacGregor, 1991) found positive results for the Logo group.

An Integrated Learning System (ILS) is the delivery of computer-assisted instruction and computer-based instruction over a local area network. A study (Clariana, 1996) considering the effects of an Integrated Learning System (ILS) on the mathematics test scores of elementary school children found that the effect size gains for the ILS group compared to the two non-ILS groups were es=0.13 for
computation, es=0.63 for concepts, and es=0.33 for applications. The effect on mathematics concepts scores surprised those who believed that mathematics software concentrates on computation skills. Another study conducted with an ILS by Brush (1996) involved students who worked collaboratively using ILS mathematics software. These students performed significantly higher on a posttest achievement measure than peer students working individually.

Taylor (1999) conducted a study in the first year of the introduction of an integrated learning system into a school. Multiple regression methods were employed to estimate the statistical relationship between the examination scores achieved by pupils at the end of the school year and the time spent using the integrated learning system. While initial level of achievement was the predominant explanatory variable of level achieved in the end-of-year mathematics examinations, time spent using the computer program was also found to improve performance significantly.

Other roles the computer can assume are "teacher" in tutorials, "drill master" with drill-and-practice software and "tool" as in computer algebra tools and geometry tools. Computer algebra tools provide both symbol manipulation programs and a wide range of algebraic graphing tools that accept data in either tabular or equation format and present it as a graphic representation. Geometry tools create a geometry environment for student experimentation in the constructivist mode. These programs typically perform a variety of geometric constructions while immediately providing measures of distance, angles, and area.
These measures are dynamic and any change in a geometric construction causes an immediate change in the measures associated with it; the teacher or students pose a problem and the students then predict a solution and use the program to experiment and collect data to either support or change the prediction.

Of the top ten mathematics tool studies using such software as Geometric Supposer, Geometer's Sketchpad, Derive (algebra), MuMath (calculus), seven of the studies (Ganguli, 1990; Heid, 1988; Mayes, 1995; McCoy, 1991; O'Callaghan & Kirshner, 1994; Palmiter, 1991; and Ruthven, 1990) found positive results for the computer tool treatment group. A trend can be noted in tool studies. Several results found that the treatment groups who used the tools had significantly higher achievement in conceptual areas and their computation and manipulation skills were not different from the control group (Heid, 1988; Mayes, 1995; McCoy, 1991; Palmiter, 1991; Ruthven, 1990), supporting computer mathematics tools as computational and conceptual aids in a constructivist classroom (McCoy, 1996).

Research results do support the use of computer-based learning in mathematics education. The relevance of teacher guidance in discovery activities that lead to learning through computer programs must be kept in mind as we consider the importance of teacher, designer and researcher input in structuring computer-based activities.

Social Studies

The social studies content area encompasses geography, history, political science, law, philosophy, anthropology, archaeology,
economics, psychology, religion, and sociology (National Council for the Social Studies, 1994). The study of social studies is intended to promote the development of competent citizens who possess the critical thinking skills necessary to function in a democratic society. To achieve civic efficacy, standards movements within the discipline are making an effort to promote students’ exposure to computers as an important technological development that is playing a pervasive role in society. Computer-based learning has the potential to develop students’ decision making and problem-solving skills, data-processing skills, and communication capabilities, while helping them gain access to expansive knowledge links and broadening their exposure to diverse people and perspectives (Berson, 1996). Data on the effectiveness of drill-and practice, tutorial, and study programs in the social studies suggest modest gains in student outcomes (Ehman & Glenn, 1991), especially using software that incorporates items involving application of content in contrast to recall only.

Simulations are programs that imitate realistic events, which would otherwise be impossible or difficult to incorporate into the classroom because the presentation would be expensive, dangerous, time-consuming, unethical, or otherwise impractical (Sharp, 1999). Simulations can facilitate the development of problem-solving skills and help students develop as decision makers. Tentative findings on the effects of simulations used in social studies suggest that students experience increased motivation, intellectual curiosity, sense of personal control, and perseverance (Ehman & Glenn, 1991).
Databases have been useful for managing the extensive knowledge base in the social studies and use of these databases fosters students' development of inquiry strategies through the manipulation and analysis of information (Foyle & Yates, 1993). Crozier and Gaffield (1990) found that use of databases encouraged students to develop insights, examine relationships, and analyze patterns while providing a foundation for systematic comparison of people.

In a research study conducted with ninth graders using a timeline database and a concept-mapping program, Davis (1995) reported experimental classes demonstrated increased academic achievement, motivation, self-directed thinking, self-initiated activity, construction of meaning, analytical analysis, and collaborative peer interaction compared to control groups who did not use the computer assisted instruction. In addition, these students expressed improved attitudes toward self, content, and instructional design. Though teachers reported not as much content could be covered because of the greater depth of processing and individual construction of knowledge, students developed into critical thinkers with a greater understanding of concepts than the control group and increased ability to link information.

In another study of computer database use, Fontana, et al. (1993) found that interaction with a multimedia database created on the Civil War enhanced students' higher order thinking skills. A study by Ehman, et al. (1992) involving eight social studies classrooms supported prior tentative conclusions of research on database use as a way to develop
higher order thinking. The researchers discovered several factors which affected the success of the problem-solving process. These factors which affected the success included integration of computers into the social studies curriculum, constructive use of time, modeling steps and procedures, providing for student practice, sharing outcomes, prior exposure to content knowledge, functional computer knowledge, cooperative learning in small groups, and use of simplified commercial databases.

Research of topics by means of computer technology has become an important aspect of a social studies class. Multimedia encyclopedias, computer programs which chronicle historical events on a time line, web quests, Internet search engines, local and distant libraries on line, and even elementary school libraries on local area networks provide multiple sources for students to explore. Another source of information is e-mail which has become an important way to communicate with other students and experts in the field. Horban (1998, p.33) relates,

Using e-mail has been invaluable for my students, giving them the opportunity to communicate with people who would not otherwise be accessible. They were able to tap into the knowledge base of other students; they, in turn, offered their own valuable suggestions. In this age of technology, communication is one of the greatest links offered. Don't overlook e-mail as an invaluable resource.

The field of Social Studies has embraced technology in many interesting ways.

Science

In recent years research on the use of computers in science education has shifted emphasis from the study of tutorials to more
inquiry based software. The shift to studying forms of technology that are congruent with constructivist models of learning has centered mainly on simulations, microworlds, and microcomputer based laboratories (MBLs). A science computer simulation is a program that allows the user to interact with a computer representation of either a scientific model of the natural or physical world or a theoretical system. The program enables the student to change the model from a given state to a specified goal state by directing it through a number of intermediate states.

Science simulation programs such as Operation Frog (Scholastic) are designed for repeated use. This program simulates a frog dissection and can be used as a prelude or alternative to a real dissection in the classroom. A whole collection of dissection programs by Digital Imaging Associates includes the frog, crayfish, perch, grasshopper, starfish, and earthworm (Sharp, 1999). Holliday and McGuire (1992) found that computer-animated demonstrations of heat and temperature with adjunct questions apparently helped eighth grade students focus on and understand the concepts presented.

In recent years, science microworlds, which are logical extensions of the simulation, have emerged enabling users to explore a particular problem area by inventing their own activities and experimenting, testing and revising of hypotheses, (Simonson & Thompson, 1994). Sixth graders who studied force and motion with a computer microworld for two months in their daily science class were compared with eighth graders who were given more conventional instruction on the topic
(White, 1993). The students using the microworld instruction performed better on a written posttest examining their ability to transfer the underlying Newtonian principles to real-world contexts.

Microcomputer-based laboratories (MBLs) might be the most promising of all educational computing tools for providing the learner the opportunity to conduct science in the context of discovery and justification (Weller, 19%). An MBL uses an electronic probe to collect analog information about a physical system, converts the data into digital input, and transforms the data into a graphical symbol system (Nakhleh, 1994). MBLs contribute to learning in four ways (Mokros and Tinker (1987), MBLs: (1) reinforce many learning modalities; (2) link, in real time, concrete experiences with their symbolic representations; (3) provide genuine scientific experiences, gathering and analyzing real data; and (4) eliminate the drudgery of graph production.

A qualitative study of learning about the bouncing and blocking of light by urban third graders during an eight-week unit using MBL setups with light probes revealed interesting findings (Settlage, 1995). He found (1) the MBLs contributed to students' science learning, particularly in the form of increased facility with scientific inquiry; (2) students developed an increasingly sophisticated understanding of graphs and how they related to light, with their theories being grounded in the data that the MBLs helped them collect; (3) students increased their graphing repertoire and sophistication of interpreting graphical representations.

Other types of computer programs such as databases and multimedia authoring programs have proved successful in science teaching
and learning. Berge (1990) found that seventh and eighth graders who spent two weeks in teams testing hypotheses by accessing two commercial databases on climate and weather significantly improved their science process skills. Turner and Dipinto (1992) found that students creating hypermedia-based science reports on mammals learned the same amount of content as those writing traditional reports, but also learned hypermedia programming skills as well as a different perspective on organizing information, a new insight into writing and new insights into the capability and limitations of computers.

A qualitative study of students creating a series of hypermedia information screens to be displayed at a touchscreen kiosk for visitors to a zoo was conducted by Beichner (1990). The researchers found: (1) there developed a reversal of student and adult roles with the students exhibiting a desire to work on their own; (2) the students' growing confidence and editing ability appeared to be an outcome of cooperative grouping; (3) students had to decide what was important enough to display and retained a great deal of this information; and (4) students appeared to transfer some skills to non science classes. The success of these activities, as well as others mentioned previously was due to tasks where creative thinking about the content is combined with real-world assignments that the students recognize as worth their time and effort.

Diffusion Research - Adoption of an Innovation

What causes people to adopt an innovation to the point of usefulness? Probably no other research field has done more work in this area than the field of diffusion research. Diffusion is a special type of
communication by which information about an innovation is communicated through certain channels over time among the members of a social system (Rogers, 1995). Diffusion research is a particular type of communication research which began outside of the academic field of communication. This is because diffusion research in other fields took place long before university departments of communication were established.

Diffusion research began in the field of anthropology in the 1920s. Anthropologists gathered diffusion data from their respondents by means of participant observation, providing insights into the respondents' perceptions of the innovation. Anthropology is the only discipline of the many that participated in diffusion research that used qualitative methods. Because of this use of qualitative methodology and the holistic perspective of the respondents' lives which they acquired, anthropology was the only discipline which had a means of understanding the consequences of an innovation. Anthropology was better able to study the relationship between an innovation's compatibility with the cultural values of the social system and the innovation's rate of adoption. Other disciplines which entered into diffusion research were early sociology, rural sociology, education, public health and medical sociology, communication, marketing, geography, and general sociology (Rogers, 1995).

Rogers determined certain characteristics of innovations that affect their rate of adoption. Relative advantage is the degree to which an innovation is perceived as better than the idea or practice it replaces.
Compatibility is the degree to which an innovation is perceived as being consistent with the existing values and norms of the social system to which it is introduced. Complexity is the degree to which an innovation is perceived as difficult to understand and use. The more complex the innovation seems to be, the less likely it is to be adopted. Trialability is the degree to which an innovation may be experimented with on a limited basis. Observability is the degree to which the results of an innovation are visible to others. The presence of all of the characteristics except complexity encourages adoption of the innovation.

Rogers (1995) discusses five main steps in the innovation-decision process through which an individual passes: (1) knowledge occurs when a person or other unit is exposed to the innovation's existence and gains some understanding of how it functions; (2) persuasion occurs when an individual forms a favorable or unfavorable attitude toward the innovation; (3) decision occurs when a person engages in activities that lead to a choice to adopt or reject the innovation; (4) implementation occurs when an individual puts an innovation into use if he has elected to adopt; (5) confirmation occurs when a person seeks reinforcement of an innovation decision that has already been made—the decision may be reversed at this time.

It is particularly during the persuasion stage and the decision stage that a person seeks information about an innovation's consequences. Interpersonal networks are very important at this stage. These are communication networks with structural equivalents (people on the same professional level), opinion leaders in the social system or
organization, or change agents who are there to assist the diffusion (Bach, 1989). In the case of adoption of technology, the communication networks could consist of other teachers in the school who use technology and who offer information and support to those considering adoption; the principal who is a technology user or strong supporter of technology; and a technology coordinator or media specialist at the school.

Opinion leaders in a social system are able to influence other members' attitudes with relative frequency. The individual is usually not on a higher level, but earns and maintains this leadership through competence, social accessibility, and conformity to the social system's norms. They are very significant in furthering the diffusion process. The opinion leader has interpersonal networks connecting her with the other members in the system. A change agent is a person brought into the social system to help the diffusion process proceed and succeed. Often change agents use opinion leaders to help in diffusion campaigns. If an opinion leader appears to be too much influenced by the change agent, it can cause her to lose credibility (Bach, 1989).

Burt (1987), in a reevaluation of the classic study Medical Innovation (Coleman, Katz, and Menzel, 1966), asks the question, "Did many of the doctors adopt the new drug tetracycline because of cohesion or because of structural equivalence?" Cohesion depends on the socialization of A and B, two doctors who are friends and have frequent communication. There is a tendency for physicians to begin prescribing a new drug at about the same time if they had a relationship of sharing advice on cases

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Structural equivalence refers to competition between doctors A and B, that is, the competition of people using one another to evaluate their relative adequacy. A and B are two physicians trying to keep up with the rush of medical development in order to live up to their image of a good physician and maintain their position in the social structure; therefore, if one adopts, the other immediately adopts.

Diffusion of an innovation research is an interesting approach to investigate the adoption of computer technology in the classroom. Education makes an important contribution to diffusion research because the school is a social system with the teachers as members of the system (Rogers, 1995). There has been a wide range in the rate of adoption of educational innovations. It took kindergartens over fifty years to reach complete adoption by U.S. schools. According to research conducted by Mort and Cornel in the 30's (Mort, 1964), it takes promising school practices fifteen years before being adopted by 3% of the nation's schools; then twenty years of diffusion, followed by fifteen years of slow acceptance before the practice becomes nationwide. Programs that are successful are those that approach change in a gradual and incremental fashion (Fullan, 1991).

In a study conducted by the Rand Corporation of local educational projects funded by federal programs, these components of the project were found to promote adoption of an innovation: extended teacher training in use of the innovation, support for the teacher in using the innovation, teacher observation of use in other classrooms, teachers'
participation in decision-making, development of project materials locally, and provision for the training of principals (McLaughlin, 1989). Huberman and Miles (1984) found that innovations requiring changes in instructional delivery were successfully adopted when the users received high levels of quality assistance at all stages, but particularly in the early stages. Teacher isolation is intimately connected to teachers' reluctance to explore and embrace alternative teaching practices which may challenge what they already do and know (Hargreaves & Dawe, 1990). For change to occur teachers need the opportunity to interact and have discussions about classroom activities (Richardson, 1990). Collaboration between teachers is heightened by the use of technology as teachers work together to develop computer expertise and design activities for students; they discuss problems and give help to colleagues who need it. This indicates that strong professional development of a collaborative nature is an important component in the adoption of technology (Schrum, 1997).

Integration of Computer Technology

Few studies have been conducted to determine the extent or efficiency of classroom teachers' implementation of computer technology. Studies were conducted to determine whether teachers were using computers at all in their teaching (Evans-Andris, 1995), (Becker, 1991). As late as 1988 (McGhan) and 1992 (Winnans & Brown), researchers were studying teachers' compliance with and attitudes toward teaching computer skills required by their school systems, focusing on teaching students how to use computers, rather than using
psychosocial barriers to technology integration and describes them as being extrinsic to teachers. Intrinsic to teachers are second order barriers to technology integration which include beliefs about teaching, beliefs about computers, established classroom practices, and unwillingness to change.

What if a school provides in-service training and adequate computers and software and the teachers still resist using the computers? Evans-Andris (1995) studied teachers' behaviors in response to computers in their schools through extensive observation and formal interviewing in nine elementary schools. She found out that what teachers said they did and what they actually did was not always synonymous. Extensive data collection from the observations and interviews determined that teachers used different coping strategies when faced with the necessity to use computers. These strategies included avoidance, technical specialization, and integration. It was found that 60% of the teachers practiced avoidance or, in other words, used routines which limited their involvement with computers, such as letting the preceding activity run overtime so that there was no time for a computer activity. They did not overtly embrace or resist computer implementation, but responded to computing as an undervalued activity, treating it as something peripheral to their task of teaching. Evans-Andris (1995) asserts that the implications of her findings are that
are that principals should help establish the relevancy of computing in the context of elementary education. Teachers should be encouraged to vary computer applications to include a broader range of computer activities to enhance the regular classroom curriculum. She recommends research to further examine the conditions under which these styles persist in elementary schools.

Vockell, Jancich, and Sweeney (1994) conducted survey research on two school systems in Indiana. Teachers in both systems rated these factors that contributed to computer use in the same order: self-training and experimentation with the computer, workshops sponsored by the school, encouragement from colleagues, and encouragement and support from the computer coordinator. Greater implementation of computer technology occurred most often in the system where the commitment to these factors was greatest.

The Technology Integration Enhancement Model (Panyan, McPherson, Steeves, & Hummel, 1994) is a training program consisting of a conceptual framework, staff development, and the Concerns-Based Adoption Model. Teachers were administered three diagnostic instruments, Stages of Concern, Levels of Use, and Innovation Configuration before and after the training to measure the level of technology integration at the elementary school level. Results from 11 schools indicate that teachers' attitudes toward and use of technology change favorably when provided well-designed staff development.

Dwyer, Ringstaff, and Sandholtz (1991) found that teachers in the Apple Classrooms of Tomorrow project went through five phases in a
technology-intensive environment: Entry, Adoption, Adaptation, Appropriation, and finally, Invention, which involved implementation of an integrated curriculum. This study, which extended over a five year period, found that the instructional change necessary to reach the Invention stage could only be reached with a corresponding change in teacher beliefs about instruction and learning.

Marcinkiewicz (1994) studied the relationship of personal variables to teachers' computer use. Using a sample of 170 elementary teachers at 4 elementary schools, researchers determined the teachers' level of computer use with The Levels of Use (Marcinkiewicz, 1994) assessment instrument. To this dependent variable, "level of computer use", the researcher correlated the independent variables: age, gender, computer experience, innovativeness, self-competence, and perceived relevance. The results of the study support self-competence as a factor that contributes to a teacher's higher level use of the computer for instruction. The results also suggest that innovativeness contributes to the prediction of a teacher's level of computer use. The term innovativeness, which is derived from the research on adoption of innovation (Rogers, 1995), refers to a teacher's "willingness to change". Willingness to change, or a greater acceptance to change is a characteristic of teachers working in a positive school climate. Marcinkiewicz concludes that integration of computers into the educational system is a distant goal unless we quickly conduct more research to study teachers and what makes them use computers.

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In one of the few studies which looked at exemplary computer use vs. typical computer use by teachers, Becker (1994) used a national survey of teachers and administrators which had been administered in approximately 1,400 schools in the United States as part of an international computer-ed survey conducted in elementary and secondary schools in 20 countries. Questionnaires which had been completed by teachers, principals, and school-level coordinators were analyzed to determine what percent of the teachers could be considered exemplary computer users and how the background and teaching environment of that select group differed from that of the remaining teachers. Only five percent of the teachers were established as exemplary computer users according to the criteria determined.

To establish the criteria for determining exemplary computer users, Becker selected from the survey 8 sets of questions from the mathematics, science, English and elementary questionnaires to be examined for his study. These questions established (1) the teacher's goals for computer use, (2) the frequency with which students used computers, (3) the saliency of the computer approaches used for the major learning activities in the class, (4) the amount of experience students had with using certain types of software, and (5) the general functions that computers played in the class. Twelve to fifteen answers were selected as those that an exemplary teacher in a content area or elementary would be expected to give. For example, answers for English teachers that depicted them as exemplary were: (1) improving writing skills is one of the most important goals for computer use, (2) computers
do not primarily serve as a reward to students for completing other work. (3) Computer activities mostly always directly support other work done that day in class, and (4) when students are given an assignment to complete a story, computers were used at least 25% of the time.

Becker found four characteristics of the teaching environment that seem to make exemplary computer users more likely to be present: (1) the presence of a social network of computer-using teachers at the same school; (2) use of computers for relevant activities, such as writing and publishing, industrial arts, business applications or research; (3) organized support for computer using teachers such as staff development activities and a full-time staff member in the role of computer coordinator; and (4) fulfillment of resource requirements such as smaller class sizes and funds for software acquisition.

Notable, too, was the lack of differences in some areas: (1) exemplary computer-using teachers were as likely to be found in low-income districts and low-socioeconomic-status schools as they were in other schools, and (2) although the use of computers in the classroom may be more easily integrated into classroom learning activities than use in a lab, exemplary teachers were as likely to use computers in lab settings as their non-exemplary counterparts. Therefore, an important aspect of the results of this study is the determination that the characteristics of the teaching environment of the exemplary teachers that differ from those of the other teachers are not characteristics that are unchangeable such as having all gifted students or teaching in schools.
serving wealthy communities, but they are characteristics that can be extended to all teachers in all schools by a concerted effort to do so.

In a study to determine how effective teachers use computers for instruction (Winkler et al., 1984), the researchers had as their primary goal to describe patterns of instructional computer use of teachers who were nominated by their peers as exemplary computer using teachers. They then determined how these patterns varied as a function of teacher and background characteristics, such as experience with using computers, major coursework in teacher preparation, district and school policies regarding computer use, number and location of computers.

Some teachers provided multiple uses of the computer and high level of integration into the ongoing instruction; some encouraged students to use computers but with a less ambitious instructional program; some used computers selectively to enhance conceptual mastery within a discipline; and some used an extensive program of drill and practice on the computer. Neither subject matter knowledge nor grade level caused statistically significant differences between patterns of use except for one group: teachers in the drill and practice cluster had taken a great deal more science coursework (47%) than did teachers in other clusters. Computer experience was unrelated to patterns of use, but knowledge of relevant course software was related. Patterns of use were unrelated to district and school policies regarding the use of computers, and unrelated to organizational variables such as the number and location of computers. On average, about 5 computers were available to
teachers, but the number varied greatly. Slightly over half of the teachers took their students to laboratories.

Foliart and Lemlech (1989) conducted a research study for the purpose of determining if the same patterns of use discovered by Winkler et al. (1984) existed in the general population of elementary level teachers. Believing that integration of computer-based instruction with the curriculum represented the desired implementation of computer technology in the classroom, the authors first defined curriculum integration. These researchers assert the concept of integration involves the linking of subject fields and/or learning objectives. Therefore, integration of computer-based instruction with the curriculum should include integration with the following curriculum elements: across subjects of content, concepts and skills; with activities; with teaching and grouping methods; of time components; and with the classroom management system.

