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Making the most of computers: an investigation of the attitudes and opinions of students and teachers concerning the use of computers for the instruction of students with special learning needs.

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MAKING THE MOST OF COMPUTERS:
AN INVESTIGATION OF THE ATTITUDES
AND OPINIONS OF STUDENTS AND TEACHERS
CONCERNING THE USE OF COMPUTERS
FOR THE INSTRUCTION OF STUDENTS
WITH SPECIAL LEARNING NEEDS

A Dissertation Presented
by
RACHEL BROWN-CHIDSEY

Submitted to the Graduate School of the
University of Massachusetts Amherst in partial fulfillment
of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2000

Education
MAKING THE MOST OF COMPUTERS:
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A Dissertation Presented

By

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ABSTRACT

MAKING THE MOST OF COMPUTERS: AN INVESTIGATION OF THE ATTITUDES AND OPINIONS OF STUDENTS AND TEACHERS CONCERNING THE USE OF COMPUTERS FOR THE INSTRUCTION OF STUDENTS WITH SPECIAL LEARNING NEEDS

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This study investigated the attitudes and opinions of students and teachers regarding the use of computers with students having special learning needs. Using a quasi-experimental design with three non-equivalent groups, within and between subjects effects were studied using a survey instrument and follow-up interviews. The students and teachers at three school sites, consisting of students in grades 5 through 13, participated in pre and post-test surveys. One site served as the experimental group, while the other two were control groups. The experimental condition
consisted of the installation of a campus-wide computer network for use by all students and teachers at the experimental site.

The survey consisted of demographic questions as well as 26 pre-test and 27 post-test questions. A 19 item scale measured participants' general attitudes about computers in schools. A four item scale measured participants' attitudes about the use of computers by students with special needs. Two items served as independent outcome measures of participants' attitudes about students' and teachers' comfort level and worry about computer use. Twelve follow-up interviews were conducted with two students and two teachers from each school. The interviews focused on having participants discuss their attitudes and opinions about the use of computers in special education.

The survey data were analyzed using analysis of variance, multiple regression, and repeated measures procedures. The interviews were evaluated using Glaser and Straus' Grounded Theory methods. Results from the surveys showed that there was no correlation between the experimental condition and changes in students' and teachers' attitudes and opinions about computer use in special education. These data also showed that the most significant variables related to students' and teachers' attitudes and opinions were variables related to past experience using computers as well as their school affiliation.
The interview data supported the survey results and showed that how the interview participants had used computers in the past related to their current attitudes, opinions. Taken together, these data suggest that schools can shape the computer-related attitudes and opinions of students and teachers. Recommendations include providing students and teachers with regular access to computer uses that are embedded in curricular activities.
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CHAPTER I

PROBLEM STATEMENT

Computers and Students with Special Needs

Computers have had a major impact on modern society. In the last two decades they have changed the conduct of business and industry around the world. Computers have also influenced education, but not as dramatically as the changes in the workplace. Many educators and lay persons see computers as a positive addition to classrooms while others view them as unwelcome foreign invaders. The use of computers for instructional purposes grew considerably in the last decade and it appears that their use will continue to expand (Blackhurst, 1997; Bork, 1997; Molnar, 1997).

The use of computers and other technologies as instructional tools is often known as instructional technology, or IT. From the first days of IT, educators who work with students with special needs have recognized the opportunities that computers can offer such students. Early services included adaptive and assistive devices for students with communication disorders and mobility impairments. More recently, IT has been used with students with so-called mild disabilities, (e.g.: learning disabilities), as a tool for practicing skills, remedial work and strategy instruction. Given the
increasing costs of special education services, it is important to determine
whether such technologies offer supports and services for students with
special needs that are not otherwise available.

An increasing body of research indicates that computers and other
forms of IT are positively related to student achievement, as measured by
both curriculum-based and standardized outcome variables (Fletcher-Flinn &
Gravatt, 1995; Khalili & Shashaani, 1994; Kulik, 1994). Other studies have
shown that IT can be especially effective for students with special needs
(Fitzgerald & Koury, 1996; Goldenberg, 1984; Male, 1994). One important
variable that has so far not been extensively studied is the attitudes and
opinions of teachers and students related to the use of technology in schools,
both in general and as this technology relates to students with special needs.
The lack of data about teacher and student attitudes is significant because
research on teacher efficacy (Allinder, 1994, 1995; Bandura, 1977, 1986;
Benz, Bradley, Alderman & Flowers, 1992; Coladarci, 1992; Guyton, Fox &
& Kaufman, 1992; Morrison, Walker, Wakefield & Solberg, 1994; Rafferty,
1993; Raudenbush, 1992; Ross, 1994; Soodak & Podell, 1993) shows that
teachers' personal efficacy (belief in their own teaching ability) and general
teaching efficacy (belief that education overcomes environmental influences)
is related to student achievement. Other research has shown that teachers
are the most critical variable in how and when IT is used in special education settings (CEC Today, 1997; Ellsworth, 1994).

It therefore follows that teachers' beliefs about whether IT is efficacious, as well as their own sense of computer ability, are going to influence the outcomes of IT applications in schools. Similarly, students' beliefs are likely to shape the extent to which IT enhances their achievement -- academically, socially, or personally. The study reported here investigated teachers' and students' attitudes and opinions concerning the use of computers in schools with a special focus on the use of IT by students who perhaps stand to benefit the most from it: students with special learning needs.

The purpose of this research was to learn whether students and teachers believe that IT applications make a difference in students' learning, whether these students and teachers believe that IT can benefit students with special needs more than others, and whether their own computer skills are related to these beliefs. These data provided indicators of the relationships between students' and teachers' computer skills and experiences and their attitudes about the role of computers in school-based instruction. Given that the research literature shows that computers are related to positive outcomes for all students (see Chapter II below), the ultimate goal is to determine, based on the collected data, what policy
decisions, training models, and protocols need to be used to facilitate the most effective use of computers by and for all students, especially those with special needs.

Investigating beliefs is not easy to do (Pajares, 1992). Pajares has suggested that such research needs to include both quantitative and qualitative approaches, as this study did. Previous investigations of both teachers’ and students’ beliefs provided methods which served as a starting point for this study. A few studies looked at both students’ (King, 1995; Kinnear, 1995; Proctor & Burnett, 1996; Riggs & Enochs, 1993) and teachers’ (Delcourt & Kinzie, 1993; Marsh, 1995; Moore, Rieth & Ebeling, 1994; Murphy, Coover & Owen, 1989; Olivier & Shapiro, 1993; Siegel, Good & Moore 1996; Yaghi, 1996) beliefs about computer use in schools and offered preliminary findings about attitudes, opinions and overall use.

The Riggs and Enochs as well as the Murphy, Coover and Owen studies focused on validating computer beliefs instruments and offered insights into how such research might be conducted. King’s work showed that students do not always perceive computers as generally helpful, and that other variables influence their usefulness. Proctor and Burnett indicated that frequency of access and use of computers is related to student attitudes. Kinnear’s work suggested that more study of how students perceive computer use is needed.
The Delcourt and Kinzie, Moore, Rieth and Ebeling as well as Siegel, Good and Moore studies pointed to the need for far greater teacher training in the use of computers. Yaghi found that there is a need for greater integration of computers in the overall curriculum. Marsh identified the importance of “making special education portable” by using computers as part of inclusive practices in special education (Reynolds & Birch, 1988 in Marsh, 1995). Olivier and Shapiro showed that there is a very high correlation between use and computer efficacy. This finding, more than the others, points to the importance of understanding more about students' and teachers' computer skills, beliefs and attitudes.

Research Questions

The specific research questions addressed in this study are:

1. Do attitudes and opinions about student computer use in schools differ among teachers and students with and without special learning needs?

