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Focus on school improvement: A planning and implementation guide for effective technology integration

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FOCUS ON SCHOOL IMPROVEMENT: A PLANNING AND IMPLEMENTATION GUIDE FOR EFFECTIVE TECHNOLOGY INTEGRATION

A Project

Presented to the

Faculty of

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In Partial Fulfillment

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in

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ABSTRACT

This was a descriptive study using quantitative data to investigate teachers' perceptions of computer integration, with a focus on what factors enable or impede them. Elementary school classroom teachers (27) completed a written questionnaire. The instrument contained items designed to collect data on perceived dimensions of integration and on facilitators and barriers. Random sampling was not used; surveys were distributed to all elementary teachers in one small, suburban school.

The primary analysis of the quantitative data concerned the investigation of the perceptions of integration and the identification of facilitators and barriers to teachers' computer integration.

Issues related to technology use in school typically focus on student-centered concerns such as improving student learning, preparing children to function successfully as citizens and workers in a technological society and enhancing student productivity and performance. While student-centered issues are of critical importance, how and why teachers use technology is also important, both for productivity implications and the fact that a teacher

who is comfortable using technology is likely to influence students. This study focused on teachers' perceptions of their computer practices in various aspects of their work and the factors which enable or impede them.

The literature suggests that computers might not only help teachers perform tasks they already know how to do more efficiently or relieve them of routine tasks, it might also assist them in doing tasks they might not otherwise be able to do. These uses have the potential to change the way individuals do their work. Current educational reform efforts expand the responsibilities of teachers while expecting them to improve their performance in the classroom. Investigations into the potential role of computers in improving how teachers do their work and decisions regarding the allocation of resources to support specific activities requires a knowledge base of current uses, the influence of those uses and the factors that facilitate or impede these uses.

Teachers in the study generally perceived computers as having a positive impact on their work. A majority felt they were more professional, more creative, better informed, and generally better educators as a result of their computer use. Surprisingly, improved interaction

with colleagues did not emerge as a particularly important factor. Creating more effective materials and saving time were rated as the most important reasons for using the computer. A majority currently used the computer to create instructional materials, while few (21.6 percent) used it to communicate with colleagues, a use that might potentially ease the isolation of the profession and foster continuing professional development. Accessibility to e-mail and Internet access was moderate or high for only 32.8 percent. Results reflect the dynamic nature of computer integration and raise further questions regarding how changes in accessible resources will alter the nature of teachers' computer integration, the reasons for using computers, and their perceptions of how the computer influences their work.

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I would also like to acknowledge the teachers who took the time to conscientiously complete the survey.

Final acknowledgements and gratitude to my immediate family. Their support and confidence was unwavering. To my husband, Paul, my special appreciation for his constant patience and enthusiasm.

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"Let ideas speak for themselves," more than one scientist told me, "and never mind the people involved." Alas, it isn't quite that simple.

Paula McCorduck, from *Machines Who Think* (1979)

CHAPTER ONE

Introduction

As state after state has to re-create schools so that they can meet 21st century demands, it has become apparent that their success depends fundamentally on teachers. What teachers know and can do is the most important influence on what students can learn (The National Commission on Teaching and America's Future, 1996).

How teachers go about accomplishing their daily tasks influences their current effectiveness and their continuing improvement. There are currently concerns regarding the performance of teachers (The National Commission on Teaching & America's Future, 1996) and acknowledgment of the increasing importance of teaching-related tasks in addition to classroom instruction (Hargreaves,1994). Despite research support that computer use improves teacher

productivity (Rockman, Pershing & Ware, 1992) and increases feelings of professionalism and effectiveness (Wilson, Hamilton & Cyr, 1994), there is limited research on how teachers are integrating computer practices to accomplish the many aspects of their work.

The purpose of this study was to expand the knowledge base concerning elementary teachers' perceptions of integration into their work and what conditions most facilitate or impede their effective computer use. This knowledge base provides a foundation for further investigation of ways in which the computer might support teachers' efficiency and effectiveness on the job.

Three areas that have profound impact on how well a school can integrate technology into the curriculum are described: preparation tasks, obtaining appropriate resources and implementation issues.

According to Webster's Encyclopedic Unabridged Dictionary (1989, p.600) one meaning of the word *integrated* is "combining or coordinating separate elements so as to provide a harmonious interrelated whole." Sergiovanni (1989) suggested two aspects of educational change: (1) how things look on the outside and (2) how things work. This project investigated not only the characteristics of

computer integration but also the conditions which determine the influence of technology.

Research Questions

There were two major research questions investigated in this study:

Research Question 1: How are teachers integrating computers into their day-to-day work?

Research Question 2: What factors enable or impede computer integration by teachers?

The literature and research on computers in educational settings; on views of the potential purpose and value of the computer, combined with personal experience provided the framework for developing these two research questions.

The literature on educational technology is full of glowing promises of dramatic and meaningful improvements to classroom activities and outcomes. But the mere presence of technology is not an automatic guarantee for improved

education. In spite of its potential power, educational technology has some well-documented, high-profile failures (Ferrell, 1986; Morehouse, Hoaglund and Schmidt, 1987; The revolution that fizzled, 1991). Success with any technology is rarely serendipitous. Certain clear factors profoundly affect whether technology helps education take a leap forward or a pratfall.

What conditions determine the influence of technology? The goal of this project is to understand how contemporary research answers this question by describing three areas that have profound impacts on how well a school can integrate technology into the curriculum: preparation tasks, obtaining appropriate resources and implementation issues.

Many educators, parents and students already believe that technology should be an integral part of K-12 education. To them, the reasons seem so obvious that everyone should recognize them. This "common sense rationale" for using technology is based on two major points:

Technology is everywhere. A widely-accepted belief holds that technology already plays a high-profile role in the educational system and that schools and classrooms

cannot deliver high-quality education without using technology-based methods. People tend to believe that since technology tools play important roles in other areas of society, education should also reflect this growing trend. Technology certainly is a part of the landscape of society. There is no place one can go, no job one can choose to avoid it. Many people conclude then that technology logically should also play a major role in educating children. Many also observe most of the country's most successful educators employing technology in key ways.

Technology has been shown to be effective. Since computers and other technology resources have been in widespread use in education for many years, people assume that a substantial body of research shows the effectiveness of computer-based methods as compared to other methods, at least for certain kinds of learning needs. However, extensive research with computer-based methods supports only a general conclusion that technology has made a difference—sometimes.

Both of these commonly held beliefs have some validity, and both provide rationales for using technology. But both also tend to be too general to show specifically how to use technology in education. That requires some

answers to some practical questions I have been researching:

Should technology take over most or all of the teacher's role? If not, how should it fit in with what teachers already do?

Should schools rely on computers at all levels, for all students or for all topics? If not, which levels, students and topics suit computer-based methods?

Does some reliable information suggest specific benefits of using technology in certain ways?

To justify the expensive and time-consuming task of integrating technology into education, teachers must identify specific contributions that technology can and should make to improvements in an education system. As Roybler (1993) noted, "Answering the question, 'Why use technology in education?' seems not only necessary but fundamental to all our efforts with technology. It is important . . . for assuring that . . .technology is used to shape the kind of future we want for education and society itself" (p.13).

Thus, developing a sound rationale for choosing technology will guide specific goals for technology use and help identify the skills and resources needed to accomplish

these goals. However, before looking at some aspects of developing a rationale, it seems important to take a careful look at the educational research from which many educators draw evidence of technology's present and potential benefits.

CHAPTER TWO

Review of the Related Literature

Computer Integration into Educational Settings

A review of the research on computer integration into schools reveals a variety of terms, definitions and measures of this phenomenon. Terms such as integration, implementation, infusion and incorporation appear in educational research on computers.

Hadley and Sheingold (1993) stated that "integration requires that teachers readily and flexibly incorporate technologies into their everyday teaching practice in relation to the subject matter they teach" (p. 265). This definition suggests daily use for core activities that are integral to the lesson rather than for peripheral activities such as reinforcement. The Levels of Technology Implementation framework similarly defines integration as occurring when "technology-based tools are integrated in a

manner that provides a rich context for students' understanding of the pertinent concepts, themes and processes" (Moersch, 1995, p.42).

Some researchers have approached measuring computer integration by employing a continuum, stages or levels of use. These approaches imply a developmental aspect to computer integration. For example, Moersch (1995) proposed a framework of levels of technology implementation with levels that included nonuse, awareness, exploration, infusion, integration and expansion.

The Levels of Use questionnaire used by Marcinkiewicz (1993-94) measures three levels: (1) *nonuse:* the absence of any use of computers for teaching; (2) *utilization:* a teacher begins to use computers, but computer use is still expendable; and (3) *integration:* when "teachers consciously and inextricably delegate some of their duties to the computer and as a result are aware of the changes in their role" (p.222). The critical element of this definition of integration seems to be that the teacher's role is altered when the computer provides instructional components the teacher would otherwise present. Results of other research have also indicated a change in teachers' roles as they

integrate computers into the curriculum (Baker, et al., 1993; Hadley & Sheingold, 1993).

Researchers reporting on the Apple Classrooms of Tomorrow (ACOT) concluded that integration was an evolutionary process (Baker, et al., 1993). In the first phase, *entry*, there was little experience, and most effort was in setting up equipment. The second phase, *adoption*, saw support of traditional drill and practice use in the classroom. *Adaptation* followed with integrated activities supported 30 to 40 percent of the time with computers. Productivity was a prime concern of this phase. *Appropriation* was the next phase in which teachers used computers for new strategies. ACOT researchers used the final phase, *invention*, as a placeholder for further development. During each phase, they also found that necessary support was slightly different.

Other researchers have acknowledged the importance of taking a comprehensive look at computer integration by measuring a variety of indicators. For example, Becker (1994) used data from the IEA Computers in Education study to examine differences between exemplary and typical computer-using teachers. In his analysis, the variable indicating exemplary use was an index based on five

components: (1) goals for computer use; (2) frequency; (3) saliency of the computer for major learning activities; (4) amount of experience with certain types of software; and (5) general functions.

Hadley and Sheingold (1993) studied experienced computer-using teachers to explore what classroom integration of computers might mean in terms of practice and definition of the term. Results of their study suggested five different profiles. *Enthusiastic Beginners* did not have extensive technological expertise but were convinced and enthusiastic about the use of technology. Their view of integration was that their students' work on computers involved the same topics studied in class. *Supported Integrators* had extensive experience using computers and taught in schools that had infused technology. For them, integration meant day-to-day use as a tool. *High School Naturals* had the most extensive computer experience of all the groups and were generally the specialist in schools where computers were not infused. *Unsupported Achievers* were younger, experienced with computers, and working in situations where the use of computers was not supported. *Struggling Aspirers* were the least experienced and the oldest. They were the least

likely to view technology integration in terms of a day-to-day access as a tool or reference and more likely to view it as reinforcement of teacher-centered learning. The different profiles and levels of use suggest differences in perceptions of the value and purpose of using the computer in the classroom.