Taped interviews, observations, and questionnaires were used to obtain data from 29, K-6 classroom teachers from 5 schools in 3 metropolitan school districts. Results of analysis of the data revealed 4 patterns of use similar to those discovered by Winkler et al. (1984) which were (1) integration of technology into the curriculum; (3) limited amount of computer use and no integration; and (4) use of computers to enrich regular program but no integration.

More important than the determination of a teacher's pattern of use was the discovery of certain "confusions" that the teachers had concerning computer use and its relationship to the curriculum elements.
investigated. Only the combination of survey, observations and interviews would have revealed these confusions which caused survey data to be inaccurate. First of all there was the confusion of process vs. product. This came about when some teachers used the computer to teach computer skills and not as an instructional tool. When questioned about the relevance of some activities, they defended these because the students were "getting the opportunity to use the computer".

The second confusion of entertainment vs. motivation was revealed when teachers were asked to explain the use of game-type software which had no link with the curriculum. They explained the software was used for motivation when it actually only provided entertainment and reward, but no learning or even motivation to learn content or thinking skills. The third confusion noted by the researchers concerned the ethical use of time. Certain students regularly missed time from other subjects to get in their computer time under the mistaken impression the teachers had that every student had to have the same experience in the same subject using the computer. A fourth confusion concerned the definition of curriculum integration; some teachers felt if they used the computer to reinforce a specific objective in a given subject area that they had previously taught, then their use of the computer was well integrated while others felt that if they used the computer for two subjects their use was well integrated when in truth neither of these teachers had integrated technology into the curriculum.

The fifth and last confusion involved student accountability which many teachers felt was not necessary since many of the drill and practice
programs which they used provided feedback to the student, but not a record of the student’s progress. As a result, they had little knowledge of what the students had accomplished with the computer. These confusions are liable to cause information gleaned from teacher questionnaires and survey instruments to be incorrect although teachers are answering correctly as they understand the questions and terms.

Professional Development

One of the factors crucial to successful integration of technology into the elementary curriculum is the program of professional development provided for the teachers. Guskey (1995) emphasizes the importance of context in which the professional development takes place. Because of the enormous variability in educational contexts, there will never be one right way to conduct professional development programs. Instead there will be different types of programs, each specific to a context, that work best in particular settings.

Professional development programs that are successful are those that approach change in a gradual and incremental fashion (Fullan, 1991). Guskey (1995) recommends procedural guidelines for planning for professional development no matter what form the program takes: (1) recognize that change is both an individual and organizational process; (2) don’t take on too much at one time. (3) work in teams to maintain support; (4) provide feedback on results; (5) provide continued follow-up, support, and pressure to use what has been introduced. Pressure is necessary for many who lack the self-impetus for change and provides
the encouragement, motivation, and provocation that many require to persist in change efforts (Airasian, 1997).

One important component of teachers' ongoing learning that must be considered is the expansion and elaboration of their professional knowledge base. Knowledge is a prime construct in cognitive psychological research and is particularly relevant to understanding and changing classroom practice (Borko & Putnam, 1995). Shulman (1999) theorized that teachers access seven domains of knowledge that they possess to plan and carry out instruction. These domains of knowledge are: general pedagogical knowledge, knowledge of students, knowledge of subject matter, pedagogical content knowledge, knowledge of other content, knowledge of the curriculum, and knowledge of educational aims.

Direct instruction models which are so prevalent in today's public school classrooms can be effective for teaching factual information and well-defined skills, but current reform efforts will require instructional approaches that enable students to take more active roles in their learning. To use these approaches well, teachers will have to think in new ways about students, subject matter, and the teaching-learning process. These changes in thinking will require new kinds of knowledge and beliefs on the part of teachers and a willingness to become more "adventurous" in their teaching (Newby et al., 1996).

Though everyone appears to want a wide array of learning opportunities that have students experiencing, creating and solving real problems and working with others - for some reason, this type of
learning is denied to teachers when they are the learners. In the traditional view of staff development, workshops and conferences conducted outside the school count, but authentic opportunities to learn from and with colleagues inside the school do not. The conventional view of staff development as a transferable package of knowledge to be distributed to teachers in small pieces needs rethinking. This concept of teacher learning is out of step with current research and practice (Lieberman, 1995). The ways teachers learn may be more like the ways students learn than we have previously recognized. Learning theorists and organizational theorists are teaching us that people learn best through active involvement and through thinking about and becoming articulate about what they have learned. Practices that are built on this view of learning are at the core of a more expanded view of teacher development that encourages teachers to involve themselves as learners in the same way as they wish their students to do (Schon, 1991).

Traditional staff development is often carried out as a four-hour session after school when everyone is tired and thinking about other problems. The school may hire an expert who arrives, delivers the presentation, and then goes home. Usually the whole faculty is required to attend whether it applies to all of them or not. Sometimes a school system or school will choose a "hot" topic found in the popular press that will be expanded to cover a full year of intensive staff development. There is very little evidence that this type of staff development makes a difference (Schrum, 1999). "Nothing has promised so much and has been so frustratingly wasteful as the thousands of workshops and
conferences that led to no significant change in practice when the teachers returned to their classrooms" (Fullan and Stiegelbauer, 1991).

Joyce and Showers (1983; 1988; 1995) have for many years studied the ways in which teachers in schools do or do not actually transfer new skills and knowledge into classroom practice. They identified four different models for staff development: (1) presentation of theoretical basis or rationale; (2) theory plus observations of demonstrations by relative experts; (3) theory and demonstrations, plus practice-plus-feedback in relatively protected conditions; and (4) theory, demonstrations, and practice, plus coaching each other as ongoing, collegial follow-up. In their most recent research Joyce and Showers (1995) have determined the extent to which the use each of these four models supports educators adopting and implementing new skills and knowledge. When staff development provided no peer structure for follow-up, a 5-10% implementation resulted. When peer coaching teams were included implementation was at 75%. When the whole faculty was organized into peer coaching teams for follow-up, the implementation was at 90%. Therefore, schools or school systems using a staff development model consisting of presentation of theory, clear demonstrations, practice with feedback, and peer coaching with follow-up will increase the probability that change will impact the classroom and ultimately the students (Schrum, 1999).

Borko and Putnam (1995) caution professional development planners that the existing knowledge and beliefs held by teachers can act as filters through which recommended new practices and activities must
pass, causing distortions in the resulting uses in their classrooms. In some classrooms small groups may mean only a new arrangement of furniture where students sit and listen to the teacher dispense information, while in other classes they become powerful collaborations among students for solving problems and thinking through ideas.

Similarly in some classrooms the new practice of using technology means students using electronic encyclopedias to search for information about a country they are studying and writing reports - an activity that can be carried out without technology. In another classroom using new technology practices means students and teachers using the internet to track and help to direct a three-month bicycle expedition of a team of cyclists and scientists, through the jungles of Central America in search of lost Mayan civilizations. Should they send the team through a difficult, untraveled jungle track to a special site? How fast can they ride? How far? What obstacles will they encounter? What are the odds of success? What plans must be made? Since students' votes around the globe actually determine the course of the journey, they must problem-solve along with the scientists. To be prepared for their decisions they read the daily journals of the adventurers, study the history of the land, geography, archaeology, flora and fauna, math (the Mayans calculated on base 20) and develop theories of why the civilization collapsed (Healy, 1999). This is a far cry from the first class described as using technology; the change in teaching practices must come first. The same knowledge and beliefs that act as filters must become critical targets of change. Any effort to help teachers make significant changes in their
teaching practice must help them to acquire new pedagogical knowledge (Borko and Putnam, 1995).

As more professional development models move away from the traditional inservice training mode and toward long-term, continuous learning in the comfort and safety of the school and classroom with the support of colleagues, professional development takes on a greater significance. If teacher learning takes place within the context of a professional community that is nurtured and developed both within and outside the school, then the effects will be substantial and bring about significant and lasting school change (Lieberman, 1995).

Technology Professional Development and Support

It is a challenge for teachers to use technology appropriately in their own classrooms. School leaders must devise a program of professional development that matches each teacher's abilities and interests, is continuous, and is linked to the ongoing activities of the classroom. Many of the best school technology plans failed because too little attention and resources were devoted to staff development (Eib & Mehlinger, 1998).

Here again, school and community context, along with financial considerations, and possibly political considerations, weigh heavily in making the choice of an inservice program. While they may at first rely on consultants, universities, or technology vendors to provide staff development, schools must devise strategies for strengthening abilities within their own ranks in order to sustain their efforts at professional development (Guskey, 1995). Even with a clear understanding of staff-
development research and principles, teaching about technology requires other considerations. Many traditional models do not take into consideration the significant and unique qualities that make technology staff development different from other types of staff development (Schrum, 1999). In general, K-12 teachers do not receive enough time, access, support, or encouragement to become comfortable with computers (Siegel, 1995).

Learning about technology is a nontrivial and life-changing event, and is qualitatively different from learning other new skills, knowledge, and activities (Bradshaw, 1997). Brief exposure to technology instruction does not provide sufficient training or practice to incorporate technology into a classroom (Macmillan, Liu, & Timmons, 1997; Schrum, 1997). This makes traditional staff development models even less effective with technology than with other topics. This is true first of all because of the longer time it takes to learn to use technology. Mehlinger (1997) estimated that it takes more than 30 hours of training plus added time for practice to see actual adoption of new technologies. The necessity for practice means the teacher should have access to equipment at home and at school for extended practice and to build comfort (OTA, 1995; Schrum, 1997).

Another facet of technology training is the use of computers and other technologies is more frightening to some teachers than a new plan for teaching reading or a system for better discipline (Robinson, 1995; Schrum, 1995). Also, the use of technology for instruction or personal
use may require educators to reconceptualize the ways in which they have completed their tasks for many years (Becker, 1999).

Considering these things it is easy to see why many technology workshops can serve to heighten these problems. Often all teachers are expected to attend, regardless of their readiness. Teachers who are not ready or fearful will learn little. Learning-style differences are not taken into consideration when planning, nor are levels of expertise. Moreover, workshops are often held in labs away from the teachers' schools, further distancing the teachers from their comfort zone. Added to this is the fact that technology training is often of the nature of "just in case", instead of "just in time" learning. An example of this is instruction in the use of a spreadsheet program, just in case they ever want to use it instead of instruction in the use of a program requested by the teachers because they want to use it in their lessons. Teachers need authentic reasons for wanting to use that type of program at that time (Schrum, 1997). Technology studies consistently show that extensive practice, comfortable atmosphere, individualized attention, and voluntary participation are essential elements to encourage teachers to adopt technology (Schrum & Fitzgerald, 1996).

Teacher training in technology has two focuses, skill development - how to operate hardware, software, and peripherals; and educational applications - how to use the technology in support of teaching and learning. Both of these focuses require long-term commitments and extensive follow-up. This need for follow-up and support can frequently be fulfilled through coaching from peers. In fact, peer coaching has been
observed to be a significant factor in the spread of computer-based education expertise (Fedewa, 1987; Joyce & Showers, 1995).

A collegial support system can be defined as a systematic process whereby principals and teachers identified for their instructional leadership ability help other colleagues to develop optimal teaching behaviors (Hopfengardner & Walker, 1984). Such support for professional development is essential in today's schools because it emphasizes a peer support network rather than a superior-subordinate relationship. Working as a group, in a "community of leadership" (Maurer & Davidson, 1998), teachers not only get useful feedback relevant to their individual interests, but begin to work together, sharing expertise and breaking down the isolation that so often is a barrier to professional development (Brophy, J. E., 1979). Collegiality, trust in others, and strong informal relationship among organizational members, providing personal and professional support, are determinants of good climate (Hoy & Miskel, 1991).

The link between collegial relationships and effective instruction has been noted by researchers for years (Goodlad, 1984; Joyce & Showers, 1988, 1995). Collegial teachers not only take pleasure in their work and have pride in their school, but they work together and respect each other as competent professionals (Hoy, Tarter, & Kottkamp, 1991). A case study (Cooper et al., 1990) of a program to improve teacher collaboration and collegial support by a school district in New York City involved twelve sets of three teachers, a veteran with ten or more years experience, a novice, and one in between. The program provided teachers with
common planning and observation periods, funding to pay for full-time substitute teachers, release time for observations, and workshops for learning peer coaching skills and improved instructional skills.

The program was evaluated at the end of two years, at which time the authors concluded that with careful planning, strong leadership, proper restructuring, and patience, teachers can and do act as colleagues. They can observe and help one another to improve their instructional skills. Schools should stop isolating and dividing teachers by allowing them no time to get together, and instead find ways to help teachers to work closely together.

Teachers need technical support from specialists who can repair and maintain the machinery; they need pedagogical support from those who know the software related to their disciplines and the pedagogical problems that the teachers face. A teacher cannot possibly be accomplished in all uses of technology. An enlightened principal will find ways of building teams of faculty and staff members who can try to solve their problems together, working collaboratively and sharing knowledge and expertise (Eib & Mehlinger, 1998).

The failure to transfer skills and knowledge gained from in-service workshops to the classroom is often due to lack of follow-up and support. Two methods of collegial tutoring applicable to supporting computer skills include one-to-one tutoring between a novice and mentor, and cooperative groups of grade level teachers in a school (Richie & Wiburg, 1994). Little (1982) found that interaction in effective schools tends to be frequent, task focused, and widespread.
Communication, collaboration, and collegiality are emphasized in effective schools (Teddlie & Stringfield, 1993).

Sergiovanni and Starratt (1993) assert that high levels of openness and trust result in colleagues discussing their concerns about change and thereby leading to greater acceptance of change. Collegial communications and support can facilitate the innovation process (Rogers, 1995). In a five year longitudinal study involving 32 elementary and secondary teachers in five schools located in four states, Sandholtz and colleagues (Sandholtz et al. 1991; Dwyer, 1994; Fisher, Dwyer, & Yocam, 1996) investigated collegial interaction among classroom teachers thrown into a technology rich environment in the Apple Classrooms of Tomorrow project. This "technology rich environment" was one in which participants had immediate access to interactive technologies. Elementary and secondary classes were equipped with computers, printers, scanners, laser disk and videotape players, modems, CD-ROM drives, and hundreds of software titles. The classrooms are true multimedia environments, where students and teachers use textbooks, workbooks, manipulative math materials, whiteboards, crayons, paper, glue, overhead projectors, televisions, and pianos as well as the technology. The operating principle is to use the media that best support learning goals across the curriculum. The project had the attention and support of Apple computer personnel. The researchers found that this innovative technology rich environment influences the frequency, form, and substance of collegial interaction among the teachers.
The results of the Sandholtz et al. study suggest that innovations such as these high-access technology classrooms tended to impel teachers to commit to more collegial interaction and instructional sharing to prepare for their classes and revise their curriculum. The researchers also found that the reverse applied: teachers in schools with a high level of collegial interaction were more eager to embrace innovations and implement new instructional strategies. The gradual shifts in instructional practice occurring in the project were accompanied by corresponding changes in the frequency and form of collegial interaction. At the beginning interaction was infrequent and mostly involved the giving of emotional support. As the project proceeded, interactions began to include technical assistance, instructional sharing, and ultimately, formalized collaboration.

In a study which examined the relationship of curriculum integration variables to the computer-based instruction planned and implemented by the teachers, Foliart & Lemlech (1989) found collegial coaching to be one of the important ways that teachers can learn to use the computer in a variety of teaching strategies necessary for curriculum integration. They assert that teachers need collegial assistance to learn teaching strategies, to deal with the integration of the computer as an instructional tool, and to provide for changes in classroom management and the environment that need to occur. Their findings indicate that staff development needs to be designed not as a time-limited experience but rather as collegial professional development over the course of several semesters.
Mentoring is one way to provide the school-based collegial support needed to help teachers learn to integrate computers into their instruction. A mentoring approach to technology education for teachers was investigated by MacArthur & Malouf (1991) and found to be an effective way to prepare teachers to use technology in the classroom. The Computer Mentor Program was a collaborative effort between a university and a school district. Experienced computer-using teachers participated in a semester course that provided guidance in mentoring and information on technology applications. These teachers each mentored one to five teachers in their respective schools. Evaluation indicated that both mentors and protégés developed increased knowledge of computer applications and that protégés made more extensive and varied use of computers both with students and for professional tasks.

A comparative case study (Cahoon, 1996) suggests that informal group learning plays a more important role in computer skill learning than formal training. Participants in the study reported that informal interactions with other group members were more important in their skill development than participation in more formal training. Interactions among group members involved identifying experts within the group, one-on-one tutoring, solving problems together and dividing computer tasks. All of the participants in the study named other members of the group to whom they turned routinely for help with the computer. Each member of the work group was potentially a learning resource for all of the others. Faculty members reported that asking and
answering questions were the most common methods of solving computer problems. Coaching on the same computer that the learner would later use for the task was perceived as more efficient than training conducted in another setting. Development of optimal educational use of computers is a gradual process, requiring both formal and informal professional development service, time, collegiality, and on-site support (Sheingold and Hadley, 1990).

To date much of the technology professional development has been unsuccessful because K-12 teachers do not receive enough time, access, support, or encouragement to become comfortable with computers (Siegel, 1995). Although many teachers are eager to use technology, a lack of effective teacher professional development programs and time to practice and experiment with technology have limited teachers' acquisition of skills and knowledge (Schrum & Fitzgerald, 1996; Shelly, 1998).
CHAPTER 3
METHODOLOGY

Design

This research has taken the form of a mixed method, multi-case study. The study has a phenomenological focus (Patton, 1990) in which the researcher concentrated on the structure and essence of the experiences of the teachers and administrators in this phenomenon, the implementation of technology in the school. Creswell (1994) characterizes a case study as the intensive, holistic description and analysis of a single entity or phenomenon such as a program, event, process, institution, or social group; and a phenomenological study as one which emphasizes the experiences of the subjects. Data was collected through descriptive observations (Spradley, 1980), open-ended interviews, and the examination of documents and artifacts. Screening for sampling purposes and for triangulation of data was provided by results of a teacher questionnaire.

There are three choices of open-ended interviews (Patton, 1990) available to qualitative researchers. These choices are: (1) the informal conversational interview; (2) the general interview guide approach; and (3) the standardized open-ended interview. I chose the general interview guide approach because I wanted the interviews to be relaxed and similar to a conversation, but still cover certain issues in each interview so that common information could be compared. The general interview guide approach involves making an outline or a list of questions about the issues to be covered without paying attention to the actual wording of
questions to elicit responses until the actual interview takes place. The issues in the outline or list do not have to be taken in any particular order but serve as a checklist of topics to be covered. The guide provides a framework within which the interviewer would develop questions, sequence those questions, and make decisions about which information to cover in greater depth. The researcher who uses the interview guide approach infers that there is common information that should be obtained from each person interviewed, but uses no set of standardized questions written in advance. The interviewer is thus required to adapt both the wording and the sequence of questions to specific interviewees in the context of the actual interview (Patton, 1990). These interviews were audio-taped and transcribed word for word.

Document analysis in qualitative inquiry produces excerpts, quotations, or entire passages from organizational records; memoranda and correspondence; official publications and reports; personal journals; and open-ended written responses to questionnaires and surveys (Patton, 1990). The experiences of participants were bracketed, analyzed, and compared to identify commonalities in their experiences to determine the essences of the phenomenon being studied.

Sampling

The sample was selected through mixed purposeful sampling (Patton, 1990). A combination of extreme case sampling and criterion sampling was utilized. Extreme case sampling focuses on cases that are rich in information because they are unusual or special in some way. The logic of extreme case sampling is that lessons may be learned from
highly unusual manifestations of the phenomenon of interest such as outstanding successes that are relevant to improving more typical programs (Patton, 1990). Outlier cases such as these are used to learn more by intensively studying one or more examples of really excellent programs or really poor programs. Outlier cases are those that do not conform to predicted patterns (Stringfield, 1994). A researcher or practitioner who wants to know what unusually effective or ineffective schools or programs are doing and how to replicate or eliminate those behavior patterns often finds an outlier study the most efficient research design. This outlier sampling is efficient because it allows the researchers to spend more of their time and resources on gathering data from the outliers, resulting in rich descriptions of these programs (Stringfield, 1994).

There are four types of outlier studies: (1) positive outlier only; (2) contrasting positive and negative outliers; (3) comparing positive outliers and typical schools; and (4) comparing positive outliers, typical schools, and negative outliers. School effects studies have used the first two types repeatedly (Anderson et al., 1992; Stringfield et al., 1993; Teddlie & Stringfield, 1993). This study will be a positive outlier only study which can be considered a first step in a group of studies.

It is not necessary to randomly sample poor programs or excellent programs. The focus becomes a question of understanding under what conditions programs exemplify excellence. The researchers and intended users of the study think through what cases they could learn the most from and those are the cases that are selected for study. In
selecting the schools that are considered outstanding successes in technology implementation relevant to improving the programs of other schools, these attributes should be veritable: (1) the schools selected for this study be considered outstanding by technology leaders in the state; (2) the students at the schools doing curriculum related technology activities; (3) documents and interviews reveal a well defined professional development program; (4) support for technology be pronounced; and (5) teacher attitudes toward technology be positive.

Criterion sampling can add an important qualitative component to the study of a program. The point of criterion sampling is to understand cases that are likely to be information-rich because they may reveal weaknesses that can become targets for program improvements. Criterion sampling can be applied to identify cases from quantitative questionnaires for in-depth follow-up (Patton, 1990). In this study, the criterion used were schools which have: (1) adequate technology equipment; (2) a variety of software available; and (3) at least 90% of the teachers using technology on a regular basis. A school has adequate technology equipment if there is computer hardware in every classroom. A variety of software is operationally defined as software: for writing and revising; to represent ideas with visual images; to acquire, organize and analyze information: to compute, manipulate and represent numbers; to demonstrate concepts through animations and simulations; to simulate experiments; to develop thinking skills; to provide drill and practice on skills; to add to the diversity of reading materials; and to develop multimedia projects which synthesize student ideas and learning.
**Instrumentation**

The Teacher Questionnaire (Appendix A), a researcher developed instrument which was used as a screening instrument, examined teacher experience, education, teaching philosophy, attitude and beliefs about technology, as well as actual technology use in the classroom as self-reported by the teacher. The instrument was developed for this study with items generated to aid in the screening process. Some items from other researcher instruments were utilized (Moersch, 1995; Winnans & Brown, 1992; Panyan, McPherson, Steeves, & Hummel, 1994, Loup, 1994). This instrument contains 50 items, 47 multiple-choice and 3 open-ended discussion questions with space for teacher responses. It was given to every teacher in the twenty schools screened. Many schools returned questionnaires from all of their teachers.

In informal interviews the principals were asked about the school's technology plans. They were asked about the professional development provided their teachers in support of technology. Teachers were asked about their experience, how they used technology, how it helped their students, and about the support they received.

**Selection Process**

Twenty elementary schools were identified by technology coordinators, central office technology personnel, and state department of education personnel as being schools where technology is used regularly. The identified schools were located in three different parish school systems. Permission was received from these school systems to conduct the study in their schools. The 20 schools, which were
recommended as meeting all of the desired criteria, were screened by the researcher using four steps, increasing in intensity.