2. Are race, sex, age, education/grade, native language, citizenship, computer access/ownership, computer skills, socio-economic status, special need (disability), teaching experience, and teaching certificates held related to the attitudes and opinions of teachers and students with and without special needs regarding student computer use in schools?

3. Do perceptions about the general use of computers in schools and the quality of student performance differ among teachers and students with and without special needs both before and after installation of computers throughout the schools?
4. Do the attitudes and opinions of teachers and students with and without special needs about the use of computers by students with special learning needs change following the installation of computers throughout their schools?

These questions were designed to help reveal what students and teachers believe about the use of computers in schools and how they perceive computers to influence instruction and student performance. The importance of this study lies in the additional data that it will provide for better understanding of the role of computers in schools and whether they are especially helpful for students with special needs.

There are few studies of students’ and/or teachers’ beliefs and attitudes about computers in schools. At the same time, there are increasing numbers of computers being placed in schools each day. Prior research has shown that computers are related to positive outcomes in student achievement (Fitzgerald & Koury, 1996; Fletcher-Flinn & Gravatt, 1995; Khalili & Shashaani, 1994; Kulik, 1994) but little research has been done to learn about the relationships between computer use and students’ and teachers’ attitudes and opinions about their use. Some researchers have found that computers can be especially useful for students with special needs (Church & Bender, 1989; Fitzgerald & Koury, 1996; Goldenberg, 1989; Goldenberg & Russell et alia, 1984; Kearsley, Hunter & Furlong, 1992; Male, 1993, 1994) but little research has investigated whether teachers are aware of these
findings or even hold such beliefs. Of note, Becker (1994) found that only 3% of teachers using computers in schools are doing so in “exemplary” ways.

Given that computers and other forms of IT are likely to remain a part of the school environment, it makes pedagogical and economic sense to learn how their use can best enable students. This study used the knowledge base and experiences of both teachers and students to learn their perceptions of the usefulness of computers in schools. Given the solid research base which indicates that teachers’ beliefs have a relationship with student achievement and the corollary assumption that the same is true for students, this study focused on investigating and interpreting teachers’ and students’ beliefs about computers as a means for understanding how best to incorporate their use into instruction. These results offer data that can be useful for policy and curriculum planners when designing and implementing IT applications in schools. The findings from this research will contribute to our understanding of the role of computers in instruction and provide more insights into computer use by students with special needs.
CHAPTER II

HOW ARE COMPUTERS BEING USED IN SCHOOLS?

A REVIEW OF THE LITERATURE

The Context of Technology and Education

Many schools have already invested large sums of money in instructional technology (IT) and others are continuing to do so. Some teachers are convinced that IT is a positive addition to their classrooms and support it wholeheartedly. But, many principals and school board members question, what can IT do that traditional instructional methods cannot? Is the investment of resources in computer hardware, software, training and personnel worth it? Do IT resources help certain populations more than others? Should funds be targeted to those groups?

This review of literature seeks to examine the available data concerning the use of computers as instructional tools for students with special needs and provide a synthesis of the research done so far. In order to best understand the process of implementation of such technologies, the historical context of instructional technology will be discussed. Then, individual studies will be reported and evaluated, followed by a summary of these findings and recommendations for future research.
Historical Context

Computers have had a powerful and lasting effect on modern society and have changed worker roles and perceptions about the tasks of daily living (Weizenbaum, 1976). Some critics have argued that computers have been given too much credit for improving society, and that they are undermining our confidence in human thinking and reasoning skills (Roszak, 1986). Some see computers as a natural continuation of the communications revolution begun with the telegraph and followed by the telephone, radio, and television, (Forester, 1985; Nickerson, 1986). These innovations have created many changes in the way that people conduct daily work activities (Giuliano, 1985). Others have argued that while computers are part of the communications revolution, they are a watershed along that continuum because of their far greater "thinking" capacity compared with earlier technologies (Crichton, 1983). Not everyone is convinced that computers are universally beneficial and some fear that they will do more harm than good. Rochell (1988) argues that automation and technology have made workers feel more powerless and vulnerable; computers have also displaced many workers. Clearly, the effect of computers needs to be examined carefully and all sides need to be heard.

Educators who support the use of computers in schools would agree that computers offer something more than speedier communication as provided by telephones. (Bork, 1997). Tuman (1992) refers to computers as
"culture tools". They are part of a long legacy of devices and practices, that began with literacy itself and included the printing press. These devices mediate language, hence culture. Computers add new elements to our conception of literacy and expand our ability to use and transmit ideas (Molnar, 1997). Rowe (1994) has argued that computers offer a whole new category to learning, communication and progress. He argues that the invention of the printing press made learning a solitary activity because it fostered communication mediated by books rather than people (teachers). He suggests that the communications revolution brought on by computers has changed that and offered "bandwidth" to the learning spectrum. He further argues that just as the printing press created social upheavals and revolutions in learning so will computers as they make it possible for more people to "publish" their ideas. His expanded vision of learning and scholarship embraces the concept of a global learning community connected by telecommunications networks and open to all.

The Context of Reform

For all the potential that IT has to offer education, these changes have been slow to appear. The primary reason for this is that schools are notoriously slow to embrace change (Bork, 1997; Cuban, 1995; Goodman, 1995; Tyack, 1991). Computers are viewed by many as an outside influence
and, as such, some educators and parents have been fearful of having them in the classroom. As with many other reform efforts in American education, IT is viewed with skepticism and caution by some. This fear persists despite the prevalence of calls for educational reform during the last fifteen years -- the very time period of IT's development and birth in education. The relationship between recent reform efforts and IT is an important one to understand.

Major calls for wide scale reform of American education emerged in the early 1980's (Goldberg, 1983) at about the same time as IBM and others introduced their personal computers to the market. Some made an immediate connection between reform and IT while others saw these as mutually exclusive.

The social climate created by a decade of educational reform efforts made the introduction of computers into classrooms more problematic. This was partly due to the nature of the 1980s reform efforts which can be characterized as a "back to basics" movement (Goodman, 1992). Just as computers came onto the scene, critics of education argued that what schools needed most was the removal of superfluous instructional methods and a return to a more traditional approach to education with a heavier emphasis on basic skills. This is, perhaps, why computers were not immediately embraced as worthwhile for students and teachers. As computers became more useful tools in the workplace, many schools did experiment with them.
Usually this involved getting one computer and letting students use it during free time. Some teachers incorporated its use into classroom activities (Bailey, 1992; Dyrli & Kinnaman, 1995).

Two individuals pioneered the use of computers in schools and viewed them as significant change agents. Alfred Bork suggested a new philosophy of education which incorporated technology (DeVillar & Faltis, 1990). He did caution against giving computers too much control. Bork focused on the use of computers to individualize education. The other IT pioneer is Seymour Papert and he is perhaps the best known advocate of IT. He created the LOGO programming language and envisioned its use as a tool for fostering problem-solving and social learning (Papert, 1980). Both these visionaries proposed their ideas just as *A Nation at Risk* (1983), a report by the U.S. Department of Education, stated that U.S. students were not scoring as high on achievement tests as they once had (Goldberg, 1993). As a result, computers were not taken seriously as change agents. "Back to basics" measures were adopted and geared toward increasing students' standardized test scores and improving U.S. students' educational achievement standing as compared to students from other nations.