Justifying Technology Use: The Case for Motivation

Some trends in technology use have theoretical support in basic research on learning and cognition; others are so new that researchers have not yet designed adequate methods to measure their impact. Still other applications do not lend themselves to behavioral research, but their practical value has been validated by several years of use in schools. Some of these trends may provide the most powerful and durable evidence of technology's benefits to education. The following section discusses some arguments that could form a rationale for continuing or expanding the use of technology in education.

Gaining learner attention. In 1965, renowned learning theorist Robert Gagne proposed a need to gain the attention of the learner as a critical first "event" in providing optimal conditions for instruction of any kind. Although other aspects of instruction must direct this attention

toward meaningful learning, teachers widely recognize that the visual and interactive features of many technology resources does, indeed, effectively help focus students' attention and encourage them to spend more time on learning tasks (Pask-McCartney, 1989; Summers, 1990-91).

Substantial empirical evidence indicates that teachers frequently and beneficially capitalize on the novelty and television-like attraction of computers and multimedia to achieve the essential instructional goal of capturing and holding students' attention.

Engaging the learner through production work. In one highly successful way to make learning more meaningful to students, teachers often try to engage them in creating their own technology-based product. This strategy has been used effectively with word processing (Tibbs, 1989; Franklin1991), hypermedia (Volker, 1992), computer-generated art (Buchholz, 1991), and telecommunications (Marcus, 1995). Reports of such uses reveal that students like the activities because they promote creativity, self-expression, and feelings of self-efficacy and because they result in professional-looking products students can view with pride.

Increasing perceptions of control. Many successful users of technology-based materials say that students find strong motivation in the feeling that they are in control of their own learning (Arnone & Grabowski,1991). Learner control seems to have especially important implications for at-risk students and others who have experienced academic failure. When students perceive themselves as in control of their learning-either through setting the pace of movement through a drill or tutorial or by creating their own computer-generated products with Logo or word processing software-it seems to result in "intrinsic motivation." That is, students become caught up in and motivated by the awareness that they are learning. This finding, which has been reported from the earliest uses of computer-based materials, continues to be one of the most potentially powerful reasons for using technology resources as motivational aids. Exceptions to this notion of learner control is when learning paths become very complex (e.g., with hypertext environments and interactive videodisc applications). In these cases, learners with weak learning skills seem to profit most when teachers supply some structure to the activities (Kozma, 1991, 1994; McNeil and Nelson, 1991).

Justifying Technology Use: Unique Instructional Capabilities

Another extremely powerful case for using technology resources is that some technological media can facilitate unique learning environments or contribute unique features to make more traditional learning environments more powerful and effective.

Linking learners to information sources. Hypertext systems are computer-based products that provide readers with links between information from a variety of sources. A student can select a keyword from a screen or get options to see several other sources with other information on the same topic. These, in turn, can lead to other, related sources and topics, forming an endless chain of information to peruse. Kozma (1991, 1994) reports that while little research has focused on hypertext to date, encouraging preliminary findings suggest that a hypertext learning environment "both calls on and develops skills in addition to those with standard text" (1991, p.203) and "helps the reader build links among texts . . .and construct meaning based on these relationships" (1991, p.204). Computers handle the logistics of this complex activity and, though

it remains a complicated process, they make it more feasible for classroom activities.

Helping learners to visualize problems and solutions. Kozma (1991) also reports that interactive visual media such as videodisc applications seem to have unique capabilities for instruction in topics that involve social situations or problem solving. He notes that these media provide powerful visual means of "representing social situations and tasks such as interpersonal problem solving, foreign language learning and moral decision-making: (p.200). The growing number of videodisc products designed for these kinds of topics (e.g., the *Aids* videodisc from ABC News, Computer Curriculum Corporation's *SucessMaker,* and *A Right to Die? The Case of Max Cowart* {Covey, 1989}) confirms that designers and educators are beginning to recognize and exploit these unique and powerful qualities.

Tracking learner progress. Integrated learning systems (ILSs) and subsequent products based on them have capitalized on the computer's unique ability to capture, analyze and present data on students' performance during learning (*Electronic Learning,* 1990, 1992; *Educational Technology,* 1992). This ability for data gathering and

reporting is central to all efforts to design efficient and meaningful instructional paths tailored to individual students' learning needs.

A teacher attempting to teach a set of skills to a large group of students needs accurate and up-to-date information on what each student is and is not learning. The teacher needs this information in a format that can be quickly reviewed and analyzed. A well-designed computer-based system for data collection (sometimes called a *computer managed instruction* or CMI system) offers a unique capacity to provide this essential information. In addition, new technology products such as pen-activated devices allow teachers and researchers alike to keep moment-to-moment records of their observations of students. These important records can later be analyzed for indications of appropriate learning experiences.

Linking learners to learning tools. The ability to link learners at distant sites with each other and with widely varied online resources has long been recognized for its unique potential to support instruction and enhance learning (Kurshan,1990; Roblyer, 1991, Marcus, 1995). These capabilities include getting access to information not available through local sources, developing research

and study skills that will benefit students in all future learning and providing multicultural activities without leaving the classroom. Some unique affective benefits have also been observed, including increased multicultural awareness as students of different cultures interact online (Roblyer, 1991) and enhanced communication skills when students correspond with each other (Cohen and Riel, 1989).

Support for new instructional approaches. The educational system is struggling to revamp its instructional goals and methods in preparation for the complex demands of life in the technology-driven 21st century (SCANS Report, 1992), Educators are beginning to look at technology resources to help make these new directions as ones feasible and motivational to students. Several new instructional initiatives can benefit from applications of technology:

Cooperative learning. There is a growing realization in American society that its traditional cultural emphasis on individualism as opposed to group activities will not promote success in the complex problem solving that lies ahead. This has led to an increase in emphasis on small-group instructional activities that involve cooperative learning. Technology-based activities that lend themselves

to cooperative, small-group work include development of hypermedia products and Logo programs, development of special-purpose databases, research projects using online databases and research projects using videodiscs and multimedia (Lillie, 1989).

Shared intelligence. In a concept related to cooperative learning, educators are exploring the potential for intelligence to function not simply as an individual capability, but also as a product of individuals and tools, each of which contributes to desired goals. Technology resources such as those described above make possible this "shared intelligence" or "distributed intelligence." According to some theorists, the capabilities afforded by new technologies make the concept of intelligence as something that resides in people's heads too restrictive. "Intellectual partnership with computers suggests the possibility that resources enable and shape activity and do not reside in one or another agent but are genuinely distributed between persons, situations and tools" (Polin, 1992, p.7). Therefore, some educators hypothesize that the most important role for technology might be to change the goals of education, as well as the measures of educational success.

Problem solving and higher-order skills. While basic communications and mathematics skills are still recognized as essential, educators are also increasingly aware that they must emphasize the learning of specific information less than learning to solve problems and think critically about complex issues (Lillie, 1989). In addition, curriculum is beginning to reflect the belief that students need not master basic skills before going on to higher-level skills. The engaging qualities of technology resources such as videodiscs, multimedia and telecommunications allow teachers to set complex, long-term goals that call for basic skills, thus motivating students to learn the lower-level skills they need at the same time they acquire the higher-level skills.

Increased teacher productivity. An important but often-overlooked reason for using technology resources is to help teachers cope with their growing paperwork load. Teachers and organizations alike have recognized that if they spend less time on recordkeeping and preparing teaching materials, they can spend more time analyzing student needs and having direct contact with students (Adams, 1985; Minnesota State DOE, 1989; George Mason University, 1989). Teachers can become more productive

through training in technology-based methods and quick access to accurate information that can help them meet individual needs. Many technology resources can help teachers increase their productivity in these ways: word processing, spreadsheet, database, gradebook, graphics, desktop publishing, instructional management and test generator programs, along with online communications between teachers (e.g., e-mail) and other online services (e.g., Prodigy).

Technology's Role In Restructuring Education: Dilemmas and Directions

Still another part of the rationale for integrating technology into education comes from its widely perceived role in school reform and restructuring. Many educators are convinced that technology is essential to the curriculum reform and school restructuring that is needed to improve the educational system (Bruder, Buchsbaum, Hill and Orlando, 1992; Hill, 1993). The proper role for computer and related technology has stimulated continued and often intense debate for some years. Although computers captured the imagination of educational innovators early in the 1960's, no commonly held vision has ever emerged to show how technology would enhance the

educational process. Even now, with an apparently growing dissatisfaction with traditional teaching and learning systems and a consensus on the need to change or restructure American education, considerable disagreement persists over the part that technology will play in the restructured system.

Replacing teacher functions versus changing teacher roles. In the early days of educational technology, when resources were available only through centrally controlled mainframe computer systems, some foresaw technology eventually replacing the teacher as the primary instructional delivery system (Norris, 1977). However, the advent of standalone microcomputers placed the power of technology directly in the hands of teachers, and the image of technology shifted from replacing teachers to supplementing and enhancing teacher-based instruction. Today, as mounting criticism assails the educational system as expensive, inefficient and outdated, technology is again proposed as an alternative to delivering instruction primarily through teachers (Reigeluth and Garfinkle, 1992).

This proposal asserts that technology-based delivery systems will achieve better results by standardizing instructional methods and decreasing personnel costs

(Smith, 1991; Reigeluth and Garfinkle, 1992). Some critics advocate technology-based systems as replacements for the traditional roles of both schools and teachers (Perelman, 1993). The opposing view seems to anticipate that teachers and schools must remain an important part of the instructional process, but that technology tools will empower them to teach better and use their time productively. As calls for curricular reform increase, however, it is apparent that far-reaching changes in traditional teacher roles will be a part of the total restructuring package.

Enhancing existing methods versus changing the nature of education. Even if one discounts the option of eliminating or decreasing the role of teachers, considerable debate remains over the related question of just how technology will change those teachers' roles. As Neuman (1991) observed, depending on how technologies are implemented, they can either help restructure a school's fundamental operations and educational goals or support existing structures. She points out that integrated learning systems (ILSs), for example, are designed to fit in with both the goals and operations of the existing school organization. However, other kinds of resources

such as local area networks can add flexibility to a school's curriculum and schedule. This flexibility facilitates long-term, open-ended student projects, the essence of a restructured curriculum.

Papert (1980) was an early critic of traditional approaches to teaching and learning that emphasize isolated skills. He advocated a less structured environment that would let students use computers to learn to think and solve problems. His vision of Logo "microworlds" as a basis for this kind of teaching received widespread attention in the later 1980's, but it later gave way to a broader view of learner-directed methods that has become known as *constructivism* (Bagley and Hunter, 1992; Strommen and Lincoln, 1992). This framework calls for assigning tasks that emphasize learners' creativity and allow them to construct or build their own knowledge rather than giving them knowledge to absorb. A separate but related view would restructure learning around "whole language" or interdisciplinary student projects that emphasize cooperative work and collaborative teaching (Butzin, 1991; David, 1991). Proponents of approaches like these view technology as a way to facilitate fundamental changes to learning methods. Technology resources allow easy access

to information and help the teacher cope with the complexities of managing individual and small-group work in the classroom (Ahearn, 1991).