The first step consisted of a letter to the principal explaining the study followed by a telephone call to determine the receptiveness to participation in the study. In some cases the process ended at this point. Two principals said that although their schools were recommended as having technology programs, those programs were just getting started and were not in a stage to be studied. They declined to have their teachers answer the questionnaires. Two principals declined to participate because although their schools had once been fore-runners in technology, their hardware and software were now practically obsolete, making the situation a poor one to study.

In step two the remaining 16 schools voiced an interest in the study and 14 received a visit from the researcher; two received a telephone interview and a mailing of questionnaires. The schools visited provided an interview with the principal or technology leader and a view of the facilities. Visits to the classrooms were made to see to what extent computer-related technologies were being used and in what ways. The ways in which technologies were used were of utmost importance. Permission was given to the researcher to wander about freely in the schools and speak to the teachers of their thoughts and beliefs concerning technology use and the role which it played in their school. The physical setup for technology was examined in these schools and available technology plans were perused. Questionnaires
were left for the teachers. Questionnaires in sufficient numbers (75% of the teachers in a school) were returned from 15 of the schools.

In step three analysis of the interview data and questionnaire data enabled the number of schools to be reduced to six from which four were chosen because of their diverse methods in obtaining outstanding success in implementing technology in the school. In each of the selected schools there was an intense commitment to technology implementation at all levels with a belief that technology was an important contributor to the success of the school in its major endeavor, educating its students. There was a strong emphasis on professional development and a community of leadership on site to support and encourage teachers. Successful implementation also included the integration of computers into the curriculum, use of technology as a process-oriented approach to enable students to reach curricular objectives already in place, a child-centered approach to learning, authentic technology extensions beyond the classroom, and project-based learning across disciplines with planned collaborative activities integrated with technology (Knapp & Glenn, 1996). Integration of computers into the curriculum is defined as integration with the following curriculum elements: 1) across subjects of content, concepts and skills; (2) with teaching and grouping methods; (3) of time components; and (4) with the classroom management system. Equity of use across students' gender, socio-economic status, and ability level should be apparent. Table 1 shows the major steps used in this selection process.
Table 1

Selection Process

A. Twenty schools recommended by technology leaders and school system officials
   1. Letters and telephone calls to schools
   2. Informal interviews and observations
      a. principals
      b. teachers
      c. technology specialists and leaders
   3. Tour of school and facilities including location and amount of hardware and software
   4. Questionnaires distributed

B. Analysis of interview, observation, and questionnaire data revealed six schools which had:
   1. Commitment to technology implementation
   2. Emphasis on professional development in technology
   3. Technology integrated into the curriculum
   4. Teachers with positive attitude toward technology

C. Four schools selected which had implemented technology in interesting and diverse ways
   1. Six teachers chosen for observation and interview;
      two from K-1, two from 2-3, and two from 4-5.
In step four, six teachers were chosen as typical computer-using teachers from each of the four schools. Two teachers were selected from grades K-1, two from grades 2-3, and two from grades 4-5 based on recommendations of principals or technology personnel and observations which identified them as using technology to meet curricular objectives. These teachers were observed and interviewed.

Table 2 (Louisiana State Department of Education, 1999) shows the student enrollment for the 1998-1999 school year at the four selected schools and the percent of free lunch students.

Table 2

<table>
<thead>
<tr>
<th>Selected Schools Student Enrollment 1998-1999</th>
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<tbody>
<tr>
<td>School A</td>
</tr>
<tr>
<td>Asian</td>
</tr>
<tr>
<td>Black</td>
</tr>
<tr>
<td>Hispanic</td>
</tr>
<tr>
<td>White</td>
</tr>
</tbody>
</table>

School B

| Asian | 0 | 4 | 2 | 1 | 2 | 4 | 2 | 0 |
| Black | 0 | 4 | 4 | 7 | 3 | 3 | 8 | 0 | 10.68% |
| Hispanic | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | Total |
| White | 0 | 84 | 97 | 89 | 92 | 83 | 100 | 7 | 598 |

School C

| Amer. Ind. | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Asian | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Hispanic | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 37.47% |
| Black | 0 | 4 | 1 | 2 | 1 | 1 | 2 | 2 | Total |
| White | 0 | 85 | 90 | 77 | 85 | 74 | 73 | 27 | 512 |

School D

| Asian | 0 | 1 | 1 | 0 | 0 | 0 | 3 | 0 | 0 |
| Black | 0 | 25 | 29 | 21 | 33 | 26 | 26 | 0 | 58.90% |
| Hispanic | 0 | 1 | 3 | 3 | 5 | 3 | 1 | 0 | Total |
| White | 0 | 55 | 69 | 58 | 63 | 63 | 57 | 0 | 546 |

Note: NG refers to non-graded special classes.

Note: Schools missing ethnic groups indicate no students in missing ethnic groups.
Data Collection

The methods used to collect data in this study are those based on the principles of qualitative field studies (Glaser & Strauss, 1967; Spradley, 1980). This methodology was selected because it allows for a variety of data gathering techniques and methods of analysis that are grounded in the recorded data itself. In addition, it enables the researcher to understand the perspectives of teachers and administrators while at the same time making generalizations among these perspectives. In the first phase of the study, the researcher made descriptive observations (Spradley, 1980) in each of the 4 schools with the purpose of getting an overview of the social situation and establishing where and how technology was utilized. (Spradley, 1980). These observations took place in classrooms, computer labs, libraries, teacher’s work rooms, and halls. At the time, informal interviews were carried out with classroom teachers, technology coordinators, computer lab technicians, librarians, and administrators.

Interviews were conducted with the selected six teachers in each school; the technology coordinator, librarians; and administrators. The open-ended interviews (Patton, 1990) were conducted using a general interview guide (Appendix B) and were audio-taped and transcribed verbatim. Additional interviews and observations were made as the phenomenon unfolded.

Data were also obtained from documents and artifacts. Documents examined include teacher plans, teacher journals, school technology plans, parish technology plans, school newsletters, and
teacher responses to questionnaires. Artifacts examined include student technology-generated artwork, creative writing, and multi-media projects.

Data Analysis

Verbatim transcripts were made from the taped interviews. These transcripts, field notes from observations, notes made about lesson plans, teachers' journals and informal conversations were reviewed and coded on a continual basis, following the principle of constant comparison. The most recent observations and interview responses were compared with previously collected data in search for similarities and differences.

Emerging themes were added as the research progressed. Thematic analysis was conducted on the data collected. Thematic analysis focuses on identifiable themes or patterns discovered in the data collected (Taylor & Bogdan, 1984). After themes or patterns were identified, then all data that related to the theme was identified and color-coded to refer to that theme. Themes that emerged from the data were pieced together to form a comprehensive picture of the experiences of the people and of the phenomenon. The analyses required more questions, and more data collection. Triangulation of qualitative data sources (Patton, 1990) was accomplished with the use of a variety of data sources including observations, interviews providing different view points, lesson plans, journals, professional development plans, and teacher responses on questionnaires.
CHAPTER IV
RESEARCH FINDINGS

Before beginning a description and analysis of findings in the four schools, the background and experiences of the researcher will be reviewed since these will possibly influence and color the presentation of these findings. Experiences include 20 years as a classroom teacher in grades 1 through 8; 13 years instructing teacher candidates in the College of Education; 3 years as graduate assistant to a professor instructing teachers and teacher candidates to use technology in K-12 schools; and two years (ongoing) as a technology coordinator and computer lab instructor at a math/science/technology magnet elementary school. Though I have had experience in teacher education, it is the classroom teachers with whom I identify and it is empathy with their situation which helps me to understand the frustrations and difficulties that teachers face in implementing technology. Perhaps this view from many points on the spectrum will promote a balanced perspective for the description and analysis of these data.

In gathering data from the four schools, I was interested to find in these schools with such different technology program design, the same areas of importance to technology implementation being brought up time and again by teachers and principals. Teachers most often mentioned instruction in the use of computers and support in using them as important in their acceptance and use of technology. The type of professional development provided was very important as was the location of these activities. The support provided the teachers for the use
of technology was extremely important. The goals for the four schools were similar but the paths they took to achieve these goals were very different. All four were highly successful with their main goal which was the education of their students. I expected leadership and professional development to be important to implement ion of technology but was interested to find that what had really developed in these schools was a community of leadership and professional development activities that had been adapted to the context of the school. During the study, emerging themes were of the importance of collegial support, the creative organization of resources by the schools, and teachers’ perceptions about the integration of technology in the schools. I will discuss each theme and how it presented itself in each school.

School A

School A is a small urban school with 315 students in grades Pre-K through 5. The student body is 84% African-American and 16% White. There is one class of Pre-K, two classes each of K through 3rd grades, one 4th grade, one 4th/5th combination grade, and one 5th grade. This school is designated a Magnet School for Computer Science and Technology. There are 12 classroom teachers; 8 special teachers including special ed. self-contained, special ed. resource, speech, reading, music, French, physical ed., and instructional support; a librarian, technology coordinator, counselor, parent liaison, and three aides.

This school is the oldest elementary school still in use in the city. Built in 1922, it seems as the magnet brochure states, “Built in the past;
plugged into the future." It is a proud, two story brick building with freshly painted trim, sitting on top of a hill, looking down on all of the commercial properties to the front and sides. To the back is the large playground with green grass and shining new play equipment. Inside, the pride shines through with gleaming floors and freshly painted interior dappled with rooms brightly decorated. In the upstairs hall is a bulletin board on which is posted the smiling face of the "Computer Student of the Week" based on (1) how much the student has learned, and (2) how well the student cooperates.

There are approximately 100 computers in this school with an enrollment of 250 students, a very high ratio of computers to students. There are two computer labs, one which they call the "big lab" and one called "the small lab". The big lab has 17 computers, 5 printers, and two TV monitor set-ups for presentation purposes located on shelves on one wall. This lab is very spacious and comfortable. The high ceilings give the feeling of even more space. The walls are a restful gray, the carpet is maroon, and the brand new rolling chairs make seating children so quick and silent. There are labeled boxes for keeping samples of children's work and examples of their computer-generated work on the bulletin boards. The small lab, in a smaller room, has 14 computers. Regular classes are scheduled into the labs at least twice a week for instruction by the technology specialist and an aide. The classes are accompanied by the classroom teacher. The small lab has flexible time when a teacher may sign up to bring her class in for extra time.
The library has 5 computers, 3 older ones that contain the card catalog available for the students to find books, and 2 new ones with encyclopedias and other reference materials on them that the students can use when in the library. The librarian keeps the software (mostly on CD now) which the teachers can check out for use in their classrooms. Each classroom has at least 3 computers while some have 4 or 5 and all have an internet connection.

**Community of Leadership**

Leadership for this technology infusion model had once been firmly in the hands of the previous principal who retired because of health problems. She had led the way with technology, securing the collection of Eduquest (IBM) computer programs for the school in years past and working hard to get the Technology Magnet designation for the school and the personnel needed. With the new magnet program only in place since September of '97, she retired in November of that year. The new principal, while not as strongly pro-technology as the recently retired principal, supports the technology program and the learning environment it creates. The new principal, along with the technology coordinator and the librarian, both already in place, seem to now share the leadership of this program. These leaders were able to bring school system officials, community leaders, business partners, and other interested persons including this researcher to community breakfasts where they spoke of the school's goals and accomplishments and teachers presented technology projects that they were developing in their classrooms.
Since this was one of only two schools encountered in this research which had technology personnel and this the only technology coordinator while the other was a technology facilitator and lab manager, it is interesting to note how this position came about in this public school. This particular teacher was teaching in the gifted program in the parish. In her capacity as gifted teacher, she had developed the computer lab in her school and when four schools went together to successfully obtain a state sponsored grant for computers, she became the computer coordinator for the program in the four schools. When the desegregation plan forced the gifted program out of her school to another site, she learned that one of the four schools under the grant was to become a technology magnet school. Since this school was not able to hire a technology coordinator at this point, she was hired as a Y-factor reading teacher. Inner city schools in this parish are allowed four Y-factor teachers to give the regular classroom teachers extra instructional support. Y-factor personnel may include an extra classroom teacher to help reduce the teacher-pupil ratio, a teacher for instructional support (TIS), a reading teacher, or a math teacher.

In this position she taught reading for half of the day and then spent the afternoons planning and organizing the technology labs which would be the hub of the technology magnet program starting the following year (the year of this interview). The following year she became the full time technology coordinator, a position funded by the magnet school budget. She emphasizes that this is "soft" money and could be discontinued at any time. She now has a lab instructor to assist
her in supervising and teaching in the technology labs, freeing her to work with the teachers in integrating technology into the school curriculum. This particular leader has an excellent foundation for this work; her background is in curriculum and instruction so she is first a curriculum specialist and second a technology specialist. She believes that technology has really helped her teachers.

I think computers have truly sparked the motivation in teachers that — the morale is very poor in this parish. Teachers are unthanked, underpaid, overworked, under appreciated, and it's like this has given them an ownership and this has given them a boost. The other thing I keep hearing over and over again is the walls have finally broken down. We're not allowed the telephone, but now can email, and go on the internet and find things. I sense a renewal, I really, truly do.

The librarian is another important part of the leadership team. She is a true media specialist whom the technology coordinator considers to be more technically knowledgeable than she. She is an excellent resource for the teachers, advising them on the selection of software and giving assistance in using it. She keeps most of the software in the library where it can be checked out by the teachers. Even though the software is installed on the teachers' computers, a CD ROM disk is still required to run most of the programs at individual computer stations.

**Professional Development**

The technology coordinator and the librarian provide for the professional development of the teachers in technology. They wanted professional development to be ongoing instead of two-day training or two-week training. The plan that they came up with has been very
successful. To begin with, the summer before the school became a magnet the teachers were given a three-day workshop at another school which had the same kind of computers which they were getting. They donated their summer time to attend this workshop and when it was over they were each allowed to take home one of the newly arrived computers still in the box along with a printer to set up at home to use all summer. With these they took five software programs they were to use in their classrooms in the fall and a list of basic computer skills they were to master.

The one thing that teachers complain about most when asked about problems in implementing computers is the fact that they don't have the time to learn because they are so busy. This was the perfect solution, taking the computers home for the summer! They finally had time and the opportunity to learn. There were three volunteer "doctors" on call who would give help over the phone or even make "house calls" when it was needed. The teachers talked to each other and the "doctors" about their troubles and triumphs, receiving encouragement and support from their peers and leaders.

In August the school paid an Apple Computer consultant to conduct a three-day workshop for the teachers. This turned out to be a big mistake for the workshop was way over the heads of the teachers and they derived little from the expensive instruction. Unless a careful assessment of each teacher's level of use and needs are made, the instruction does not accomplish its purpose.

The teacher was wonderful, but I'm going to say, right off the bat, it completely bombed. It was not the teacher; what it
was, we went too fast, too soon. The teachers were just getting used to the computers and then all of a sudden to have them do a slide show and all that, it was like, forget it! I wish the teacher had lowered the level, but there were a few teachers who had been to other workshops that were happy. It was two thousand dollars totally wasted, but that's how you learn. My best advice to others is to take it slow, one tiny bite at a time, because now the teachers are completely ready for that. She even brought out the digital camera. They would say, "I don't want to touch that." Now they are saying "Teach me." We've taught them how to use a digital camera a little bit. So, I cannot emphasize enough taking it slow.

Another form of professional development begins in the School Improvement Plan and develops in the school's computer labs. In the School Improvement Plan it is written that every teacher will learn to use two software programs every nine weeks and plans for using these will be written in the teacher's lesson plans along with one internet lesson and one cable television lesson. Each teacher signs an accountability agreement stating that each nine weeks period she will learn to use two software programs, teach one lesson using the internet and one lesson using cable TV. Each teacher is required to attend her class' sessions in the computer lab to learn the software program while the students are learning to use it.

It's wonderful because I can bring my class into the computer lab and our coordinator will say, "Okay, here are these programs; why don't you sit down and try them on your own?" - which helps me so much because that gives me the time to sit down and go through a program so that I can help my kids. And it gives me time to get more exposure to different programs, which, on my own, I would love to sit down and spend hours doing it but, I just don't have the time. So that gives me the time, which is wonderful because we all need that.
The classroom teacher must learn how to integrate these software programs, internet sites, and cable programs into the curriculum for her grade and show this knowledge in her lesson plans. The technology coordinator provides support and resources for the classroom teacher as she is doing this. Many of the teachers learn more than the required two and are eager to share this knowledge with others. Several of the teachers have presented at mini-conferences, sharing with other teachers the technology activities that they have planned and carried out in their classrooms. The preparations necessary to teach others at these conferences helps the presenter to learn, also.

I was a presenter at a technology conference in town a few weeks ago. It (her presentation) was called "Small Kids, Big Results" and, basically, was about how to use computers with younger children and I think I went through one or two programs real quick just to give some other teachers some ideas of what to do. For me to present, I had to really stop and think about all of the things that we've done and go through my files and say, "Okay, what exactly did we do?" It is something that I just take for granted and don't even think of anymore; I don't think of computer as separate. It's like when I teach I don't necessarily think of reading separate from writing. It's all sort of together and that's how I'm thinking of computers, and I had to really stop and think, "How do I separate that out so I can show people how you put it all in there?" So, that was good for me to do. That was good.

The librarian also helps provide support and resources for the classroom teacher. The librarian explained that when a teacher wants her class to research for a unit they are studying, the librarian accompanies the class to the computer lab where there is a license for 25 encyclopedias and other references. There they do their research with the
help of the teacher, technology coordinator, technology lab aide, and librarian.

The teachers also receive instruction in technology use from the school system in which they teach. The school system has a new multimedia lab in their media center for instructing teachers in the use of technology. A listing of courses is sent out at the beginning of school in the fall, and in January. The courses usually consist of two, three-hour sessions. Teachers may select courses they would like to take each semester and usually are accepted for only one course each semester. Teachers are paid a stipend of $15 an hour for attending these courses. The demand for these courses is great, but there is also criticism of the level being taught and the lack of time to practice. Although there are prerequisite courses required it is still difficult to satisfy everyone's needs with such a large group of teachers participating. Some teachers feel the level addressed is too easy and others feel it is too difficult.

Questioned as to whether the system-provided professional development in technology was sufficient, a teacher who has been using computers in the Title One program for over five years gave the following response.

Yes and no, everybody is on a different level and that's where the problem comes. There are a lot of things that are being offered that I have no interest in going to. Because I already know it and if I didn't know it, I went and taught myself. Consequently, I go out of state to conferences to learn more. There are other people who are on that beginning level who need somebody to come in and sit down with them. I guess, really, what the teachers need is free time to explore. And, if they had the free time to explore, they would go in and they would do it. A lot of them would
do it without even stipends, so I think that's one of the keys right there.

Another teacher expressed similar thoughts.

The best way (to give technology instruction) would be just to say, "Here it is. Let me show you and you work through it yourself," because the best thing with computers is working through it yourself. I can read the book and somebody can stand up there and tell me, and I'm still going, "Duh," you know. If you break it up into segments and say, "Now, this is what you do. Work through it and when you get that down, then we'll go on," like that. You really have to do that; somebody can't tell you.

One very popular course offered by the parish school system was an internet course that upon completion awarded the teacher free internet service at home. The local public television station also offered an internet course that provided free internet service upon completion. Several of the teachers at this school attained their Internet Service Provider (ISP) from taking these courses. While the school system still provides internet courses, this policy of providing an ISP is no longer in effect, but the school system informs teachers about free internet service available on the internet at the altavista.com site. Technology courses are also available for teachers at the Louisiana Resource Center for Educators, a project of Friends of Environmental Education. To teachers or school systems who are members of the center, these courses are available for a reduced fee. The system to which School A belongs is a member so teachers also have this option. Therefore, the teachers in this school are fortunate. If they want to learn computer basics or software that will be used in the classroom by the students, they can learn this in
the school's computer labs or from the librarian. If they are interested in learning to use software programs not taught in the lab, or learn how to integrate technology into the curriculum, they can take courses with the school system, or the Louisiana Resource Center for Educators.

Technology Integration

The technology coordinator is careful to see that what she teaches in the computer lab fits in with the instructional plans of the teacher. She checks with each teacher weekly to find out what the teacher would like the students to cover in the lab. If they are working on fractions in the classroom, the coordinator uses software which contains problems and practice on fractions. If they are working on a writing assignment, the students use the word processor to write their stories, or complete a step in the writing process. The students make slides to accompany a unit they are studying or conduct research in electronic encyclopedias or on the internet. In this way computer usage is integrated smoothly into the curriculum and not taught as a separate subject on how to use technology as happens in some computer labs.

In visiting the classrooms of School A where some of the teachers are just learning to grapple with this "new" form of instruction since this is the first year the technology magnet is in place, instances of thoughtful integration with the lesson were found. One such instance was a visit to the Blarney Stone on the internet for a lesson on St. Patrick's Day in a fifth grade. The children were fascinated as they watched people lean over backwards over the edge of the cliff to kiss the stone. They then tried to recreate the scene. In another classroom the students of one reading
group were drawing pictures with a paint program illustrating parts of the story they had read in their basal reader.

First grade students discussing the food groups with their teacher looked up pizza on the internet and discovered a site which described the making of a pizza and also contained a delightful activity in which the students could add different food as topping for a pizza. The teacher capitalized on this by discussing what food groups they were adding or taking off of the pizza. Questioned about her use of computers in her classroom, she replied,

"Well, I always thought that they (computers) would be good, but I was just leery as to how easy it was going to actually be to incorporate it (technology use) and for me to learn it, because anything new you’re kind of standoffish about. But now, I wouldn’t trade it for anything; I love it!"

Also encountered were instances of games or drill and practice in use, and internet searches on topics about which the students had questions. In some classrooms the computers were covered or turned on, but idle. One teacher had trouble managing student computer use in one group while directing other activities in another group. The help given to the students using computers constantly interfered with the work of the teacher-directed group.

The technology coordinator emphasized the fact that each teacher seemed to favor a certain way of using technology even though she had learned two programs every nine weeks. One teacher favors using drill and practice programs in math and language; another uses the computers mainly for writing since she is heavily involved in Writer’s Workshop; one teacher’s class is constantly on the internet researching
every topic they encounter in their lessons. This teacher told me about a unit she had done built around sites on the internet.

It is called, "Let Your Fingers Do the Walking Through the USA." We did like a virtual reality tour. We were studying symbols of America, and we studied the Liberty Bell so we went to Pennsylvania. And we were studying the White House so we went to Washington, DC and there were tours. We were studying the Statue of Liberty, so we went to New York and there is a tour of the Statue of Liberty. The kids loved the unit.

