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TEACHING IN THE INFORMATION AGE: FACTORS AFFECTING TEACHERS UTILIZING TECHNOLOGY IN EDUCATION

By

Jason Butki

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ABSTRACT

**TEACHING IN THE INFORMATION AGE:
FACTORS AFFECTING TEACHERS
UTILIZING TECHNOLOGY IN EDUCATION**

By

Jason Butki

The American school system is one of the last labor-intensive industries to begin to use technology in a day-to-day manner. The goal of this paper is to explore the factors affecting teachers who are attempting to utilize technology in their classrooms. Research questions that will be covered include: What are the reasons for lack of change in which technologies are used in schools? What are the factors affecting teachers implementing technology in the classroom? What is the definition of technology? What are the teachers' attitudes towards technology?

This thesis is based on a survey of 1,200 elementary teachers in Michigan, New York, and Pennsylvania completed by Public Sector Consultants (PSC), Inc.

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I. INTRODUCTION

We are living in the Information Age. There have been massive changes in the amount of information available, changes in the value of information, and changes in the way information is used. Consider the following facts:

- In 1992, it was estimated that the volume of available information was doubling every two years.
- Today a weekly edition of The New York Times contains more information than an average person would come across in a lifetime in 17th Century England.
- Research libraries are adding two miles of shelf space per year.
- More than half of all mathematics known today has been invented since World War II.
- Information is referred to as having a half-life (the amount of time within which half of it will become obsolete).

(ECNet Project Participant Manual)

The dramatic rise in information available is directly related to advances in technology. Computer technology has consistently continued to increase in capabilities while decreasing in cost. This increase in technological capability has not only improved the computer, but has driven other technologies as well. Computer technologies have merged with telecommunication technologies, and networks such as the Internet and the proposed National Research and Education Network (NREN) are becoming available

to provide access to this wealth of information. Suddenly, new kinds of learning opportunities are available as the walls which once constricted classrooms are suddenly becoming easy to breach by students collecting information and communicating with each other, with other teachers, with scientists, and a various host of other contacts.

As wonderful as these communication/information gathering computers and networks are, they are not alone in the advancing technologies. Multimedia applications have also opened new worlds of learning opportunities, and an assorted array of other new technologies, including CD-ROM, laser discs, LCD panels, audio systems, and others, are finding their way into classrooms of today. Buzz words such as "implementing technology into the classroom," "surfing the Internet," the "information super-highway," and "instructional-based multimedia resources" abound, and offer promise after promise into educators' ears. This "techno-hype" offers technology as the cure-all for education, the tool for saving America's schools and for bringing them up to speed with other institutions that have been revolutionized by technology. (Rockman, pg 25) There is no doubt that the potential opportunities for students to take advantage of this multitude of technological advances has generated an enormous amount of excitement, and an even greater amount of confusion, in the educational community.

A general question for this thesis is: where does the "techno-hype" glamour of new technologies and wondrous new

learning opportunities intersect with the current reality of a classroom teacher with an estimated six classes, six subjects, and 20-30 students per class to instruct on a daily basis? This paper will attempt to answer this question, as well as the following:

Question 1: What are the reasons that systemic and wide-spread changes have not taken place in the way technologies are used to teach in public schools? Math and science, because of their natural links to and increasing dependence on technology, are areas of great need that could potentially benefit most by a systemic and carefully implemented plan to increase the use of technology in the classroom. The reasons for schools failing to keep pace with other institutions in the use of technology will be sought out and will focus on those factors that more directly affect and hinder the "average" classroom teacher in utilizing technology.

Question 2: What is the definition of technology? It is important to fully understand the specific technologies in question before generalizations about use of technologies can be made. The term "technology" will be explored and categorized into sub-components intended to act as points of

reference to compare specific pieces of hardware or software and their intended uses.

Question 3: What are the teachers' attitudes towards technology? Specifically, are teachers willing to use technology more in the classroom? The key to improving the way technology is used in schools will ultimately rest upon the shoulders of the classroom teacher. Teachers' attitudes and willingness to accept and utilize technology is a critical factor, and will be looked at closely.

These general questions help formulate the following premises which provide the outline for this thesis:

1. There is a lack of change in the American school system compared to other institutions regarding implementation of technologies into everyday practice.
    a. There are several widely varied reasons for this lack of change.
2. There is a movement to restructure America's school system, and technology plays a supporting role.
    a. There is a resistance to change in schools, especially regarding technology.
3. There is a need for change in the way schools utilize modern technologies.

a. New standards are arising to assist in the process of change.

4. The term "technology" is multi-faceted, and is often too all-encompassing, which creates further confusion in the education community.
   a. Categorizing, or defining different technologies by use, is helpful to understand how they can work together.
5. Teachers recognize the need to change the way technologies are viewed and how they are used in schools.
   a. Teachers need a great deal of technical assistance while working with new technologies.
   b. The amount of technology currently in place in schools can be quantified.

II. HISTORY OF TECHNOLOGY AND REFORM

There is a common analogy describing the stagnation of technological advancements in the American school system. The analogy has been repeated, in one form or another, in many books, conference presentations, and articles involving issues of education and technological reform. The analogy goes something like this:

Imagine that a small group of professionals from 100 years ago are somehow transported through time to present-day. Each is given the opportunity to visit the modern workplaces of their respective fields. Imagine a businessman from the past witnessing today's multi-national corporations communicating virtually instantaneously with other offices worldwide using faxes, digital phone switches, and global computer networks. Imagine a time-traveling doctor watching a modern day counterpart utilize a dizzying array of technological advances, including x-rays, heart monitors, lasers, and advanced testing laboratories. Imagine the sights our visitors from industries such as communications, entertainment, transportation, engineering, science, and other fields would see! Awash in the glare of blinking electronics, advanced communication devices, satellite networks and glowing computers, many of the visitors would hardly recognize their own professions! However, if the group included a teacher, that person would readily recognize a classroom of today. A few tools may be different, and the standard techniques may have changed, but

the teacher would fully see the point of most of what was being attempted, and probably could quite easily take over the class! (Papert, pg 1)

The analogy, though common, is somewhat misleading. One cannot say that there has been no change at all in education for the past 100 years - of course there have been changes, and of course technology has advanced in the classroom. VCR's, television production equipment, computers, satellite and cable programming and other forms of technology are being used in many of today's schools, but none have yet to drastically alter the way classrooms operate. The analogy highlights the fact that while some areas of human activity have been revolutionized by the incredible growth of science and technology in our recent past, school is a notable example of an area that has not. While the system of schooling has changed, it has not advanced in ways which substantially altered its nature. The example sets up an often asked question: Why, through a period when so much human activity had been revolutionized by technology, have we not seen a comparable change in the way we help our children learn? (Papert, pg 2)

II. A. Reasons for Lack of Change

The question of why schools have not kept up to date with emerging technologies is a very complex one, and the reasons are as varied as the applications of technologies themselves. Funding issues, curriculum mandates, differences between local and state administrations, and a predomination of social problems are but a few of the obstacles schools face. The perceived lack of technological growth in schools is often overshadowed by other "outside" problems such as deteriorating home environments, teen pregnancies, drugs, and gangs and a multitude of urgent, every-day problems. Providing students with the best resources available to aid them in learning is obviously a wonderful idea, but to impoverished schools facing overwhelming social problems such as these, it is often very difficult to do.

Much of the problem also lies with the technologies themselves. Attempting to keep pace with technologies that are continuously changing and advancing can be very expensive. Purchasing the hardware in question is only the first step: installation, maintenance and training are also major expenses.

Training concerns are also major factors. Lengthy and continuous training is necessary for many more advanced technologies. This becomes a major problem for a staff that has already been trained without these technologies in mind.

Training time is often hard to come by in a system as structured as education.