Preparing for an uncertain role. The educational system clearly is responding to recent criticisms of its productivity by making profound changes in its goals and methods. Technology will certainly play a key role in the new system. However, the nature of the role remains uncertain, since it will depend on the paradigm or combination of paradigms that are eventually adopted. As Sheingold (1991) emphasized ". . . it is not the features of technology alone, but rather the ways in which those features are used in human environments that shape its impact" (p.18). The "ways in which those features are used" (i.e., integration strategies) are still being decided. Meanwhile, teachers face the difficult task of preparing appropriately for a future that is still in the process of being shaped. The set of skills and integration strategies needed to use technology effectively could differ radically depending on which restructuring direction a school takes.

Predictions on technology's role in restructuring education. Literature on technology's role yields some

common principles (Ahearn, 1991; Norris and Reigeluth, 1991; Foley, 1993; Luterbach and Reigeluth, 1994; Chesley, 1994; Reigeluth and Garfinkle, 1994; Jostens Learning Corporation, 1995). The following recurring themes seem to be perceived as central to all efforts at building a more effective system of education:

Teachers will retain a key role. Although teacher roles will undergo radical changes, few consider replacing teachers with technology-based delivery systems as a viable option. Even where teachers are not available or in short supply (e.g., in rural schools and highly technical subject areas), the technology strategy of choice seems to be networking or distance learning to optimize the power of available teachers. Technology resources will also help teachers shift their emphasis from delivering information to facilitating learning.

Interdisciplinary approaches will flourish. Curriculum will change from a disjointed collection of isolated skills training to integrated activities that incorporate many disciplines and call for teacher collaboration. The theme-based projects illustrate how technology resources can both focus and facilitate cross-disciplinary activities.

Research and problem solving skills will gain attention. Pure constructivist principles may prove difficult to implement under conditions of current constraints and resource limitations, but educational goals are already undergoing two kinds of shifts. First, an increasing emphasis on general-purpose study and research sills seeks to help learners in any content area. Use of databases, online information services and hypermedia systems will promote success in this new direction of studies. Second, the emphasis is shifting from learning isolated skills and information within each content area to learning how to solve problems specific to each area. Again, the emerging qualities of technology resources such as videodiscs, multimedia and telecommunications help teachers to focus students on such complex goals that call for underlying basic skills.

Assessment methods will change to reflect the new curriculum. New calls for "authentic assessment" methods mirror the need to make both instruction and evaluation of progress more relevant to student needs. Assessment of performance is shifting from paper-and-pencil tests to performance-based methods and student portfolios. Technology-based production tasks can serve both as means

of accomplishing this assessment goal and ways to track acquisition of underlying skills.

A Technology Planning Guide

Although no one is ever sure exactly what the future will bring, teachers know that they can strongly influence events in schools. Setting appropriate goals and developing sound plans for reaching them are such common-sense prerequisites for success in any endeavor that someone might assume that any technology project would follow a well-conceived plan. Sadly, this is not always the case.

Recent surveys indicate that schools and districts often purchase technology resources without first adopting technology usage plans (Dyrili and Kinnaman, 1994a). Lack of planning does not guarantee failure of an educational technology project any more than planning assures success. Still, technology experts and technology-oriented educators generally agree that developing and maintaining a school-level plan increases significantly the likelihood of receiving the full benefits of technology's potential for improving teaching, learning and productivity.

A technology plan helps a school make sure that its investment in technology pay expected dividends. However,

the process of planning itself requires an investment of time and resources. Technology planners can spend a substantial amount of time researching various products and services, meeting to discuss options and make decisions, documenting their findings and communicating them to others. Agreement may not come easily on issues such as which brands of computers and software to adopt and who gets computers first. In fact, these issues can spark ongoing, heated debate among faculty and staff. Anyone who undertakes this task must recognize that technology planning is worth the time and effort it requires. Several factors summarize the rationale for this preliminary investment:

Planning saves time and money. A technology plan helps to prevent purchases and activities that do not move the organization toward its goals. For example, if preset criteria guide equipment and software purchases, it is less likely that someone will buy products in a casual or uninformed way. Also, thorough, basic research on products and services ahead of time by a central committee avoids wasteful duplication of efforts later.

Planning helps achieve goals. As Robert Mager 1984) once said, "If you're not sure where you're going, you're

liable to end up someplace else"(p.v). Without a clear idea of what a technology issue should accomplish, it is difficult to know whether or not technology is achieving its goals and, if not, how to make changes. Technology plans require educators to set goals, periodically evaluate their progress toward achieving them, and revise them based on concrete evidence.

Planning builds motivation. Any effort to take advantage of technology's benefits must overcome a major problem of convincing people in the school that these resources justify the effort to integrate them. Planning for technology forces participation by key people from each group in the organization. As they review resources and set goals for technology use, they become acquainted with the potential benefits; they are also more likely to begin using technology resources that they have helped to select. Finally, participants in the planning process are more likely to become advocates for technology, working to convince other members of their groups to use resources that become available.

In sum, even the smallest school can find an abundance of good reasons to develop and adopt its own technology plan. Indeed, it hardly makes sense to use technology

without completing the planning process as an essential first step.

Planning Strategies and Steps

Before planning can begin, the planners must be identified. Most reports of first-hand experience with planning for technology (Apple Computer Company, 1991; Association for Media and Technology, 1991; See, 1992; Bruder, 1993, Dyrili and Kinnaman, 1994a; Wall, 1994; Brody, 1995) recommend assigning the task to a technology committee made up both educators and technology experts, as well as representatives from all groups in the school. As Dyrili and Kinnaman (1994a) and Brody (1995) point out, such committees are most effective when appointed by administrators who give them authority to implement what they recommend.

Several good sources document the steps that a planning committee should follow to develop a sound technology plan. In 1991, the Apple Computer Company developed a planning guide entitled *Teaching, Learning and Technology-A Planning Guide.* This recently updated multimedia package describes these steps in detail and gives examples in both written and video formats. Dyrli and Kinnaman (1994a) also describe a good sequence of

planning steps, and Brody (1995) gives a well-prepared summary of planning steps and guidelines. A recommended sequence common to these and other sources includes six steps:

Create a "merged version." As a critical first step, planners should envision potential applications of technology. As part of this process, they should identify a clear statement of the organization's mission and philosophy in order to articulate a role for technology. For example, a school's central goal may emphasize accelerated academics. Technology planners should then emphasize applications that will promote and reflect this priority. Dyrli and Kinnaman (1994a) advocate collecting and analyzing all available materials that document the organization's mission, curricular goals and objectives and educational guidelines. With this kind of information in hand, the committee can begin to research technology resources and activities with the aim of merging the educational version of the school with a vision of the benefits of technology to promote organizational goals and priorities.

Assess the current status. In the next step, technology planners review the organization's current uses

of technology. This usually requires a survey instrument to collect data on current resources and activities. The members of the planning committee may also want to visit classrooms and labs to observe technology uses first-hand and talk to those involved. Whenever possible, the committee should present data in visual ways such as charts and graphs so anyone can easily see who is doing what with technology resources.

Set goals. Dyrli and Kinnaman (1994a) call this activity "developing a guiding framework" (p.53). At this stage, planners specify concrete goals that direct the organization's later actions. These principles should address instructional, administrative and teacher productivity uses as specifically and in as much detail as possible. For example, a school may specify a goal that by a certain date, all teachers will keep their grades on an electronic gradebook program and that all teachers will make one presentation via presentation software or a multimedia system. To keep these performance aims practical and feasible, the committee will probably want to review other, previously developed plans that talk to a variety of experts and technology-oriented educators who have successfully adopted technology resources. Apple

(1995) also recommends careful review of and reflection on potential goals, leading to revisions that produce final statements.

Develop activities. After developing technology goals, the committee must outline specific activities that will take the organization from where it is to where it wants to be. This part of the plan specifies needed purchases and training and a timeframe for accomplishing them. The Apple Computer Company (1995) model calls for several events at this step: identifying human resources, developing a time line, developing a budget and identifying funding sources and deciding how to evaluate implementation. It also recommends developing a presentation package to communicate the plan to everyone involved.

Implement the plan. To make sure that a plan leads to actions, planners begin by obtaining approval and endorsement of key decision makers. They may present their findings to the board of trustees, principal and/or PTO board. Once the plan is approved, several individuals and groups will play key roles in implementation. The planning committee will continue to supply guidance and direction.

A technology coordinator can also help to oversee all the activities.

Evaluate and revise the plan. Implementation is not really the end of planning; in fact, technology planning should never really end. Technology changes so quickly and dramatically that periodic review and revision of any plan is an absolute necessity. Activities should be monitored continuously and adjusted as necessary to assure accomplishment of the overall goal: to use technology to improve education and promote the organization's educational agenda.

Characteristics of Good Planning

Apple (1991), See (1992), Dyrli and Kinnaman (1994a), and Wall (1994) offer good advice to assure effective completion of all phases of technology planning. There are several common points:

Involve teachers and other personnel at all levels. To obtain widespread support for a plan, the planning team should include parents, community leaders, school administrators and teachers. Involving teachers is especially important. Any technology plan must show where and how technology resources will fit into instructional plans for all grade levels and content areas. Just as

curriculum plans require input from teachers, technology plans depend on direct guidance from those who implement them.

Budget yearly amounts for technology purchases. Technology changes too rapidly for schools to expect one-time purchases of equipment or software to suffice. A technology plan should allow for yearly upgrades and additions to keep resources current and useful.

Make funding incremental. Few schools' yearly budgets allow the purchase of all needed resources or teacher training. A plan should identify a specific amount to spend each year and a priority list of activities to fund over the life of the plan.

Emphasize teacher training. Knowledgeable people are as important to a technology plan as up-to-date technology resources. Successful technology programs hinge on well-trained, motivated teachers. A technology plan should acknowledge and address this need with appropriate training activities. See (1992) recommends close coordination between technology training plans and staff development plans.

Apply technology to needs and integrate curriculum. To paraphrase the old adage, "If technology is the answer,

what's the question?" Effective planning focuses on the correct questions. For example, planners should ask, "What are our current unmet needs and how can technology address them?" Too many skip this question and jump to "How can we use this equipment and software?" It is difficult to identify needs since the emergence of technology has a way of changing them. Many educators did not realize that they needed faster communications until the fax machine, e-mail and cellular telephone became available.

Curriculum integration should also focus on "unmet needs." Technology should become an integral part of new methods to make education more efficient, exciting and successful. Planners should ask, "What are we teaching now that we can teach better with technology?" and "What can we teach with technology that we couldn't teach before but that should be taught?"