Reforms put in place after *A Nation at Risk* did not significantly change students' achievement test scores and concern about the state of American schools continued (Hodgkinson, 1993; Simmons, 1993). In the later

One of the major concerns expressed with this wave of school reform was the worry that American students would not be prepared for the technologically-oriented workplace of the future (Goodman, 1995; Thurow, 1992; White, 1993). These reformers argued that American education needed wide scale and significant changes. They held that education was still entrenched in the "factory-system" approach (Goodman, 1995) that was embraced in the early twentieth century to educate large numbers of urban-dwellers, especially immigrants, who were needed as laborers in factories. They argued that modern schools need to educate students for a new workplace model in which workers will need to have expertise with technology and be expert at problem-solving approaches to daily tasks (Harley, 1993). This concern with the economic impact of education has helped to strengthen support for more extensive use of IT in schools (A Competitiveness Strategy, 1993; Daggett, 1993; Twigg, 1994).
As a result of new concerns for the employability of students as well as U.S. economic competitiveness, educators have re-examined IT with the goal of developing practices that will bring about needed reforms. Assessment of previous practices has led to a greater consensus about what directions schools should take regarding IT implementation (Bailey, 1992; Bork, 1991, 1997). La Follette (1992) suggests three conceptualizations for the ways that computers have been used in schools: 1) tools, 2) systematic agents, and 3) systemic agents. He argues that schools and teachers have not taken advantage of the computer resources available because there has not been a sense of the overall place of computer resources in the curriculum. Muffoletto (1994) suggests that educators need to get away from seeing computers as merely efficient, and learn to see them as tools that can support problem-solving with a new mindset for learning and education. Farnan and Dodge (1995) suggest that useful applications of technology in education will come only when integrated with school reform. Bureau (1989) has argued that IT can, and should be, an agent of change in schools.

**Special Education Reform**

While IT was making its slow inroads into schools, special education was undergoing its own reform period. Again, starting in the early 1980's, there were calls for changes in Special Education because it was viewed as...
too costly. The first policy changes occurred in the mid 1980's when the Regular Education Initiative (REI) was introduced. The primary effort here was to place more students with special needs, especially mild needs such as learning disabilities, in regular education classes for larger portions of the day (Baker, 1995; Schumm & Vaughn, 1991). The hope was that students would benefit from the positive social and academic influence of general education students (Sale, 1995; Schumm & Vaughn, 1995).

A second reform effort followed REI and is known as Full Inclusion. This movement seeks to place all students in general education classrooms, regardless of ability. It is guided by the principle that all students should be educated together in a democracy (Fuchs & Fuchs, 1994). Led by advocates of students with very significant needs, this movement has created tremendous controversy among teachers, parents and community members (Shanker, 1995). Of greatest concern is whether general education teachers are prepared to teach students with such significant needs (Baker & Zigmond, 1990; Schumm & Vaughn, 1995; Vaughn & Schumm) and whether inclusion is really best for such students (Baker, Wang & Walber, 1995; Vaughn & Schumm, 1995). Successful examples of both REI and Full Inclusion have been found, but achieving this success requires tremendous planning and commitment (Logan, Diaz, Piperno, Rankin, McFarland & Bargamian, 1994).
Some special educators have looked into the use of technology as another component of improving the services provided to students with special needs. Male (1994) has suggested that using IT with such students fosters social interaction -- a goal of REI and Inclusion -- and promotes academic gains. Choi (1995) reported that adaptive and assistive technologies in particular can be very beneficial to students with physical disabilities. Further, technology can create long-term cost savings by making it possible for more students with disabilities to be in general education classrooms. A 1992 study by the National Council on Disability found that 27% of students who were able to use adaptive and assistive technologies were able to move into general education classrooms for full-time placements.

Educational reform efforts have had a large role in U.S. education policies of the last decade. Both in relation to technology and Special Education, there have been many efforts to enhance the classroom gains of students (Blackhurst, 1997). These reforms provide the context for examining individual research studies of the uses of technology both in general and special education settings.

Research Study Findings

There are certain methodological concerns in conducting research on the efficacy of computer use in schools. As McQuillan (1994) points out, if the
same instructor teaches both the experimental group and the control group, there is the chance of a carry-over effect from one class to the other. But, if different instructors teach the sections, the differences in results could be related to the instructor's style rather than the computer intervention. Other researchers, such as Mehan, (1985) discount these concerns by saying: "teachers teach, computers mediate" (Mehan, 1985:276 in McQuillan, 1994).

Miller and Olson (1994) have taken this line of thinking a step further by suggesting that apparently successful computer interventions are really the result of successful teaching practices. They base this argument on the idea that teachers who use computers in the classroom (at least up to now) are generally exceptional teachers who are more likely to use innovative instructional practices and who are highly motivated to make certain that such practices are working. Miller and Olson conducted a study of teacher use of computers in a rural Canadian elementary school. Using observation, interviews and other qualitative data from one teacher, they concluded that this teacher used the computer in her classroom in ways that reflected her previous teaching style, thus it did not change her teaching.

Miller and Olson's conclusion is premature, given the paucity of data they used. However, they raise important questions about the design aspects of studies involving IT. Becker (1994) conducted a study comparing "exemplary" computer-using teachers with other teachers. Using national
survey data collected in 1989 from 516 3rd through 12th grade teachers, Becker constructed a set of standards for an "exemplary" teacher in each subject area. These standards included both focus on content and the use of computers. The survey answers were indexed according to the standards criteria. Based on the data he used, Becker concluded that only 3% of teachers who use computers in the classroom could be considered "exemplary" computer using teachers.

Becker also found that administrative support of computer use and teacher background were related to patterns of computer use. He found that the exemplary teachers were not over-represented in high socio-economic communities nor did they teach mostly upper ability students. Becker's study has a number of flaws, especially the subjective determination of "exemplary" standards. Nonetheless, he raises important questions about how computers are being used in classrooms. The mere presence of a computer in a classroom does not mean it has any relationship to students' learning or the teacher's teaching. In looking at studies of IT use in schools, it is important to consider what questions the researcher asked and whether the study design is valid. Some studies yield only good questions, while others provide results that can be interpreted meaningfully, if cautiously.

A further concern is the method of measuring computer efficacy. Many studies have used student achievement test scores as their dependent
variable. This tendency reflects the continuing influence of reform efforts. The school reform movements of the 1980's and 1990's have focused heavily on improving students' achievement test scores as a measure of success (America 2000, 1989; A Competitiveness Strategy, 1992). Some case studies and other qualitative approaches use other measures, such as teacher and student reactions or social variables. It is important to consider what exactly is being measured in each study. While students' scores may reflect the positive impact of IT, other variables may as well, and researchers need to bear these in mind (Rockman, 1993).

A total of 78 studies are discussed here. The approach to evaluation of the studies is based on what research questions they asked. The studies can be broken down into a number of categories. Some categories include only quantitative studies while others include both quantitative and qualitative studies, including case studies. This review includes studies with a variety of research methods in order to get as good a sense as possible of what schools are actually doing with IT. When appropriate, anecdotal evidence will also be reported. The categories are listed in Table 2.1.

Not all of the studies reviewed here involved specifically students with special needs. Instead, studies were chosen based on their possible contribution to a knowledge base about effective IT applications that could benefit students with special needs. Again, the goal is to determine what IT
Table 2.1. Categories of research studies

<table>
<thead>
<tr>
<th>Category of Study</th>
<th>No. of Studies</th>
</tr>
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<tbody>
<tr>
<td>Access to Computers</td>
<td>2</td>
</tr>
<tr>
<td>Attitudes about Computers</td>
<td>6</td>
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<tr>
<td>Case Studies/Examples</td>
<td>5</td>
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<tr>
<td>Cognitive Style</td>
<td>5</td>
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<tr>
<td>Communications</td>
<td>5</td>
</tr>
<tr>
<td>Computer Efficacy</td>
<td>1</td>
</tr>
<tr>
<td>Hypermedia</td>
<td>6</td>
</tr>
<tr>
<td>Integrated Learning Systems/Drills</td>
<td>6</td>
</tr>
<tr>
<td>Math</td>
<td>2</td>
</tr>
<tr>
<td>Memory</td>
<td>2</td>
</tr>
<tr>
<td>Meta-Analyses</td>
<td>4</td>
</tr>
<tr>
<td>Problem-Solving</td>
<td>5</td>
</tr>
<tr>
<td>Reading</td>
<td>5</td>
</tr>
<tr>
<td>School Life</td>
<td>1</td>
</tr>
<tr>
<td>Training</td>
<td>4</td>
</tr>
<tr>
<td>Usage</td>
<td>4</td>
</tr>
<tr>
<td>User Control</td>
<td>3</td>
</tr>
<tr>
<td>Writing</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>78</strong></td>
</tr>
</tbody>
</table>

applications can make a difference with students on a range of levels, academically, socially and behaviorally. All of these factors are important to student growth and success and may be useful in developing models for students with special learning needs.