Utilizing new technologies to their fullest potentials are yet another concern. Throughout history, individuals' first inclinations towards new technologies have been to use them as they used the traditional technologies that were replaced. A strong case can be made that this is currently happening to today's classrooms. For example, teachers often use computers only as typewriters, or desktop publishing software only to turn out more beautiful overheads, or neatly organized seating charts. The majority of today's computer-based instructional programs do little more than put the ubiquitous student workbook on a computer monitor and automate the right/wrong scoring that a teacher would otherwise do by hand. (Means, pg 4)

The key issue should be the use of the technology - having educators develop reformed sets of curricular and instructional goals, and then using the technology as a tool to support those goals. When this approach is taken, the introduction of technology is viewed not as an end in itself; but, as support for instructional goals relate the increased student involvement with complex authentic tasks and new organizational structures within classrooms and schools, technology appears more attractive to those who must reach the new goals. (Means, pg 4)

II. B. Restructuring

"The starting point for school reform or school restructuring should be a good understanding of what has changed to make our current system inadequate."
--Dave Moursand, The Computing Teacher

The movement to restructure U.S. schools has come about as the result of changes in society, advances in technology, and a recognition of disappointing student achievement in the past. Restructuring is a challenge to question and redesign the ways in which schools are governed, allowing teachers to become school decision-makers and collaborators. It calls for improved strategies for teaching and learning. The still-recent explosion of information has resulted in an ever-changing body of knowledge to teach. Faster and better thinkers are needed who are able to access and interpret an intimidating amount of facts. As the world is exploding with new information, it is also becoming more complex, requiring people to work together to solve problems, answer questions, and explore ideas. Students today must learn concepts and problem solving, rather than bare facts. Teachers must facilitate knowledge construction, rather than simply transfer content. (ECNet training manual, pg 6). Technology can be a very effective means of supporting this restructuring, but it must not be seen as a "cure-all" to solve all problems, and must be carefully planned for in the restructuring process.

This nation has been through a series of recurring educational reforms over the past century. There have been

reforms of pedagogy based on theory (Skinner, Piaget, Montessori). There have been curriculum reform efforts based on the perceived needs of a specific subject area (new math, process science, affective education). There have been reforms based on political and demographic issues (tuition-tax credit, vouchers, desegregation). Reform efforts have dealt with practically every instructional issue, and yet there is still a belief that schools are not performing as well as we would like and are in need of additional reforms.(Rockman, pg 1)

Technology has been called upon by education to help solve significant problems before. Television and the computer have both received the hype that today's technologies are receiving. Many years ago, the same projections we make today were being made about the roles of teachers and learners and the integration of technology in the instructional equation. Teachers acting as facilitators of learning rather than the single source of information, technology providing basic instruction and supplementary instruction in classrooms, and increasing teacher professionalism have all been topics before. People knew then about the barriers to overcome in getting teachers (and administrators) to use technology.

Today, as was then, teacher preparation and teacher training are seen as significant barriers to the use of technology for instruction and classroom management. Everyone knows what needs to be done, but it has not been

accomplished so far. After years of research on instructional materials, strong evidence exists that implementation is everything. What a teacher does with technology is more important than what the technology is. We have learned how to develop interesting, entertaining, and sometimes effective telecommunications projects, but low levels of implementation still present a problem. (Rockman, pg 25)

Cuban (1986) notes that the transfer of technology to schools follows a cycle beginning with exhilaration and exhortation from the advocates of any new technology. This is followed by the reality of low level implementation in the classroom and disappointment on the part of the administrators and of the general public. The realization that the technology had not lived up to expectations and ended up covered with dust or in the closet concluded the cycle when people blamed teachers for standing in the way of progress. (Rockman, pg 25)

II. C. Resistance to Change

"[Teachers] will either resist or be indifferent to changes that they see as irrelevant to their practice, that increase their burdens without adding benefits to their student's learning, or that weaken their control of the classroom."
--Larry Cuban, The Classroom Use of Technology since 1920.

In a society where most work is becoming

computer-based, "school-work" cannot forever resist change. (Collins, pg. 28) Computer technologies and electronic networks have slowly been infiltrating the schools. Because of the growing use of such technology in both the home and the workplace, computer equipment is unlikely to end up in closets or even to sit idle for most of the time. Hence, for both students and teachers, there is a kind of "authenticity" associated with using this equipment; for students, the technology represents the future. (Collins, pg. 28)

Resistance to change, both general and specific to technology, is another major factor affecting the implementation of technology into schools. The two are obviously closely linked, but should be recognized as being different and addressed separately if restructuring is to be successful. The integration of technology into education is not an easy task. Many of the technologies available were not designed with education in mind, and educational practitioners are left with trying to apply hardware and software that was not designed with education in mind. (Schank, pg 19) Many arguments have arisen that technology will have little effect on schools. Specifically, David Cohen and Larry Cuban have argued that, to the degree that technology is flexible, it will be bent to fit existing practice, and that, to the degree it cannot be bent to fit existing practice, it will not be used. (Collins, pg 31)

Teachers lack of experience with technology is another

concern, but that should diminish as people come to rely more on technology, specifically computers, for writing, calculating, and communicating. (Collins, pg. 31) This is already happening, as college students, secretaries, bookkeepers and others use technology in every day life. However, just because a technology becomes accepted in society, its acceptance in schools is not guaranteed. Television is pervasive in society, but will probably never be widely used in schools. (Collins, pg 31) So how can other technologies come to be widely used when television is not? The technologies that have the most common uses related to work are becoming necessary to accomplish school goals. Technology is playing a critical role in preparing students for the modern workplace, but schools are in the business of teaching students to read and write and calculate and think. As technology becomes an essential tool for doing these things in society at large, its use by students is inevitable. (Collins, pg 31)

Another argument is that using technology is time-consuming, and makes the teacher's job more difficult. Of course, this varies depending on the technology in question. While it may be true that when there are only a few computers available, the teacher has to figure out who uses them and when, what to do with the students not using them, or allow the students who are working on the computers to make up a lesson being taught in the meantime. For computers, this problem could be only temporary, for as

costs for hardware and networking capabilities continue to decline and emphasis continues to be placed on their use, more should become available for classroom use. The management problem is then likely to be similar to the one teachers currently face when students work individually or in small groups. To the degree that the tasks student are doing with computers are more engaging that those they currently carry out with textbooks and worksheets, computers will make the teacher's job easier. (Collins, pg. 31) Other technologies, such as satellite broadcasts, audio systems, or presentation devices, are more group-oriented, and can, by their nature alone, allow for ease of use in the classroom.

Another related problem in the reasons for lack of change is that of teachers not willing to relinquish their control of and authority over students. There are two aspects to this argument: first, that teachers want to be masters of everything that comes up in their classrooms, but they fear they will lose authority because computers contain more information than they can possibly master. The second aspect is that teachers like to hold the attention of their students. If students are off working on their own, then the teacher has lost their attention as well as control over the activities the students are involved in.

Both of these aspects are magnified by the fact that teachers do not yet feel comfortable enough with technologies to assume a "source of knowledge" role.

Control becomes difficult when it is obvious the teacher is less knowledgeable than the student. The answer to these concerns is also two-fold. First, as technologies become more commonplace, new teachers enter the field better prepared and current teachers will gradually become more technology literate. Aided by continuing training, teachers will carry enough knowledge and experience to feel comfortable enough to use the technologies, answer most questions and keep control. Second, the use of the technologies will gradually change the view of the teacher's role to that of a facilitator of students self-directed learning rather than a dispenser of information. (Collins, pg.31) Of course, this change will come about slowly, and will only fully occur when reliable and useful technology is available in the classroom on a large scale.

II. D. Need for Change

> "Many of the technologies available today offer powerful tools for transforming what we do, what our organizations look like, and even how we think about the world. (David, pg. 38) As technology pervades all aspects of our lives, it will inevitably do so in schools as well. But whether significant changes in teaching and learning will accompany the spread of technology in schools remains an open question."
>
> --Jane L. David, "Restructuring and Technology: Partners in Change"

Slipping math and science scores by American students have caused alarm, and technology seems to be in the forefront of the remedies to bring these scores back up.

Detractors of technology argue that simply because technology has revolutionized other areas, it does not guarantee that is will have a wide-spread effect on schools.