Keep current and build in flexibility. Both technology and users' opinions about how to implement it change daily. Leading-edge technology solutions can become out-of-date soon after their development as more capable resources emerge and new research and information clarify what works best. To keep up with these changes educators must constantly read and attend conferences, workshops and

meetings-a full time job in itself. Each school's technology plan should address how it will obtain and use technology resources over a 3-year to 5-year period. (New York State School Boards Association, 1989; Mageau, 1990; Orlando, 1993). But any technology plan should be designed to incorporate new information and changing priorities through yearly reviews and revisions (See, 1992).

Planning essentials and mistakes. See (1992) and Palazzo (1995) cite critical attributes and criteria for successful technology plans. These include: planning committees made up of parents, teachers, administrators and business leaders; provisions for on-site technical support; access to hardware and software; long-term staff development and in service training; assessment of present technology status and future needs; and ongoing assessment and evaluation methods. On the other hand, Wall (1994) and Dyrli and Kinnaman (1944a) note some common pitfalls to avoid:

1. Failing to link the organization's education goals to its technology planning goals.
2. Preoccupation with overly detailed recordkeeping or surveys that obscure or overlook the "big picture" of technology use.

3. Making plans too general (e.g., stating goals too vaguely) or too specific (e.g., requiring purchases of certain hardware that will become obsolete over time).
4. Making massive investments in untried, first generation technology.

The Apple Computer Company multimedia package (1995), Dyrli and Kinnaman (1994a), Van Dam (1994) and Palazzo (1995) offer good examples of plans that have already been developed. Apple demonstrates planning and implementation activities of four example schools. Dyrli and Kinnaman's article cites sample plans from the National Center for Technology Planning (NCTP) at Mississippi State University. They note that these plans can be obtained either by ftp (file transfer protocol) via the Internet at RA.MSSTATE.EDU in the directory /PUB/ARCHIVES/NCTP or by mail. Van Dam (1994) gives a very down-to-earth description of one school's experience in renovating its facility to accommodate and promote the use of new technologies. Palazzo (1995) describes five "great technology plans" that won a planning contest sponsored by a magazine.

Obtaining the Right Material and Personnel Resources

Funding for Technology Resources: Problems and Recommendations

In a field known for its lack of consensus, it is remarkable that there is the general agreement that adequate funding can mean the difference between the success or failure of even the best technology plans (November and Huntley, 1988; Bullough and Beatty (1991). Formal studies of obstacles to technology integration have reached the same conclusion (Bailey, 1990; Mahmood and Hirt, 1992). The most important issues in educational technology reflect those in the education system itself, and both place funding at the top of the list. Funding issues may be defined by three critical questions:

1. What do schools need to improve the present situation?
2. What kind of investments will it take?
3. Where and how will schools get the funds?

The first question is the most difficult to answer. Educators invest time and money in technology because they believe it will help to improve their ability to teach and students' ability to learn. Teachers devote great effort in locating resources to accomplish these aims. Once a school or an individual teacher decides what to do, a

wealth of guidelines and advice suggest resources that will meet the identified need and how to find money to buy them. However, several problems can complicate the identification of resources and the search for funding.

The high price of keeping up with technology. Besides the high initial cost, the primary problem with investing in technology is the changing pattern of technology usage along with revisions in the associated definition of "adequate resources." When microcomputers first entered schools in the late 1970's educators have striven to get enough microcomputers to lower their computer-to-student ratios and enough drill, tutorial and simulation software packages matched to all content areas and all grade levels. Schools that invested heavily in early mircocomputers were often surprised not only at how quickly their equipment became out-of-date, but also at its incompatibility with newer models. Within a relatively short period of time, a completely new generation of more capable and "friendly" equipment became available.

In addition, the philosophy of the benefits of technology for teaching and learning was evolving rapidly. The problem of providing adequate teacher training, always a difficult and expensive need, became even more difficult

without agreed-upon directions for how best to integrate technology into instruction. Maintenance and security for existing resources also became important cost issues. In the 1980's and 1990's, new directions in technology use replaced the emphasis on microcomputers with the trend toward multimedia and integrated learning systems. Schools now face a dual challenge that seems likely to remain the only constant amid changing educational technology: how to acquire technology resources adequate for today's needs while keeping an eye on emerging trends in the field that could affect future purchases and training.

Recommended funding strategies. Positive trends seem likely because most people are becoming aware of the increasingly pervasive influence of technology throughout society, and this influence cannot avoid education. Investments are at an all-time high in education because educators and parents alike recognize its critical role in current and planned efforts to make the educational system more efficient and more responsive to the needs of today's students (Branson, 1988; Dede, 1992). Current uses of technology based on past experience help to define and shape this future role. This accompanies a growing awareness among legislators and funding agencies that

technology in education will require major investments—both initially and continually (Clark, 1990; Rose, 1992). Several tactics can help educators who need funding for technology resources to identify the most promising technology-based activities and maximize their chances for finding financial support for their plans.

Business and industry partners have become part of a major strategy for funding education in general in recent years (McCarthy, 1993). Many companies have come to share a special interest in funding technology in education, and other potential sources abound. Several recent publications have documented these sources and how schools can tap them (*Technology and Learning, 1992; Electronic Learning, 1993)*. These journals' special issues, which also include advice on grant writing and fund raising, provide invaluable assistance in locating and obtaining support for technology.

In the best American tradition of frugality and economy, educators have created many ways of making do with their current technology resources (Smith, 1992; Finkel, 1993). Some strategies for optimizing resources emphasize:

- Requiring competitive bids for large sums or frequently used supplies
- Upgrading current software whenever possible
- Recycling whenever possible (e.g., re-inking printer cartridges)
- Using older equipment to meet lower-profile, noninstructional needs
- Sharing resources among groups whenever feasible

Setting Up Physical Facilities

Schools have developed several common arrangements for technology equipment. Table 1 details the benefits and limitations of each. A school could conceivably need several of these configurations, but which it will select depends on practical factors such as how much funding is available and how many students it serves. As Milone (1989) observes, the kinds of instruction that a school needs and wants to emphasize also influence these choices. Labs, for example, are usually considered more useful for providing group instruction, and they are more common at secondary levels; individual workstations seem better suited to small-group, classroom work, and they appear more often at lower grades.

Ideally, however, a school would have access to both classroom and lab resources. Each classroom should have a workstation capable of performing the full gamut of technology-based instructional and productivity activities from word processing to multimedia applications. This station could act as a learning station to support either individual or small-group work. In addition to classroom resources, every school should have at least one general-purpose lab with at least 15 to 20 stations to serve the productivity needs of students and teachers.

Dyrli and Kinnaman (1994b) describe how today's classrooms should "target for technology." They advise schools to plan to supply four computers per classroom, network and telecommunications access, CD-ROM and laserdisc players and display capability for both computers and large-screen projection. Although every school may not be able to attain these ideal conditions (at least not right away), a school should identify the facilities that it wants in its technology plan and set up a priority list that will help it work toward achieving them.

Bunson (1988) gives a rather complete list of concerns to address when setting up a microcomputer lab in a media center. These include:

Environmental factors. A lab's layout must provide spatial arrangements for equipment and traffic flow; furniture; power outlets, uninterrupted power sources, and backup power sources; antistatic mats and sprays; and proper temperature, lighting and acoustics.

Equipment acquisition. Software and hardware needs govern design criteria.

Administration. A lab's design must set policies for copyright enforcement, equipment distribution, control and access; staff responsibilities and training; budgeting for hardware, software, personnel, supplies, and maintenance; and public relations.

Manczuk (1994) updated this list with some additional factors to address. These include equity and access issues to assure that special populations (e.g., physically handicapped users) can benefit from the center and selection of an automated system to maintain and locate resources easily. Security measures and safety features (e.g., preventing electrical shocks) are also major concerns in lab design and placement. Apple Computer Company (1995) has developed a helpful guide that addresses all these important factors. Wilson (1991) also adds

design concerns specific to elementary schools, which need to "scale down" workstations for smaller students.

Van Dam (1994) is among a growing number of educators who urge schools to provide facilities that allow teachers "access to information via voice, video and computer data, anytime, anyplace" (p.56). For many schools this involves complete redesign or retrofit of their facilities. Van Dam describes how her school went about this effort. Such dramatic change is an expensive undertaking, but some organizations consider it so important to the future of technology integration that they have decided to allocate special funds to support the redesign activities (Macon, 1992).

Table 1

Types of Technology Facilities and Their Uses

	Benefits/ Possibilities	**Limitations/ Problems**	**Common Uses**
Laboratories	Centralized resources are easier to maintain and keep secure; software can be networked and shared.	Need permanent staff to supervise and maintain resources. Students must leave their classrooms.	Group instruction for instructional and productivity activities from word processing to multimedia.
Special-purpose labs	Permanent setups group resources specific to the needs of certain content areas or types of students	Usually exclude other groups	Programming courses; word processing classes of students in math, science, etc., teacher work labs, multimedia

	Benefits/ Possibilities	Limitations/ Problems	Common Uses
			production courses and activities
General-use computer labs open to all school groups	Accommodate varied uses by different groups	Difficult to schedule specific uses. Usually available to only one class at a time	Student productivity tasks (preparation of reports, assignments); class demonstrations; followup work
Library/media center labs	Same as general-use labs, but permanent staff are already present. Ready access to all materials to promote integration of computer and noncomputer resources	Same as general use labs. Staff will need special training. Classes cannot do production or group work that may bother other users of the library/media center	Same as general-use labs
Library/media center labs			Same as general-use labs
Mobile workstations	Stretch resources by sharing them among many users	Moving equipment increases breakage and other maintenance problems. Sometimes difficult to get through doors or up stairs.	Demonstrations
Mobile PCs (laptops)	On-demand access	Portability increases security problems	Individual student or teacher production tasks; teachers' assessment tasks
Classroom workstations	Easily accessible to teachers and students	No immediate assistance available to teachers. Only a few students can use at one time	Tutoring and drills; demonstrations; production tasks for cooperative learning groups; e-mail between other teachers
Standalone classroom computers	Easily accessible to teachers and students	Same as classroom workstations	Tutoring and drills; whole-class demonstrations

Training Teachers

Researchers generally agree that properly trained teachers make the difference between success or failure of an integration effort (Sheingold, 1991; Munday, Windham and Stamper, 1991; Dyrli and Kinnaman, 1994b; Siegel, 1995). Recent studies have settled on the kinds of areas in which teachers should be trained. The National Council for Accreditation (NCATE), the agency responsible for accrediting colleges of education, enlisted the help of the International Society for Technology in Education (ISTE) to develop standards for teaching about technology in education. Todd (1993) and Dyrli and Kinnaman (1994b) summarized fundamental technology goals that ISTE recommended for every teacher:

- Operate a computer system to use software successfully.
- Evaluate and use computers and other technologies to support instruction.
- Explore, evaluate and use technology-based applications, communications, presentations and decision making.