In the small lab an observation of the Pre-K teacher who takes every opportunity to bring her class to the lab during flexible scheduling time, in addition to her class’ regular time, proved very interesting. She was in the lab with her class and Pre-K aide working with an electronic paint program. She managed the lesson very well, moving around providing help and interesting comments about their work. The kids were engrossed with drawing pictures and coloring them. The topic of the pictures was "A Snowy Day"; the students had great fun putting snowflakes all over their pictures. They were doing a lot of talking among themselves about what they were doing and how they were doing it. I discussed this with the teacher and she said, "A lot of language is going on right now!" This is very important because it is one of the main objectives of this developmental class which prepares students for kindergarten. She encourages them to talk about their work which she believes helps them to see cause-effect relationships. "They don't always produce what they want and have to rethink and try again." She also thinks work with this and similar programs helps to improve their hand-eye coordination. Later during the day she sought me out in the
lunchroom to continue the conversation. When asked why she thought the children enjoyed the computer use so much, she replied, "Power, it gives these kids a lot of power."

All of the teachers interviewed believe that technology use improves student learning. One teacher when questioned about the effect on learning replied,

I think it improves learning because when they get on them (computers), they are enthralled. You could put the most boring topic on there that you could not teach any other way and they would love it just because it's hands-on, it's pictures, they can see it, they can touch it, and it really makes learning much, much easier for them, because it's just different.

A teacher whose students were using a word processor contends that it is much easier for the students to learn writing conventions after using the computer. Having to put a space between each word on the word processor helped to remind them to leave a space between words when writing on paper.

As soon as they start writing their sentences, I've seen, it helps them with their spacing and first grade has a hard time with those spacings, you know. But the practicing the dragging and the click (with the mouse) helps them with their fine motor skills. Last year I had this little girl, precious, and she, bless her heart, was having trouble. We had her tested and everything and she couldn't connect from here to... (gestures from head to hand); she couldn't write. I mean that it was just so hard for her to hold that pencil and to manipulate that pencil. But you put her on the computer and it was like the equalizer. She was so impressed that she could write a sentence on the computer and that meant so much. There's no question that all of the kids are writing more. If I would have asked them to write a letter to their mother, it would have been just a scrawl. Now it's sentence
after sentence, after sentence. And editing, of course, is no problem.

A teacher described using the computer in her unit on Louisiana.

There's flex time in the mornings in the computer lab from nine to ten. So, different classes can sign up because it's free time, so we did. We went to the internet and looked at the symbols of Louisiana. There was a picture of the governor, the lieutenant governor, products of Louisiana, and all kinds of neat things related to the state. Then we (she and the lab assistant) had the kids write a little story about Louisiana using KidPix (a paint/write program) and they had to use the mouse to draw their own picture rather than use the stamps (ready made pictures) from the program. They really turned out cute, so, that was a real neat integration thing.

I also saw paint/write programs and drill & practice programs in reading and math in use in classroom centers. Since it was close to standardized test time, drill and practice programs seemed very popular. The librarian showed me a variety of software available for check-out by teachers including electronic books and a problem-solving collection.

This school is making solid progress after only 7 months as a technology magnet and as evidenced is doing many things to encourage and assist teachers in integrating technology into the curriculum.

School B

School B is a suburban school with a student body of 600. The student body is 92% Caucasian, 5% black, 2% Asian, and less than 1% Hispanic. There are four classes for each grade, K-5. The school has the French Immersion Program for students who wish it. In this program, a student has his morning classes in English and his afternoon classes in French (or vice versa). No English is spoken during the French portion.
This sprawling, one-story school with the original building surrounding a central courtyard, has newer sections jutting out from the corners. Though the older section classrooms are not as roomy or bright as the new, and often contain less than adequate wiring for all the technology in use, all of the classrooms are bright with examples of student work, often computer-generated. There are no computer labs in this school, but there are at least 3 computers in each classroom, in some, 4 or 5; in every classroom there is a hook-up to a central TV monitor for the teacher’s use for instruction. In the library, equipment such as digital cameras, QuickTake cameras, video cameras, and scanners can be checked out for use in the classroom. The Audio-Visual room, located in the library is a room where teachers can bring their classes to use any of this equipment including also a video visualizer, laser disk player, cassette recorder, TV with 2 VCRs, overhead projector, or scanner. The school is piloting a cellular phone project which puts cellular phones in the hands of every classroom teacher. Parents, community members, school officials, or other teachers may call a teacher and leave voice mail. Later when she has free time the teacher can use the cell phone to return these calls.

Community of Leadership

Leadership for this model rests solidly on the shoulders of the principal who is a knowledgeable and capable technology user and who encourages and supports her teachers in using technology by every manner possible. She often is a presenter at technology conferences and encourages her teachers to do so; she sometimes presents with a group of

90
her teachers. This is the second school in the parish system that she has established as a leading technology model. She has a conviction that her teachers can do whatever they are determined to do and she imparts this philosophy to them so they are willing to try new types of hardware, software, and ways of integrating technology into the school's curriculum. The students are also encouraged to develop leadership skills. Pairs of older students are assigned to younger students' classrooms to mentor them on use of software and to help them complete learning activities. The motto of this school might be, "You can do it; I will help you." There is a group of about four teachers who are experienced, accomplished technology users who are leaders with the principal. These teacher leaders are dedicated to helping the other teachers learn about technology and to accomplish this goal, give freely of their time. This group epitomizes the "community of leadership".

**Professional Development**

Though there is no technology specialist, the principal and the teacher leaders are available to help the other teachers with technical and resource assistance. This was witnessed by the researcher when a technology leader immediately came in when called to assist a less experienced teacher with a technical problem during an observation. Professional development for the teachers in technology use comes in the form of in-service presentations by these teacher leaders and in-services provided by the parish, which are numerous. It also comes in the form of learning by teaching because when a teacher learns something, then she is asked to teach others on the faculty and to present at conferences.
One group of in-service presentations took place on a teacher work day when students were not present and teachers were working in their classrooms. Each of the four leaders held workshops in her room all day and teachers who wanted to learn about a particular topic could come in to learn. One leader taught integrating a word processor into the curriculum in the morning and a multimedia presentation program in the afternoon. Another leader taught two sessions on use of the video visualizer and the scanner and one session on a grade book program. After a one hour presentation about the software or hardware, the teachers were allowed hands-on time on the computers or other equipment. The other two leaders also had two topics for the day. The principal made available door prizes, and the grand prize was a scanner. This added greatly to the excitement of the day. One person from every grade level won a door prize. The best part of it was that they were learning about things available there in the school and they could get their hands on it for the next day to use. As one teacher remarked during the inservice, "Don't give me the big picture, just tell me what I can go and do tomorrow."

The inservice received a great response from the teachers, so much so that the leaders are planning to have technology learning sessions every Tuesday afternoon the following year. Teachers may be freed to attend by teacher's aids or auxiliary personnel. These sessions took place in the leaders' classrooms so there were not that many computers available for hands on activities. The school is planning to establish a lab, not for the children's use because they believe that should be
integrated into classroom work, but for the teachers instruction in technology. This lab will also be used to provide technology in-service to the teachers of other schools. The school has also been selected to hold the children’s technology camp for the school system during the coming summer and the expectation is that the new lab will be ready for that.

Besides these planned sessions the leaders participate in informal professional development sessions. When asked about informal help, one of the leaders explained how this worked.

It's probably the most rewarding. We actually take time after school. As designated technology leaders of the Challenge Grant/Learn Grant we spend four out of the five afternoons after school with another teacher, working on a project or trouble-shooting a computer, scanner, printer, or other and showing them new ways to get technology integrated into their curriculum. It generally lasts about an hour. What I do is hang a clipboard on my door on days that I know that I'm going to be here after school and they come and sign up and write "I need you at X time on X day for about an hour," and they like that. They like having that option. Sometimes if I have taught someone else how to do this, they will go and help this teacher while I help someone else. Sometimes a teacher will come in my room during class and ask me to show her how to do something when I have time and one of my students will raise a hand and say "I can do that," and she will. So our students are part of the support base.

This teacher is a fifth grade teacher and she mainly helps 3rd, 4th, and 5th grade teachers. Another teacher leader who is a fourth grade teacher helps K, 1 & 2; and the art teacher helps all the specialties.

Our technology committee is at our disposal at all times. There's always at least one that you can get hold of, that can come and help out if you have a problem, and they make themselves very available to us. Quite a few of them have a Masters in Educational Technology so that works out really nice for us.
Another teacher spoke about their plans for the future:

Through helping each other we are building a staff that is well versed (in technology use) and the whole point of this is to not only make our school better but to make our school more accessible to teachers outside of this school in the parish area. Eventually we would like to spread it out to where we are in-servicing people throughout the state, so that they can come during the summer, during weekends, or during the Christmas holidays to learn about using technology in the classroom.

Not only the leaders participate in sharing their knowledge. The teachers here believe that assistance and sharing of information is much more meaningful when it comes from someone with whom you work.

Information and assistance is better received if it comes from someone you're teaching with. In first grade, we have a teacher, who is still willing after so many years of experience to go learn about the computer and is willing to share knowledge with her colleagues, which we find very refreshing.

The librarian was on sabbatical this year so an interview with her was not possible, but the teachers spoke of her as an important source of assistance for them.

Our librarian, who is on leave, is an excellent source of information and help. She is working with the Louisiana Challenge Grant (a state technology program), and I can't wait to get her back next year, because she has learned even more. She is going to teach us next year and we are going to concentrate on making web pages.

The school system in which this school resides, is one of the technology pioneers in the state and has long offered technology courses to its teachers. One of the sessions that these teachers attended is the "Apple for the Teacher" instruction presented by Apple Computer
Company to teach the teachers how to use the Apple computers and the software that accompanies each computer. Also included are some trouble-shooting tips. Another in-service provided by the school system is called "The Plug"; it involves teaching the teachers how to integrate technology into their lessons. The classes are taught by classroom teachers who explain how to use the program and tell how they have used it in their classrooms. All of the teachers in the parish speak very highly of this program because it is very basic and one does not have to be very advanced in the use of technology to profit from the lessons on integration. A teacher attends sessions on her grade level. Accompanying these sessions is a notebook full of curriculum-based activities for the teacher which she can use in her classroom to integrate technology into the curriculum.

These teachers have received well-rounded, balanced professional development that seems to have met their needs on each level of their development as technology users. Beginning with the basic Apple instruction on how to operate the computers, through the instruction on basic integration of technology into the curriculum provided by the Plug to the individualized instruction for hardware and software specifically available at the school provided by peer teachers, these teachers have had a beneficial mix of professional development activities.

Technology Integration

Technology integration into the curriculum is significant at this school. The lessons observed by the researcher had technology components which blended with and complemented other instructional
strategies to provide a well-designed lesson. All of these components were included in the teachers' lesson plans. Observed in use were hyperstacks about pandas made by third grade students; a teacher-made hyperstack about author Marc Brown to introduce one of his Arthur stories; a tiny book dictated and illustrated by first graders, then printed, bound and read aloud by them page by page; and a number recognition lesson in kindergarten presented by a software Count Dracula and the teacher together (she even talked to him). He would say after a while if no answer was put in, "Don't you know the answer? What is the answer?" and she would say, "We're trying, Count, we're working on it." Also observed were: a French immersion class writing a story together in French using a word processor; a second grade science lesson using the weather forecast on the internet; a hyperstack presented by fifth grade students reviewing for a test on their space unit; and a fifth grade lesson on biomes introduced with a teacher-made hyperstack on this topic.

A kindergarten teacher sat in a chair with the mousepad and mouse on a book in her lap and the computer on a low shelf next to her. The children sat in a circle on the floor facing her and the screen. First she reviewed the concept of "fair shares" (division) she had introduced the previous day. She then displayed on the screen the pizzas the kids had made yesterday using the software, ClarisWorks for Kids then adding their choice of toppings and dividing into "fair shares" for a number of students. Today she put two dogs on the screen using the same software and asked the children to come up and divide a pile of bacon strips among the dogs to give them fair shares. The children were
very attentive and also eager to come forward to use the mouse to grab bacon strips and distribute them equally to the dogs.

A second grade teacher began her lesson by accessing a web site on the internet called the Friendship Page. On this site children's poems were published. She read some of the poems to the children and some of the children read poems orally from the site. They then did pre-writing brainstorming of ideas that they could possibly use to write their poems. The children asked for words that they might need to be written on the board. Each child then began to write a first draft of a poem they would like to submit to the Friendship Page. This lesson would continue for several days. The children seemed very excited about the possibility of having their poem published on the web site. This gave them an authentic reason for writing; not only would they give pleasure to their classmates who read their poems but also to children throughout the country. Children are much more inclined to work hard on something for which they see an authentic purpose rather than just an assignment to finish. Publishing a classroom book, reading to a younger class, cheering up someone in the hospital with cards and letters, or publishing on the internet are just some of the many good reasons for writing stories and poems.

Teachers here are convinced that technology use improves student learning.

It (technology use) adds an element of real world, "I'm doing this for a purpose." It's not, "I'm going to make this cute little book report," which has it's place, I mean, it has it's place in the scene of teaching but their dad doesn't go to work and make a cute little book report, but dad does go to
work and he might graph his information or he might make a presentation. Well, (when using technology) they're doing something that relates to the world as they see it, and it gives some importance to their world.

A third grade had read a story in their basal readers about Nadia Comaneci that day. Their purpose was to learn to paraphrase information and write a paragraph about Comaneci in their own words. On the computer connected to the TV and the internet the teacher put in the URL for a site which she had already discovered. The students read the information aloud. They discussed ways they could paraphrase the information for their paragraphs. They took turns giving some of the information in their own words. The teacher listed words they requested on the board. The students began to write their paragraphs. This was recent information on Comaneci that they probably could have only gotten from a sports magazine if they happened to locate one. This timely information helps the students to better understand the basal story and adds to the interest in the story. Technology minded teachers usually check each topic covered in their readers to find if additional information can be found on the topic on the internet. One teacher told of using Scholastic's site to find out about the myths her students were reading.

Besides providing authentic activities for students, technology provides motivation and very current sources of information.

I don't think the level of learning that happens in this classroom could be achieved if you took these tools (technology) away from me. It would be so much harder to bring up the interest level of the children - the days of dittos
are gone because these children see Gameboys and Nintendos and Segas and they are visual.

When questioned as to whether authenticity and motivation were the most important aspects of technology contributing to student learning, she replied that those two aspects along with a third, currency of material, were the most important.

As an example, she cited an incident that took place in her husband’s ninth grade geography class.

They bought all brand new atlases. Well, that was when the whole world changed, you know. Europe broke apart and then he gets his atlases in and they’re outdated. They just arrived in his classroom and were already out of date! That doesn’t happen in here when I have the Internet - I can get what happened today. So it opens so many doors for the children that just would not be there without it and I really think we are cheating children when we do not give them access to the world around them.

Some teachers were more reticent about technology use in the classroom.

"It shouldn’t be used as an end in itself. It can be a good tool but you shouldn’t throw away everything else. Technology must be considered but not at the expense of more appropriate resources."

One teacher told of getting her ideas to integrate technology from in-services she had attended. The teachers think that the parish system’s in-services have also helped them greatly.

I went to a PLUG workshop where a classroom teacher taught us to use technology activities that she had used in her room. So I just came back to my room and tried doing some of the same things and the ideas were very good for my class. I also went to a school system in-service that taught us how to use ClarisWorks (word processor software), how to incorporate it into our lessons, and that was very beneficial. Now, whenever we have stories to write, I might
pick two or three kids to go to the computer and they write their stories using ClarisWorks and I can put each of their stories up on the TV screen and we together check for misspelled words and sentence structure and make corrections. It is very exciting. The children really enjoy this and I think it has improved their writing skills a lot.

One teacher is currently writing a grant to get a laptop computer because she wants to take the children to the grocery store to do comparison shopping and use the laptop to record the data.

One of our reading clusters is called "Decisions, Decisions", where they have to learn to make good decisions. Comparison shopping at the grocery teaches them how to not just listen to the commercials and buy that but to read the label, find out how much it is per ounce, determine what's the better buy, to slow down and make good decisions.

Then we could also use the laptop when we're studying electricity in science and take a trip to Entergy. We could walk with the meter reader. This was the last month's reading and here is this month's reading, how many kilowatt hours did they use? Any way that's why I'm working on the grant. I'll never be satisfied. My principal says, "You got a new one (computer) this year, but you still keep nagging me." I said, "Well, the squeaky wheel gets the grease." And I'm never going to be satisfied until this room is lined with computers.

Often there are several forms of technology in use. In the fourth grade of one of the technology leaders, a student teacher teaching a lesson on decimals was using the overhead projector, the chalkboard, and the computer to show what she was teaching in different ways and the students were using hundred block papers with markers to figure their answers. The kindergarten teacher used a small hand-held chalkboard to make explanations as she was using the computer. Many of the slides in computer projects of the students contained pictures taken with
the video camera. The teacher using the web site with Comaneci printed the page and then made a transparency of it to use in future lessons. A boy in third grade showed how his group had scanned pictures of pandas to put in their hyperstack. Fourth graders showed how they had taken pictures of each other with the digital camera to put in Kid Pix slide shows about themselves. Some of the second and third grade teachers are making classroom videos of events that take place during the year in their class. "And the kids will leave at the end of the year with a video tape showing how the year has gone, field trips, all of the events, even some daily activities that the children have done in the classrooms, so it's kind of like a video yearbook." This use of multiple technologies was evident throughout the school.

A teacher expressed her belief that parents are much more receptive and proud of student projects done with technology and this parental approval spurs the children to new heights of interest and determination.

We found that their (computer) projects were better received by parents than the traditional paper and pencil reports that nobody really wanted to read. These projects were colorful; they had information and the students' own voices; they were interactive in that you could hook on to other sites and directly connect to the Internet, which was a wonderful opportunity for the parents to see that the kids could generate their own projects and that they were capable of doing so.

The software collection at the school is extensive including programs for word processing; electronic paint and draw programs; programs with spreadsheet and database capabilities; programs to
develop thinking skills; to provide drill and practice on skills; electronic books and student authored books; and programs to develop multimedia projects. In addition, the school subscribes to the Scholastic Network online and has an internet connection in every classroom. A goal toward which this school is striving is to have every teacher using technology extensively.

School C

School C is a rural school with a student body of 525. This school population is 97% White and 3% Black. There are also two Asians, one American Indian, and two children of Hispanic origin. The building is a modern, airy two-story one built around a courtyard which can be seen from both stories. The courtyard has a pond, tropical plantings, stone tables and benches and even a green alligator statue, donated by the school bus drivers. There are three classes of each grade, kindergarten through fifth grade. This school has a Spanish Immersion Program. There are 4 computer labs in this school. There are 30 computers in the Jostens ILS Lab, 12 in the Writing to Read Lab, 26 in the Tapestry Lab, 17 in the Computer Art Lab, 31 located in classrooms, 6 in the library, and 3 located in the office. Beginning in kindergarten, students are introduced to the Writing to Read program in what they have named the Writing to Read Lab. This program is a computer-based instructional system designed to develop the writing and reading skills of the students. The program continues through the first half of first grade and is designed to enhance learning in language arts. In this lab students also receive
instruction and drill in math through interesting and motivating math software.

The first and second grade students participate in the Tapestry program in the Tapestry Lab. Tapestry is an early learning childhood program. The students receive language arts and math instruction with practice in this lab which they attend every day for thirty minutes. The language software provides opportunities for language development as the children listen to stories, play out the action with animated characters and write by typing letters on the keyboard. There is also a carefully sequenced literature collection on the software. The math software includes twenty programs sequenced by difficulty level that teach basic mathematical concepts.

Grades three through five use the Jostens Integrated Learning System in the Jostens Lab for the enrichment of language arts and math instruction. This system was obtained with money received from an 8G grant. There are 30 student stations in the Jostens Lab. Each station contains only a monitor, keyboard, mouse, diskette drive, and a headphone. The student stations are connected to the master station by network cable. The master station sends all of the information to the student stations. Each lesson follows a sequential plan. The student is taken through introduction, evaluation, instruction, practice, and mastery. Each lesson builds on what the student has done before and will be doing in the future. This feature, the company assures, provides individualized instruction. The program provides tests before and after units of material.
The multimedia art lab directed by the art teacher facilitates the teaching of traditional art concepts and philosophies in a nontraditional manner that encourages risk-taking and experimentation with visual elements and images. Each class attends art instruction in the art lab once a week. Here there are 17 computers, 3 printers, a scanner, a digital camera, 16 quick cams, a video cassette recorder, a laser disc player, a color television, and a camcorder. Here the students create projects related to their school work on electronic paint and multimedia programs. These projects often involve using much of the other hardware available in the lab, depending on the level of the child.

The internet can be accessed only in the library at this time through a program provided for schools by LDS and I-America. In the planning stage is internet access in a lab and then eventually the classrooms. It is unusual that a school with so much hardware available would have so little internet access but the nature of the structured programs provided on the hardware explains this situation. All efforts were originally directed toward these integrated learning systems. There still is quite a bit of effort directed toward them; they are in the process of writing a grant to obtain an updated version of the software for the Jostens Integrated Learning System. Also notable was the fact that teachers do not have systems to present their computer programs or projects on a monitor or television screen for student instruction. As a result, the one or two computers in the rooms are used mainly as drill and practice or for writing with each student having an opportunity to use it at his special time for 30 minutes once a week.
The school has a closed-circuit television station where a morning television program is written, filmed, and presented by the fourth and fifth grade students. It is used for announcements, menus, weather forecasting, trivia-type questions, the pledge to the flag, Spanish words presented by Spanish Immersion classes, chess moves presented by the Chess Club, and special events in which the school or classes are involved. The students use video equipment, sound equipment, the Xap Shot computerized camera, Scanman software, computers for graphic presentations, communication skills, and research skills to produce the news program. After it is filmed the show is broadcast from the library to the classrooms on closed circuit television. The upper elementary classes take turns producing the news show for a week at a time. This is something that only a few schools have, a wonderful opportunity for students, and an authentic way to teach language arts skills.

Community of Leadership

The principal of this school provides strong leadership through a firm belief that students must be prepared to meet the technological advances and challenges of the future. He believes that the learning environment should be very structured and the way that the technology model is set up reflects that striving for structure. Each teacher brings her class to the scheduled lab and remains to give assistance to those who need it. There is also a lab technician to give assistance to the students who move through the materials at their own pace. A teacher told us that although the material covered might not coincide with what was
being taught in class that day, it would eventually be taught or had already been taught in class and would be practice.