This paper will identify the need for change in the way schools utilize technology in two broad categories, the first of which is the fact that many states and national organizations have already begun to develop educational technology plans and have produced recommendations to ensure that the formation and implementation of quality technology programs and services are made available not only to educational institutions, but to society at large. (Ramirez & Bell, pg 117) These standards and initiatives recognize and support a need for change, and are making efforts to aid and guide schools in this process. New standards for mathematics and science education are an important step in the school improvement process. These standards are necessary to ensure quality, indicate goals, and promote change which in turn leads to the formation of new goals. (ECNet manual, pg 7) Establishing new standards not only defines expectations for students, but will also call for renewed involvement of teachers and demand improved assessment options.

Without standards to act as guidelines for all schools, technology is often infused into schools in "islands." Individual buildings or districts may take it upon themselves to decide which technologies are used and how they are used. They will install and begin to use their

technology, whether it be a computer network, distance learning television network, or other forms of technology. At the same time, other buildings, districts or regions may also be adding new technologies, but using different hardware platforms, different software, or a entirely different type of technology. The result is two or more functioning types of technological use in schools that many times are technologically incompatible with each other, preventing the schools in question from communicating with each other, or making it difficult to compare success or failures with each other due to the differences in the technologies they have chosen.

To prevent "islands" of technology and help insure that guidelines are created to provide a common base for technology in *all* schools, standards and systemic reform efforts are increasingly being linked with efforts to build the National Information Infrastructure (NII). The NII is based on legislation introduced by Vice-President Gore when he was a senator. The purpose of the NII is to "expand the scope of the National High-Performance Computing Program to identify and promote the development of applications of high-performance computing and high speed networking which will provide large economic and social benefits to the nation." (Ramirez & Bell, pg. 38) Education is targeted in several sections, and the main purpose is to "improve education at all levels, from preschool to adult education, including the development of new educational technologies."

(Ramirez & Bell, pg. 38)

When considering the need for a change in the way technology is used in schools, policy makers at the federal, state, and local level need to consider the following when designing plans to connect to the NII, and when planning for technology in general:

- Technology can have an enormous impact on teaching and learning.
- Technology can accomplish a range of goals from instructional to managerial to assessment.
- Technology reduces the "teacher as lecturer" approach and invites active participation by students. Research indicates that students internalize concepts when they are actively involved with what they are learning - manipulating data, asking questions, and consulting with peers and experts.
- Accessing information will be much easier for students and teachers.
- Classrooms will be more closely linked with real world activities and situations. Students will have opportunities to solve relevant tasks or problems in each discipline by accessing primary data sets, such as photographs taken by the Hubbell telescope or historical texts through the Library of Congress.
- Technology can remove the barriers of time and distance, permitting students from rural communities or from communities without adequate resources to access

experts and information sources to the same extent available in more affluent areas.

- Different types of technology may be used to meet different needs at various sites within the classroom, the school, or the district, e.g., use older computers for simpler tasks such as keyboarding, spelling and reinforcement.
- "Low-tech" technologies, such as e-mail, bulletin boards and gophers can lay the groundwork for full and widespread use of more advanced technologies. Once teachers see the utility of the more user-friendly "low-tech" technologies, they will be much more anxious to use and see the benefits of the more advanced technologies.

(Ramirez & Bell, Executive Summary)

The second, and equally as tangible a reason for a need for change, is that the teachers themselves recognize a marked need for an increase in the use of technology in the classroom, and are receptive to the idea of making these changes. The survey used for this paper targeted this area, and it will be discussed more fully in this paper in Section IV, part A, **Teacher's Views on Change.**

II. E. Categorizing Technology

"Technology is not an end in itself. It is a means to an end -- an evolving process and a communications network that enables people to do things differently and more effectively. Consequently, "technology" is defined more by what it can cause than what it is. The electronically driven technologies of the current era -- such as computers, VCRs, interactive videos, satellite dishes, and laser discs -- have emerged as significant educational tools. These tools not only enhance the productivity of the educational enterprise, they also provide access to learning itself."
--National Alliance of Business, "Primer for Business on Education"

The computer is not the only technology to affect changes in schools. When a technological innovation -- be it the book, the automobile, or television -- becomes widely available, its ramifications spread throughout society, and that includes education. (Collins, pg 28) For example, the invention of the printing press -- and with it the advent of affordable books -- had profound effects on education. (Collins, pg 28) It made the ideas of universal literacy and public schooling possible and led to a de-emphasis on teaching the art of memory. The automobile and the bus led to the consolidation of rural schools, the dispersion of people to the suburbs, the split between urban and suburban education, and the practice of busing to achieve racial integration. (Collins, pg 29) Today's technologies are likely to have equally significant effects on education, but obviously still have several barriers to cross before they become commonplace and widely accepted. (Collins, pg 29)

"Technology" is a multi-faceted term that is continually fluctuating in its meaning, is often all-encompassing and difficult to understand because of the several different meanings it can have. Ask any group of people their definitions of technology and you are very likely to get several very different answers. Definitions can range from the exceedingly complex to the exceedingly simple. To some, technology means the hardware, or the devices that deliver information and serve as tools to accomplish tasks. To others, technology can simply mean anything invented after one was born. Terms such as "distance learning," "educational technology," and "instructional technology" often actually combine several types of hardware and software. An important part of understanding technology, and the buzz words that surround it, is to understand the different types of technology, how they are used, and how they relate. The following is an example of one method of categorizing some of the more common technologies found in schools into broad sub-groups:

- **Presentation Technologies:**
  video cameras, video projectors, LCD panels, slide makers, VCRs, large screen monitors, laser disc players, audio systems, overhead projectors
- **Computer, or Stand-Alone, Technologies:**
  personal or portable computer systems, DOS, Windows and Macintosh interfaces, CD-ROM, computer software (word processing, desktop publishing, databases,

spreadsheets, drawing programs, HyperCard, hypertext, electronic mail), multimedia applications

- **Networking Technologies:**
  local- and wide-area computer networks, phone networks, Ethernet, media retrieval systems, routers, bridges, client servers, gateways
- **Communication Technologies:**
  audio conferencing systems, cable television, audio graphic systems, satellite broadcasting, distance learning systems, on-line information services, Internet services, compressed video systems

Obviously, this is only one way of separating different types of technology. It is easy to see why this process can get confusing, especially when one piece of hardware can be used for several different subgroups, and types of technology listed could be placed in several different categories. It should also be noted that categorizations such as this are not "shopping lists" of everything that schools "need" in order to be technologically functional. The important point is that teachers and students should be "technologically literate" -- being able to conceptualize the broad understanding that many different components combine to make technology, and to be able to form an understanding of how they relate.

III. METHOD

III. A. Survey Goals

The survey used for this paper was conducted by Public Sector Consultants (PSC) on behalf of the Great Lakes Collaborative to help shed some light on these and other questions. Twelve hundred public elementary school teachers in Michigan, Pennsylvania, and New York were surveyed. The goals of the survey were:

- Goal 1

  To measure teachers' assessments of (a) the quality of mathematics and science education, (b) measure the current use of technology in the classroom, and (c) teachers' willingness to change, specifically, the Collaborative is interested in the extent to which teachers are willing to adopt technology to meet mathematics and science learning objectives.

- Goal 2

  (a) measure teachers' perception of their need for new technologies, new instructional materials, and additional education and training and (b) determine whether the services provided by the Collaborative are in demand and which of the Collaborative's services are most important to elementary teachers.

III. B. Methodology

Four hundred telephone interviews were conducted with teachers in each of three states, yielding a sample of 1,200 public elementary school teachers, which provides for a margin of error of plus or minus 2.5 percent in 95 out of 100 samples. For each state, the margin of error is plus or minus 6 percent. The sample was drawn using two methods.

Sampling method 1

The first method was random selection of 1,000 elementary schools in each state. A letter from the Collaborative, signed by top education officials in each state, was sent to the principal of each selected school. Principals were not told that the survey would concentrate on technology-related issues. The school principal was asked to provide the names and phone numbers of two teachers s/he felt were representative of the teachers in their building. Five hundred principals were asked to provide names of early elementary school teachers (preschool through grade 2) and 500 principals were asked to provide names of teachers who taught grades 3 through 5. This sampling technique was used to interview 457 teachers.