Specific studies, however informal, were not located for a number of topics that are important issues for students with special needs. Therefore, anecdotal evidence and suggestions from the field are included as additional
background information for topics which include adaptive and assistive
technologies, artificial intelligence (AI), assessment, pre-school applications,
spelling, and social issues. This information is included to provide as much
data as possible on how educators are using IT with diverse populations.

The studies covered a wide range of IT application types: word
processing, drills, integrated learning systems, simulations,
hypermedia/multimedia, programming, networking, electronic mail, and
Internet/World Wide Web uses. This is impressive because it indicates that
educators are using a large variety of IT resources in many different ways.
Most of the studies reported here date from 1990 to the present. Given the
ongoing enhancements and changes in computer technology, this body of
research reflects IT hardware and software that has shown itself to
withstand the effects of time and is yet still readily available. Some
applications are relatively inexpensive while others are quite costly. Both
show what is possible. The studies are discussed according to category in
alphabetical order, with the exception of the meta-analyses. These studies
are discussed first as a background for the remaining literature.

Meta-Analyses

A special pull-out section on technology in education in The Wall Street
Journal in November 1995 contained a section on the overall effects of IT.
Without naming his sources, Neal (1995) reported that IT can have a positive influence on self-esteem, basic skills and cognition. He suggests that effects are more pronounced for low-achieving and low socio-economic status students. These appear to be sweeping generalizations about the effects of IT, but to some extent they are found in other more formal meta-analyses of the effects of IT. In a study published in 1987 the Organization for Economic Co-operation and Development argued that computer-assisted instruction (CAI) allows for the use of instructional methods not otherwise available and the testing of methods in lab settings (Information Technologies and Basic Learning, 1987). Further, they pointed out that computers facilitate hypothesis testing and the use of experiment as instructional tools. In their view, computers also "reify" learning tasks and help students to revise and reflect. They concluded that CAI needs to incorporate lessons learned from research in cognitive psychology. While this was not a formal study, it does provide key points that distinguish CAI from other instructional methods.

Several meta-analytic studies of IT offer indicators of the extent to which computer use influences specific student outcomes. Meta-analysis is a statistical method which examines and synthesizes the effect sizes of a number of studies related to the same topic (Smith & Glass, 1977). Kulik (1994) has conducted a number of studies of the effectiveness of IT in schools.
In summarizing his own research, he finds that there are five general conclusions that can be drawn about the effects of IT:

1. Students learn more
2. Lessons are learned in less time
3. Students enjoy their classes more
4. Students develop more positive attitudes toward computers
5. Computers do not create positive effects in every area

Kulik points out that there are problems with meta-analytic approaches to research, including an over-reliance on statistical effects and the failure to consider the many methods and designs that may have been used in the individual studies. Kulik's most recent meta-analysis (1994) included 97 studies with an average effect size of .32; these data indicated that IT can raise the average students' performance from the 50th to 60th percentile. He notes that the standard deviation of effects is .39, showing a great deal of uncertainty about the actual effects.

Kulik has found that tutoring programs have the highest consistent effect size at .38. He notes that studies of the popular program, LOGO, are difficult to compare because the results are highly varied. Compared with other instructional innovations, including accelerated classes, mastery learning, peer tutoring, classes for the gifted, group projects, learning packages and programmed instruction, the effect size of CAI tutoring programs, falls exactly in the middle. Kulik's work provides a good synthesis of past research but is limited by the constraints of meta-analytic research.
In a second meta-analysis published in 1994, Khalili and Shashaani pointed out that computer use in schools increased 50 fold in the decade from 1984-1994. This study examined the available literature about the effectiveness of CAI that was published from 1988 through 1992. They point out that early studies of CAI from the 1970's showed that when CAI supplemented traditional instruction, student performance was enhanced, however, when CAI replaced traditional instruction, the results were ambiguous (Khalili & Shashaani, 1994:49). Data from the late 1970's and early 1980's indicates that CAI helps students learn more in class, remember longer and spend less time on lessons. They did not indicate how such performance was measured on these early studies. The early studies they cited also indicate that when teachers get more than ten hours of training the effect of CAI is better.

Khalili and Shashaani's meta-analysis included 36 studies. The studies were chosen based on solid design and methodology. All the studies used student achievement as the dependent variable. The studies were coded on 13 characteristics by two raters with an inter-rater reliability of .90 or better. For the meta-analysis, effect size was the dependent variable; a total of 151 comparisons were made. 91% of the effect sizes from these comparisons were positive with a mean effect size of .38, meaning that the
performance of the experimental groups was, on average, .38 standard deviations above the performance of the control groups.

Further analysis showed that longer term studies, those four to seven weeks in duration, produced larger effects than shorter ones. Studies using the LOGO programming language had the largest effect on achievement. Unfortunately, the authors did not explain what the LOGO studies were evaluating. Given that LOGO is most frequently used with primary grade students (K-3) and the limitations pointed to by Kulik, these gains may have been the result of normal growth and progress. Their analysis of IT types shows that simulations are the most effective type, while drill and practice is least effective. This finding will be discussed further below. Problem-solving programs were second most effective.

Of note, half of the studies were math oriented and thus, the biggest gains were found in math achievement. Khalili and Shashaani found that computers were most effective for high school students and less so for elementary grades. Middle school students showed the least gains. The authors did not comment on different program types used with each age group. As with earlier studies, they found that CAI was most effective when it supplemented regular instruction rather than replaced it. Overall, Khalili and Shashaani found that the studies they looked at show that CAI can enhance achievement.
Khalili's and Shashaani's work is flawed by its lack of detail about the actual programs and CAI applications used but it does offer some preliminary information about the effects of computers in certain situations. More important was their finding, consistent with earlier studies, that CAI works best when it supplements other instruction rather than replacing it.

Fletcher-Flinn and Gravatt (1995) conducted a very similar meta-analytic study in New Zealand. They commented on the problems in the design of studies of IT, especially their frequent short duration and novelty effects. Fletcher-Flinn and Gravatt examined 120 studies of CAI, selecting them based on solid study design and classroom applicability. Student achievement, as measured by a post-test was the common dependent variable. The studies were coded according to nine variables; for the meta-analysis effect size was the dependent variable. For these studies the mean effect size for the experimental groups was .24, placing them at the 60th percentile.

Their other findings show that students' attitudes toward instruction and subject matter were higher in CAI groups. High ability groups and females profited the most from the CAI instruction. Eighteen of the studies were long-term (more than six months) and controlled for teacher effects; these showed less of a benefit from CAI. This finding suggests a Hawthorne or novelty effect from CAI when implemented for shorter durations.
Importantly, outcomes from studies with students with special needs were stronger than those with general education students. Fletcher-Flinn and Gravatt conclude that since the gains from CAI are equal to or greater than traditional instruction, CAI is worth using.