Though the principal does not share his authority, he does share some of the leadership role where technology is concerned, to two knowledgeable faculty members. One of these faculty members is the art teacher. She has a boundless enthusiasm for computer technology which is second only to her love of art. This is where the creativity blossoms in the school. She has filled the walls of her art lab and the halls of the school with beautiful computer graphics and traditional art. She presently is teaching the upper elementary grades to use HyperStudio to create hypermedia stacks related to topics they are learning about in their classrooms. Her lab is the only one containing Macintosh computers - 16 Power Macs. Experience in technology use for the classroom teacher comes mainly in the labs where the students are using the integrated learning software. The teacher is busy helping students with this software so that is what she learns to use, but this cannot be carried back to her own classroom since this is not used in the classroom. While the art teacher is willing to provide instruction and help in using the programs she uses with the students in the art lab, the teachers do not stay with their students in the art lab, but use the time as a break.

The other technology leader is the librarian. Both she and the art teacher have attended system level classes to help them to be technology leaders in the school. Computers are available in the library with internet access so students and teachers can research topics. The
library's card catalog can be accessed from the computers, as well as the program, Accelerated Reader and electronic encyclopedias. The librarian is available to both students and teachers for help with the computers.

**Professional Development**

While the art teacher and the librarian are available to help the classroom teachers, there are no planned, systematic professional development activities devoted to technology at the school site. The art teacher has stated that she welcomes teachers coming with their classes to learn to use the software, but the teachers do not take advantage of this opportunity for informal instruction in technology use. Interviews with the teachers do not reveal much peer tutoring or collaboration among teachers in the technology area.

The teachers interviewed did indicate that they attended some in-service sessions on technology provided by the parish school system at a central location. When the teachers received their Apple computers about five years before from the parish system, they attended a three day session called "An Apple for the Teacher" which taught them how to use the computers. Now when they get a new Macintosh computer they attend three days of classes about the Mac spread out over three months. They learn how to use them and the software that comes with them. They don't receive these computers all at the same time. The school system gives each school one computer each year and it goes to a teacher, therefore some of the teachers have not yet received a Macintosh computer and have only the old Apple II GS in their classrooms. Two of
the teachers had attended the school system class called The Plug which teaches about integrating technology into the curriculum and one had attended a class on the use of the word processing software, Claris Works.

When questioned about the lack of training taking place in the school itself, one teacher replied,

That's what we're working on right now. I don't know a lot about it. I just heard little bits and pieces about things they're planning. They're going to teach the teachers that are interested, more about the computer. We had to write down two or three goals (in technology) that we wanted to reach for next year, and that's what they are going to try and teach us. Possibly get together. No, there's no definite plan. But I would think, get together and then, do some basics and see where you are and if you're more advanced, then you can learn on your own.

**Technology Integration**

Since there is a heavy reliance on courseware systems with extensive management features, more emphasis is placed on this type of computer use instead of integration into classroom lessons. Students move from their classroom to the designated labs where they engage in learning activities assigned according to their level of proficiency in the content areas of language arts and math. Software utilized includes the Jostens Learning System and the IBM Writing to Read program. Other software is available to supplement these courseware learning systems.

Teachers think that the structured Jostens Program helps student learning even though it is not integrated with the classroom activities. "The Jostens lab makes it easier for students to learn. The program does an inventory at the beginning and the students then work on their ability
level. It's an interactive program.” Another teacher replied when questioned about the Jostens Lab,

Yes, it’s not exactly what we’re doing in class, but comprehension and whatever they learn in there, it just enhances what they've learning in here or vice versa. And a lot of times, in math they learn things before I get to it and they’ll say, "I learned how to do that on the computer." And so it helps. If they don’t understand it, the computer goes back; if they miss a problem, the computer explains it to them.

Another teacher explained:

Well basically, what I’ve noticed, it’s (the Jostens Lab) a reinforcement. Or the kids will tell me, especially with math, "I’ve been doing this in computer," so it’s either an introduction to what I do in the classroom, or it’s an ending or reinforcement. They don’t get bored; they look forward to going. They are entertained and they think they are playing when they go down to the Jostens Lab. They don’t realize how much they’re learning. A major push for us next year is to write a grant to get an updated version of the Jostens software. I think it has improved the kids’ ability to think and solve problems.

Students using games, drill and practice software, and Accelerated Reader were observed in the classrooms. Since there is only one up-to-date computer in the classrooms and some of the teachers have not received that yet and may not for several years and there is no internet access in the classroom, teachers have been reluctant to use these as a part of the lesson. Also most of the teachers do not have a connection from the computer to the TV so they could introduce and teach topics in this way. Therefore they set up a time schedule and each student gets to spend about 30 minutes a week on the classroom computer. Sometimes
it is part of a center or often it is an enrichment activity to be used if all work is completed.

With as yet only one computer and no internet access, the teachers thought the most useful approach to using the computer in the classroom at the time of the interview was a designated time for each student with games and fun software that provide practice on skills.

When you have only one computer and they have to take turns, it would take you months to complete a project. I use my computers mostly for centers, reinforcement of material that's being taught in the classroom, and enrichment. We're not on line in the classroom so it limits what you can do. I use mostly MECC software obtained through the school system; there are probably about thirty different games available to us.

We previewed all of the math books for the choosing of the new math series, starting next year. And I've noticed that almost every book has a net page, or an on-line page, so those publishers are creating pages to interact with the lessons in your math books. But we're not able to do it, because we don't have it (access to internet) in our class. I have a schedule right now. I just let them play games to go along with our lesson, enhance our lesson, the math, perhaps, and science and social studies. And now that I have the Macintosh, they continue to take turns on this Apple. But everyone wants the Macintosh. And we go thirty minutes at a time and it's a little hard right now keeping up with who's turn it is. Thirty minutes at a time, and whatever they missed in class, they have to make up. I would love to see two or three computers in every classroom so we don't have to take just one time a week. We have a math workshop, an encyclopedia, Simtown, Printshop; they love making business cards. We just took a field trip. They wrote about it on paper, corrected it, and then when it's their turn on the computer they can write it on the computer using Simpletext.

We also have our KBFN broadcast here. It's a little news station that each fourth and fifth grade class take six weeks at a time. We broadcast the news and the weather
and a Spanish word of the day. So we turn that on every day to watch our news broadcast.

It is in the Art Lab that technology is integrated into the curriculum when students create projects which complement their lessons in the classroom. The art teacher utilizes Adobe Illustrator, HyperStudio, Painter, Freehand, and Video Director in the creation of these slide shows and multimedia presentations in the Art Lab.

All of the teachers believe that the art teacher is doing a wonderful job, teaching the children interesting things using exciting software and most would like to learn to use the software, but none of those interviewed accompanied their students to the art lab.

"When the kids go to the art lab, I don’t go with them. She does wonderful things, but I don’t stay in there long enough to familiarize myself with it."

Other teachers discussed the work in the art lab:

"Our art teacher has an art computer lab, so she knows pretty much anything on the computer. No, I don’t go with my students when they go to the art lab; they have art and we have a break."

"No, I don’t stay when I take the students to the art lab. That’s for the - the art teacher does that. I don’t know exactly what she does, but she does a lot of her activities on the computer and it’s amazing. I love that. I would love to learn that, myself."

Encouraged by the researcher to stay in the art lab with her students because she would learn so much, this teacher replied, "Yes, I would. I’ve been staying in my classroom everyday when a Spanish
teacher comes in and now I can speak as much Spanish as the students can. Now, next year I will start bugging the art lab everyday.”

Asked whether she thought technology use in the classroom would last, one teacher replied,

It's just such a big part of our lives that we're going to have to keep technology in this classroom and in the schools. I think it may even out, where we're not striving to get more and more, because we've saturated our schedule with it. We can't sacrifice any more of our reading instruction time, or our math instruction time to do it. But we have to get these children computer literate in order to survive, I guess. Because everything is computer or technology. That's where everything is going. And technology is a great thing, but it dates itself very quickly and it's very expensive to keep up. So, that, too, will hold us back a little.

In saying that she cannot sacrifice anymore of her reading or math instruction time to computers, this teacher is informing us that she is not integrating computer use into her lessons but making it separate. Some of the teachers in this school may feel that the time taken up by the integrated learning systems is excessive and that the students do not need to take any more time for computer work. This view shows that they consider the computer work as add-on to the teaching that goes on in the classroom. It seems that the type of computer use that is emphasized at the school lessens the emphasis given to integration of technology into classroom lessons. Teachers feel no urgency to do this because the students get so much computer work with the integrated learning systems, while at the same time the teachers experience a lack of hardware, training and collegial support found at some other schools. Perhaps when they all have more up-to-date hardware, more instruction

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School D

School D is a suburban school in a school system near a large city. There are 546 students. The student body is approximately 67% White, 29% Black, 3% Hispanic, and less than 1% Asian. The school is in a red brick building approximately 20 years old with modernistic architectural touches, all unusual angles and arches. There is a second floor to some parts of the school. It faces a busy street with its large playground in front of the building, surrounded by a chain link fence. There is almost no school property at the rear of the building. There is room only for a small circular drive; a street and houses are approximately 20 feet from the school building.

An interesting facet is that during this school year every brick in the building has been replaced and classes continued on. An inspector found structural weakness and recommended the replacement. Everyone said classes could not proceed with this renovation going on, but the principal insisted that school would continue on this site and it did, with no resulting injuries or upset. They simply moved away from the wall that was being replaced at the time (both inside and outside bricks were replaced). Few principals could have pulled this off as smoothly.

This school is committed to providing leading-edge educational technology for students in kindergarten through fifth grades. The school has a Computer Lab/Resource Center and a school-wide Local Area Network.
Network that provides for networked computer programs in all classrooms. There are 150 computers on the network; 26 of them are in the lab and 3 or 4 in every classroom. There are 8 new computers to be installed in the library, a project which was awaiting the completion of the library wall. There are internet connections in the lab, library, and in every classroom. This school also has a closed circuit television system. News is gathered, written, edited and filmed by fifth graders and is broadcast over the closed circuit school-wide channel.

Community of Leadership

Much of this is due to the drive, determination and people skills of the principal. Ten years ago when she first became principal of the school, she met with an official of one of the school's Business/Education Partners in his office. He was working with a computer when she arrived and he half jokingly said, "I've got to learn how to use this thing if I want to keep my job." It came to her that she had to prepare her students for this also and immediately asked the company to help her in this endeavor. The school's two Business/Education Partners are Shell Oil Company and Lockheed-Martin. Shell Oil Co. provided the school with its Local Area Network. Lockheed Martin provides Space Education Programs and IBM/EduQuest provides support for the integration of educational computer programs and the curriculum. Throughout the ten years following, the business partners have continued to help the school with its technology aspirations. When Shell Oil was having new wiring installed for
more sophisticated equipment, she asked for the same for the school. The company spoke to the contractors and suppliers doing their job and these contractors and suppliers provided the same wiring for the school at no cost - after first removing all of the old wiring! Now the school has 200 drops, 4 of these in each classroom; each drop can serve 4 computers.

Many of the computers were acquired by grants awarded the school through the efforts of the principal and faculty. An ongoing, innovative professional development program, Integrating Educational Technology into the Curriculum, is funded by a State Innovative Professional Development Grant from the 8G Fund (a large amount of money settled on the state by the federal government in payment for off-shore oil). Also, teachers are encouraged by the principal to attend the Louisiana Free-Net classes on use and integration of internet resources into the classroom. As a result each teacher who participates receives free internet access in their homes. The teachers are very pleased that the principal lead them in this direction. One veteran teacher remarked,

I believe technology is a necessary element. It has to be intrinsic to what you do. It's here; it's here to stay. But it's not everything; it's not the total picture. I firmly believe that. It's a tool to enhance instruction. It's a tool to motivate students. It's a tool to develop your own creativity. But it's still not everything, there are still other elements there. When we started, I was never resistant to using technology. If anything, the only thing that would have stopped me would have been fear, fear of the equipment, how does everything work, those kinds of things. I think that's true for most people here. We've been very receptive to taking the bits as we got them and using them and we just built up to a level of expertise. We visited other school sites in different parishes that are involved in Louisiana Challenge. Quite often, it's just one or two teachers that are spearheading the
movement and most people are, still......well, they have a computer in their classroom, but they use it for the kids to play on or maybe to do solitaire after school. Really, you would think it would be more widespread than it is by this time, but it’s not. So, I think our principal was very wise in getting us started with technology.

Another leader in technology implementation here is the technology facilitator. She is half-time teacher of gifted students and half-time technology facilitator, with the Louisiana Challenge Grant paying the technology half of her salary. She is also the computer lab manager and the network systems operator. A person who works in the background, this leader was responsible for getting the teachers started in this exciting new area. Originally the teachers brought their classes to the lab where the manager taught the students and the teachers observed the use of the software programs. Gradually the teachers have learned more and more from her and from other sources and they now bring their classes to the lab and conduct the lesson themselves.

There are also teachers who are technology leaders in the school. Two of these are fifth grade teachers on sabbaticals at this time. Both of them come to the school to help the other teachers with technology use and to attend their grade level sessions of Technology Tuesday. They are also taking internet training with The Greater New Orleans Freenet as well as university technology courses. These two teachers plan to continue helping others with technology when they return with their new knowledge and skills. One speaks enthusiastically about her interesting and exciting sabbatical,

This has really been a meaningful sabbatical. I've been on site (at the school) and I've learned so much. We've been in
the position to help other teachers locate things on the internet or just help them with their computers, trouble shoot with their printers and other equipment. We've been able to attend the Technology Tuesday sessions for our grade level. In addition we’ve done training in Intermediate Internet and Advanced Internet with Louisiana Freenet. I forgot to mention, I'm also taking technology graduate courses at Louisiana Tech as part of my sabbatical. Isn't that wonderful?

Professional Development

The experiences the teachers had in the technology lab with the students and the technology facilitator were invaluable. These experiences served to make the teachers feel more comfortable with computer use and to spark their interest in learning to use it in their classrooms. When the principal and the tech facilitator decided the teachers needed more in depth instruction and time to practice what they had learned, they applied for and received an 8G Fund grant to provide professional development for the teachers from an outside consultant. These classes to help the teachers learn how to integrate technology into the curriculum were dubbed, "Technology Tuesday". An excerpt from the School D Technology Plan reads as follows:

Professional Development has been a top priority with the understanding that the level of student use and student proficiency is directly related to the teachers commitment and knowledge of the instructional programs, Internet resources and global communications. "Technology Tuesday" has been the lead component of Professional Development.

On Technology Tuesday a group of teachers spends the whole day learning more about technology in the school’s computer lab. The groups are made up by grade level and substitutes are provided for the
teachers for the whole day while they work with a technology consultant. On the first Tuesday of the month the fourth and fifth grade teachers attend; on the second Tuesday, the second and third grade teachers attend; on the third Tuesday, the kindergarten and first grade teachers attend; and on the fourth Tuesday there is make-up time for teachers who missed their sessions and time to solve problems and answer questions at teachers' off periods. That means that there are six teachers in an all day session with a consultant teaching things relevant to their grade level on the same make and model computers that they have in their classrooms with the same software. If the consultant spends two hours in the morning teaching something to them, then they have the rest of the day to practice the new skills and develop lesson plans for use with their students with the support from their peers and the consultant.

One teacher who had participated in school system professional developments sessions, technology classes at a university and Technology Tuesday sessions was asked which types of classes she preferred. Her reply was,

I really like the way our Tech Tuesdays are done, because it is on site, it is relevant to what we are doing in the classrooms, and everything can be applied immediately. And what is useful in having a consistent schedule like that is that you always get a chance to practice and apply what you've learned. You know, so often you have training, spotty training, and then never have a chance to practice or apply it. It's really not useful at all to do it that way.

Another teacher expressed her ideas about the professional development sessions provided the teachers.
We go to Technology Tuesday once a month and it’s just been a great help for us, because if we did not know what we were doing, we wouldn’t be able to do it in the classroom. We have three third grade teachers and four second grade teachers, so there’s seven of us with the one consultant for the whole day. We work in groups, too, so we’re helping each other and she’s helping us.

Still another teacher remarked:

We have had one Technology Tuesday every single month and it’s been on different topics. We’ve had a session on e-mail, saving to a disk, making an HTML page, and a big session on searching the Internet including how to search, how to do Boolean searches, and so on. We’ve pretty much covered the waterfront.

And another:

The training here (Technology Tuesday) has, I think, done a lot to bring us together. We realize that this is here to stay; there’s no going around this. Who would want to anyway? Who would want to avoid this? This is wonderful, and now, it’s very infectious. We’ve all become very enthusiastic about it. We send links to each other all the time, we e-mail each other, we rejoice in our successes, and if there is something one doesn’t understand, someone else always does. Our consultant is there to answer all the hard things, but for the most part, we find that we can figure things out on our own and we can help each other in that way. So I think it has brought us closer together.

Teachers here for only a short time are happy with the opportunity to learn so much about technology. For example, a temporary teacher who was replacing one of the teachers on sabbatical said she was delighted to be exposed to such a wealth of technology and help in using it. She will not be able to return next year. There is hardly ever any turnover, and a teacher with seniority in the system gets the spot if there is a vacancy, unless it occurs unexpectedly in the middle of the term.
Many of the teachers have over 20 years of experience with the exception of three who had been student teachers there. Most of the teachers have been at the school for ten years or longer.

One teacher who had been here for 26 years remembered when the first computers arrived about eight years ago. First there were little Commodore computers, then some Apple computers. Next the IBM computer lab was set up and the teachers were given training to use the IBM Writing to Write program. Then about four years ago they got the wiring for the internet. Now this first grade teacher has four computers and a printer in her room. One of the computers can access the internet and the other three run network programs from the lab. Her internet computer has a connection to the TV so she can use it to teach the students. She had great praise for Technology Tuesdays:

Yes, she (the consultant) gives us great handouts so we can go back and practice it and I take notes so I can figure it out later. We have had enough latitude whereby we can say, 'We just really didn't get that. Could you go over that again?' And a couple of things she's gone over two or three times. Because, we've found — everyone, I think, feels the same way, that if you don't practice it, you just cannot remember. And it's very hard to practice all these little details when you teach in school. You can't do it. You must go home and practice. Where else are you going to practice? Unless you're going to stay here two hours after school and I don't like doing that.

The administration does not encourage the teachers to stay after school. School ends at 3:45 and they expect the teachers to leave by 4:00.

I definitely prefer on-site in-service. The benefit of being right here in our own lab at school, is that you do have an identical set-up to what you have in your classroom, so there's not that confusion with transferring to a different
computer or different software or whatever. Also, I can come up here (to the classroom) and bookmark sites immediately. That means you can put it to use in your classroom the next day, if needed. If we’re working on something that has application to science, English or whatever, I can run upstairs and get a manual to look up something. Besides, the convenience of not having to go out to another site, having it in your own building, of course, is a tremendous physical convenience.

When the Technology Facilitator was asked if any of the teachers among this experienced faculty expressed opposition to using technology as older teachers sometimes do, she replied that none of them had. She said they were senior faculty and experts in their own field and no principal or technology facilitator could make them use technology if they did not want to use it. She felt it was a combination of encouragement, example, excellent training, bountiful supplies and equipment, and their own belief that technology did improve the learning environment that ensured their technology use. The principal’s open style of administration allowed them, in her opinion, to make their own choice and they chose to use technology for the good of the school. They have a feeling of ownership for the school. She emphasized, “We feel like we own this school.”

Technology Integration

The ideas by these experienced teachers reiterated those of the Technology Facilitator - that they chose to support technology because they believe that it improves student learning and makes their teaching more interesting and exciting.

I think technology in the classroom is here to stay because that’s what the world is coming to. It’s in society.
Computers are going to run everything you’re doing. I don’t think it (technology) will take the place of the teacher, but it will be an added aid in the classroom. I think it improves student learning because the students are interested in what they’re doing, and they’re not distracted. The same child could sit in class and just go into space, but for some reason, the change of the screen or just being able to do things constantly changing just keeps them really focused. And it’s motivational; it’s informational. They may not read a book, but they will sit there and read something at the computer. Today they read about an astronaut in space: what he did, how he ate, how he slept, and how he bathed. These were questions that they wanted answered.

I do believe that technology improves student learning. It’s a tremendous motivator, for one thing. I have kids that are very poor readers who really learn all the basics on the Internet within a few days. Okay, I don’t know how they absorb it, or how much reading they do - but it’s a motivator to them and it’s a reward tool. For the kids that have the ability, it’s a tremendous research and enrichment tool. But no matter the ability level, the fact that they’re getting the exposure to the technology and they feel comfortable with it is important since it will be a part of their lives.

Teachers also see this as a learning experience for themselves and a rejuvenation of their interest in teaching and learning.

Let the state of Louisiana stop spending all of their money on all of these textbooks, because they’re out of date anyway. The amount of money they spend on textbooks, they ought to prioritize that a bit and update some of these schools. I think that they would have a lot of happier students, and teachers, too. Teachers are the same as students, I mean, we want to learn new things, too. We want to learn. I was a really good student when I was in school and I’ve been just delighted to learn something new. And it’s been a rejuvenation. I think a lot of teachers need that. Whether you are going to have to really sort of force them and push them and cajole them or whatever it is you have to, until they realize it; then they’ll get on the bandwagon. You’ve got to get some PR going and some support and get that technology and those machines in there and get them
rolling. But if they want to stay out of last place, they cannot continue the status quo. Now, I'm not saying this is the answer to everything, because it's not. You still need good people, but this is a help; it's a tool. But I think it's a big advantage if you have this. You are probably going to see everybody here loving it, because I don't know anyone here who is not totally sold. So you are going to get a biased opinion from us.

With four computers in the classroom, three of which are connected to the internet, the upper elementary teachers use the internet constantly in conjunction with their lessons. The teachers usually do the searches themselves at night or in the morning before school or during some off time. They are concerned about the students accessing sites that they should not be on and also it is more efficient time-wise to have the sites ready for use. A fifth grade teacher explained her internet use in this way:

Starting last year, I had at the beginning of the day a list of two or three hot sites on the board. The children each had a turn to go to the computer. We explored these sites that I would gather for them and they would have to answer certain questions. I always prepared something for them to have to answer or explain when they looked at this site. It was always content related; I make bookmarks for each of our themes in reading and social studies. I put the bookmarks on a disk. No matter what the class period, social studies, reading, language; I could put in the disk and the children could go to those sites and look up matter that was related to the theme in those subject areas.

Teachers at this school use a noteworthy strategy to prepare for their reading. They bookmark sites on the internet that relate to every story coming up for the next nine weeks and combine them for the grade level. Then the sites are available for the teachers and students to use
when ready. Other teachers in the parish visiting the school to observe have been known to plead for a copy. A second grade teacher explained her use of bookmarks in her units of study. This practice promotes collaboration and sharing with the teachers on their grade level. The lower elementary grades have three computers, one of which can access the internet.

I just spent a lot of time organizing bookmarks, putting them into folders, searching out other sites, previewing things. I'm just putting together a unit on shells and animals that live in shells, and I have eight or nine sites and each site is there for a reason. I want to develop little question cards for different things I want them to do when they get to the computer. Like: "Click on these links and see if you can find the answer to this question...". I teach second grade and I have a mixed bag of students and I don't have every single little person in there training properly on the internet, even yet. And some, I might not want to do that because I want them on the network programs reinforcing their basic skills in math or reading. But I do have 22 and I would say at least half of them can go and explore the sites. But then I have the shell table where they want to touch the physical shells and see if they can find the Lion's Paw, whatever. And that's fun, too, so we can have all of these things going on at once, which is nice.