Sampling method 2

The second method was random selection of public school elementary teachers from a list of elementary school teachers purchased from American Business Lists (ABI), Inc.

Enough interviews were conducted in each state to complete the goal of 400 surveys per state. A screening process ensured that only current public school elementary teachers with instructional supervision responsibilities were included in the survey sample.

III. C. Sample characteristics

The number of completed surveys derived from the two sampling methods differed by state. A significantly better response came from Michigan principals than from principals in New York or Pennsylvania. **Figure 1** (below) suggests that while the source of the respondents differed by state, it did not distort the overall composition of each state sample by the respondent's sex, ages, and race and the grade levels s/he teaches show that the demographic breakdown of the sample is consistent with the actual composition of the elementary school teacher population. Comparing the sample with data from Michigan, New York, and Pennsylvania Departments of Education shows that the sample is very similar to these departments' records of the composition of the population of elementary school teachers. The comparison provides confidence that the sample accurately reflects the elementary school teacher populations of Michigan, New York, and Pennsylvania.

Figure 1

Composition Of The Total Sample, By Sampling Method, State, and Grade Level Taught

	Michigan	New York	Pennsylvania
Sampling Method			
Sampling Method 1	65%	25%	35%
Sampling Method 2	35	75	65
Grade Level Taught by Respondent			
Preschool	3%	3%	3%
Kindergarten	8	9	8
Grades 1-3	33	35	32
Grades 4-5	33	28	30
Other	13	14	18

The survey instrument was developed in cooperation with the Collaborative staff, teachers, board, and Program Advisory Committee and PSC. Initial drafts of the survey were reviewed by 54 teachers who participate in the Collaborative projects. Their ideas and suggestions were incorporated as much as possible in the final draft of the survey.

The survey instrument was pretested by the interviewing firm and was adjusted to reflect comments made by the interviewers and participating teachers. A copy of the survey questions and results is available in **Appendix A** of this thesis.

IV. RESULTS AND DISCUSSION

IV. A. Teacher's Views on Change

Survey respondents believe that the teachers in their building are receptive to changes in the way mathematics and science are taught. Fifty-two percent said they believe their staff would be very receptive, and 43 percent said the staff would be somewhat receptive to changing their teaching methods for those two subjects. Only 5 percent believe that the staff in their building would not be very receptive, or refused to answer the question. Certainly one of the most revealing signs that change is needed is whether teachers themselves feel a change is needed. This was one of the questions targeted in the PSC survey. The teachers surveyed were first asked to grade the quality of mathematics and science education in the schools which they teach by using the traditional grading system: (A= excellent, B = good, C = average, D = below average, E or F = failing).

Figure 2 lists a number of subgroups of the sample and the percent of each subgroup who gave their school an A or B grade for mathematics and science education. The largest difference in these grades is by type of district and racial composition. Clearly, teachers from inner-city schools with a high percentage of minority students give their schools lower grades for mathematics and science than teachers from other districts.

Figure 2

Percentage of A and B Grades, By Subgroups

Subgroup	Mathematics	Science
Michigan	89%	68%
New York	83	70
Pennsylvania	86	67
Suburban Teachers	92	74
Inner-City Teachers	65	55
Males	87	73
Females	86	67
Teachers in schools where 0-25% of the student population is minority	91	72
Teachers in schools where 75-100% of the student population is minority	60	47
Entire Sample	86	68

While 86% of teachers graded mathematics education in their schools as an A or a B, and 68% of all surveyed gave science education equally high marks, there is still marked room for improvement. A strong case could be made that when it comes to an issue as important as the education of our children, anything less than 100% is simply not good enough.

Perhaps the most telling statistic in reflecting the need for change in the use of technology in learning comes from the attitudes and current patterns of the teachers who will utilize these technologies. This paper has already asserted that technology and technological change is affecting every profession. In particular, computers and

telecommunications are changing the way society operates. Technological change has come more slowly to educators than to other professions. So it should come as no surprise that an overwhelming 87 percent of the survey respondents said they are interested in using technology more to teach science and mathematics. Only 9 percent said they are not interested in using technology to teach these subjects. Many of this 9 percent are preschool and early elementary school teachers who said that increased use of technology was more appropriate at higher grade levels, and others explained that their technology is adequate for their needs.

IV. B. Teacher's Evaluations of their Current Skill Level

Nearly half (49 percent) of the sample said they feel very comfortable using technology in mathematics and science teaching. Only 39 percent, however, use technology for more than 25 percent of the mathematics and science instruction period in their classroom. To attain a clearer picture of technology use among teachers in the three states, a typology was created by combining the teacher's reported comfort level of technology use and the extent of technology s/he uses. (see **Figure 3**)

Figure 3

Typology of Teachers, By Use and Comfort Levels

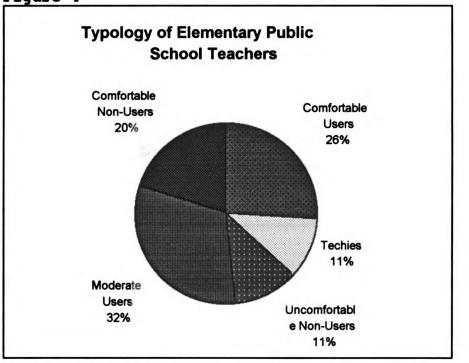
Category	Percentage of Time Technology is Used in Math and Science Teaching	Level of Comfort With Technology
Techies	51% or more	very comfortable
Comfortable Users	11-50%	very comfortable
	51% or more	somewhat comfortable
Moderate Users	11-50%	somewhat comfortable to very uncomfortable
Comfortable Non-Users	0-10%	very comfortable to somewhat comfortable
Uncomfortable Non-Users	0-10%	somewhat uncomfortable very uncomfortable

Using this typology, the entire sample was categorized into five kinds of teachers. At one extreme are techies, who use technology extensively to teach mathematics and science (51 percent or more of the time) and are very comfortable with it. Next are comfortable users, who often use technology in their mathematics and science classes (11-50 percent of the time) and are comfortable with it. Moderate users use technology 11-50 percent of the time in their classes but are not entirely comfortable using it. Comfortable nonusers use technology 10% of the time or less to teach mathematics and science, although they do feel comfortable with it. The final group is uncomfortable nonusers, who use technology 10 percent of the time or less in their mathematics and science classrooms, and feel very

uncomfortable using technology to teach these subjects.

Techies make up 11 percent of the teacher population, and an additional 26 percent are comfortable users. (see **Figure 4**)

Figure 4



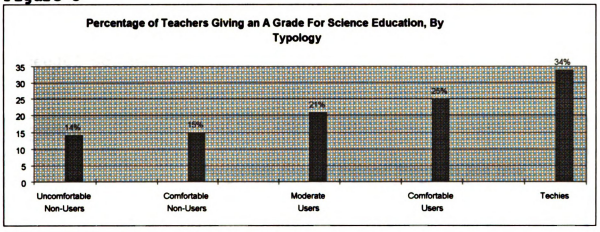
Taking these two groups together yields 37 percent, or approximately one-third of the respondents who are oriented towards technology. In contrast, 11 percent of teachers are uncomfortable nonusers of technology, and an additional 20 percent are comfortable nonusers. The remaining 32 percent of the respondents are moderate users.

IV. C. Teacher's Grades of Math and Science Education

Cross tabulating the survey questions with the

typological categories suggests that the more technologically oriented a teacher is, the more likely s/he is to give her/his school an A in science education. (see **Figure 5**)

Figure 5



In addition, 60 percent of techies believe their colleagues are very receptive to changing mathematics and science education compared to 42 percent of uncomfortable nonusers who hold the same view of their colleagues.