Fletcher-Flinn and Gravatt's study provides some correlation of the findings presented by Kulik and Khalili and Shashaani plus additional information. All three studies indicate that CAI can lead to student gains in achievement. Fletcher-Flinn and Gravatt show that CAI is especially helpful for certain populations, including females and students with special needs. Kulik's and Khalili and Shashaani's effect sizes were closer to each other than to Fletcher-Flinn and Gravatt's. This may be the result of the latter study's larger size. Importantly, these meta-analyses all included some of the same studies, limiting the comparability of findings. None of the studies gave much detailed description about the kinds of programs used and this lack of data restricts the interpretation of their findings. Nonetheless, all these studies show that CAI can improve students' scores on achievement measures and is useful as an enrichment tool in the classroom.

Fitzgerald and Koury (1996) conducted a more subjective meta-analysis of research related to the use of IT among students with mild and moderate disabilities. They examined studies published from 1988-1995 in the areas of reading, math, writing, social studies, and science. They report
that students with mild and moderate disabilities showed gains in all areas when CAI was used. The authors did not report the effect sizes of the gains but did identify successful components of the methods used, including:

1. Control the size of the instructional set;
2. Use time delay and controlled response time to build fluency;
3. Intersperse mastered items with new items for maintenance and successful rates of responding;
4. Provide immediate feedback of results to students;
5. Limit the use of extraneous graphics and arcade format “games” in drill materials;
6. Provide learner options to use hypermedia enhancements and speech synthesizers to support understanding.

Fitzgerald and Koury also found that effective use of CAI requires teacher training and time to be effective.

Fitzgerald and Koury provide additional evidence that IT can be beneficial for students with mild and moderate disabilities. Their meta-analysis is limited by the lack of statistical evidence in their summarization, but they do provide more descriptive detail about what aspects of CAI benefit students with certain disabilities the most. While their research did not address the issue of the nature of the outcome measure, in general, they found that CAI enhanced the achievement of students with mild and moderate disabilities.

A fifth source provides information about how CAI designers are using learning strategies based on cognitive models. Park (1995) investigated a number (N not given) of CAI programs to evaluate the instructional
strategies being used. He identified 13 strategies identified by cognitive psychological research as important for learning. These are:

1. Adjunct questions
2. Reflective questions
3. Summarization
4. Note-taking
5. Key-word method
6. Peg-word method
7. Method of loci
8. Advance organizers
9. Underlining
10. Concept maps
11. Vee diagrams
12. Matrix frames
13. Signaling

Park argues that IT designers are not using these methods sufficiently in their design of IT programs. He also suggests that teachers need to be aware of these methods in order to evaluate IT programs critically.

While Park's findings are not based on a formal research study, they do suggest that the quality of IT applications needs to be evaluated whenever such programs are being considered. A solid body of research points to effective instructional methods that IT designers and educators should keep in mind (Engelmann & Carnine, 1982).

Access to Computers

Two studies investigated the effectiveness of providing students with access to computers at home. Rozik-Rosen and Atlas (1994) investigated the
effectiveness of the TLALIM program in Israel. This program provides school services to students who are temporarily or permanently homebound. The goals of the program are: 1) helping students to strengthen the healthy parts of their lives and, 2) strengthening the students' sense of being connected to the world outside. The program relies on home-based computers and other technology such as VCRs to help students stay caught up with their classes. An important component has been the use of modems to connect the students with their teachers for extra help and with their classes directly. Both students and teachers report that the regular contact makes a big difference in helping students remain current with their classes as well as achieve the goals of the program.

A case study analysis of the program using student and teacher interviews as well as achievement data shows that it is effective at achieving the program's goals. Further studies of the program's effects on student recovery are on-going. This program provides an example of how technology can be especially useful for students who cannot participate in traditional classroom activities. It could be an important model for use with students with special needs who cannot attend classes regularly.

A second study concerning student access to computers involved the Buddy System project in Indiana (Miller & McInerney, 1995). The experimental group consisted of 147 fourth and fifth graders at one
elementary school; 142 matched students from another school were the controls. Each student in the experimental group was given a computer, printer and modem for home use for the school year. The research base behind the project included findings that time on task, attitude, self-esteem and increased parent involvement in school work are related to student achievement. End of year achievement test scores were not significantly higher for the experimental group. This would suggest that the placement of computers in students' homes did not have an effect on achievement as measured by these tests. The authors report that the computers did seem to have an effect on self-esteem, interest, parental involvement and time on task but recommended more research on these issues.

This study presents a number of interesting findings. From the standpoint of the effectiveness of IT, the design of the study appears seriously flawed. The study did not provide for adequate teacher or parent training in the use of the computers. Some teachers integrated the computers into their lessons but many did not. As a result, actual use was very uneven. This lack of full implementation makes it impossible to determine whether the computers had any real impact on achievement or learning, as measured by one test. Further, the use of one post-hoc test as a dependent variable is highly questionable. Many educators are eager to know if IT can enhance test scores. If no instruction is provided that would foster use of the
computers to prepare for the tests, then using these tests is not a reliable measure of IT effectiveness.

Finally, the use of one test to measure the effectiveness of home-based computers seems extremely short-sighted. A more comprehensive study design that incorporates analysis of the effects on self-esteem, interest, parental involvement and time on task would have yielded far more useful information. These issues are just as important for overall student success as achievement scores (more so, some would say) and need to be given serious consideration.

Assessment

There are few studies investigating the use of IT for assessment. Kelly-Benjamin (1995) conducted research on the use of both computers and video-cameras for assessment of students in math instruction. She reported that only 12% of technology using classes include assessment in IT activities. The subjects were 15 elementary and middle school math teachers who had experience using technology in math instruction. Teachers were videotaped during assessment activities. Teachers then participated in workshops to learn new assessment methods using the computers. They continued to videotape assessment activities during math instruction. The teachers reported that this method of ongoing support enhanced their use of
technology for assessment. Kelly-Benjamin concluded that three variables influence teachers' use of technology for assessment: 1) availability of technology, 2) opportunities for professional development and 3) consistent support.

A more philosophical approach to computer use in assessment is found in Moran's (1992) discussion of computers for grading of essays. Back in the 1960's and early 1970's some educators envisioned computers doing grading of essays to free teachers for other tasks, like discussions with students. He suggests that while this original idea may not work, the concept of developing rubrics for holistic grading is a very good one and deserves further research. More information on the use of such a computer-based rubric will be given in the section on writing below. Much more research and practice with the use of computers in assessment is needed. One important aspect of the issue of assessment involves school reform as discussed above. Computers and other IT's may not have a strong role in traditional assessment activities like tests, but could have a very vital role in new assessment measures such as portfolios done with hypermedia or multimedia or cooperative and online projects.
Attitudes and Beliefs

An important precursor to having computers in the classroom is an adequate understanding of students' and teachers' attitudes and beliefs about computers themselves. Riggs & Enochs (1993) piloted a Microcomputer Beliefs Instrument (MBI) among 269 urban middle school students. Results showed significant differences by sex and whether the students had home computers. Kinnear (1995) found that there are important differences among students' beliefs and attitudes concerning computers that vary by age and grade.

Proctor and Burnett (1996) conducted another study of students' attitudes about computer use. Subjects included 167 sixth and seventh grade students in Australia in a study that investigated whether computer access time is related to attitudes about computer use. Data from pre and post-test surveys showed no significant relationship between students' attitudes and increased access time. The authors suggested that there may be a negative effect from requiring students to use computers for school-related work instead of just for games.

Marsh (1995) used a qualitative design to investigate the perceptions, beliefs and practices of teachers, parents, special educators, and administrators of inclusive first grade classrooms. Attitudes that emerged from the data were control, responsibility, and equity. Moore, Rieth, and
Ebeling (1994) conducted a study of the relationship between teacher's computer training and attitudes about computers. Eight students in a Master's degree program in special education participated in a qualitative and quantitative repeated measures design study. Results showed a relationship between the amount of training in classroom computer use and positive attitudes regarding the instructional benefits of computers.