This same teacher is the only one among the lower elementary teachers who has the TV connector accessory which she thinks is wonderful and uses every day to teach. The upper elementary teachers all have them and the rest of the lower elementary teachers will receive them next year. This accessory is an important tool for the teacher because it allows her to teach the whole class with the computer screen projected on a large TV monitor.
One thing to keep in mind about School D is that the teachers plan the lesson and take their students to the computer lab where they conduct the lesson; and there are two of these 55 minute sessions a week. This is different from the other schools. Two of the other schools have labs, but persons other than the classroom teacher conduct the activities in the technology lab. This practice in School D means that this time in which there is a computer for each student can be integrated with the classroom lessons planned by the teacher. One lower elementary teacher uses a program that teaches her second grade students keyboarding.

We do touch type, usually early in the year so they get accustomed to the keyboard. And they get pretty good with that. It's amazing what a seven-year-old can do. It helps them with their writing. We have Writing to Write (IBM) which teaches them to write; process writing - five steps, and it's very structured, but it's good for them. And the other software I use is just math drill: time, measurement, and money. In the room I have one internet computer. That's our favorite. We find sites to go with our reading stories, so for each story, we have something to go with it. It could be about the author; it could be an activity on something related to the topic. One story we read was "I Love New York". We went to the New York Chamber of Commerce site. We had a story, "The Empty Pot," which took place in China. One site we found was a dictionary. They go in and put any word they want and click the Chinese dictionary and it comes out written in Chinese. They are just amazed that this is a word. It makes no sense to them. And, of course, they'll never remember it or copy it, but it's the idea that they get to see different cultures.

A fourth grade teacher explained how she used a site that contained a virtual dissection of the heart with her anatomy lesson:

It shows the whole interior. It shows you the blood flow and everything in a three-dimensional way that you can't with a textbook or even with a video. It leads them through, step by
step. It's interactive. We do a lot of research. When we read a story we research the topic. We looked up the Chinese New Year. We read a story about totem poles. We looked up sites with totem poles - places that still make them, sell them. There were sites that showed them the different symbols that they use and the animals and the meaning. It enriches (the lessons) a lot, I think. Another thing my student teachers love are the lesson plan sites. I mean, you have access to every grade level, every subject that you can imagine with lesson plans!

This same teacher has, without a doubt, discovered one of factors that may influence many teachers to use technology in their classrooms. When questioned about what it would take to get teachers who were not using technology to use it, she gave this wise and enlightening reply.

I think the internet access, for us, has been a big part of it. As I said, I kind of looked at it before as an extension of games. It was okay for a little part-time or a reward or for drills, it was great. I think once we got into this and had the internet training, you feel just like — I mean, it's awesome! I think that once you get in and you get the training and you feel comfortable, then you start seeing the applications.

Comparison of Schools

In the following section common themes emerging from the data collected at these four schools will be presented along with contrasts that became evident. Common themes (Tables 4 and 5) that emerged in the study of these schools were the presence of a community of leadership, effective professional development, and abundance of hardware and software provided for by a technology plan which resulted in the integration of technology into the curriculum of the schools.

Leadership seems to be an important factor in every model. All of the four schools have strong administrative leadership, extremely
<table>
<thead>
<tr>
<th>Cross Case Themes</th>
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<tbody>
<tr>
<td>Community of Leadership</td>
</tr>
<tr>
<td>Principal has strong belief in value of technology to support curricular goals</td>
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<tr>
<td>Principal is adept at fund raising for technology</td>
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<tr>
<td>Computer specialist and/or teacher leaders provide leadership and support for teacher use of technology</td>
</tr>
<tr>
<td>Professional Development</td>
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<tr>
<td>At the school with familiar hardware and software</td>
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<tr>
<td>Teacher input into content of professional development sessions</td>
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<tr>
<td>Strong connections to curricular goals</td>
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<tr>
<td>Collaboration and collegial support from peers</td>
</tr>
<tr>
<td>Technology Plan</td>
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<tr>
<td>Detailed plan for hardware/software purchases</td>
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<tr>
<td>Specified timelines</td>
</tr>
<tr>
<td>Provides for ongoing professional development in technology</td>
</tr>
<tr>
<td>Expectations for teacher participation and development</td>
</tr>
<tr>
<td>Details for participation by business partner, community</td>
</tr>
<tr>
<td>Integration With Curriculum</td>
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<tr>
<td>Helps students achieve curriculum objectives</td>
</tr>
<tr>
<td>Motivates students' interest in learning</td>
</tr>
<tr>
<td>Provides students with additional resources</td>
</tr>
<tr>
<td>Hardware and Software</td>
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<tr>
<td>High ratio of computers to students</td>
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<tr>
<td>Wide range of innovative hardware and software</td>
</tr>
<tr>
<td>Internet access</td>
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</tbody>
</table>
favorable to technology use, but with very different styles. One principal is very low-key, calm and supportive; one authoritative and structured; one cool, technology-competent and encouraging; and the other, an effervescent, charismatic, people-person.

Table 4 shows some features of the technology implementation in these schools. Note that School A has two computer labs, School C has four and School D, one.

Table 4

Technology Implementation Site Features by School

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
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</thead>
<tbody>
<tr>
<td>Computer Lab</td>
<td></td>
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<tr>
<td>Computers in Classrooms</td>
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</tr>
<tr>
<td>Internet Access in Classrooms</td>
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<tr>
<td>Technology Specialists</td>
<td></td>
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<tr>
<td>Teacher Leaders</td>
<td></td>
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<tr>
<td>Principal Supports Technology</td>
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<tr>
<td>In-School Professional Develop.</td>
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<tr>
<td>Collegial Support</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Time to Practice Provided</td>
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<tr>
<td>Teacher Input into PD</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Closed Circuit TV Production</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Computer Converter to TV</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Integrated Learning System</td>
<td></td>
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</tr>
<tr>
<td>Teachers Present at Conferences</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

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A point concerning in-school professional development is that help was available to teachers in School C from the librarian and art teacher and teachers could accompany their classes to the art lab to learn, but this was not required nor taken advantage of and no formal program of professional development was in place.

Concerning time for teachers to practice technology skills, School A teachers had the time when their students were in the computer lab to practice while in there with them. This, however was not the only time. These teachers were allowed to take a computer and software home during the summer - a time to explore and practice in a relaxed atmosphere.

Three of the models have a technology resource person. The technology professionals in Schools A and D help the classroom teachers learn to use software, and help them develop lessons which integrate technology activities. They are part-time something else such as gifted and talented teacher or reading teacher because school systems are reluctant to accept and pay for such a position. The technology professionals in School C do not provide help or instruction to the classroom teacher except in the operation of the ILS. They are available to assist in selecting lessons which the classroom teacher would like her students to be working on in the lab. Their expertise is with the ILS software and hardware.

Table 5, which follows on the next page, displays the characteristics of technology implementation influenced by the configuration of the computer system in use in the schools. The
computer system includes the hardware and the software in use in the school.

Table 5

**Characteristics of Implementation by Computer System Configuration**

<table>
<thead>
<tr>
<th>School Computer Configuration</th>
<th>Teacher Use in Classroom With Varied Software</th>
<th>Teacher Collaboration</th>
<th>Effort Used To Overcome Obstacles</th>
<th>Use Distracts Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Classrooms &amp; Labs With Varied Software</td>
<td>moderate</td>
<td>moderate</td>
<td>moderate</td>
<td>no</td>
</tr>
<tr>
<td>2. Classroom Use Only With Varied Software</td>
<td>much</td>
<td>much</td>
<td>much</td>
<td>no</td>
</tr>
<tr>
<td>3. Labs With ILS Software</td>
<td>little</td>
<td>little</td>
<td>little</td>
<td>yes</td>
</tr>
</tbody>
</table>

Found on the next page, Table 6 contains information about teacher experience in the four schools studied. This information is from the Teacher Questionnaire. Note that the teachers in the four schools have teaching experience ranging from one to thirty years. Sixty percent of School A's, sixty percent of School B's, fifty percent of School C's, and seventy-four percent of School D's teachers have eleven or more years of experience; and further, they have fifty, thirty, twenty-six, and forty-three percent, respectively, above twenty years. These are stable, experienced teachers who did not resist, but embraced technology after teaching for so many years.
<table>
<thead>
<tr>
<th>Item</th>
<th>School A n=10</th>
<th>School B n=23</th>
<th>School C n=19</th>
<th>School D n=16</th>
<th>Item Freq. Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teaching Experience</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-5</td>
<td>3 (30.0%)</td>
<td>6 (26.1%)</td>
<td>4 (21.1%)</td>
<td>2 (12.5%)</td>
<td>22.1%</td>
</tr>
<tr>
<td>6-10</td>
<td>1 (10.0%)</td>
<td>3 (13.0%)</td>
<td>5 (26.3%)</td>
<td>2 (12.5%)</td>
<td>16.2%</td>
</tr>
<tr>
<td>11-20</td>
<td>1 (10.0%)</td>
<td>7 (30.4%)</td>
<td>5 (26.3%)</td>
<td>5 (31.3%)</td>
<td>26.5%</td>
</tr>
<tr>
<td>21-30</td>
<td>4 (40.0%)</td>
<td>6 (26.1%)</td>
<td>5 (26.3%)</td>
<td>7 (43.8%)</td>
<td>32.4%</td>
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<tr>
<td>&gt;30</td>
<td>1 (10.0%)</td>
<td>1 (4.4%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>2.9%</td>
</tr>
<tr>
<td><strong>Computer Use (yrs)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0%</td>
</tr>
<tr>
<td>1-3</td>
<td>5 (50.0%)</td>
<td>2 (8.7%)</td>
<td>4 (21.1%)</td>
<td>2 (12.5%)</td>
<td>19.1%</td>
</tr>
<tr>
<td>3-4</td>
<td>0 (0%)</td>
<td>7 (30.4%)</td>
<td>1 (5.3%)</td>
<td>9 (56.3%)</td>
<td>25.0%</td>
</tr>
<tr>
<td>5-6</td>
<td>0 (0%)</td>
<td>4 (17.4%)</td>
<td>4 (21.1%)</td>
<td>4 (25.0%)</td>
<td>17.6%</td>
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<tr>
<td>&gt;6</td>
<td>5 (50.0%)</td>
<td>10 (43.5%)</td>
<td>10 (52.6%)</td>
<td>1 (6.3%)</td>
<td>38.2%</td>
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<tr>
<td><strong>Computing Courses (hrs)</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>7 (70.0%)</td>
<td>9 (39.1%)</td>
<td>6 (31.6%)</td>
<td>12 (75.0%)</td>
<td>50.0%</td>
</tr>
<tr>
<td>3</td>
<td>1 (10.0%)</td>
<td>6 (26.1%)</td>
<td>6 (31.6%)</td>
<td>1 (6.3%)</td>
<td>20.6%</td>
</tr>
<tr>
<td>6-9</td>
<td>1 (10.0%)</td>
<td>2 (8.7%)</td>
<td>5 (26.3%)</td>
<td>1 (6.3%)</td>
<td>13.2%</td>
</tr>
<tr>
<td>12-15</td>
<td>1 (10.0%)</td>
<td>1 (4.4%)</td>
<td>2 (10.5%)</td>
<td>1 (6.3%)</td>
<td>7.4%</td>
</tr>
<tr>
<td>&gt;15</td>
<td>0 (0%)</td>
<td>5 (21.7%)</td>
<td>0 (0%)</td>
<td>1 (6.3%)</td>
<td>8.8%</td>
</tr>
<tr>
<td><strong>Computing Inservice (hrs)</strong></td>
<td></td>
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<td></td>
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<tr>
<td>0</td>
<td>2 (20.0%)</td>
<td>0 (0%)</td>
<td>1 (5.3%)</td>
<td>1 (6.3%)</td>
<td>5.9%</td>
</tr>
<tr>
<td>3</td>
<td>2 (20.0%)</td>
<td>1 (4.4%)</td>
<td>3 (15.8%)</td>
<td>0 (0%)</td>
<td>8.8%</td>
</tr>
<tr>
<td>6-9</td>
<td>0 (0%)</td>
<td>2 (8.7%)</td>
<td>5 (26.3%)</td>
<td>1 (6.3%)</td>
<td>11.8%</td>
</tr>
<tr>
<td>12-15</td>
<td>1 (10.0%)</td>
<td>3 (13.0%)</td>
<td>4 (21.1%)</td>
<td>1 (6.3%)</td>
<td>13.2%</td>
</tr>
<tr>
<td>&gt;15</td>
<td>5 (50.0%)</td>
<td>17 (73.9%)</td>
<td>6 (31.6%)</td>
<td>13 (61.3%)</td>
<td>60.3%</td>
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<td>3 (5.3%)</td>
<td>0 (6.3%)</td>
<td>4.4%</td>
</tr>
<tr>
<td>below ave.</td>
<td>2 (20.0%)</td>
<td>2 (8.7%)</td>
<td>2 (10.5%)</td>
<td>3 (18.8%)</td>
<td>13.2%</td>
</tr>
<tr>
<td>average</td>
<td>5 (50.0%)</td>
<td>10 (43.5%)</td>
<td>10 (52.6%)</td>
<td>2 (12.5%)</td>
<td>39.7%</td>
</tr>
<tr>
<td>above ave.</td>
<td>3 (30.0%)</td>
<td>7 (30.4%)</td>
<td>3 (15.8%)</td>
<td>10 (62.5%)</td>
<td>33.8%</td>
</tr>
<tr>
<td>high</td>
<td>0 (0%)</td>
<td>4 (17.4%)</td>
<td>1 (5.3%)</td>
<td>1 (6.3%)</td>
<td>8.8%</td>
</tr>
<tr>
<td><strong>Expertise in Integration</strong></td>
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<td></td>
<td></td>
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<td>0 (0%)</td>
<td>3 (15.8%)</td>
<td>0 (0%)</td>
<td>4.4%</td>
</tr>
<tr>
<td>below ave.</td>
<td>3 (30.0%)</td>
<td>1 (4.4%)</td>
<td>3 (15.8%)</td>
<td>2 (12.5%)</td>
<td>13.2%</td>
</tr>
<tr>
<td>average</td>
<td>2 (20.0%)</td>
<td>12 (52.2%)</td>
<td>9 (47.4%)</td>
<td>4 (25.0%)</td>
<td>39.7%</td>
</tr>
<tr>
<td>above ave.</td>
<td>5 (50.0%)</td>
<td>6 (26.1%)</td>
<td>4 (21.1%)</td>
<td>8 (50.0%)</td>
<td>33.8%</td>
</tr>
<tr>
<td>high</td>
<td>0 (0%)</td>
<td>4 (17.4%)</td>
<td>0 (0%)</td>
<td>2 (12.5%)</td>
<td>8.8%</td>
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<td></td>
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<td>7 (70.0%)</td>
<td>5 (21.7%)</td>
<td>13 (68.4%)</td>
<td>7 (43.8%)</td>
<td>47.1%</td>
</tr>
<tr>
<td>1</td>
<td>1 (10.0%)</td>
<td>3 (13.0%)</td>
<td>2 (10.5%)</td>
<td>4 (25.0%)</td>
<td>14.7%</td>
</tr>
<tr>
<td>2</td>
<td>1 (10.0%)</td>
<td>3 (13.0%)</td>
<td>2 (10.5%)</td>
<td>1 (6.3%)</td>
<td>10.3%</td>
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<tr>
<td>3-4</td>
<td>0 (0%)</td>
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<td>2 (10.5%)</td>
<td>1 (6.3%)</td>
<td>5.9%</td>
</tr>
<tr>
<td>&gt;4</td>
<td>1 (10.0%)</td>
<td>11 (47.8%)</td>
<td>0 (0%)</td>
<td>3 (18.8%)</td>
<td>22.1%</td>
</tr>
</tbody>
</table>
The school system in which Schools B and C are located has been a leader in technology and emphasized technology in learning long before the other systems. It is also the teachers in these two schools who have taken many more hours of computing courses at colleges and universities than teachers in the other two schools, even though the other two schools have a greater number of universities to choose from in their area. A majority of the teachers in all of the schools have attended six or more hours of computing in-services and consider themselves average or above in expertise in technology use and technology integration.

Table 7 indicates teachers' responses on support for technology. The teachers in Schools B and D collaborate most often with their peer teachers. School B encourages this with their teacher leaders and teacher presentations at conferences; School C's teachers attend Technology Tuesday with their grade level cohorts prompting grade level collaboration. School B has the highest level of mentoring which is one of their methods of providing professional development. They press all of their teachers into mentoring as soon as they become proficient in a software package or skill. In general, teachers are more likely to request help from a colleague in any area of instruction. Technology is no exception, as seen in Table 7. A number of the teachers in schools with technology professionals seek help from them as would be expected.

Patterns of technology applications preferred by the teachers were observed. When considering the observations made and the interviews conducted in Schools A, B, and D, most of the integrated technology activities observed involved the use of the Internet.
### Table 7

**Planning & Support for Technology Use**

<table>
<thead>
<tr>
<th>Item</th>
<th>School A</th>
<th>School B</th>
<th>School C</th>
<th>School D</th>
<th>Freq.</th>
<th>Mean</th>
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</thead>
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<tr>
<td></td>
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<td>n=19</td>
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<tr>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
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<td>3 (13.0%)</td>
<td>12 (63.2%)</td>
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<td>25.0%</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3 (30.0%)</td>
<td>8 (34.8%)</td>
<td>7 (36.8%)</td>
<td>5 (31.3%)</td>
<td>33.8%</td>
<td></td>
</tr>
<tr>
<td>2-3</td>
<td>4 (40.0%)</td>
<td>7 (30.4%)</td>
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<td>6 (37.5%)</td>
<td>25.0%</td>
<td></td>
</tr>
<tr>
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<td>1 (6.3%)</td>
<td>5.9%</td>
<td></td>
</tr>
<tr>
<td>&gt;5</td>
<td>0 (0%)</td>
<td>3 (13.0%)</td>
<td>0 (0%)</td>
<td>4 (25.0%)</td>
<td>10.3%</td>
<td></td>
</tr>
<tr>
<td>Mentoring (hrs)</td>
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<td>10 (43.5%)</td>
<td>16 (84.2%)</td>
<td>8 (50.0%)</td>
<td>58.8%</td>
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<tr>
<td>1</td>
<td>1 (10.0%)</td>
<td>5 (21.7%)</td>
<td>2 (10.5%)</td>
<td>6 (37.5%)</td>
<td>20.6%</td>
<td></td>
</tr>
<tr>
<td>2-3</td>
<td>3 (30.0%)</td>
<td>2 (8.7%)</td>
<td>0 (0%)</td>
<td>2 (12.5%)</td>
<td>10.3%</td>
<td></td>
</tr>
<tr>
<td>4-5</td>
<td>0 (0%)</td>
<td>2 (8.7%)</td>
<td>1 (5.3%)</td>
<td>0 (0%)</td>
<td>4.4%</td>
<td></td>
</tr>
<tr>
<td>&gt;5</td>
<td>0 (0%)</td>
<td>4 (17.4%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>5.5%</td>
<td></td>
</tr>
<tr>
<td>Requests Help From:</td>
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<td></td>
</tr>
<tr>
<td>colleague</td>
<td>3 (30.0%)</td>
<td>19 (82.6%)</td>
<td>15 (78.9%)</td>
<td>9 (56.3%)</td>
<td>67.6%</td>
<td></td>
</tr>
<tr>
<td>principal</td>
<td>0 (0%)</td>
<td>1 (4.4%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>1.5%</td>
<td></td>
</tr>
<tr>
<td>technology coord.</td>
<td>5 (50.0%)</td>
<td>1 (4.4%)</td>
<td>3 (15.8%)</td>
<td>7 (43.8%)</td>
<td>23.5%</td>
<td></td>
</tr>
<tr>
<td>friend</td>
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<td>1 (4.4%)</td>
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<td>0 (0%)</td>
<td>4.4%</td>
<td></td>
</tr>
<tr>
<td>software vendor</td>
<td>0 (0%)</td>
<td>1 (4.4%)</td>
<td>1 (5.3%)</td>
<td>0 (0%)</td>
<td>2.9%</td>
<td></td>
</tr>
</tbody>
</table>

The Internet seems to be much easier for teachers to integrate into their lessons than much of the software. The Internet provides content information. Skills can be practiced and mastered through the use of drill and practice game-type programs. More advanced technology-using teachers such as those in School B are beginning to integrate problem-solving programs such as spreadsheet and hypermedia authoring programs. Teachers in Schools A and D are scheduled to begin instruction in hypermedia authoring software soon. Table 8 shows hardware and types of software used in the four schools and the
applications that the teachers make in the content areas with these resources.

Note in Table 8 that most of the classrooms in the four schools have between two and three computers and that there is a wide variation of hours per week spent on the computer. The computers are most frequently used for drill and practice and for creative writing. Next in frequency of use are reference, Internet, and problem solving. Internet results are skewed by School C which doesn't have access to the Internet in classrooms. Schools B and D selected Internet as the most used and School A selected it after creative writing, drill, games, and reference.