- Apply current instructional principles, research and appropriate assessment practices to the use of computers and related technologies.
- Demonstrate knowledge of uses of computers for problem solving, data collection, information management, communications, presentations and decision making.
- Develop student learning activities that integrate computers and technology for a variety of student grouping strategies and for diverse student populations.
- Evaluate, select and integrate computer/technology-based instruction in the curriculum in a subject area and/or grade level.
- Demonstrate knowledge of uses of multimedia, hypermedia and telecommunications tools to support instruction.
- Demonstrate skills in using productivity tools for professional and personal use, including word processing, database management, spreadsheet software and print/graphic utilities.

- Demonstrate knowledge of equity, ethical, legal and human issues of computing and technology use as they relate to society and model appropriate behavior.
- Identify resources to keep current in applications of computing and related technologies in education.
- Use technology to access information to enhance personal and professional productivity.
- Apply computers and related technologies to facilitate emerging roles of learners and educators.

All widespread recognition of the importance of teacher training has accompanied the recent concurrence on the list of required skills. Still, Sheingold (1991) pinpoints a fundamental stumbling block that will complicate teacher training for some time to come: "Teachers will have to confront squarely the difficult problem of creating a school environment that is fundamentally different from the one they themselves experienced" (p.23). Using technology doesn't stop with computer-based grades or assigning students to use word processing to produce traditional book reports. Instead, technology confronts teachers with both new possibilities and imperatives for radical changes in teaching behaviors.

Collins (1991) describes how these new teaching/learning environments differ from those of the past by citing eight trends identified from observations of schools that have begun using technology. He notes the following shifts in classroom behaviors:

- From whole-class to small-group instruction
- From lecture and recitation to coaching
- From working with better students to working with weaker ones
- Toward more engaged students
- From test-based assessment to that based on products, progress and effort
- From competitive to cooperative social structures
- From all students learning the same things to different students learning different things
- From primarily verbal learning to an integration of visual and verbal thinking

Since more preservice and inservice teachers experience educational environments far different from the one Collins describes, their technology training must provide first-hand experience with these new methods. Effective training must model the desired environment as it

teaches about the new technologies. Brooks and Kopp (1989) and Roblyer (1994) describe ways of modeling technology by using it in the regular activities of teacher education programs; these same methods could also improve inservice training. Suggestions for teacher trainers include:

Using cooperative learning activities, telecommunications-based projects and other non-traditional, non-lecture methods to carry out training; using presentation software to teach groups and requiring its use for learner presentations to classes and other groups; requiring use of technology products (e.g., software and videodiscs) in trainees' research projects or demonstrations for other courses or training workshops; requiring learners to do research for class projects using online, CD-ROM, or disc-based databases (e.g.ERIC);having each learner develop and maintain a personal database of recommended teaching resources that includes technology products and projects.

The research also generally reflects that technology training requires an ongoing school program rather than a one-shot, learn-it-now-or-else session. This new learning introduces too many new concepts and too much information for a teacher to absorb at one time, however long the

course. Finally, effective training requires "just in time" exposure to new ideas. Quality staff development is a process driven by the staff. When teachers determine for themselves what they need to learn, there is a positive feeling of ownership and a greater likelihood that the skills and information from the training will be internalized, retained and integrated. Finally, resources should be in place so that teachers can apply what they learn immediately after the training experience.

Implementation Issues

Maintenance and Security Concerns

With all their power and capabilities, computers and related technologies are simply machines. They are subject to the same mundane and frustrating problems as any equipment; that is, they can break down, malfunction or be damaged, or stolen. The literature reports that as microcomputers came into schools in greater numbers in the 1980's, these problems became increasingly important and expensive. Schools found that the initial cost of equipment was a fraction of the funds required to keep it available and useful to teachers. There are no easy answers to maintenance and security issues, and these subjects represent an important aspect of planning for

technology use. This section describes some of the ongoing maintenance and security concerns that will continue to powerfully affect teachers' ability to integrate technology.

Technology Labs and Workstations: Rules and Procedures. Most labs adopt rules intended to extend the lives of the resources they buy and make sure that the labs fulfill the purposes for which they were designed. Teachers will find that most of these same rules should apply to the classroom workstations. Lab rules and procedures should be posted prominently and should apply to everyone who uses the lab, from the administration to teacher aides:

- No eating, drinking, or smoking should be allowed near equipment.
- Lab resources should be reserved for instructional purposes (e.g., no one should play non-instructional games).
- Only authorized lab personnel should check out lab resources.

- Group work should be encouraged, but lab users should show respect for others by maintaining appropriate noise levels.
- Schedules for use should be strictly observed.
- Problems with equipment should be reported promptly to designated personnel.

Gray (1988) offers a dozen "gems" for managing a microcomputer lab effectively. Although written in 1988 for use in higher education, these guidelines apply equally well to labs and workstations in any educational organization, and they are as useful now as when they were written. They include:

1. Conduct a needs assessment.
2. Improve staff communication.
3. Use written operational guidelines.
4. Be cost-conscious.
5. Use wish lists.
6. Inspire student assistance.
7. Manage time effectively.
8. Provide staff development.
9. Keep accurate utilization methods.
10. Perform frequent evaluations.

11. Practice hands-on management.

12. Stay abreast of new developments.

Maintenance Needs and Options

Each teacher who uses technology needs training in simple troubleshooting procedures (e.g., how to confirm that the printer is plugged in and the "online button" lit, what to do if a computer says disc is "unreadable"). Educators should not be expected to address more complicated and diagnostic and maintenance problems, though. Nothing is more frustrating that depending on a piece of equipment to complete an important student project only to discover it is broken or functioning poorly. A technology plan must make some provision ahead of time to expediently replace and repair equipment designated for classroom use.

Schools can minimize technology repair problems if users follow good usage rules and do preventive maintenance procedures (e.g., regularly cleaning disc drives). Even under the best of circumstances, however, computers and other equipment will break or suffer damage. Whole businesses have sprung up to provide maintenance for microcomputers. Educational organizations usually choose one of the following maintenance options:

Maintenance contracts. Like health insurance for machines, these contracts guarantee that equipment will be repaired if and when it breaks. Equipment owners pay per-machine annual fees to outside suppliers that provide this service.

In-house maintenance office. Some educational organizations are large enough to hire special personnel and set up internal offices to service their equipment. Brody (1995) offers some tips on how to set up an effective in-house maintenance program.

Built-in maintenance. Some kinds of equipment, most notably integrated learning systems (ILSs), cover maintenance costs as part of their purchase or lease prices.

Repair and maintenance budget. Still other school settings choose to pay for repair and replacement of equipment needed by allocating portions of their operating budgets for this purpose.

Each of these methods has its problems and limitations, and debate continues over which method or combination of methods is most cost-effective for an organization of a given size with a given number of computers and peripherals.

Security Requirements

Microcomputers and peripherals such as the disc drives and printers can be very portable. Security is a separate, but equally important equipment maintenance issue. Loss of equipment from vandalism and theft is a common problem in schools. Again, several options are available to deal with this problem:

Monitoring and alarm systems. Some schools install security systems for their entire facilities or for areas that house technology equipment (Brody, 1995). As with home security systems, these systems typically monitor door or window openings, noises and/or movement within protected areas. If any problem is detected, the system automatically sets off an alarm and notifies the monitoring office which, in turn, calls the police and prearranged contacts.

Security cabinets. Specially-designed cabinets are available that enclose whole microcomputer stations, allowing teachers to close and lock them when not in use.

Lock-down systems. A variety of other methods can make equipment less easy to move. These include devices that attach computers to tables, and wires that tie equipment to furniture or floors.

As with maintenance strategies, each method of protecting equipment from loss is less than perfect and each involves considerable expense. Depending on the problems encountered at a specific site and the methods selected for dealing with them, equipment maintenance and security arrangements can easily take up a significant portion of the technology budget. But no school should leave security to chance. Everyone should start with the assumption that unprotected equipment will be stolen. Although security can be a significant technology-related expense, it is usually cheaper than replacing stolen or vandalized equipment.

Viruses: Causes, Prevention and Cures

Computer viruses are programs written specifically to cause damage or do mischief to other programs or to information (Hansen and Koltes, 1992). Like real viruses, these programs can pass to other programs they contact. Computer viruses can be passed by connecting one computer to another via telecommunications or by inserting the disc containing the virus into the computer. Some viruses are carried into a computer system on "Trojan horses," or other attractive programs ostensibly designed for another,

productive purpose but also carry instructions that get around protection codes (Lee, 1992). Some viruses are "worms," or programs designed specifically to run within (at the same time as) other programs; others are "logic bombs" that carry out destructive activities at certain dates or times. Many different strains of viruses plague computer systems, and more are being generated all the time. Hansen and Koltes (1992) hypothesize that most viruses are written out of curiosity or as intellectual challenges. Less often, they seem to have been produced as destructive forms of political or personal protest or revenge. However, Mungo and Clough (1992) warn that this latter kind of activity may be on the increase.

The impact of a virus can take many forms. Some viruses eat through data stored in a computer. Others replicate copies of themselves in computer memory and destroy files. Still others print mischievous messages or cause unusual screen displays. No matter what their purposes, viruses have the general effect of tying up computer resources, frustrating users and wasting valuable time. Even after a virus has been detected and removed from hard drives, it can return if users do not diligently

examine their floppy discs as they insert them into the computer.

Since computer viruses are currently as widespread and as communicable as the common cold, and they can interfere with planned activities nearly as much, teachers and schools must take precautions against contracting these electronic diseases. Dormady (1991) recommends a four-point programa of activities to minimize the impact of viruses:

Establish good practices. Scan systems and discs regularly for infections and foreign, suspicious software. Always backup important data or files.

Enforce safety policies. Do not allow users to run illegal copies of software on your computers. Allow only authorized programs to be placed on hard drives.

Use virus detection programs. Consider low-cost virus detection and removal programs as required purchases for labs and workstations.

Educate users. Train all personnel who store information on discs how to prevent, detect and remove viruses and how to prevent their spread among computers.

Ethical and Legal Issues

In many ways, technology users represent the society in a microcosm. The culture, language and problems of the larger society emerge among technology users, and their activities reflect many of the rules of conduct and values of society in general. The same array of problems arise when people try to work outside those values and rules. Applications of technology in education create two major kinds of ethical and legal issues that educators should be prepared to address. They should know both the causes and the implications of both problems.