IV. D. Teacher's Awareness of National Standards

Figure 6 lists the percentage of each typological category who are aware of each set of national standards and the percentage who believe their schools exceeded the national standards. Techies and comfortable users are much more likely to believe their schools exceeded national mathematics standards than respondents who use technology less often or not at all. Very little relationship is

evident between respondents typological categories and their perceptions about whether their schools exceeded the science standards. It is unclear from the survey data why a relationship can be identified between respondents' typological categories and their beliefs about whether their schools exceeded mathematics standards but not between their categories and their beliefs about whether their schools exceeded science standards.

Figure 6

Percentage Aware of National Standards And Who Think Their School Exceeded Them, By Typological Category

Category	Science		Mathematics	
	Aware	Exceed	Aware	Exceed
Uncomfortable non-users	48%	16%	58%	15
Comfortable non-users	50	7	60	15
Moderate users	54	15	64	21
Comfortable users	60	17	71	25
Techies	79	19	80	33

Comfortable users and techies report a slightly higher (approximately 5 percent above average) use of various teaching methods (for example, integrating mathematics and science teaching with other subjects, using hands-on manipulatives, and using a thematic approach to teaching). In general, technology-oriented respondents are consistently more likely than teachers who are less comfortable with technology to report (1) using a variety of methodologies,

(2) giving their schools higher grades, and (3) working with other teachers. These results may be a measure of the teachers' flexibility and innovations as well as their technological sophistication.

IV. E. Expected Effects of Practices

Survey respondents were also asked to measure the expected effect of five educational practices and technologies on mathematics and science education. The teachers were asked whether they expect the practice to improve mathematics and science education "a great deal," "improve it some," "have no effect," or whether it might "have a negative effect." Three of the practices are related to computer use, and the other two are management-oriented options. (See **Figure 7**)

Figure 7

Percentage Expecting A Practice To Improve Mathematics and Science Education a Great Deal	
Teaching Practice	**Percentage**
Computers used with video cameras, printers, sound cards, and compact disk players to create multimedia instructional units	65%
Computers used by individual students working on instructional objectives	64
Computers tied into national and international telecommunication networks where students and teachers can access databases, instructional software, and electronic mail	64
Site-based decision making	41
Outcomes-based education	36

A substantially larger number of teachers believe that technology would improve mathematics and science education "a great deal" more than that management reforms would improve mathematics and science education. There was little variation in respondents' answers to the three technology-related options. Fifty-seven percent of the sample responded that all three technology options would improve mathematics and science education "a great deal," and an additional 24 percent said that two of the three technology options would improve education "a great deal."

Only 19 percent said that one or fewer of the technology options would improve education "a great deal."

Figure 8 lists the percentages of teacher who said that all three of the technology practices would improve mathematics and science education "a great deal." Clearly, support for technology as a tool for improving education is very strong.

Figure 8

Percentage Saying All Three Technology Options Would Improve Mathematics And Science Education a Great Deal, By Selected Groups

Groups	Percentage
Sampling Method 1 teachers	65%
Sampling Method 2 teachers	51
Men	66
Women	55
Techies	66
Uncomfortable non-users	44

IV. F. Teacher's Interest in New Services

Another section of the survey focused on the Great Lakes Collaborative. Interviewers identified and explained the services provided by the Great Lakes Collaborative, and then asked respondents if they had "a great deal" of interest in the resource mentioned, "some interest," or "little interest." While the focus of this paper is not on the Great Lakes Collaborative, the services offered by the

Collaborative are a focus.

Seven technology-related services were tested. Interest in the services varied from a high of 73 percent of the sample who said that having access to instructional videotape was of great interest, to a low of 41 percent who said that having access to electronic mail or digitized pictures for use with computers and printers was of great interest. **Figure 9** lists the percentage of various subgroups who said that they have a "great deal" of interest in having access to that particular service. As the exhibit shows, there was little difference between the states in the interest in different services or in the relative rankings of the seven services. The results clearly show that teachers in the three states are interested in these services.

Figure 9

Percentage With A Great Deal of Interest in a Collaborative Service, By Selected Subgroup

Service	Total	MI	NY	PA	Techies	Sampling Method 1	Sampling Method 2
Electronic Mail	41%	40%	42%	40%	48%	54%	32%
Digitized Pictures	41	41	42	43	59	50	36
Internet databases	50	48	54	50	68	64	42
Statewide technology conferenc	54	55	54	53	64	67	46
Lesson plans and activities	68	66	67	70	74	75	63
Instructional software	71	71	67	75	80	81	64
Instructional videotapes	74	74	75	73	81	81	69

IV. G. Teacher Views of Technology Needs

The PSC survey asked respondents a number of open-ended questions about technology and instructional materials. The responses to these questions indicate what kind of technologies and instructional materials elementary teachers want and how they might use them to teach other subjects. Respondents were asked to identify the technologies they need that they presently do not have by listing as many items as they wanted to. Of the 1,200 respondents, slightly more than 1,000 responded to this open-ended question. The responses were divided into categories. **Figure 10** lists the coded categories and the number of times survey respondents listed an item in that category.

Figure 10

Technology Needs, By Coded Category

Number of Times Listed	Category
328	Computers/buy computers/more computers/ add computers
112	Software/instructional/science series
87	Laser disc player
77	Video cassette recorder (VCR)/video equipment
76	Computers/update them/more sophisticated
62	CD ROM player
58	Video cameras
57	Science labs/chemistry equipment/micro- scopes/scientific materials
44	Instruction on how to use technology/training/ information/memo updates
41	Have enough for my needs/ I'm happy
34	Calculators
28	LCD panel/overhead projector for computers
28	Could use almost anything/all/more equipment/ funding
27	Television/TVs
22	Hands-on material/"cube links'/science blocks
21	Modems/telecommunications technology/ software
20	More time for using technology/better access to technology
18	Computer labs/create labs/enhance computer labs
18	Fax machines
15	Disk system monitoring device/networks/ distance learning
13	Printer
11	Multimedia equipment/interactive video
41	Other
25	Don't know/not familiar/unsure

Computers and computer software dominate the list. Laser disc players and video cassette recorders (VCR) and equipment were mentioned less frequently than computers and software, but are mentioned more often than other

categories, suggesting that a substantial need exists for increased integration of computers and videos. The demand for increased telecommunication capability was not high. The responses noting the need to update computers were tallied separately from those mentioning the need to purchase new computers, and respondents expressed more need for basic technology than for enhancing technology.

Respondents were also asked to note what additional instructional material they need, including computer programs and videotapes. **Figure 11** lists the categories into which responses were divided. Instructional material for teaching science and mathematics programs are high on the list. Science material was mentioned more often (224) than mathematics material (184). The media mentioned most often are computer software (214) and video tapes (154). Most teachers were unable to identify specific computer software or videotapes they wanted. Typically, respondents provided general responses rather than specific requests. As technology is used more extensively in the schools, future teachers should find that teachers list specific instructional materials they want.

Figure 11

Desired Instructional Material

Number of Times Listed	Category
244	Science programs
	In general (113)
	Software (49)
	Videotapes (69)
	Laser disc/CD ROM (13)
184	Mathematics programs
	In general (100)
	Software (50)
	Videotapes (27)
	Laser disc/CD ROM (7)
117	I don't know/no equipment/other
108	More software generally
81	Everything that's available/ I need everything
71	Computer-related equipment/ modems/laser discs/ etc.
63	Computer/training
58	Videotapes generally
36	Problem-solving/critical thinking material (all media)
34	Upgrade/more of what we have
27	Grade-level specific programs/ advanced units
25	Reading and writing programs (all media)
13	Science-related equipment/ microscopes/microscope slides
13	CD ROM programs generally
11	Laser disc programs generally
11	Geography programs/Where in the World (all media)
9	Drawing/graphics/charting software
9	Simulations
7	Experimentation software
3	Multimedia programs/interactive instruction
65	Other
81	None

IV. H. Other Subjects Which Technology Would Aid

It is interesting to note that when asked to list subjects other than mathematics and science in which technology might used effectively, two subjects dominated the list. (see **Figure 12**)

Figure 12

Subject Areas Other Than Mathematics And Science Which Technology May Be Useful

Category	Number of Responses
Social Studies	569
Reading	474
Language arts (reading/writing/literature)	466
All subjects	267
Writing	247
Art	33
Geography	20
Health	14
Other (includes music, creative dramatics, and Spanish, as well as others)	78
None	46
I Don't know/no equipment	20

Social studies (569) and language arts (466) were mentioned most. Although language arts includes writing and reading, some respondents did not use this inclusive term and instead listed writing and reading separately. Consequently, **Figure 12** includes numbers for writing and reading in addition to language arts. Combining the responses for these three categories makes language arts the most often mentioned subject by a substantial number.