A similar study by Siegel, Good, and Moore (1996) studied whether the inclusion of technology/computer-related instruction in Master's level special education courses was related to students' attitudes about computer use. Results showed a statistically significant increase in the student teachers' attitudes about computers. Use of this information could be helpful in IT design. Beliefs are difficult to study but better understanding is nonetheless needed. Studies need to include not only teachers' reports of beliefs but also data on actual practices and how these might differ. Gathering such data can have an important role in understanding how change happens in schools (Pajares, 1992).

Case Studies of Schools Using Technology

A number of schools have implemented school-wide IT applications that serve as case studies of what effects IT has. Case studies of five schools which have implemented or are in the process of implementing school-wide
computer networks show that the overall effect is very positive. These schools (listed in Table 2.2) all report student-centered instruction, improved student attitudes, more relevant learning, and overall good morale among students and faculty. Parents in McKinney, Texas, the site of ACT Academy were initially skeptical of the plan for an entirely "wired" school but student achievement and enjoyment have changed parental thinking about computers (Helliker, 1995).

Three of the schools, ACT Academy, Salem High School and Silver Ridge School, implemented sweeping instructional and institutional reforms when they incorporated technology into their schools (Helliker, 1995; Holland, 1995; Matteson, 1992). These reforms include interdisciplinary instruction, block scheduling, student-centered instruction and multi-grade classes. So far, parents, teacher and students have reported that these changes are successful. Students at Ft. Lauderdale, Florida's magnet technology school report that they are better prepared to get a job once they graduate (Stecklow, 1995).

Table 2.2. Case studies of IT implementation

<table>
<thead>
<tr>
<th>School</th>
<th>Location</th>
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<tbody>
<tr>
<td>ACT Academy</td>
<td>McKinney, Texas</td>
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<tr>
<td>Brewster Academy</td>
<td>Wolfeboro, New Hampshire</td>
</tr>
<tr>
<td>Technology Magnet School</td>
<td>Ft. Lauderdale, Florida</td>
</tr>
<tr>
<td>Salem High School</td>
<td>Conyers, Georgia</td>
</tr>
<tr>
<td>Silver Ridge Elementary</td>
<td>Silverdale, Washington</td>
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</table>

36
Brewster Academy implemented their school-wide network with the use of laptop computers (Bain, 1996). Every teacher and student has one and can connect to the network from a number of ports around campus. Brewster's plan has two guiding principles: 1) universal access for everyone from everywhere and, 2) embedding of technology into the curriculum. Their implementation began with a needs assessment and is being implemented in four stages. Eventually, all the school's curriculum will be integrated with the computer network.

A number of other IT programs serve as case studies of classroom based programs. An Albuquerque, New Mexico program using Skills Bank, an integrated learning system (ILS) has been very successful in preparing dropouts to pass the General Equivalency Degree (GED) exam (Albuquerque, 1995). This program has a success rate of 89% and students report that they find it more interesting than traditional methods of instruction. The Lawrence Hall of Science in Livermore, California uses portable workstations to provide lab experiences to students visiting the science institute (Harper, 1994). The computers are set up so that they can be used as either stand-alone or network stations.

Teachers at Deerfield Elementary School in Deerfield, Massachusetts and Quarry Hill School in Leverett, Massachusetts have used Internet connections to participate in science projects with their students. A Pillbug
project connected sixth grade students with entomologists from around the
country in a study of insects (Heins, 1996). A school in Philadelphia used
computers for a Chapter I school-wide project in which students studied
artwork and created class-based museums. The students used hypermedia
programs to create their own artwork and commentary on famous works of
art (Novelli, 1993).

Programs such as these are ideal for students with special needs
(Kearsley, Hunter & Furlong, 1992). They provide opportunities for students
to be more productive and foster different types of learning. Students with
special needs are better able to participate in classroom activities when there
is greater diversity and more hands-on activity. Still, school-wide IT
applications need to be planned carefully and respond to the needs and
mission of the school. Centralized applications are not always the best
answer (Person, 1994).

Cognitive Style

Five studies examined cognitive style as it relates to computer use.
Ester (1995) investigated whether students' learning style (abstract or
concrete) relates to student achievement when CAI is used. The subjects
were undergraduate music students. The results indicate that concrete
learners, as measured by the Gregorc Learning Styles Profile, did essentially
the same under the CAI condition compared with the lecture condition, but abstract learners did better in the lecture condition. The same instructor taught both groups and so these results can be interpreted as potentially valid measures of learning style and CAI interaction.

Another study investigated the relationship between cognitive style and personality type and the likelihood of computer use. Using the Myers-Briggs Type Indicator, Jones (1994) conducted a study with 140 students enrolled in graduate and undergraduate educational psychology classes. Subjects completed the abbreviated Myers-Briggs inventory and two questionnaires on attitudes and likely use of computers. Results showed that all subjects reported a high likelihood of computer use but no relationship between personality type and computer use. More positive attitudes about computers were associated with the N (sensing) and T (thinking) traits. There was no relationship between general attitudes about computers and the MBTI. This study suggests that computer use has become quite widespread and personality type is probably not a variable in use. Further studies which investigate how different individuals use computers would be helpful for designing IT applications for students and teachers.

Weller, Repman and Rooze (1994) conducted a study of the role of cognitive style in students' use of hypermedia-based programs. The subjects were 33 eighth grade students in two southwestern middle schools. These
students were all enrolled in a computer literacy course. Students took the Group Embedded Figures Test (GEFT) as a measure of cognitive style. Within the context of the computer literacy class students them completed one of four versions of a HyperCard stack about computer ethics. The four conditions were: 1) advance organizer, 2) structural organizer, 3) no advance organizer, and 4) no structural organizer. These versions varied according to amount and type of embedded features and support for users.

After completing the HyperCard lesson, each student completed a twenty item paper test of the ethics lesson material. Using computer audits, the researchers determined to what extent each student used the features embedded in the four versions of the program. The results show that field independent students learned computer ethics better than field dependent students, regardless of which program version they used. The field dependent scores varied considerably but were highest for the no structural organizer condition. This study, which was well-designed and conducted, yields some important information about students' learning style and computer use. More research on enhancing IT applications for field dependent cognitive styles is needed.

Two studies of the relationship between learner cognitive style and level of user control over the program give further evidence of the importance of cognitive style in program design. Yoon (1993/4) conducted a study of 86
second and third grade Korean students. These students first completed the GEFT to determine cognitive style and then took a pre-test of multiplication facts knowledge. The subjects were them randomly assigned to one of three instructional strategy groups: 1) program control, 2) learner control or 3) learner with advisement control. After using the math facts program students took a post-test. The results show that there was a significant difference between the learner control and program control groups. However, two other variables also were apparent. Field dependent students took longer to complete the program but there was no overall significance between these students' scores according to strategy group. In addition, prior knowledge was found to be significant and it reduced the importance of cognitive styles. The design of this study, with several overlapping variables, makes it difficult to interpret the results, however it does contribute important information concerning prior knowledge and time on task as they relate to the cognitive style of learners.

A final study of cognitive style was conducted by Santiago and Okey (1992). This study investigated the relationships among three levels of computer program advisement (adaptive, evaluative and combined) and three levels of locus of control (internal, middle and external). Pre-service teachers (N=74) at the University of Georgia's School of Education were assigned randomly to three groups for a computer-based task concerning instruction
methods. Students completed a survey to determine their locus of control and then completed the computer task.