Table 8

**Technology Application**

<table>
<thead>
<tr>
<th>No. of Computers in Classroom</th>
<th>School A (n=10)</th>
<th>School B (n=23)</th>
<th>School C (n=19)</th>
<th>School D (n=16)</th>
<th>Item Freq. Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0%</td>
</tr>
<tr>
<td>1</td>
<td>1 (11.1%)</td>
<td>0 (0%)</td>
<td>8 (42.1%)</td>
<td>1 (6.3%)</td>
<td>14.7%</td>
</tr>
<tr>
<td>2-3</td>
<td>3 (33.3%)</td>
<td>17 (73.9%)</td>
<td>10 (52.6%)</td>
<td>3 (18.8%)</td>
<td>48.5%</td>
</tr>
<tr>
<td>4-5</td>
<td>3 (33.3%)</td>
<td>6 (26.1%)</td>
<td>1 (5.3%)</td>
<td>12 (75.0%)</td>
<td>32.4%</td>
</tr>
<tr>
<td>&gt;5</td>
<td>2 (22.2%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>2.9%</td>
</tr>
</tbody>
</table>

**Preparing (hrs)**

<table>
<thead>
<tr>
<th></th>
<th>School A (n=10)</th>
<th>School B (n=23)</th>
<th>School C (n=19)</th>
<th>School D (n=16)</th>
<th>Item Freq. Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0 (0%)</td>
<td>1 (4.4%)</td>
<td>7 (36.8%)</td>
<td>0 (0%)</td>
<td>11.8%</td>
</tr>
<tr>
<td>1-2</td>
<td>8 (80.0%)</td>
<td>12 (52.2%)</td>
<td>11 (57.9%)</td>
<td>10 (62.5%)</td>
<td>60.3%</td>
</tr>
<tr>
<td>3-4</td>
<td>1 (10.0%)</td>
<td>8 (34.8%)</td>
<td>1 (5.3%)</td>
<td>5 (31.3%)</td>
<td>22.1%</td>
</tr>
<tr>
<td>5-6</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>1 (6.3%)</td>
<td>1.5%</td>
</tr>
<tr>
<td>&gt;6</td>
<td>1 (10.0%)</td>
<td>2 (8.7%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>4.4%</td>
</tr>
</tbody>
</table>

**Hours Per Week Using Computer for Instruction**

<table>
<thead>
<tr>
<th></th>
<th>School A (n=10)</th>
<th>School B (n=23)</th>
<th>School C (n=19)</th>
<th>School D (n=16)</th>
<th>Item Freq. Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>3 (15.8%)</td>
<td>0 (0%)</td>
<td>4.4%</td>
</tr>
<tr>
<td>1-3</td>
<td>1 (10.0%)</td>
<td>9 (39.1%)</td>
<td>7 (36.8%)</td>
<td>4 (25.0%)</td>
<td>30.9%</td>
</tr>
<tr>
<td>4-6</td>
<td>4 (40.0%)</td>
<td>8 (34.8%)</td>
<td>3 (15.8%)</td>
<td>7 (43.8%)</td>
<td>32.4%</td>
</tr>
<tr>
<td>7-10</td>
<td>1 (10.0%)</td>
<td>3 (13.0%)</td>
<td>1 (5.3%)</td>
<td>2 (12.5%)</td>
<td>10.3%</td>
</tr>
<tr>
<td>&gt;10</td>
<td>4 (40.0%)</td>
<td>3 (13.0%)</td>
<td>5 (26.3%)</td>
<td>3 (18.8%)</td>
<td>22.1%</td>
</tr>
</tbody>
</table>
### Purposes for Classroom Use of Computers

| Item                              | School A (n=10) | School B (n=23) | School C (n=19) | School D (n=16) | Mean  
|-----------------------------------|-----------------|-----------------|-----------------|-----------------|-------
| drill                             | 9 (90.0%)       | 17 (78.3%)      | 17 (89.5%)      | 12 (75.0%)      | 80.9% 
| creative writing                  | 10 (10.0%)      | 20 (87.0%)      | 11 (57.9%)      | 13 (81.3%)      | 79.4% 
| reference                         | 9 (90.0%)       | 19 (82.6%)      | 5 (26.3%)       | 12 (75.0%)      | 66.2% 
| problem solving                   | 8 (80.0%)       | 17 (73.9%)      | 12 (63.2%)      | 9 (56.3%)       | 67.6% 
| games                             | 9 (90.0%)       | 19 (82.6%)      | 16 (84.2%)      | 11 (68.8%)      | 80.9% 
| presentations                     | 5 (50.0%)       | 18 (78.3%)      | 1 (5.3%)        | 7 (43.8%)       | 45.6% 
| project-based learning            | 6 (60.0%)       | 14 (60.9%)      | 4 (21.1%)       | 8 (50.0%)       | 47.1% 
| to organize information           | 5 (50.0%)       | 11 (57.9%)      | 3 (15.8%)       | 5 (31.3%)       | 35.3% 
| class newspaper/making books      | 7 (70.0%)       | 17 (73.9%)      | 2 (10.5%)       | 2 (12.5%)       | 41.2% 
| Internet                          | 8 (80.0%)       | 22 (95.7%)      | 0 (0%)          | 14 (87.5%)      | 64.7% 

### Types of Software Programs Used in Classroom Instruction

| Item                              | School A (n=10) | School B (n=23) | School C (n=19) | School D (n=16) | Mean  
|-----------------------------------|-----------------|-----------------|-----------------|-----------------|-------
| word processor                    | 8 (80.0%)       | 21 (91.3%)      | 9 (47.4%)       | 12 (75.0%)      | 73.5% 
| paint and draw                    | 10 (100.0%)     | 16 (69.6%)      | 10 (52.6%)      | 7 (43.8%)       | 63.2% 
| simulation                        | 4 (40.0%)       | 9 (39.1%)       | 3 (15.8%)       | 1 (6.3%)        | 25.0% 
| drill and practice                | 8 (80.0%)       | 17 (73.9%)      | 18 (94.7%)      | 13 (81.3%)      | 82.4% 
| games                             | 8 (80.0%)       | 19 (82.6%)      | 15 (78.9%)      | 11 (68.8%)      | 77.9% 
| electronic books                  | 4 (40.0%)       | 12 (52.2%)      | 2 (10.5%)       | 4 (25.0%)       | 32.4% 
| hypermedia authoring              | 4 (40.0%)       | 8 (34.8%)       | 0 (0%)          | 0 (0%)          | 17.6% 
| encyclopedias                     | 6 (60.0%)       | 15 (65.2%)      | 4 (21.1%)       | 5 (31.3%)       | 44.1% 
| presentation developers            | 3 (30.0%)       | 8 (34.8%)       | 0 (0%)          | 1 (6.3%)        | 17.6% 
| testing                           | 3 (30.0%)       | 8 (34.8%)       | 4 (21.1%)       | 4 (25.0%)       | 27.9% 
| spreadsheet                       | 2 (20.0%)       | 10 (43.5%)      | 3 (15.8%)       | 1 (6.3%)        | 23.5% 
| database                          | 1 (10.0%)       | 4 (17.4%)       | 2 (10.5%)       | 1 (6.3%)        | 11.8% 
| tutorials                         | 3 (30.0%)       | 3 (13.0%)       | 6 (31.6%)       | 6 (37.5%)       | 26.5% 
| activity generators               | 8 (80.0%)       | 17 (73.9%)      | 12 (63.2%)      | 11 (68.8%)      | 70.6% 

Note. Activity generators generate such items as crossword puzzles, calendars, greeting cards, banners, certificates, and the like.

Integration of technology with the curriculum was clearly evident in Schools A, B and D, and to some extent in School C. Actually proponents of Integrated Learning Systems would say that technology is greatly integrated into the curriculum with the ILS, even though the lessons do not exactly fit with the classroom teacher's, it is part of the...
curriculum for that grade. However, it is not a natural integration, but a forced one. No attempt was made to determine which strategy, activities, or media would be best to teach the particular skill or topic. The teachers in School C, while enthusiastic about the integrated learning system in the labs were not as enthusiastic about classroom use of the computers as part of the lesson. This could have been due partly to the fact that they did not have Internet availability in the classrooms. This could also have been due to the teachers' concerns that the students spent so much time working with computers in the integrated learning labs.

Table 9 on the next page shows the teachers' attitudes toward technology integration at the four schools. In responses to the TQ as well as in interviews the teachers express their belief that computers are very important in the classroom, and that they are willing to exert a large amount of effort to integrate them into the classroom curriculum. This willingness to work hard to accomplish the goal of integration while accepting some failure along the way characterizes the attitude of a majority of teachers in these schools. One impression remains with you after interviewing the teachers from all of the schools. That impression is of the enthusiasm the teachers express for technology use. Everyone spoken to, whether interviewed formally or not, expressed this enthusiasm. They were proud to be a part of these ground-breaking, technology-rich schools. They were pleased that the students could have this advantage. Of course, there were those who cautioned that technology should not cause other areas to be neglected, but even they expressed enthusiasm for considered use.
Table 9

**Attitude Toward Technology Integration**

<table>
<thead>
<tr>
<th>Importance of Computers in Classroom</th>
<th>School A n=10</th>
<th>School B n=23</th>
<th>School C n=19</th>
<th>School D n=16</th>
<th>Item Mean</th>
</tr>
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<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0%</td>
</tr>
<tr>
<td>slightly</td>
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<td>0 (0%)</td>
<td>2 (10.5%)</td>
<td>0 (0%)</td>
<td>2.9%</td>
</tr>
<tr>
<td>moderately</td>
<td>1 (10.0%)</td>
<td>6 (26.1%)</td>
<td>7 (36.8%)</td>
<td>2 (12.5%)</td>
<td>23.5%</td>
</tr>
<tr>
<td>very</td>
<td>5 (50.0%)</td>
<td>8 (34.8%)</td>
<td>6 (31.6%)</td>
<td>9 (56.3%)</td>
<td>41.2%</td>
</tr>
<tr>
<td>extremely</td>
<td>4 (40.0%)</td>
<td>9 (39.1%)</td>
<td>4 (21.1%)</td>
<td>5 (31.3%)</td>
<td>32.4%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy / Effort / Persistence used in integrating technology</th>
<th>School A n=10</th>
<th>School B n=23</th>
<th>School C n=19</th>
<th>School D n=16</th>
<th>Item Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>little</td>
<td>1 (10.0%)</td>
<td>0 (0%)</td>
<td>4 (21.1%)</td>
<td>0 (0%)</td>
<td>7.5%</td>
</tr>
<tr>
<td>some</td>
<td>4 (40.0%)</td>
<td>9 (39.1%)</td>
<td>10 (52.6%)</td>
<td>6 (40.0%)</td>
<td>43.3%</td>
</tr>
<tr>
<td>large amount</td>
<td>5 (50.0%)</td>
<td>14 (60.9%)</td>
<td>5 (26.3%)</td>
<td>9 (60.0%)</td>
<td>48.5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy / Effort / Persistence used to overcome obstacles to integration of technology</th>
<th>School A n=10</th>
<th>School B n=23</th>
<th>School C n=19</th>
<th>School D n=16</th>
<th>Item Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>little</td>
<td>3 (30.0%)</td>
<td>0 (0%)</td>
<td>5 (26.3%)</td>
<td>0 (0%)</td>
<td>11.8%</td>
</tr>
<tr>
<td>some</td>
<td>4 (40.0%)</td>
<td>12 (52.2%)</td>
<td>10 (52.6%)</td>
<td>10 (62.5%)</td>
<td>52.9%</td>
</tr>
<tr>
<td>large amount</td>
<td>3 (30.0%)</td>
<td>11 (47.8%)</td>
<td>4 (21.1%)</td>
<td>6 (37.5%)</td>
<td>35.3%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Would failure cause decreasing effort to integrate technology?</th>
<th>School A n=10</th>
<th>School B n=23</th>
<th>School C n=19</th>
<th>School D n=16</th>
<th>Item Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>little or no decrease in effort</td>
<td>5 (50.0%)</td>
<td>15 (65.2%)</td>
<td>13 (72.2%)</td>
<td>10 (62.5%)</td>
<td>63.2%</td>
</tr>
<tr>
<td>some decrease in effort</td>
<td>3 (30.0%)</td>
<td>7 (30.4%)</td>
<td>4 (21.1%)</td>
<td>5 (31.3%)</td>
<td>27.9%</td>
</tr>
<tr>
<td>a large decrease in effort</td>
<td>2 (20.0%)</td>
<td>1 (4.4%)</td>
<td>1 (5.3%)</td>
<td>1 (5.3%)</td>
<td>7.4%</td>
</tr>
</tbody>
</table>

Table 10 with data from the Teacher Questionnaire shows effects of computers in the classroom that teachers consider to be crucial negative or positive impacts on their instruction.
## Table 10

### Crucial Impact of Computers in the Classroom

<table>
<thead>
<tr>
<th>Item</th>
<th>School A n=10</th>
<th>School B n=23</th>
<th>School C n=19</th>
<th>School D n=16</th>
<th>Freq. Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Positive Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>aids learning</td>
<td>3 (30.0%)</td>
<td>11 (47.8%)</td>
<td>9 (47.4%)</td>
<td>4 (26.6%)</td>
<td>40.3%</td>
</tr>
<tr>
<td>makes record keeping easy</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>1 (6.6%)</td>
<td>1.5%</td>
</tr>
<tr>
<td>aids cooperative learning</td>
<td>1 (10.0%)</td>
<td>1 (4.4%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>3.0%</td>
</tr>
<tr>
<td>makes teaching more enjoyable</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0%</td>
</tr>
<tr>
<td>motivates</td>
<td>6 (60.0%)</td>
<td>11 (47.8%)</td>
<td>10 (52.6%)</td>
<td>10 (66.5%)</td>
<td>55.2%</td>
</tr>
<tr>
<td><strong>Negative Effects</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>feel pressured to use</td>
<td>0 (0%)</td>
<td>1 (4.4%)</td>
<td>0 (0%)</td>
<td>2 (12.5%)</td>
<td>4.4%</td>
</tr>
<tr>
<td>distracts students from content</td>
<td>0 (0%)</td>
<td>1 (4.4%)</td>
<td>8 (42.1%)</td>
<td>1 (6.3%)</td>
<td>14.7%</td>
</tr>
<tr>
<td>forces adjustment of curriculum to fit software</td>
<td>0 (0%)</td>
<td>3 (13.0%)</td>
<td>2 (10.5%)</td>
<td>0 (0%)</td>
<td>7.4%</td>
</tr>
<tr>
<td>requires increased planning time</td>
<td>5 (50.0%)</td>
<td>12 (52.2%)</td>
<td>5 (26.3%)</td>
<td>11 (68.8%)</td>
<td>48.5%</td>
</tr>
<tr>
<td>contributes to confusion in classroom management</td>
<td>2 (20.0%)</td>
<td>6 (26.1%)</td>
<td>2 (10.5%)</td>
<td>2 (12.5%)</td>
<td>17.6%</td>
</tr>
</tbody>
</table>

Three important findings stand out in Table 10. No teacher in any school said that computers made teaching more enjoyable. All said that computer use requires increased planning time. However, they do say that they think computer use aids learning and motivates the students. These teachers are willing to work harder and longer to provide their students with this advantage. Clearly computers have made a huge impact on these four schools, although in different ways. The distribution of computers, the availability of the internet, the presence or
absence of technology labs, the type of support and professional
development activities all converge to produce a different impact on each school.
CHAPTER FIVE
DISCUSSION

This mixed method multiple case study examined the factors influencing the implementation of technology in elementary schools. The study has provided models of technology implementation in different contexts, allowing those in practice to select components which work best in the context of their own schools. The four schools studied were from school systems in a southern state. They can be considered outlier cases in that they are deemed outstanding examples of technology implementation. The study was guided by some questions of anticipated importance by the researcher and some which emerged during the course of the study. This chapter will contain discussion of conclusions that were made, the implications of these conclusions for those in practice in the field, and some suggestions for future research that could be helpful.

Conclusions

Leadership

A strong community of leadership within the school was important to technology implementation in all of these schools. The principals in these schools believed technology to be important to teaching and learning and imparted this to their teachers. A climate was created in which experimentation with technology was looked on with favor and given encouragement. The principals worked hard to acquire the money to purchase the hardware and software necessary for implementation. They readily accepted the concept of community of
leadership by encouraging technology specialists and teachers to take leadership roles in teaching and supporting technology use by the whole faculty. These roles are similar to those described by Maurer and Davidson (1998) when discussing community of leadership. In the community of leadership teacher leaders were very important. In Rogers' (1995) diffusion of an innovation research, he found "opinion leaders" on the same level as the participants to be very important to adoption. These opinion leaders, on the same level as the members they influence, maintain their leadership through competence, social accessibility, and conformity to the social system's norms. Teachers see that it is possible for classroom teachers to become expert technology users from their example.

Support, collaboration and mentoring among the community of leadership in these schools were found to promote implementation of technology, supporting the findings of Schrum (1999) and Lieberman (1995). This was especially evident in School B and to an extent in School D where teachers who became proficient in using certain software or skills then began to teach others. They did not have to be the leaders with technology degrees or recognized by the Challenge Grant as mentors, but were rank and file teachers who became proficient in an area of technology. This learning through the teaching of others also took place in School A but in a different form. The teaching of others was not directed to other faculty members (that was left to the technology coordinator) but to teachers in other schools through presentations at area conferences. Teachers with newly learned technology skills were
encouraged and supported in presenting at these conferences. These cases support Schon's (1991) view that people learn best through active involvement and through thinking about and becoming articulate about what they have learned.

**Professional Development**

Professional development activities conducted at the school using equipment and software the teachers use with their students were the most effective according to the teachers in this study. This type of in-service meets the criteria of the model found by Joyce & Showers (1995) to result in the greatest amount of implementation. This model consisted of presentation of theory, demonstrations, practice, and coaching each other as ongoing, collegial follow-up. The professional development program most like the Joyce & Showers model is the Technology Tuesday at School D. Also similar but minus the theory, was the program at School B where the teacher leaders instructed others in technology use. School A also had effective in-school professional development, minus presentation of theory, in their computer labs. The teachers in these schools liked having time to practice and having their colleagues available to give assistance and support. Even more importantly they liked having sessions on topics they needed right at that time for their grade level on an ability level with which they could cope.

Mandating certain levels of participation can be effective in engaging teachers in the acquisition of new skills (Airasian, 1997). The teachers in School A were required to accompany their students to the computer lab and to learn a certain number of software programs. They
became so accomplished they began presenting their ideas and applications at conferences. The teachers at School C were allowed, but not required to accompany their children to the art lab where a variety of computer-based art activities were ongoing. While they were very interested, they did not accompany their students, they took a break. Mandating a level of participation while at the same time giving choices (such as software, time, skills) can provide good results.

The content of professional development sessions that were deemed most helpful by the teachers were those concerning internet use. Teachers seemed to feel that acquisition of this knowledge was most rewarding and extremely important for their students. Also important were the initial sessions in which they first learned to use their new computers; sessions in which they learned to use the software to be used in their classrooms; sessions in which they actually learned how to integrate technology into their lessons; and for more advanced teachers, sessions on hypermedia authoring programs.

Implementation

It is difficult to conclude which might be the best way to organize technology resources for implementation. This necessarily depends on the context of the situation and these successful schools organized theirs quite differently. School A had two computer labs, and one to five computers in each room. They had a technology coordinator and a lab assistant. School B had three to ten computers in each room with internet connections but no computer lab. They had no technology personnel, but a network of teachers' helpers. School C has four labs and
an integrated learning system. They had one to two computers in each room and no internet connection in the rooms. They had two lab assistants who worked in the ILS labs. School D had a computer lab and one to five computers in each classroom, all with an internet connection. They had a technology facilitator and a hired outside consultant. All of these schools successfully implemented technology in their own way. All of these models could be successful adopted at other schools, depending on the context of the school, except possibly the model at School C. Though School C has been very successful, with student scores second only to those of School B in the same system, the ILS may not be a major factor but only a support for a strong emphasis on the basics and a structured learning environment. Important to the success of these schools is their strong emphasis on student achievement and the respect which the principals have for the knowledge and expertise of their teachers.

Technology Plans

Well designed technology plans provided a solid foundation and guide for the implementation of technology in all of the schools. The plans specified what types of computers and peripherals such as printers, scanners and cameras were to be purchased. The types of software were specified such as drill and practice programs, word processors, paint programs, or spreadsheet programs. The location of the hardware and software were specified such as library, classroom, computer lab, office, or teacher work room. Professional development activities were contained in a plan book of their own which was a subset
of the school technology plan. Parental, community, and business partner contribution of time, money and supplies were included in the technology implementation plan. Included in the plans was a timeline which expressly stated when each goal would be accomplished and how it would be evaluated.

Implications for Practice and Future Research

Practice

Writing grants to acquire hardware, software, and a professional development program is an effective way of gathering funds. A school system does not ordinarily provide these things. As with School C, the system provided one computer a year to the school. A school interested in providing an adequate amount of hardware will necessarily need to find other sources of funding. School A was provided the computers by the school system, but this was because the school is a designated technology magnet school. Only a certain few schools in that system were designated as such (a plan designed to aid in desegregation). The other three schools all wrote grants for their extra equipment and software, and in some cases received help from their education/business partners. School C's integrated learning system and lab were provided for by a grant. School D even received a grant to provide for their unique professional development program. Although the school systems all provided some classes in technology use, they were not sufficient to make the teachers comfortable technology users.

Computer labs are not thought to be as important as they once were. Currently the focus is on classroom-based computers to facilitate
the integration of computer-supported learning. However, there may yet be some important uses for labs. If teachers want very much to have technology training at "home", then what better place to have this training than in the school's own computer lab. "Technology Tuesday", School D's professional development, took place in the school's lab which had plenty of space for two grade levels of teachers to work with all having access to the internet. School A's teachers learned to use their classroom software in the computer labs; School C is planning some inservices for the teachers to be taught by their art teacher in her wonderful lab. Even School B which does not have a lab in the school is planning to create one. It will be developed not primarily for the students but for the training of the teachers. As a side effect, teachers then have the availability of a lab to bring the whole class for writing assignments, research, and making multimedia presentations or other projects relevant to the curriculum.

A needs assessment to determine teachers' level of expertise so that they can attend sessions which address their needs and interests will enable administrators to plan effectively. As we have seen in this study, professional development activities conducted without determining the teachers' present level of expertise can be ineffective. Teachers in the study expressed the need for time to practice their newly learned skills - they simply cannot grasp and retain the skills without some time spent using them. The importance of time and extended practice have been noted by many (Schrum, 1997; Mehlenger, 1997; Siegel, 1995).
School administrators might consider Rogers' (1995) characteristics of innovations that affect their rate of adoption. A professional development program that helps technology meet the criteria for adoption of an innovation will help to make computers more acceptable to teachers. To review these criteria: (1) Relative advantage is the degree to which an innovation is perceived as better than the idea or practice it replaces. If technology is introduced to teachers under circumstances in which the technology can do the job as well or better than other educational tools, they will see the relative advantage of using it. Technology could be introduced to teachers in the context of authentic tasks so they will see the relevance to theirs and their children's lives. Teachers need to feel that its use will make their teaching more interesting, more motivational, and more relevant.

(2) Compatibility is the degree to which an innovation is perceived as being consistent with the existing values and norms of the social system to which it is introduced. Teachers could be permitted to visit within their school and other schools in the system and the state to observe other teachers using technology. They could be encouraged to attend technology conferences to hear other teachers tell about their computer use in the classroom. In this way they will see that the innovation is consistent with the values and norms of the social system in which they work - the school.

(3) Complexity is the degree to which an innovation is perceived as difficult to understand and use. The more complex the innovation seems to be, the less likely it is to be adopted. Complexity of computers has
presented a barrier to teachers in the past but as more teachers become comfortable with using them and this word gets around, this idea of complexity will be dispelled. Moving slowly and thoroughly with professional development activities with plenty of peer support provided will help to alleviate this problem.

(4) Trialability is the degree to which an innovation may be experimented with on a limited basis. Teachers need to be able to try out this innovation without a lot of people looking over their shoulders. School administrators that let their teachers take home the computers in the summer give them the opportunity to practice their newly learned skills. At the very least the school could provide the teacher with some basic instruction on the computer and then provide some release time (through use of an aid or other auxiliary personnel) to retreat to their room, the computer lab or the library to spend time trying out the computer, with support available if needed.