IV. I. Technical Assistance

The importance of technical assistance to teachers is crucial. A teacher's job is to teach, not to maintain hardware, install software, or to be technical "wizards." A technical support person becomes crucial in helping both to maintain and keep equipment running, as well as to help answer the multitude of questions using technologies can raise. The PSC survey addressed this area, and found that while technical support is available for the technology schools do have, this support is not always adequate. Seventy-five percent of the teachers said that someone is available to assist them if they have problems using technology. Of this 75 percent, however, 23 percent (or 18 percent of the entire sample) said the help was inadequate. Combining the 19 percent of all respondents who said help is not available with the 18 percent who said available help was inadequate yields 37 percent of the entire sample who have no or inadequate support for using technology. Slightly more than a third of the teachers feel that getting adequate technological assistance is a problem.

IV. J. Professional Development

Respondents were also asked if they felt they needed additional education and/or training in eleven different areas. (See **Figure 13**) The teachers seem to be very interested in receiving additional education and/or training. An average of 60% responded that they did need

additional training and or education to improve their teaching. At the top of the list of areas where training was most needed were multimedia instruction (79%) and using computers as instructional tools (78%).

Figure 13

Percentage Expressing Interest in Additional Education and/or Training

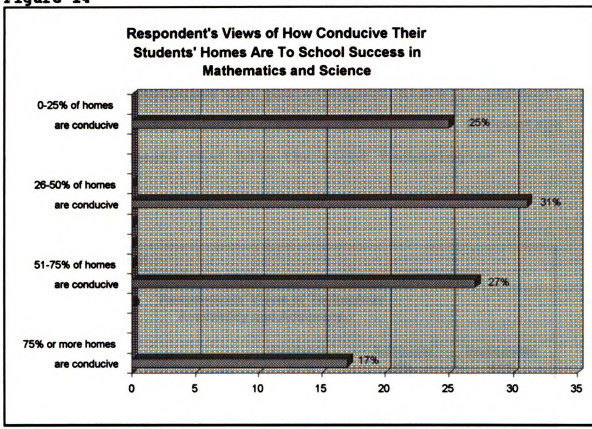
Education/Training	Percentage Interested
Multimedia instruction	79%
Using computers as an instructional tool	78
Working with business and community groups	76
Outcomes-based mathematics and science education	70
Teaching to learning skills	60
Using more hands-on education	59
Mainstreaming special education students	56
Thematic instruction	53
Integrating different subjects	52
Cooperative learning strategies	43
Team teaching	42

IV. K. Teacher's Views on Effects of Home Environment

Elementary teachers are pessimistic about the influence of the home environment on the likelihood of student's success in mathematics and science. Fifty-six percent of the respondents believe that less than half of the students in their school come from home environments conducive to success. (See **Figure 14**) As might be expected, teachers employed in large city schools and inner-city schools (65 percent and 85 percent, respectively) believe that less than half of their students come from home environments conducive

to success. It is interesting to note that 64 percent of teachers from rural areas also believe that less than half of their students have home environments that support success in these two subjects. Only the suburbanites have a majority (62 percent) who believe that more than half of their students come from home environments conducive to success. Teachers face a significant challenge in overcoming what they perceive to be shortcomings in their students' home environment that affect academic success. This concern is particularly high among inner-city and rural school teachers.

Figure 14



IV. L. Quantifying Technology Already in Schools

To determine what technologies teachers already have at their disposal, the respondents were given a list of eight technologies and asked whether they are "readily available" to the teacher for mathematics and science instruction. The results of this survey were similar to the results of other surveys. The results of a 1992 Michigan Information Technology Network survey of Michigan school districts are nearly identical. In addition, a 1993 survey of Michigan teachers by the Michigan Partnership for New Education also reported very similar results.

The most common technologies available to respondents are computers (67 percent) and VCRs (51 percent responded that they have a VCR in their classroom). The least available technologies are photo-compact discs (7 percent) and scanners (12 percent). **Figure 15** shows the percentage of the respondents that have the eight technologies available.

Figure 15

Respondents' Views of Technology Availability and Adequacy

Technology	Available	Adequate	Inadequate
Computers in your classroom	67%	26%	41%
A VCR in the classroom	51	40	11
A CD-ROM (compact disc with read-only memory)	28	16	12
Ability to connect via modem to outside databases	19	12	7
A video camera that connects to a computer	17	11	6
Instruction at a distant site through technology	15	9	6
A scanner	12	9	2
A photo-compact disc	7	6	2

After respondents were asked what technology is available to them, they were asked whether the resource is adequate for their needs. While 67 percent of the sample said they have computers available in their classroom, nearly two-thirds of that group (61 percent of the 67 percent, or 41 percent of the entire sample) said that the computers are inadequate for their needs. The need is

greater for computers than for VCR. Although 51 percent of the sample said they have a VCR in their classroom, only 22 percent of those who have VCR said that the VCR is inadequate for their needs. The column in **Exhibit 15** labeled "adequate" shows that 40 percent of the sample feel they have adequate availability to VCR, compared to only 26 percent who feel that the availability of computers is adequate.

Although close to two-thirds of the sample said computers are readily available for teaching mathematics and science, the need for computers is nevertheless great. Only 28 percent of the entire sample believe the current supply of computers is adequate. Clearly, the technologies available to teachers are not adequate.

IV. M. Obstacles to Change

The survey presented respondents with five potential obstacles to changing the way mathematics and science are taught in their schools. (See **Figure 16**) Uncertainty about what is the best teaching method and lack of professional development are related concerns. Taking these categories together yields 37 percent of the sample who are concerned about methodology and development, nearly equal to the 38 percent who believe that lack of resources is the major obstacle to change.

Figure 16

Most Significant Obstacle to Changing Mathematics and Science Education

Obstacle	Percentage
Uncertainty about what is the best teaching method	20%
Lack of professional development	17
Lack of resources	38
Lack of motivation to change	8
Lack of technical support	12
Other volunteered	3
Don't know/refused to answer	3

V. CONCLUSIONS

Through historical review and analysis of the survey, the following conclusions can be made to the research questions this paper is based upon:

- **Question 1: What are the reasons that systemic and wide-spread changes have not taken place in the way technologies are used to teach in public schools?**

The reasons for lack of change in the use of technology in public schools are many and **greatly** varied. A summary of some of the larger problems that directly affect teachers attempting to utilize technology into every-day classroom instruction include:

1. Unfair comparisons and the educational institution: Technology **has** found its way into the classroom. Every day, teachers and students are being exposed to newer and more powerful technologies that help enhance and expand the way teachers teach and students learn. However, when looking at the rate at which many other industries have adapted to make better use of the advantages technology provides, schools usually pale in comparison. The public educational institution is simply not structured like many industries are, and in its current state, cannot begin to keep pace with the multitude of advantages afforded these industries. Until dramatic steps are taken to provide a better system of support to our school systems, education as a whole will

always be outpaced by the most visible measuring stick available: private industry.

2. Funding: Technology is expensive, and schools usually must wait until newer and more powerful innovations drop in price before they can afford to purchase the equipment. Simply having the hardware available is a start, and many schools are actually fairly well-stocked with equipment, but the continuing costs of training and on-going technical support often prove to be far out of reach for the average local school system's budget.

3. Math and Science specific: This paper focused on the use of technology in conjunction with math and science instruction in public schools, primarily because these two subjects show the greatest margin of difference in what students are being taught and skills that are needed in today's job market. The obstacles these two high-visibility subjects face are, unfortunately, the problems of the educational system in general rather problems inherent to these specific subjects. Once again, until dramatic reforms are implemented in America's educational system as a whole, math and science will continue to be marked as "problem areas" because of the differences in what schools can provide in comparison with the increasingly technology-oriented needs of the job market.