Copyright infringements. Software packages are very much like books. Like book publishers, the companies protect their products against illegal copying under U.S. copyright law. When microcomputer software became an industry, the problem of illegal copying of discs, called software piracy, became widespread. Forester (1990) reported on large-scale illegal copying operations in some foreign

countries that produce thousands of copies of best-selling programs and sell them for as little as $10 each. Illegal copying has also become common among individuals, especially in education where teachers usually need multiple copies (e.g., for lab uses) but cannot afford per-copy prices. Many school personnel are not aware of laws protecting software copyrights or do not feel the same compunction about copying software that they do about making illegal copies of books or videos. Many educators have not clearly understood when copying is illegal and when they are permitted to make copies (Becker, 1992). Even when teachers clearly grasp these issues, their students make illegal copies, and schools are legally responsible for these infractions (Becker, 1992).

Software publishers initially responded to illegal copying by placing protection codes within the software on each disc. These quickly proved ineffective, as many computer enthusiasts set about breaking these codes as an entertaining challenge. Subsequently, software producers omitted such codes, put stern copyright warnings on their products and began to prosecute offenders.

Illegal Access

Another ethical problem has received increasing notoriety in the media in recent years: computer users gaining illegal access to computerized information. These problems are often classified as either "computer crime" or "hacking," although the definitions tend to overlap. In the usual image of computer crime, individuals gain illegal access to computerized records for illicit purposes from which they can profit. Software piracy and acts of mischief such as viruses and destruction of information are also considered computer crime. Hacking is not illegal in itself, but when this activity turns toward exploring ways to invade privately held information, it becomes a crime. This can be an especially serious problem in education since students just learning about the computer can easily cross over the line between harmless exploration and illegal access.

Recommendations to Address Ethical and Legal Issues

Educators' general response to these problems should two forms. First, they must keep their students and others informed of rules and expectations for ethical and legal

computer use. Second, they must adhere to strict rules of conduct themselves. This is not always easy to do, but educators must remember that by modeling ethical behavior with computers, they impart in their students principles that are just as important as skills in computer use. The following additional suggestions can help teachers deal with specific ethical issues:

Stop illegal copying. One noted authority on copyright issues for educational media has documented many pertinent copyright problems, laws, and punishments, how the problems came about and how to prevent them (Becker, 1992). The Software Publishers Association (1994) has also developed a summary of guidelines for software copying and a video entitled *Don't Copy that Floppy,* both of which are available upon request. Technology-oriented teachers should accept responsibility for obtaining and using these materials to keep themselves and others informed on this important issue. As Becker points out, educational organizations would be well-advised to protect themselves against copyright infringement suits by stating and publicizing a policy regarding software copying, requiring teacher and staff training on the topic and maintaining

hard drive and network programs that discourage users from making illegal copies. Schools should also consider options for providing adequate numbers of copies for their users (e.g., purchasing site licenses, lab packs or networkable versions).

Restricting illegal access. Although computer crime poses a greater threat in business and industry settings that in education, schools that maintain computer files on students and staff must take steps to restrict illegal access. Teachers should be sure to cover the topics of computer crime and ethical behavior and help students to understand the implications of illegal access.

Keeping Up—When Change Is The Only Constant

The literature reveals that most experts acknowledge that technology involvement can pose an intimidating challenge under the best of circumstances (Dyrli and Kinnaman, 1994b). Many teachers feel threatened by this challenge, for one reason, because it represents a journey into the unknown. "Technology-induced feelings of vulnerability can arise" (p.20). Technology's well-recognized pattern of rapid change complicates this

problem. Just when one gets used to a machine or software option, it changes and one has to learn another one. Some educators hesitate to buy any one kind of computer because they fear it will quickly become outdated (Jordahl, 1995).

There are no easy answers to these problems. Some teachers will have more trouble than others with this rapid rate of change. Perhaps some people feel challenged and energized by new situations, while others strongly prefer familiar things. For planning purposes, however, both kinds of people may benefit from a recognition that some changes are inevitable and predictable and that many changes will be good ones. Everyone should anticipate some of the following predictable changes:

Interfaces will get friendlier. As computer systems change, they are also getting increasingly easy to use. The invention of the on-screen desktop was a major leap forward in ease of use, and it will likely be around a long time. This means that skills in using a desktop will probably transfer to whatever microcomputer one uses in the future. Devices such as personal digital assistants (PDAs) and voice recognition input devices will also become more prevalent (Roybler, 1994).

More software will be on CD-ROM. Media for storing programs and files are getting more durable and reliable. CD-ROMs represent the latest development in this trend. Roblyer (1994) suggests that whenever possible teachers should get microcomputers equipped with CD-ROM drives and software in CD-ROM versions.

Dyrli and Kinnaman (1994b) seem to give teachers the best advice: ". . . embrace, (do) not fear, technological advance . . .{T}he earlier you get in the game, the better your position will be for taking advantage of what is to come" (p.48). For many teachers, the bad news is that change is inevitable; the good news is that the changes are usually for the better.

CHAPTER THREE

Method

The purpose of this research was to investigate two major questions: (1) How do teachers perceive integrating computers into their day-to-day work? and (2) What factors enable or impede computer integration by teachers? In the study quantitative data were collected and analyzed.

Quantitative data were collected from a survey administered to elementary classroom teachers from a small

suburban school in Los Angeles County. The 71-item survey was distributed to all elementary teachers in kindergarten through eighth grade at the school. Participation was voluntary and responses confidential. Descriptive statistics from questionnaire items designed to measure existing conditions of computer integration were used to investigate the questions "how do teachers perceive integrating computers into their day-to-day work?" and "what factors enable or impede computer integration by teachers?"

Subjects

The subjects in the study were elementary school teachers from kindergarten to eighth grade in a small suburban school in Los Angeles County. The school recently implemented school-wide technology resources and is beginning to develop a technology plan. A copy of the survey was placed in the mailboxes of the 36 teachers at the school. Of this total, 27(75 percent) were returned.

Survey Instrument

The survey consisted of 71 items which measured aspects of computer integration, facilitators and barriers and integration characteristics as identified in the review of

the related literature in Chapter 2. Responses to items were primarily Likert-type ranges or multiple choice. See Appendix A for the complete questionnaire. The instrument was revised once based on comments from various educators. It was pretested using five elementary classroom teachers. A final revision reflected their comments.

The questionnaire contained multiple-choice items to measure perceptions of frequency of use, whether at home or school and how often the computer is used during various time periods. One set of questions measured use for specific tasks related to teaching. Responses used a four-point range from "don't use" to "use routinely." The nine tasks were based on literature of teaching, particularly Reynolds (1992) and from the questionnaire used by Rockman, et al. (1992). In addition, subjects also indicated the importance of computer use for each task with choices that ranged from "not important" to "essential." Respondents also had an opportunity to add "other" tasks to the list.

A set of eight questions with a three-point Likert-type scale ranging from "not important" to "very important" measured reasons for using the computer. Items were developed based on previous studies (Hadley &

Sheingold,1993; Rockman, et al., (1992). A fill-in item was included so respondents could add "other" reason.

The instrument also contained ten statements about effects of computer use on teachers' work. Subjects chose from a four-point range from "strongly disagree" to "strongly agree."

Eleven items measured availability of various resources and ten measured the importance of various barriers. Responses for all items had a four-point range from "none" to "high." Resources and barriers included were based on research in computer integration in education.

Table 2

Questionnaire Items Measuring Conditions of Computer Integration

Computer Integration Conditions	**Indications**	**Survey Number(s)**
What tasks	Planning/preparing Research/information Managing Communication Reflection Professional growth	1-10
How often used	How often used	11
Where used	Whether used primarily at school, home or both	16
When used	During school prep time Before or after classes Evenings/weekends Vacation periods	17-20
Participation	Request hardware/software Request staff development Help other teachers Participate in technology planning	57-60

Computer Integration Conditions	Indications	Survey Number(s)
Why Used	Can do things faster Can do things better Learn to do new things Access information Collaborate/communicate with peers	21-29
Essentiality	Overall and by task	1-10,12
Influence on work	More confident, More work More time with students Better educator More professional, More productive More collaboration, More creative	30-39

Table 3

Questionnaire Items Measuring Facilitators and Barriers to Use		
Facilitators/Barriers	**Indications**	**Survey Number(s)**
Computer/related staff development	Availability/value	48,54,62
Hardware	Availability/value	14,15,47,64,68
Software	Availability/value	46,66,67
Onsite support	Availability/value	51,61
Time	Availability/value	55,63
Administrative support	Perceptions of support for computer use	49
Specific goals	Awareness of specific goals for computer use	50
Collaboration	Extent to which teachers help one another with computers	52,53
Confidence	Confidence in computer ability	69
Relevance	Appropriateness for daily tasks	70
Experience with Computers	Number of years experience using computer	40
Expertise	Perceptions about computer expertise	43-45
Technology Training	Computer courses taken	41

Procedures

Data Collection

Data collection was accomplished with the assistance of the school's Technology Director. I obtained permission to distribute the surveys to the teachers from the Headmaster. Copies of the survey were delivered to the school and the Technology Director placed them in the teachers' mailboxes. Attached to each survey was a letter explaining the study and a return envelope. See Appendix A for a copy of the cover letter. The Headmaster requested that teachers return the surveys to the Technology Director in the envelope provided. He then forwarded them to me.

Data Analysis

Frequencies were a primary method used to analyze quantitative data analysis collected in the study. Analyses included frequency distributions for responses to items measuring perceptions of computer integration and facilitators and barriers.

CHAPTER FOUR

Results

The purpose of this study was to explore how elementary teachers perceive the integration of computers in their day-to-day work and what facilitates and inhibits them. Results include frequency distributions, which address the research questions.

Frequency Results for Measures of Computer Integration

This study used a variety of indicators to measure differing perceptions of how elementary teachers are integrating computers into their day-to-day work. The following sections present these results.

How Often Teachers Use Computers

Teachers indicated their frequency of use by responding to the item, "about how often do you currently use a computer for any work-related activities?" Three-fourths of the teachers responding to the survey (75.4 percent) used the computer at least two to three times a

week; less than a majority (45.1 percent) use it daily. Table 4 shows the distribution of responses to the item.

Table 4

Frequency of Computer Use	
Frequency	**N (%)**
Never	1 (5.6)
Less than once a month	1 (5.6)
One to two times a month	1 (5.6)
Once a week	4 (7.8)
Two to three times a week	8 (30.3)
Daily	12(45.1)

Where Teachers Use Computers

Only one teacher (5.6 percent) reported that there was no access to a computer at school, and 70.4 percent of the subjects reported having a computer in the classroom. Most (77.5 percent) also had a computer at home. Of the 17 subjects who had a computer at home, 16 indicated that they used their home computer more than a computer at school for work and 11 used the computer both at home and at school. Table 5 shows the location of the computer more for work.

Table 5

Location of Computer Used More Often for Work		
Response	**N**	**(%)**
At home	6	(23.2)
At school	8	(29.6)
Both at school and at home	11	(40.8)
Other	2	(4.9)

When Teachers Use Computers

Most of the subjects reported using the computer at least sometimes during prep time (76.6 percent), before or after class (84.8 percent), evening or weekends (59.4 percent) and during vacation periods (48.2 percent). Responses indicated that the most frequent use of the computer was during prep time followed by before or after class, evenings or weekends and during vacation periods. Table 6 shows when subjects most often use the computer in order of range from "frequently"(4) to "never" (1).