Results show that there were significant differences among student scores in the different advisement groups with adaptive advisement having the highest scores regardless of locus of control type. There was a significant difference between the internal and external locus of control groups but not the middle group. Overall, internal locus of control subjects performed better than external locus of control subjects regardless of advisement type. The straightforward design of the study provides even more useful data on the role of cognitive style (locus of control) in computer effectiveness. The results from this group of five studies indicate that certain components of learner cognitive style, especially field dependence and external locus of control, are linked to poorer performance on computer-based tasks. Further research on how to make IT programs more effective for such learners is needed and will be especially helpful for making effective use of technology for students with special learning needs.

Communication, Electronic Mail, and the Internet

No aspect of technology is more talked about today than the Internet. It is an unending collection of resources that students and teachers have found useful. There are a large number of resources available to teachers
providing instruction in how to use the Internet, especially the World Wide Web (Chrobak, 1995; *Classroom Connect*, 1995; December, 1994; Falcigno & Green, 1995; Johnson, 1995; McKenzie, 1995; Porterfield, 1994; Powell, 1995; Taylor, 1995). Experienced Internet and Web users report that it is important for teachers to plan their use of Internet resources carefully so that the use is instructional and purposeful (McKenzie, 1995; Vandergrift, 1996; Wallmannsberger, 1994).

Few studies of electronic mail (e-mail) and Internet projects have been published because their use is too recent. However, the one major study to date suggests that online communications is related to enhanced student achievement (*Scholastic*, 1996). A study sponsored by Scholastic and using Scholastic online services involved 500 fourth and sixth graders in seven urban school districts. The quasi-experimental design compared the achievement of students who did or did not have access to online information for a project on civil rights. Results show that the quality of the work submitted by students in online classrooms was better than those in non-connected classes. These data must be interpreted cautiously because the projects were evaluated subjectively by a small number of raters. Still, the results suggest that more research into the use of online services in education is warranted.
Von Holzen (1995) reported that college students who use e-mail to communicate with their professors report better and more frequent communication. When used for journal keeping, the students report they prefer writing via e-mail and the professors report longer entries (Von Holzen, 1995). Student teachers who had the option of using e-mail to communicate with a methods course professor reported that they preferred this mode of communication and that it fostered greater knowledge about computers.

Seventh grade students with learning disabilities who participated in a class project using e-mail to write a play with another class reported that they enjoyed the creativity and communication (Sauer, 1994). Their teacher reported that they all took increased pride in their work as they had the chance to share their learning experiences with other students. A program in New York sponsored by Nynex linked six public schools to computer services at Syracuse University (Mills, 1995). The focus of the project was to provide information on demand services to students as a research tool. Students used the services for a geography project and reported that using computers made the project more fun. Bulkeley (1995) reported on a number of Internet projects by students in K-12 schools. These include participation in global expeditions such as the 26 Peaks project. In the project, students
communicated with researchers in the field and had the chance to contribute original data to ongoing research projects.

As the availability of Internet and e-mail resources expands further, research into the use of such services will become available. Initial information indicates that students are very enthusiastic about using such global resources because doing so makes them feel more connected to the "real" world and gives them a sense of purpose about their learning. Teachers have also reported impressive social and academic gains from such projects (Brown-Chidsey, 1995). Programs utilizing communications resources need to include students with special needs because such programs may be very well suited to their unique learning styles and needs.

**Computer Efficacy**

While a very large number of studies have been done concerning teacher efficacy in regard to teacher beliefs about their own teaching, few studies have been done concerning teachers' and students' beliefs about their own computer efficacy. Olivier and Shapiro (1993) found a strong relationship between computer self-efficacy and computer use among a number of professions. They also reported that some studies have suggested that computer efficacy is learned, and therefore, teachable. Carlson & Grabowski (1992) conducted a study of computer-based direction following
behavior among individuals with high, medium and low levels of computer efficacy. Other variables included sex and ROTC membership. Subjects in the study were 57 undergraduates in an education program. Twelve of the subjects were ROTC students. Subjects completed two surveys measuring direction-following behavior and computer self-efficacy; these measures were embedded in a CAI program designed to teach use of a mainframe computer. Analysis of covariance (ANCOVA) indicated significant results for sex and ROTC status by direction-following behavior. Males exhibited higher computer self-efficacy than females and males and females exhibited different direction following behaviors. Females with lower self-efficacy followed more directions than males with lower self-efficacy. Overall, ROTC students exhibited more direction following behaviors than the other subjects. Those who followed more directions, took longer to complete the training.

This study provides some useful preliminary information concerning computer efficacy. The differences in male and female behaviors suggests that more research is needed on how males and females use computers differently. ROTC students were included because it was hypothesized that they would, as a group, be more likely to follow directions given their military training to do so. This was the case in this study, but the small number of ROTC subjects is too small to draw any firm conclusions. However, the
significant differences in ROTC/non-ROTC scores suggests that further
research into computer efficacy according to various cognitive styles is
needed, as addressed above. In general, more research on student and
teacher computer efficacy should be done to provide better indicators of how
much support such users will need. Delcourt and Kinzie (1993) and Murphy,
Coover & Owen (1989) have piloted computer efficacy scales so perhaps more
data on this aspect of IT is forthcoming.

Hypermedia/Multimedia

Many people confuse the terms hypermedia and multimedia. They
mean two different things, but hypermedia is an example of multimedia.
Multimedia refers to the combined use of several different media (forms of
expression) to communicate a set of ideas or a lesson. Multimedia can
include text, paper/pencil, video, audio, graphic arts, fine arts, computer
generated art, etc. Hypermedia is a specifically computer-based form of
communication. Hypermedia refers to certain computer programs that allow
non-linear "links" or jumps from one idea, graphic, or other "clickable" point
in the program. Hypermedia can include the use of text, original and
computer-generated art, audio, and video. It is a very versatile form of
thinking, composing and communicating and many educators see a
tremendous opportunity for hypermedia use in IT applications.
There are relatively few formal studies of hypermedia, again, because of its newness. Educators who have used hypermedia in their classrooms generally are very supportive of its potential for students (Bucher, 1995; D'Ignazio, 1995). Bucher (1995) and others (Brown-Chidsey, 1995) have argued that it is especially effective for students with special learning needs because it is non-linear and very adaptable to individual learning styles. A large-scale computer-based multimedia project at the University of Southampton (England) has been successful in helping both modern language majors and English as a Second Language (ESL) students take advantage of Internet resources by creating a database of such resources for student use (Piper, Wright, Hall & White, 1994).

Okolo and Ferrati (1996) conducted a study of the use of hypermedia for report generation by 21 high school students with learning disabilities. Ten students were assigned to the hypermedia group and the other 11 were controls. While the effect size of gain for the students with learning disabilities was very small, the students with the most severe disabilities made the greatest gains. Follow up interviews with the students showed they enjoyed the hypermedia format and wanted to use it again.

Case studies of multimedia and hypermedia use with individual students have shown their strong potential for further application. In a case study of a visually-impaired student, Lee, Groom & Groom (1996) found that
use of multimedia enriched the experience of both the visually-impaired student and his classmates. The multimedia components of the class provided greater detail, but the presence of a visually-impaired student forced the instructor to slow down while teaching these materials and describe and use them in ways that he would not have otherwise. A second case study involved a 22 year old male with severe learning difficulties and communication deficits. He was not able to work and required constant supervision. The experimenters designed a hypertext stack designed to foster greater language and communications skills. The subject was unable to use a mouse so the stack was redesigned with a touch screen. The subject was able to make some connections between screen icons and their sounds, improving his sound-symbol skills. This was viewed as a big step for this individual student.

Delclos and Hartman (1992) investigated whether a multimedia assessment program is more effective for mastery of problem-solving skills than traditional research projects. The subjects were 75 undergraduates of varied majors in an introductory psychology course. The researchers created a computer program which incorporated four curriculum components known to be effective tools for content mastery: 1) metacognitive component, 2) grounding in domain-specific knowledge, 3) practice opportunities, and 4) means of transfer to "real world" experiences. The program used a
hypertext language to foster non-linear connections. The same teacher taught both the experimental and control sections of the class. The experimental group’s class consisted of both lectures and computer lab use of the program but the control group had lectures only. The dependent variable was student performance on a term paper. These papers were graded by master’s degree students.