4. "Outside" Interference: If being a step behind private industry in the use of technology was the single most important problem facing schools, life would be sweet indeed. Unfortunately, the environment students face once inside our schools is a reflection of our society. It becomes difficult to argue the importance of spending time, energy, and much needed funds on technology and training in school systems that face such urgent and such real every-day problems as gangs, drugs, teen-age pregnancies, deteriorating home environments, crime and violence. These problems are real, and these are problems that teachers must face. If technology must take a back seat to making our schools a safer, healthier place for our students to retreat to and learn in, I think few would argue.

5. Technology Itself and Lack of Standards: Technology is fast-paced, continuously changing, and multi-faceted, which makes it difficult to embrace in an institution like education. The amount of choices available to schools is available, and different school systems have made widely varied choices. In any given state or district, the difference of the technologies available to students in specific schools may vary greatly. Without standards or guidelines to guide schools in the purchase of and use of technology, a trend of "islands of technology" has taken root in our schools. Many districts or school systems have taken it upon themselves to form technology plans and commit

themselves to a particular technology or group of technologies. As a result, students from different areas are graduating from our schools with a vastly varied background in exposure to technology. Whereas there is an understood standard of reading and other basic skills across the nation, there is no such standard for technological skills. Technology will always continue to grow and change, and until standards are implemented to help guide schools in the use of technology, schools will continue to flounder in the wake of technological growth.

- **Question 2: What is the definition of technology?**

There is no single, clear-cut definition of technology. The term "technology" covers a multitude of meanings, as well as an even greater number of individual types of hardware and software. Applying restrictive or incomplete definitions may not capture the complex and increasingly symbiotic relationship between technologies. One way to gain a better understanding of technology is to break it down into subgroups, organizing different types of hardware by their function. Schools do not need to purchase and have available every type of technology, but should strive to reach a level of "technological literacy" for both teachers and students. At this broader level of understanding of technology, students and teachers should be able to conceptualize differences between similar technologies,

understand how different technologies can work together, be able to the identify the correct technology for a particular task, and understand how technology can make many tasks easier, faster and more efficient. As technological advancements such as multimedia and digital audio and video continue to grow and allow different types of technology to work together, a broader understanding of technology will be needed.

- **Question 3: What are the teachers' attitudes towards technology? Specifically, are teachers willing to use technology more in the classroom?**

Teachers in the survey supported changing the way mathematics and science education in conducted, and in particular, they support using technology to improve education. Eighty-seven percent of the respondents are interested in using technology more for teaching mathematics and science. They also believed that the technology that is currently available to them is inadequate for their needs. While 67 percent of the respondents said that they have computers in their classroom, 61 percent of that 67 percent believe that the computers are inadequate. Respondents also express a great interest in other kinds of services and technologies. When asked what other technologies they need most, software and computers are listed most often, but 65 percent of the teachers believe access to multimedia instructional units, having students use computers for

individualized mathematics instruction, and connecting teachers to a national database of instructional software would improve mathematics and science instruction "a great deal." The respondents also believed that before such services can be effective, more computer equipment and more training are necessary.

VI. FUTURE TRENDS

The amount of information available to people today continues to grow at an amazing rate, and it is becoming more complex, requiring faster and better thinkers. Students today must learn concepts and problem solving, rather than bare facts. Teachers must facilitate knowledge construction, rather than simply transfer content. Effective use of technology in schools will play a critical role in preparing students to deal with an increasingly technological world. Many states and national organizations have already begun to develop educational technology plans. These recommendations and standards will provide direction to teachers in increasing the use of technology in the classroom. These standards and initiatives recognize and support a need for change, and are making efforts to aid and guide schools in this process. With better standards for schools to plan around, and more carefully developed technology plans, schools will have a broader understanding of technology and how to use it more effectively. Better planning will produce the foundation to remain technologically solid and the flexibility to survive the changes inherent to technological advancements.

Curriculum mandates will change to increase the amount and use of technology in the classroom. Preservice training for teachers will be a major factor in closing the gap between technology and traditional instruction. Traditional classroom techniques will expand to incorporate the

advantages technology can provide. Training for current teachers will change to become increasingly technology-oriented, and an emphasis on a systemic and on-going training will replace one-time inservices. Technology will continue to advance in capability and decrease in cost, and new teachers will enter the field with more complete preservice training in, and understanding of, the uses of these technologies. Current teachers already recognize the potential advantages that technology can provide, and are willing to adapt to utilize technology more.

Decreasing costs of technology, better preservice and continuing training for teachers, and stronger technology plans in schools will provide a solid and consistent technological foundation. Teachers will have better resources and the skills to incorporate a wider variety of technologies and services in the daily classroom. Students will be led through a clearly defined curriculum with a strong technological orientation. The basic structure of classroom learning will change incrementally to more fully utilize the advantages that technology can provide.

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APPENDIX A

APPENDIX A

Math and Science Elementary Teacher Survey

December 1993

Hello, this is _____ of Public Sector Consultants of Lansing, Michigan. I appreciate your willingness to be interviewed for this survey. It will take approximately 20 minutes depending on the length of your responses. If there are questions you prefer not to answer, just let me know and we will skip that particular question.

The survey is being done as part of a multistate collaborative of math and science teachers under a grant from the federal government. Your responses are confidential. The surveys will be analyzed as a group.

The first set of questions is about the quality of math and science education at the elementary school where you work.

1a. Using the familiar grading system of an A being excellent; B, good; C, average; D, below average; and E or F, failing, what grade would you give your school for the quality of math education?

a.	A	32%
b.	B	54%
c.	C	11%
d.	D	1%
e.	E/F	0
	Don't know/other	2%
	Refused	0

1b. What grade would you give your school for the quality of science education? Would you give your school an A, B, C, D or failing grade?

a.	A	21%
b.	B	47%
c.	C	26%
d.	D	4%
e.	E/F	1%
	Don't know/other	2%
	Refused	0

2. What percentage of students at your school do you believe come from an environment at home that is conducive to being successful in math and science? Would you say 25 percent or less, 26 to 50 percent, 51 to 75 percent, or greater than 75 percent?

a.	0 to 25%	25%
b.	26 to 50%	31%
c.	51 to 75%	27%
d.	76% plus	16%
	Refused	1%

3. How receptive to changes in teacher methods in math and science is the staff of your school building? Would you say the teaching staff in your building was very receptive, somewhat receptive, or not very receptive to changing math and science teaching methods?

a.	Very receptive	52%
b.	Somewhat receptive	43%
c.	Not very receptive	5%
	Don't know/other response	1%
	Refused/other	0

4. As you think about changing the way math and science are taught, which one of the following would you say is the one most significant <u>obstacle to change</u>?

a.	Uncertainty about what is the best teaching method	20%
b.	Lack of professional development	17%
c.	Lack of resources	38%
d.	Lack of motivation to change	8%
e.	Lack of technical support	12%
	Other volunteered	3%
	Don't know/refused/other response	3%

The next questions are about the math and science curriculum in your school.

5a. Are you aware or unaware of the National Science Teachers Association national science standards?

a.	Aware	57%
b.	Unaware	42%
	Don't know/other	1%

5b. IF AWARE: Does the science curriculum in your school exceed the standards set by the national organization, meet the standards, or is it below the standards?

a.	Exceed	9%
b.	Equals	29%
c.	Below	14%
	Don't know	8%
	Other	0

6a. Are you aware of unaware of the National Council for Teachers of Mathematics national standards for math?

a.	Aware	65%
b.	Unaware	33%
	Don't know/other	2%

6b. IF AWARE: Does the mathematics curriculum in your school exceed the standards set by the national organization, meet the standards, or is it below the standards?

a.	Exceed	15%
b.	Equals	39%
c.	Below	9%
	Don't know	5%
	Other	1%

The next few questions are about how you teach math and science.