Table 6

Frequencies for When Subjects Use the Computer

N=27	Never N(%)	Rarely N (%)	Sometimes N (%)	Frequently N (%)
During prep time	4 (15)	2 (8.5)	7 (25.9)	14 (50.7)
Before or after class	4 (15)	3 (11.3)	10(35.9)	13 (48.9)
Evenings and/or weekends	5 (18.6)	3 (11.3)	5(18.6)	11 (40.8)
During vacation periods	7 (25.9)	4 (15)	5 (18.6)	8 (29.6)

For What Tasks Teachers Use Computers

A majority of subjects indicated that they routinely use the computer to create instructional materials. The

computer was used for this task by the highest number of respondents; only two indicated that they did not use the computer for this activity.

Three subjects added an "other" activity to the nine that were listed on the survey. These additional activities included writing letters, using a music writing program and training others to use the computer. Some responses, such as roll sheets, report cards and presentations, were already covered in the specified activities.

A majority of the subjects did not use the computer for two of the tasks, interacting with colleagues (51.8 percent) and analyzing the effectiveness of specific lessons (62.9 percent). Table 7 shows the number and percent of subjects using the computer for each task by frequency of use. Activities appear from highest (use routinely=4) to lowest (don't use=1) score.

Table 7

Number and Percent of Subjects Using the Computer for Specified Tasks

Activity N=27	**Don't Use N (%)**	**Use Rarely N (%)**	**Use Occasionally N (%)**	**Use Routinely N (%)**
Create instructional materials	2 (8.5)	3(11.3)	8 (29.6)	14(51.8)
Perform administrative tasks	5 (18.6)	4(14.2)	6 (22.2)	12(44.4)

Activity N=27	Don't Use N (%)	Use Rarely N (%)	Use Occasionally N (%)	Use Routinely N (%)
Develop units or lessons	4 (14.2)	4(14.2)	9 (32.6)	10(35.9)
Gather information	6 (22.2)	7(25.9)	9 (32.6)	5 (18.6)
Monitor/assess student learning	8 (29.6)	7(25.9)	4 (14.2)	8 (29.6)
Continue professional growth	8 (29.6)	5(18.6)	7 (25.9)	7 (25.9)
Present lessons	11(40.8)	7(25.9)	5 (18.6)	4 (14.2)
Interact with other teachers	14(51.8)	5(18.6)	5 (18.6)	3 (11.3)
Analyze effectiveness of specific lessons	17(62.9)	6(22.2)	2 (7.5)	2 (7.5)

Essentiality of Computers to Work

When asked to rate how essential computers were to their work, 48.6 percent of the subjects indicated that they couldn't imagine doing their job without a computer; at the other end of the scale, 7.5 percent said that they would do just as well without one. Table 8 shows how the subjects responded to the survey question.

Table 8

Overall Essentiality of Computer	
	N (%)
I'd do just as well without it	2 (7.5)
There are a few things I would miss	2 (7.5)
There are several things I would miss	10 (34.5)
I can't imagine doing my job without it	13 (48.6)

Respondents also rate how essential the computer was for specific tasks. The computer was rated as essential for administrative tasks by 40.8 percent of those responding (N=27). Creating instructional materials received the second highest percent of essential ratings (40.8 percent of 27 responses). Table 9 shows how the subjects rated the importance of the computer for the nine specified tasks. Tasks appear from highest (essential) to lowest (not important) score.

Table 9

Essentiality of the Computer for Specified Tasks

Activity N=27	**Not Important** N (%)	**Somewhat Important** N (%)	**Important** N (%)	**Essential** N (%)
Create instructional materials	2 (7.5)	4 (14.2)	10 (35.9)	11 (40.8)
Perform administrative tasks	4 (14.2)	3 (11.3)	9 (32.6)	11 (40.8)
Develop units or lessons	4 (14.2)	5(18.6)	9 (32.6)	9 (32.6)
Gather information	4 (14.2)	6 (22.2)	10 (35.9)	7 (25.9)
Continue professional growth	5 (18.6)	6 (22.2)	8 (29.6)	8 (29.6)
Monitor, assess student learning	6 (22.2)	6 (22.2)	7 (25.9)	8 (29.6)
Present lessons	7 (25.9)	7 (25.9)	8 (29.6)	4 (14.2)
Interact with colleagues	10 (35.9)	6 (22.2)	6 (22.2)	5 (18.6)
Analyze effectiveness of specific lessons	14 (50.7)	5 (18.6)	5 (18.6)	3 (11.3)

Subjects were also asked to indicate a single activity they would fight for if they were limited to only one computer activity. Of the 27 who responded to the item, the largest number listed word processing followed by recordkeeping and grading. Table 10 summarizes responses to this fill-in item.

Table 10

What One Computer Activity Subjects Would Fight to Keep	
Activity	**Number of Responses**
Word Processing	7
Recordkeeping, grading	7
Developing materials, lessons	6
Internet access	2
Research	1
More computers	1
Miscellaneous (student use)	3

Why Teachers Use Computers

Of the eight reasons specified for why they use a computer in their work, the highest percent of teachers (74.1 percent) rated "to create more effective materials" very important. A large percent of teachers (70.4 percent) also indicated "to save time" was very important. Table 11 shows the number and percent of responses for each rating. Reasons appear in order from the highest (very important) to lowest (not important).

Table 11

Importance of Reasons for Using the Computer			
Reason	**Not Important N (%)**	**Somewhat Important N (%)**	**Very Important N (%)**
I can create more effective materials	2 (7.5)	5 (18.6)	20 (74.1)
It saves time	2 (7.5)	6 (22.2)	19 (70.4)
I can keep better track of student performance and records	7 (25.9)	7 (25.9)	13 (48.9)
I can use the Internet to access information and ideas	9 (32.6)	7 (24.9)	11 (39.7)
It can help me do things I don't currently know how to do very well	9 (32.6)	12 (44.4)	6 (22.2)
It helps me seek and find valuable information on students	13 (48.2)	7 (25.9)	7 (25.9)
I can communicate with others regardless of where they are	13 (48.9)	8 (29.6)	6 (22.2)
I get lots of ideas and help from other teachers	12 (44.4)	11 (39.7)	4 (14.2)

How Teachers Advocate Computer Use

A majority of teachers had in the past year requested new hardware (66.6 percent) and helped other teachers with computer-related problems (62.9 percent). A smaller percent had requested computer-related staff development (44.4 percent), and 40.8 percent had participated in the development of a technology plan. Only 11.3 percent belong to a computer-related organization. Table 12 presents the responses to questionnaire items measuring advocacy of computer use.

Table 12

Advocating Computer Use		
Type of Advocacy	**No N (%)**	**Yes N (%)**
Requested new hardware or software from school	9 (33.3)	18 (66.6)
Helped other teachers use the computer	10 (35.9)	17 (62.9)
Requested additional staff development from school	15 (55.5)	12 (44.4)
Participated in the development of a technology plan	16 (59.3)	11 (40.8)
Belong to a computer organization	24 (88.8)	3 (11.3)

Computer Use and Teachers' Perceptions of Their Own Work

Ten questionnaire items measured various ways in which using the computer might influence teachers' perceptions of their work. Over one-third of the subjects (35.9 percent) strongly agreed with the statement "I am more productive," and nearly one-third (32.6 percent) strongly agreed with the statement "I feel more professional." Only ten percent indicated that they have more time with students, and even fewer (3 percent) collaborate more with other teachers. Table 13 shows the distribution of responses to the questionnaire items. Statements appear by score from highest (strongly agree=4) to lowest (strongly disagree=1).

Table 13

Influence of Computer Use on Teachers' Perceptions of Their Own Work				
Statement	**Disagree Strongly N (%)**	**Disagree N (%)**	**Agree N (%)**	**Agree Strongly N (%)**
I'm more productive	3 (11.3)	3 (11.3)	11(40.8)	10 (35.9)
I feel more professional	4 (14.2)	4 (14.2)	11 (40.8)	9 (32.6)
I'm more creative	4 (14.2)	5 (18.6)	12 (44.4)	6 (22.2)
I'm a better educator	5 (18.6)	6 (22.2)	12 (44.4)	4 (14.2)
I am better informed	4 (14.2)	8 (29.6)	10 (35.9)	5 (18.6)
I'm more excited about work	6 (22.2)	5 (18.6)	10 (35.9)	4 (14.2)
My workload has increased	5 (18.6)	11 (40.8)	7 (25.9)	4 (14.2)
I have more time with students	5 (18.6)	14 (50.7)	6 (22.2)	2 (7.5)
I work more at home than even	8 (28.8)	10 (35.9)	5 (18.6)	4 (14.2)
I collaborate more with other teachers	8 (28.8)	13 (48.9)	5 (18.6)	1 (3)

Frequency Results for Facilitators and Barriers To Teachers' Computer Integration

Available Resources

Specified resources were either moderately or highly available to a majority of respondents except for the following three: (1) release time to observe examples (14.3 percent either moderate or high); (2) E-mail and Internet access (32.8 percent either moderate or high). Access to hardware and software were the more available resources with each moderately or highly accessible to 73.6 percent of respondents. Table 14 lists the accessibility of

specified resources in order of score from high (4) to none (1).

Table 14

Accessibility of Resources				
Resource	**None N (%)**	**Low N (%)**	**Moderate N (%)**	**High N (%)**
Computer hardware	1 (3)	6 (22.2)	10 (35.9)	10 (35.9)
Computer software	1 (3)	6 (22.2)	12 (44.4)	8 (29.6)
School administrator support	2 (7.5)	6 (22.2)	9 (32.6)	10 (35.9)
Help with hardware or software problems from other teachers	1 (3)	7 (25.9)	11 (40.8)	8 (29.6)
Formal onsite technical assistance	3 (11.3)	6 (22.2)	9 (32.6)	9 (32.6)
Conversations among teachers about uses of computers	2 (7.5)	10 (35.9)	10 (35.9)	5 (18.6)
Computer-related inservices	2 (7.5)	10 (35.9)	8 (29.6)	6 (22.2)
Specified goals for teacher computer use	4 (14.2)	7 (25.9)	10 (35.9)	6 (22.2)
Opportunities to take voluntary classes	4 (14.2)	11 (40.8)	7 (25.9)	5 (18.6)
E-mail and Internet Access	7 (25.9)	11 (40.8)	5(18.6)	4 (14.2)
Release time to observe good examples of computer use by other teachers	13 (48.9)	9 (32.6)	3(11.3)	1 (3.6)

Barriers to Computer Integration

The only barrier which a majority of respondents rated as having either moderate or high importance was "too many other responsibilities," with 25.9 percent of respondents rating it as moderately important and 32.6 percent rating

its importance as high. The importance of not enough staff development opportunities was rated as moderate or high by 36.4 percent of those responding. Table 15 lists the number and percent of responses for each potential barrier listed by score from highest to lowest.