(5) Observability is the degree to which the results of an innovation are visible to others. Teachers successful in creating interesting lessons integrated smoothly with technology could be encouraged to invite others to visit and observe. They might help with inservice activities in the school and provide peer help and support. They could be encouraged to attend and present at technology conferences which all of the teachers would be encouraged to attend. They could see the visible approval of the system in which they work, thus encouraging others.

Planning for support of classroom teachers' use of technology will help schools just beginning to use technology. Three of the models have
a technology resource person to evaluate and recommend software; to help the classroom teachers learn to use software; and to help them develop lessons which integrate technology activities. They are called by various names (technology specialist, technology facilitator, computer lab technician) and paid in various ways, often from grant money or soft money of some sort. They can provide different levels of service and support, often being centered more on students than teachers. This depends on the school’s needs. The technology specialists could possibly be hired as part-time something else such as gifted and talented teacher, reading teacher or some other such designation because school systems are reluctant to accept and pay for such a position. If there can be no technology specialist, then administrators could encourage the development of teacher leaders before implementation by sending them to technology classes and conferences and to observe in other schools, being careful to select teachers whose opinions are respected by the other teachers in the school.

Hardware considerations are important as we see from the study that both the number and location of equipment influence the way it is used. Teachers need at least two and preferably three (or more) computers in the classroom. If a teacher has four centers, of which the computers make up one, then a group of six can be sent to the computer center, working in pairs. A printer for each room is helpful or if the school is networked, all printing can be sent to a lab. At-risk and underachieving students are often motivated when their work is printed to display, to send home, or just to show to others.
As to the purchase of software, it is helpful to have a committee of the school’s technology leaders and grade level representatives give suggestions for selections. Today there is a wide variety of good software available. Software for purposes such as reference, development of thinking skills, creative writing and drill are made by many companies, each striving to make theirs more motivating, more thought provoking, and more effective in improving learning. Only the teachers know whether the software will fit with their curriculum and style of teaching. Often teachers are not familiar enough with software to make a decision. It is helpful to turn to teachers in other schools who have used software and recommend it. If possible they could receive professional leave to visit other schools to observe software in use. School system technology classes often highlight certain software and are a good resource on software.

Teachers would like to have an internet connection for each computer. While the wiring and drops are being provided it is much simpler and less expensive to do them all at once than to add them later. As mentioned before when discussing implications for professional development, a computer lab for teacher training and whole class and whole school projects, if viable, is an important addition which could also house other equipment needed by the teachers and students. This additional equipment such as a scanner, digital camera, several printers, video camera, and tape recorder will aid students and teachers in creating multimedia projects.
Another important piece of equipment observed in this study that could be placed on the recommendation list right after the computers and printers is a converter that allows the television screen or a large monitor to act as the computer monitor for instructional purposes. This enables the teacher to provide instruction to the whole class via the computer. Although it is possible to gather a class of kindergarten students around a computer or sitting on the floor for a lesson, it is not effective to do this for older students. This one small, inexpensive piece of equipment enables the teacher to integrate the internet smoothly into her ongoing lesson; it enables her to present a multimedia lesson that she has created; it enables students to show their projects to students and parents at culminating activities.

Right next to provision of equipment and provision of professional development for teachers, provision of internet access could be placed on a priority list because I do believe that it is the one thing that will draw teachers inexorably into technology use. The teacher in school D said it very succinctly,

I think the internet access, for us, has been a big part of it. As I said, I kind of looked at it before as an extension of games. It was okay for a little part-time or a reward or for drills, it was great. I think once we got into this and had the internet training, you feel just like -- I mean, it's awesome! I think that once you get in and you get the training and you feel comfortable, then you start seeing the applications.

Educational software is not always easy to integrate into a lesson but the internet is; it is always possible to find a site right to the point.
Future Research

This study found that teachers want to use programs that help their students to learn. Research to determine the effect of various types of software programs on student learning and how to best design these programs is needed. It is also important to find ways to make software that is easier to use, requiring less preparation time for the teacher and less monitoring time when other activities are going on in the classroom.

More research on professional development programs in technology is needed. School systems and individual schools are now spending tremendous amounts of money to train teachers, but little is said about what is being accomplished and how the training translates to student learning. Many systems do not even evaluate the effectiveness of the professional development in which their teachers participate. Evaluation research is necessary; feedback from teachers and a clear understanding about the effects of various models of training are needed.

Research is needed to determine the effect of on-site technology specialists and their role in the implementation of technology. Teachers asked help from both colleagues and technology specialists. Future research would be helpful to determine the kind of help sought from each. Though school systems and administrators are reluctant to provide the funding for technology personnel, both instructional and technical research might convince them of the efficacy of providing such positions.
Summary

I believe that teachers are the key to integration of technology into our classrooms and judging from the teachers in this study and their expressed beliefs about teachers in other schools, progress in technology implementation will be made if leaders develop implementation plans appropriate to the context of the school. The teachers in these schools were not handpicked because these schools were going to be technology rich schools. These teachers were veterans in many instances and they became enthusiastic about technology as they became comfortable with it and experienced the effects on their teaching and on student learning. Also, it was observed that these teachers were not technology fanatics. They were experienced teachers with a firm foundation who knew that many things were more important but they liked the lift they received from using technology in addition to the motivation and increased variety of educational experiences their students were receiving. If conditions are made favorable in any school with the type of professional development and support described here and with adequate hardware and software, implementation can be successfully accomplished.

Mellon (1999), writing about the "Great Pendulum of Education", very succinctly expresses my thoughts about teachers and technology:

Although I have no doubt that integrating selected technologies into appropriate parts of the educational process can greatly enhance learning, I am doubtful that any tool of learning can have the same impact as a good teacher. On the other hand, forcing technology down the throats of teachers without adequate training, support, and a reasonable time frame is unlikely to improve student performance in every classroom. And, unfortunately, all too often the resulting failure is blamed on the teachers rather
than on the administrative or legislative framework that created the mandate without sufficient input from the teachers who would be expected to carry it out.

The simple fact is that teachers vary in their enthusiasm toward and facility with technology. At one end of the continuum are the technology zealots who claim that most educational problems can be solved by technology. At the other end are the technology Luddites who are afraid of, or who are baffled by, the increasing emphasis on technology. Fortunately, despite the constant change in educational conviction as the great pendulum of education swings back and forth, many teachers fall in the middle. They see technology as an important tool for learning, but not the only tool for learning.

For technology-based learning to be effective, teachers must select materials that help meet carefully defined instructional objectives and integrate them into learning experiences that motivate and excite learners. They must be aware of differences in learning styles and have alternative approaches to the use of technology available for those who prefer to learn with other methods. In other words, the effective use of technology to help most learners reach instructional goals requires time, energy and creativity. And although many teachers have the creativity, the reality of the school environment, with its increasing problems of discipline, support, and respect rarely provides time and quickly drains energy from even the most caring and committed teachers. It is time to acknowledge the vital role that teachers play in the successful use of technology for learning with time, support, and respect rather than poorly conceived mandates. (p. 33-34)

It is clear that many factors contribute to successful implementation of technology in elementary schools. One of these critical factors that must not be overlooked is time. Time to learn, time to practice, time to seek help, time to give help, and time to reflect are all needed. After-school workshops provide neither the time nor the context in which to promote the effective use of technology. Short-term instruction, even when conducted intensely during summer months
cannot, by itself, produce change. A professional development program must be accompanied by a well-designed maintenance plan that provides collegial opportunities for teachers to talk about their issues, ask questions, and get feedback. By viewing the adoption of technology as a process that takes place gradually and involves a community of leadership, schools can provide both the time and the resources to help teachers implement technology effectively.
REFERENCES


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APPENDIX A

TEACHER QUESTIONNAIRE
TEACHER QUESTIONNAIRE  
Use With Scantron

NAME__________________________________

SCHOOL________________________________

PLEASE PUT YOUR NAME ON THE SCANTRON ANSWER SHEET FOR THIS PORTION OF THE QUESTIONNAIRE.

SELECT THE ONE BEST RESPONSE FOR EACH OF THESE QUESTIONS.

1. How many years of teaching experience do you have?  
   a. 1-5   b. 6-10   c. 11-20   d. 21-30   e. > 30

2. How many years have you used a computer?  
   a. 0   b. 1-3   c. 3-4   d. 5-6  e. > 6

3. How many computers do you have in your classroom?  
   a. 0   b. 1   c. 2-3   d. 4-5   e. > 5

4. How many hours a week do you use a computer at school for instructional purposes?  
   a. 0   b. 1-3   c. 4-6   d. 7-10  e. > 10

5. How many hours a week do you spend preparing for your instructional computing activities?  
   a. 0   b. 1-2   c. 3-4  d. 5-6  e. > 6

6. How many credit hours of Educational Computing courses have you taken at a college or university?  
   a. 0   b. 3   c. 6-9  d. 12-15  e. > 15

7. How many hours of Educational Computing in-service sessions have you logged?  
   a. 0   b. 1-5   c. 6-10  d. 11-15  e. > 15
8. How would you rate your level of computer expertise in comparison to other teachers?  
   a. low  b. below average  c. average  
   d. above average  e. high  
9. Given all of the ways that computers can be used in the classroom, rate your knowledge and expertise in educational computing.  
   a. low  b. below average  c. average  d. above average  e. high  
10. How important do you feel computers to be in today's classroom?  
   a. not at all  b. slightly  c. moderately  d. very  e. extremely  
11. To whom do you turn most often when you need help using computer software?  
   a. a colleague on the faculty of my school  b. my principal  c. our technology coordinator  
   d. a friend (not at this school)  e. software vendor  
12. How many hours a month do you spend in collaboration with other teachers to prepare instructional computing activities?  
   a. 0  b. 1  c. 2-3  d. 4-5  e. > 5  
13. How many hours a month do you spend tutoring or teaching other teachers how to use or implement instructional computing?  
   a. 0  b. 1  c. 2-3  d. 4-5  e. > 5  
14. How many educational computing conferences have you attended?  
   a. 0  b. 1  c. 2  d. 3-4  e. > 4  
15. Do teachers from your school get together to go to educational computing conferences?  
   a. yes  b. no
16. Who is the main selector of software in your school?
   a. coordinator of technology  
   b. principal  
   c. committee of teachers  
   d. individual teachers  
   e. librarian

17. What is the most crucial positive effect of computer use in your classroom?
   a. aids learning  
   b. makes record keeping easier  
   c. beneficial to cooperative learning  
   d. makes teaching more enjoyable  
   e. motivates

18. What is the most crucial negative effect of computer use in your classroom?
   a. I feel pressured to use  
   b. distracts students from content  
   c. forces me to adjust curriculum to fit software  
   d. requires increased planning time  
   e. contributes to confusion in classroom management

19. If there is a computer lab, which statement best describes its use?
   a. You send your students to sessions with the technology teacher.  
   b. You participate with your students in sessions with the technology teacher.  
   c. You instruct your students in the lab.  
   d. In addition to class use, individual student(s) may use lab to work on projects.  
   e. My class does not use it.

20. How much energy/effort/persistence do you put forth in integrating computer technology into your classroom?
   a. little  
   b. some  
   c. large amount
21. How much energy/effort/persistence do you put forth to overcome barriers/obstacles to integrating computer technology into your classroom?
   a. little       b. some       c. large amount

22. To what extent would failure to accomplish a goal in using technology in your classroom result in decreasing effort to accomplish future goals?
   a. little or no decrease in effort  b. some decrease in effort  
   c. a large decrease in effort

INDICATE FREQUENCY OF USE IN YOUR CLASSROOM.
SELECT:  a. never  
          b. rarely  
          c. occasionally  
          d. frequently

23. project-based learning
24. set time blocks for individual subjects
25. collaborative group projects
26. develop units across subject areas
27 teacher acting as a facilitator of learning
28. use supplementary workbook materials
29. present content information using direct teaching
30. students create authentic products
31. revise lesson plans during instruction
32. students using their own personal experiences to develop knowledge
33. require students to learn content and basic skills
34. structure classroom time for specific content instruction

PLEASE INDICATE THE EXTENT TO WHICH YOU AGREE OR DISAGREE WITH THE FOLLOWING STATEMENTS. THERE IS NO RIGHT OR WRONG ANSWER.

SELECT:  a. if you strongly disagree with the statement
          b. if you disagree with the statement
          c. if you agree with the statement
          d. if you strongly agree with the statement

35. Learning materials should be concrete and relevant to the child's life.
36. Instruction should consist mainly of reading groups, whole-group activities, and seat work.
37. During most learning activities, children should be encouraged to work cooperatively in informal small groups.
38. The teacher’s primary goal regarding children’s behavior should be to establish and maintain teacher classroom control.
39. Instruction should consist mainly of projects, learning centers, and pupil selected activities.
40. In the child’s acquisition of knowledge, the teacher’s role should be to diagnose and correct errors in a specified body of subject matter content and skills.
41. Teacher observation is the most valid way to monitor children’s performance.

42. Curriculum should be primarily designed to develop the intellectual domain, stressing the acquisition of carefully defined discreet skills.

43. While participating in learning activities children should be expected to work quietly on their own and in teacher-led small groups.

44. The school should be organized so that the individual teacher integrates instruction across the areas of the curriculum.

45. Circle all of the purposes for which you use computers in the classroom.
   a. drill       b. creative writing   c. reference   d. problem solving  e. game   f. for presentations  g. project-based learning  h. to organize information  i. class newspaper/making books  j. internet

46. Circle content area/s in which you use computer activities.
   a. reading   b. science   c. math   d. social studies  e. writing  f. foreign language

47. Circle types of software programs that you use in your classroom instruction.
   a. word processor    b. paint & draw    c. simulation    d. drill & practice    e. games    f. electronic books    g. multimedia authoring    h. encyclopedias    i. presentation developers
j. testing    k. spreadsheet l. database    m. desktop publisher
n. tutorials    o. activity generators (e.g. crossword puzzles,
banner makers, certificate makers)

PLEASE WRITE THESE COMMENTS. YOU MAY CONTINUE ON TO THE NEXT PAGE.

48. Comment on how you think computer use affects your students.

49. What requirements does the school have for the inclusion of technology in lesson plans?
50. Comment on ways that computer use has changed (if it has) your beliefs about teaching/learning and/or your teaching practices.
INFORMAL INTERVIEW GUIDE

Instructional Information
1. In what ways do computers facilitate the instructional process in your classroom?
2. What software applications do you use for the children?
3. What software applications do you use for the development and management of instruction and record keeping for your class?
4. How do you go about selecting the software?
5. How do you use and manage computer assisted instruction in the classroom?

Factors Underlying Failure to Use
6. What are the reasons why some teachers do not use computers?
7. What are some of the problems with using computers in class?

Encouraging Teachers to Use Technology
8. What are factors that encourage teachers to use computers?
9. What made you start using computers with your students?
10. Who are the people in the school who encourage you to use computer assisted instruction? How do they do this?

Professional Development
11. How often are you provided PD opportunities in technology use?
12. What is the nature of these sessions?
13. What teaching and learning practices are utilized?
14. How effective do you feel these sessions are?
15. How would you change them?
16. Describe informal professional development opportunities.
17. How do you use what you have learned in your classroom?

Technology in the Future
18. What do you see as the role of technology in elementary classrooms in the future?

Of course, unexpected turns of conversation often develop in this informal interview format and additional questions have been prompted by the interview process.
APPENDIX C

OBSERVATION FORM
OBSERVATION FORM

1. For what purpose is the teacher using computers?

2. What part does the computer activity play in the overall lesson?

3. How many children are engaged in working at the computers? How does the teacher manage the various activities going on?

4. What kinds of computer activities are the students doing?
5. What kind of teacher-student-technology interactions are demonstrated?

6. What computer hardware is available in the classroom?

7. What software is being used?

8. How are the computers situated in the classroom? (Does the arrangement give the students a sense of being worthy of trust?)

9. If there is a computer lab, how are teachers and students admitted for use and for what purpose is the lab used?
APPENDIX D

PERMISSION TO CONDUCT RESEARCH
December 3, 1997

Ms. Marilyn H. Catchings
847 Daventry Drive
Baton Rouge, LA 70808

Dear Ms. Catchings:

Your application requesting permission to do a graduate research study on factors which influence technology integration in the elementary classroom in Calcasieu Parish has been approved.

Attached are the names of the principals from the seven schools that were recommended by Cyn Bertrand and Adrienne Hunt for contact. Upon completion of your research, please direct completed study to Barbara Bankens, Director of Testing and Research.

Best wishes for a successful study.

Sincerely,

Barbara I. Bankens, Director
Testing and Research

BIB: sbm

pc: Mr. Leo Miller
    Annette Ballard
    Dolores Hicks
    Cyn Bertrand
    Andrienne Hunt

doc18

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MEMO TO: Marilyn Catchings, Doctoral Student
Louisiana State University
College of Education
111 Peabody Hall
Baton Rouge, Louisiana 70803

FROM: Dr. Bernadette Morris, Director
Planning, Evaluation, Research, and Development
Curriculum and Instruction

SUBJECT: Letter of Permission to Conduct Study
Computer Use in Classrooms

October 8, 1997

After reviewing your request to conduct the investigation described in your proposal, you have permission to begin your study.

Authorization to conduct this study is granted with the following stipulations:

1. The principals of the schools agree to participate. The principal must be given a copy of this memo.

2. Written permission is granted by the parents/guardian allowing their child/children to participate in the study. A copy of the permission form must be housed at the school.

3. The information obtained from the students will be anonymous and will remain confidential.

4. This department will receive two (2) copies of the completed study.

This authorization is based on the information submitted to this office. If you should deviate from the proposal, please contact this office.

If you have any questions, contact me at 922-5464.

Approved:

Don Mercer, Associate Superintendent
Office of Curriculum and Instruction

C:
Dr. Gary Mathews
Harry Ingalls

Quality and Equity: Our Children Are the Reason
ASSURANCES

As the principal investigator for the proposed research study, I assure that the following conditions will be met:

1. The human subjects are volunteers.
2. Subjects know that they have the freedom to withdraw at any time.
3. The data collected will not be used for any purpose not approved by the subjects.
4. The subjects are guaranteed confidentiality.
5. The subjects will be informed beforehand as to the nature of their activity.
6. The nature of the activity will not cause any physical or psychological harm to the subjects.
7. Individual performances will not be disclosed to persons other than those involved in the research and authorized by the subject.
8. If minors are to participate in this research, valid consent will be obtained beforehand from parents or guardians.
9. All questions will be answered to the satisfaction of the subjects.
10. Volunteers will consent by signature if over the age of 6.

Principal Investigator Statement:

I have read and agree to abide by the Louisiana State University policy on the use of human subjects. This project will be conducted in accordance with federal guidelines for Human Protection. I will advise the Office of the Dean and the University's Human Subject Committee in writing of any significant changes in the procedures detailed above.

Signature: [Signature] Date: Oct. 24, 1997

Faculty Supervisor Statement (for student research projects):

I have read and agree to abide by the Louisiana State University policy on the use of human subjects. I will supervise the conduct of the proposed project in accordance with federal guidelines for Human Protection. I will advise the Office of the Dean and the University's Human Subject Committee in writing of any significant changes in the procedures detailed above.

Signature: [Signature] Date: Oct. 24, 1997

Reviewer recommendation:

- exemption from IRB oversight. (File this signed application in the Dean's Office.)
- expedited review. (Follow IRB regulations and submit 2 copies to the Dean's Office.)
- full review. (Follow IRB regulations and submit 12 copies to the Dean's Office.)

Review Date: 10/7/9

Name of Authorized Reviewer (Print) / Signature / Date
Application for Exemption from IRB (Institutional Review Board) Oversight for Studies Conducted in Educational Settings
LSU COLLEGE OF EDUCATION

Title of Study: A Study of Factors which Influence Technology Integration in the Elementary School Classroom
Principal Investigator: Marilyn H. Catchings
Names (Print)

Faculty Supervisor: S. Kim MacGregor
Names (Print)

Dates of proposed project period: From Dec. 1, 1997 To Feb. 20, 1998

<table>
<thead>
<tr>
<th>ITEM</th>
<th>YES</th>
<th>NO</th>
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<tbody>
<tr>
<td>1. This study will be conducted in an established or commonly accepted educational setting (schools, universities, summer programs, etc.)</td>
<td>✓</td>
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<tr>
<td>2. This study will involve children under the age of 18.</td>
<td>✓</td>
<td></td>
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<tr>
<td>3. This study will involve educational practices such as instructional strategies or comparison among educational techniques, curricula, or classroom management strategies.</td>
<td>✓</td>
<td></td>
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<tr>
<td>4. This study will involve educational testing (cognitive, diagnostic, aptitude, achievement).</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5. This study will use data, documents, or records that existed prior to the study.</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>6. This study will use surveys or interviews.</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>7. This study will involve procedures other than those described in numbers 3, 4, 5 or 6. If yes, describe: observations</td>
<td>✓</td>
<td></td>
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<tr>
<td>8. This study will deal with sensitive aspects of subjects' and/or subjects' families' lives, such as sexual behavior or use of alcohol or other drugs.</td>
<td>✓</td>
<td></td>
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<tr>
<td>9. Data will be recorded so that the subjects cannot be identified by anyone other than the researcher.</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>10. Informed consent of subject 18 and older, and/or of the parent/guardian of minor children, will be obtained.</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>11. Assent of minors (under age 18) will be obtained. (Answer if #2 above is YES)</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>12. Approval for this study will be obtained from the appropriate authority in the educational setting.</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

Attach an abstract of the study and a copy of the consent form(s) to be used. Also, attach a copy of any surveys, interview protocols, or other procedures to be used.
VITA

Marilyn Hill Catchings was born in Louisiana. She received her bachelor of science degree, master of education degree, and certification as an education specialist from Louisiana State University. Shortly after graduating from Louisiana State University, she married her husband Bob, a graduate of Tulane University. She served as an elementary classroom teacher for twenty years in Texas and Mississippi. She has one daughter, Caroline, and one grandson, Adam. Returning to Louisiana State University when her daughter enrolled there, Marilyn worked to attain the master of education degree and remained at the university as an instructor for thirteen years. After retiring from the university, she continued to work to attain a doctoral degree. She is at present employed as a computer specialist with the East Baton Rouge Parish School System.
DOCTORAL EXAMINATION AND DISSERTATION REPORT

Candidate: Marilyn Hill Catchings

Major Field: Educational Research

Title of Dissertation: Models of Professional Development for Teachers: Factors Influencing Technology Implementation in Elementary Schools.

Approved:

Susan Kim Mauro
Major Professor and Chairman

J. M. Parlin
Dean of the Graduate School

EXAMINING COMMITTEE:

Charlie Tidwell

Charles D. Elliott

Earl Cheek

Richard Swenson

March 22, 2000

Date of Examination:

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