7. To what extent do you use the following teaching methods? Do you use the method extensively, occasionally, or seldom?

	Ext.	Occ.	Seldom	Never Offered	DK/ Other
a. Teach math as part of another subject such as social studies.	32%	53%	10%	2%	3%
b. Teach science as part of another subject such as social studies.	40%	46%	8%	2%	3%
c. Use hands-on manipulatives when teaching science.	70%	21%	4%	1%	4%
d. Use hands-on manipulatives when teaching math.	71%	22%	3%	1%	2%
e. Work as a team with other elementary teachers.	41%	30%	20%	8%	1%
f. Use thematic approach to inter-disciplinary topics.	48%	39%	9%	1%	3%

The next questions are about technology in the classroom. By technology I mean all mechanical tools such as computers, video cameras, videocassette recorders, television, laser disks, and fax machines.

8. Would you describe yourself as comfortable or uncomfortable in using technology in teaching math and science? If (comfortable/uncomfortable), would that be very (comfortable/uncomfortable) or just somewhat comfortable/uncomfortable)?

a. Very comfortable 49%
b. Somewhat comfortable 33%
c. Somewhat uncomfortable 14%
d. Very uncomfortable 3%
Don't know/unsure/ other 1%

9. For what percentage of the time given to math and science instruction do you use technology? Do you use technology...(READ OPTIONS)

a. None of the time 6%
b. 1 to 10% 23%
c. 11 to 25% 30%
d. 26 to 50% 27%
e. More than 50% of the time 12%
Other 2%

10a. Are you interested in using technology more to help teach math and science?

a. Yes 87%
b. No (GO TO #10e) 9%
Don't know/undecided (GO TO #11) 4%

10b. IF YES: What technology do you need that you currently don't have? (Open-ended)

10c. IF YES: What types of computer programs, videotapes, or other instructional material do you need? (Open-ended)

10d. IF YES: For what subject areas other than math and science would you like to use technology? (Open-ended)

10e. IF NO: Why?

11. What effect do you believe the use of the following practices or technologies will have on math and science education? Will _____ improve math and science education a great deal, improve it some, have no effect, or might it have a negative effect? (ROTATE)

	Improve a Great Deal	Improve Some	No Effect	Negative Effect	Don't know
a. Site-based decision making	41%	44%	5%	1%	9%
b. Outcomes-based education	36%	43%	6%	4%	11%
c. Computers used by individual students working on instructional objectives	64%	31%	2%	0	3%
d. Computers used with video cameras, printers, sound cards, and compact disk players to create multimedia instructional units	65%	29%	2%	0	4%
e. Computers tied into national and international telecommunication networks where students and teachers can access databases, instructional software, and electronic mail	64%	29%	4%	1%	3%

We are particularly interested in the use of telecommunications. Telecommunication is often used to enhance multimedia projects, distance learning, and computer education. One common use is to connect computers with databases, receive free instructional software, and communicate with other elementary school teachers and classes.

12. The Great Lakes Collaborative makes available a number of resources to help teachers use technology in math and science instruction. As I read the type of resource available, please tell me if you have a great deal of interest, some interest, or little interest in having the resource.

	Great Deal	Some	Little	Don't Know Other
a. Instructional software	71%	22%	6%	1%
b. Electronic mail to connect classes and teachers	41%	38%	18%	4%
c. Science and math lesson plans and activities	68%	24%	6%	2%
d. Digitized pictures for use with computers and printers	41%	36%	13%	10%
e. Reference library of math and science instructional videotapes	73%	20%	5%	1%
f. Access to Internet databases such as the NASA database	50%	31%	13%	5%
g. Statewide conference on instructional technology	54%	34%	10%	2%

The following questions are about the current resources available to you in teaching math and science.

13. Do you have _____ readily available for math and science instruction? IF YES, is the resource adequate for you needs?

	Yes	No	DK	Ade.	Ina.	DK/Other
a. Computers in your classroom	67%	32%	0	26%	41%	1%
b. Ability to connect via computer modem to outside databases	19%	74%	6%	12%	7%	2%
c. Instruction at a distant site through technology	15%	77%	7%	9%	6%	2%
d. A CD-ROM (compact disk with read only memory)	28%	65%	7%	16%	12%	3%
e. A video camera that connects to a computer	17%	74%	8%	11%	6%	3%
f. A scanner	12%	80%	8%	9%	2%	2%
g. A photo-compact disk	7%	84%	9%	6%	2%	2%
h. A VCR in the classroom	51%	48%	0	40%	11%	0

14a. If you have difficulty using technology, do you have someone available to help?

a. Yes.....74%
b. No.....19%
Don't know/depends.....6%

14b. IF YES: Is this support available in a timely manner?

a. Yes.....53%
b. No.....18%
c. Depends 10%
Other/don't know 1%

14c. IF YES: Is the technical support adequate for your needs?

a. Yes.....54%
b. No.....18%
Depends.....6%
Don't know/other 3%

15. Do you have adequate financial resources to purchase the equipment and instructional material you need to use technology effectively?

a. Yes.....17%
b. No.....76%
Don't know/depends.....7%

The next questions are about professional development.

16a. Do you feel you need additional education and/or training in the following areas?

		Yes	No	DK
a.	Cooperative learning strategies	43%	57%	0
b.	Integrating different subjects	52%	47%	1%
c.	Using computers as an instructional tool	78%	22%	0
d.	Team teaching	42%	58%	1%
e.	Mainstreaming special education students	56%	43%	1%
f.	Using more hands-on education	59%	41%	0
g.	Working with business and community groups	76%	23%	1%
h.	Thematic instruction	53%	45%	2%
i.	Multimedia instruction	79%	20%	1%
j.	Outcomes-based science and math education	70%	29%	2%
k.	Teaching to learning skills	60%	37%	3%

16b. When is the best time for you to receive this additional training?

a. After school hours 20%
b. During the weekends 6%
c. During regularly scheduled professional development time 63%
Other 9%
Don't know/other responses 2%

16c. How many days each month do you have available to learn and plan to use new professional skills?

a. Less than one day a month 49%
b. One day a month 19%
c. Two to four days a month 18%
d. More than four days a month 8%
Other 3%
Don't know/other 3%

The last questions are for statistical purposes only and to insure equity of access.

17. What grade level is your primary teaching responsibility?

a. Preschool 3%
b. Kindergarten 9%
c. Grade 1 to 3 ..... 43%
d. Grade 4 or 5 ..... 30%
Other 15%

18. How would you describe the school district you teach in? Would you say the district was:

a. Rural 22%
b. Small city/town 21%
c. Suburban 34%
d. Large city 9%
e. Inner-city school 13%
Other/don't know 0

19. What percentage of your students are minority students?

a.	0 to 25%	69%
b.	26 to 50%	11%
c.	51 to 75%	5%
d.	76% or more	13%
	Don't know/other	2%

20. What is the highest education level you have attained?

a.	Bachelor's degree	7%
b.	More than bachelor's but less than master's degree	23%
c.	Master's degree	38%
d.	More than master's but less than Ed.S. or Ph.D.	29%
e.	Educational Specialist	2%
f.	Ph.D.	1%
	Other responses	0

21. Do you use a computer at home?

a.	Yes	63%
b.	No	37%
	Other	1%

22. What group comes closest to your current age?

a.	18 to 35	19%
b.	36 to 50	62%
c.	51 to 65	18%
d.	Over 65	1%
	Other	0

23. What is your race or ethnic background?

a.	Black/African-American	4%
b.	White/Caucasian	94%
c.	Asian/Pacific Islander	0
d.	Hispanic	0
e.	Native American/American Indian	0
	Other: (specify)	0
	Refused to answer/Other	1%

24. INTERVIEWERS: CODE RESPONDENT'S SEX HERE. DO NOT ASK.

a. Male.....14%
b. Female.....86%

25. INTERVIEWERS: CODE RESPONDENT'S STATE HERE. DO NOT ASK.

PA: 34% MI: 34% NY: 33%

Thank you for participating in the survey. We really appreciate it.