Table 15

Importance of Barriers to Computer Use

Barrier	None N (%)	Low N (%)	Moderate N (%)	High N (%)
Too many other responsibilities	4 (14.2)	7 (25.9)	7 (25.9)	9 (32.6)
Not enough staff development opportunities	8 (29.6)	9 (32.6)	6 (22.2)	4 (14.2)
Hardware capacity too limited	8 (29.6)	10 (35.9)	5 (18.6)	4 (14.2)
No technical support when I need it	9 (32.6)	9 (32.6)	5 (18.6)	4 (14.2)
Can't get the right kind of software	10 (35.9)	8 (29.6)	5 (18.6)	4 (14.2)
Software is too complicated	9 (32.6)	10 (35.9)	5 (18.6)	2 (7.5)
Can do my work as well without computer	11 (39.7)	8 (29.6)	5 (18.6)	3 (11.3)
Few interested teachers at school	10 (35.9)	12 (44.4)	5 (18.6)	2 (7.5)
No convenient access to a computer	14 (51.9)	6 (22.2)	3 (11.3)	4 (14.2)
Not confident enough	12 (44.4)	8 (29.6)	4 (14.2)	3 (11.3)

Conclusions

The purpose of this study was to expand the knowledge base regarding how teachers perceive integrating computers into their day-to-day work and what factors facilitate or impede their computer use. Limited prior research provides

support that computer use improves teacher productivity (Rockman, Pershing & Ware, 1992) and increases feelings of professionalism and effectiveness (Wilson, Hamilton & Cyr, 1994). Advances in educational technology have expanded notions regarding the use of computers to support performance, for example where humans and computers work together to know and perform beyond what either could do alone. The results of this study build on research and contribute information and insights into teachers' current computer practices and the factors, which enable or impede them.

The subjects in this study reveal a picture of teachers who generally are interested in using the computer and who already, at least to a certain extent, do use the computer in certain conventional and high priority aspects of their work. The results suggest that teachers use computers more than in the past, and they are interested in learning new ways in which the computer can help them do their work. Regardless of their frequency of computer use and perceptions of their own computer expertise, the subjects generally responded that it is important for teachers to use computers.

The study has implications for the design and delivery of computer training. Lack of training has emerged as an important barrier in most prior research on computers in education. Results of this study indicate that training to expand the computer knowledge and skills of teachers remains a critical issue. With increasingly complex machines and more network access, training will certainly be a necessary resource to encourage teachers to take appropriate advantage of the resources the computer provides.

The importance of the perception of relevance in this study suggests that for training to succeed, teachers must perceive it as relevant and applicable to their particular situation. Another potentially effective avenue to facilitate computer use suggested by the results is providing release time to observe other teachers. The teachers in this study who use the computer most frequently and perceived themselves as having more expertise appear to use the computer in a greater variety of ways. Effective training might include a wider variety of potential uses.

Results that teachers are currently using the computer to increase their productivity and to do tasks they already know how to do are consistent with the vision of the

computer as a productivity tool. If the desired outcome is for teachers to use computers to transform their teaching or to support their professional growth, there is work to be done. Results of this study suggest additional research questions to be investigated. For example, what type of training do teachers need to expand their uses of computers in their work, and what approach is most effective? As the presence of facilitators and barriers changes, do teachers' perceptions of their use of computers for work change? These are among the questions that will provide insights into ways that teachers might more fully utilize the increasing intelligence of computers to support their ongoing development as reflective, professional educators.

APPENDIX A

COVER LETTER AND QUESTIONNAIRE

August,1999

Dear Elementary Classroom Teacher:

I am a graduate student in the California State University, San Bernardino masters program in education. I need your help for a study I am conducting for my project that investigates computer integration. The focus is on how you use computers in your work. The attached survey seeks your opinions and experiences. Your responses will contribute valuable information on what "computer integration" in teachers' work means and what enables or prevents teachers' computer use. Your responses are valuable no matter how much or how little you use the computer.

Please complete the survey and return it to the Technology Director in the envelope provided. He will forward it to me. Should you have any questions, please call me at (909)985-9332.

Sincerely,

Nancy Pitre-Jasko

TEACHERS' INTEGRATION OF COMPUTERS IN THEIR WORK

Below are some tasks generally associated with teachers' work. Please circle the response that best describes your computer use for each task and how important you consider that use to be (circle one for each item in each category).

	Frequency of Use				Importance of Use			
	Don't Use	Use Rarely	Use Occasionally	Use Routinely	Not Important	Somewhat Important	Important	Essential
1. Develop units or lessons	1	2	3	4	1	2	3	4
2. Create instructional materials	1	2	3	4	1	2	3	4
3. Gather information	1	2	3	4	1	2	3	4
4. Present lessons	1	2	3	4	1	2	3	4
5. Perform administrative tasks	1	2	3	4	1	2	3	4
6. Monitor, assess student learning	1	2	3	4	1	2	3	4
7. Interact with colleagues	1	2	3	4	1	2	3	4
8. Analyze the effectiveness of specific lessons	1	2	3	4	1	2	3	4
9. Continue professional growth	1	2	3	4	1	2	3	4
10. Other (Please specify) _____ _____	1	2	3	4	1	2	3	4

11. About how often do you currently use a computer for any work-related activities?
    _____a. Never
    _____b. Less than once a month
    _____c. Once or twice a month
    _____d. Once a week
    _____e. Two or three times a week
    _____f. Every day

12. Overall, how essential is the computer to your work as a teacher?
    _____a. I'd do just as well without it.
    _____b. There are a few things I'd miss.
    _____c. There are several things I'd miss.
    _____d. I can't imagine doing my work without it.

13. If your computer use were limited to one activity, what would you fight for?

    _____

14. Do you have access to a computer at school?
_____a. No
_____b. Yes, in my classroom
_____c. Not in my classroom, but accessible

15. Do you have a computer at home?
_____a. No
_____b. Yes

16. Which computer do you use most often for your work?
_____a. At school
_____b. At home
_____c. Both at school and at home
_____d. Other (Please specify)_____

I use the computer for work	Never	Rarely	Sometimes	Frequently
17. During scheduled prep time.	1	2	3	4
18. Before or after classes.	1	2	3	4
19. Evenings and/or weekends.	1	2	3	4
20. During vacation periods.	1	2	3	4

Below are some reasons teachers might give for using computers. Please indicate how important each reason is to you.	Not Important	Somewhat Important	Very Important
21. It saves time.	1	2	3
22. 1 can create more effective materials.	1	2	3
23. It can help me do things I don't currently know how to do very well.	1	2	3
24. It helps me seek and find valuable information on students.	1	2	3
25. 1 can keep better track of student performance and records.	1	2	3
26. 1 can communicate and collaborate with others regardless of where they are.	1	2	3
27. 1 can use the Internet to access information and ideas.	1	2	3
28. 1 get lots of ideas and help from other teachers.	1	2	3
29. Other (Please specify)	1	2	3

Below are some statements teachers might make regarding computers and their work. Please circle the response that corresponds most closely with your opinion.

Since I started using the computer	Strongly Disagree	Disagree	Agree	Strongly Agree
30. 1 think I am a better educator.	1	2	3	4
31. 1 am more productive.	1	2	3	4
32. 1 have more time with my students.	1	2	3	4
33. 1 feel more professional.	1	2	3	4
34. 1 am generally better informed.	1	2	3	4

35. I find myself doing schoolwork at home more than ever. 1 2 3 4

36. I collaborate more with other teachers. 1 2 3 4

37. I find I am more excited about my work. 1 2 3 4

38. My workload has increased even more. 1 2 3 4

39. I find I am a more creative teacher. 1 2 3 4

40. For approximately how many years have you used a computer?_____

41. Approximately how many of each of the following have you taken?
_____a. University or college computer courses for credit
_____b. Required computer-related inservices.
_____c. Voluntary computer-related inservices.

42. Do you belong to any computer-related organizations or special interest groups?
_____a. No
_____b. Yes

43. How would you rate your overall computer expertise?
_____ Nonuser _____ Novice _____ Moderate _____ Above Average _____ Experienced

44. How would you rate your computer expertise compared to that of the other teachers at your school?

_____ I'm less experienced than most _____ I'm about the same _____ I'm more experienced than most

45. How would you rate your computer expertise compared to that of your students

_____ I'm less experienced than most _____ I'm about the same _____ I'm more experienced than most

Please rate how accessible each of the following is to you at school and how valuable a contribution it has made to your work (circle one for each item in each category)

	Accessibility				Value			
	None	Low	Moderate	High	None	Low	Moderate	High
46. Computer software	1	2	3	4	1	2	3	4
47. Computer hardware	1	2	3	4	1	2	3	4
48. Computer-related district or school inservices	1	2	3	4	1	2	3	4
49. School administrator support	1	2	3	4	1	2	3	4
50. Specified goals for teacher computer use in a School Improvement (or other) Plan	1	2	3	4	1	2	3	4
51. Formal onsite technical assistance (such as a technology coordinator or specialist)	1	2	3	4	1	2	3	4

	Accessibility				Value			
52. Help from other teachers with software or hardware problems	1	2	3	4	1	2	3	4
53. Conversations among teachers about uses of computers.	1	2	3	4	1	2	3	4
54. Opportunities to take voluntary inservice classes	1	2	3	4	1	2	3	4
55. Release time to observe good examples of computer use by other teachers	1	2	3	4	1	2	3	4
56. E-mail and Internet access	1	2	3	4	1	2	3	4

In the past year have you...

57. Requested new hardware or software from your department, school, or district? _____ No _____ Yes

58. Requested additional staff development from your department, school, or district? _____ No _____ Yes

59. Helped other teachers use the computer? _____ No _____ Yes

60. Participated in the development of a technology plan? _____ No _____ Yes

How much of a factor is each of the following in preventing you from using the computer in your work?

	None	Low	Moderate	High
61. I can't get technical support when I need it.	1	2	3	4
62. There aren't enough staff development opportunities.	1	2	3	4
63. I have too many other responsibilities to devote the time I need to learn more about new uses for the computer.	1	2	3	4
64. I don't have convenient access to a computer when I need it.	1	2	3	4
65. Few other teachers at my school are interested in talking about computers.	1	2	3	4
66. The software is too complicated for me to figure out on my own.	1	2	3	4
67. I can't get the right kind of software for what I want to do.	1	2	3	4
68. The capacity of the hardware available to me is too limited.	1	2	3	4
69. I don't feel confident enough to try new things on the computer.	1	2	3	4
70. I can do my work just as well without a computer.	1	2	3	4
71. Other (please specify) _____	1	2	3	4

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