The hypertext group did better on theory use and integration of information than did the lecture students. The hypertext students included more research and theory in their papers than the other students did. Interviews of the hypertext students revealed that they found the program a help and they would take another class using the same format. This study has several limitations due to the mixed design, but the findings do suggest that the hypertext program had a role in improving students’ use of information and perhaps contributed to greater mastery and integration. Larger studies with more outcome measures would help to expand understanding of the usefulness of hypertext in classroom instruction.

In a different kind of study Farrow (1993) investigated the use of hypermedia in understanding and mastery learning. Farrow refers to this approach as knowledge-engineering and views hypermedia as a unique way of linking information to promote understanding. Undergraduate students (N=32) in an occupational therapy program in Australia created a Hypercard
stack about a specific neurological condition. Using student interviews and questionnaires, 74% of the students reported that they found the Hypercard project to be a good and worthwhile experience. They also found the presentation of their projects to the rest of the class via Hypercard to be less stressful than traditional oral presentations. However, fellow students rated the Hypercard presentations lower than the oral presentations.

Farrow's approach here is an important means of learning how hypermedia programs affect student learning. The results must be interpreted cautiously, but are promising. Farrow's work shows not only that hypermedia may be an important tool for mastery learning but that there are qualitative as well as quantitative methods for learning about the effects of such programs. Further studies such as this one, with larger samples and wider outcome variables will help educators learn more about how hypermedia can be an important IT tool. Important in the design considerations is thorough teacher and student training and preparation for use of such tools. Issing (1993) has suggested five principles to guide the design of multimedia/hypermedia applications:

1. Learner-oriented study environment
2. Creative learning with reference to problems
3. Active learning
4. Open study/learning opportunities
5. Self-initiated independent further study
Palumbo and Prater (1993) have suggested that hypermedia is well-suited to special education settings because it allows synthesis of information in nonlinear ways. These principles promote instructional practices that take advantage of the flexibility that hypermedia and multimedia offer students of many different learning styles (Moellers & Jeffers, 1996).

**Integrated Learning Systems/Drill Software**

Integrated Learning Systems (ILS) are a more recent version of one of the oldest IT applications: drill and practice software. Drill and practice programs provide students with the chance to practice weak skills and develop mastery. Such programs have been shown to enhance students skills but often these skills are not generalized to other situations (Van Dusen & Worthen, 1995). ILS provide stand-alone and network based drills programs across the curriculum. Van Dusen and Worthen have argued that ILS can be a strong help for students, but only if implemented correctly. They are not designed to replace teachers or traditional methods, but serve as a companion to these other approaches.

A study of ILS implementation in New York City showed that 63% of students and 88% of teachers felt that students had more control over their learning when using ILS (Swan & Mitrani, 1993). A follow-up study conducted with 185 at-risk high school students in Brooklyn and Staten
Island consisted of alternating traditional methods and ILS for remedial instruction in math and reading. Using observations of student and teacher behaviors in each setting the researchers concluded that ILS settings were more student-centered and teacher-student interactions were more individualized. Further, the teaching styles of the traditionally trained teachers shifted when they used ILS methods and they became more individually oriented.

Swan and Mitrani's work here indicates that ILS can be effective for changing the classroom climate. Unfortunately, their study did not report whether the treatment was related to gains in math and reading, the tasks that the ILS provided. This is disappointing because the qualitative data they collected could be an important contribution to our understanding of how ILS programs influence both student learning and classroom climate.

Another study of ILS was conducted by Clariana (1992), an employee of the WICAT corporation which publishes a number of ILS applications. This study investigated the effectiveness of WICAT's reading and writing instruction programs. Fifth and sixth grade students (N=115) from a public elementary school participated in the study. The students attended two 20 minute sessions in the computer lab each week. These sessions were also attended by the researcher; their teachers were invited to attend but did not. All students took the Stanford Reading Test as a pre and post-test. Analysis
of variance by treatment type (reading or writing) and sex showed that girls made no significant changes while the boys did. This study is of limited value because the research questions were not well defined and there is possible bias by the researcher. It does give further evidence of possible differences between the computer use of males and females.

A program at Florida State University includes an ILS called the Learning Strategies Courseware (Hannafin, 1991). This program prepares at-risk students to take an associate's level qualifying exam. No information on outcomes is given but Hannafin found that preliminary results are encouraging and she encouraged systematic study of the program.

Two studies point to the importance of design considerations in ILS materials. Edwards, Blackhurst and Koorland (1995) investigated the use of Constant Time Delay (CTD) as a component of drills based programs. This design feature involves slowly increasing the time between the task and response on drill activities. The authors suggest that it is particularly beneficial for teaching sight word reading, spelling and multiplication facts. Four elementary grade students used Apple IIe computers to work a program called Abbreviation Countdown, designed to teach students correct abbreviations. Results indicate that the CTD trials (embedded in the software) maintained or enhanced students' abbreviation use. The authors suggest that CTD should be used in other types of software, not just drill and
practice. The CTD study is a very limited example of ILS features worth further study. While the CTD trials were linked with successful recall of abbreviations, the study did not include long-term practice or any generalizability data. The authors may be premature to call for wider use before drill and practice success is established.

An Australian study by Toomey and Ketterer (1995) investigated the use of Computer-Enhanced Learning (CEL), an approach they see as different from CAI. This approach involves using multimedia computer programs alongside traditional instruction. The critical variable, in their view, is that the software (the ILS) is integrated into the curriculum seamlessly. In such a classroom, teachers are facilitators and the instruction is student-centered. Toomey and Ketterer contend that all uses of IT need to consist of integrating the technology into the curriculum such that it complements the full program rather than directing it. The use of ILS should not replace teachers or isolate students but serve as a catalyst for strengthening individual skills while enhancing the overall achievement of all students. More long-term and broad-based research on ILS programs is needed. If they truly deliver on these promises then they could have a powerful role in programs for students with special needs.

A different approach to the use of drills software and ILS programs has been suggested by Kromhout and Butzin (Butzin, 1992; Kromhout and
Butzin, 1994). A five year project in a number of Florida schools has investigated the use of a variety of softwares, including drills programs and ILS in a systematic and school-wide manner. Project CHILD (Computers Helping Instruction and Learning Development) involves the introduction of computers into multi-age grouped classrooms at a number of elementary schools. Each classroom is grouped by K-2 and 3-5 grade students. These classrooms have three to six computer stations running softwares chosen to complement and support the curriculum. Each day the classrooms are used as learning resource centers. Using the computers and other classroom resources, students work individually and collectively on projects based on an inquiry approach to learning.

Preliminary results indicate that students' achievement test scores have improved since project CHILD went into effect in these schools. The CHILD program is a different approach to using ILS and focuses on integrating new teaching practices with technology use. More of such large scale programs are needed to determine the long-term outcomes from ILS use.

A final note about ILS programs. An increase in home-schooling has occurred alongside the rise in ILS availability (Abramson, 1995). Some software vendors have targeted sales to home-schooling parents, offering entire K-9 curricula. This is certainly one possible use of such softwares, but
no research has been done to support such use and in-school uses of ILS are probably the most beneficial for students.

Math

Only two studies of the use of computers in math instruction were found. Salerno (1995) investigated the relationship between amount of time spent using computers and math achievement with 150 at-risk fifth grade students. A standardized math test was used as a pre and post-test measure of the students’ math achievement. The computer group had an additional 60 minutes of computer use time per week. The results showed that the gains made by the computer group were significantly greater than those made by control students. When the data were analyzed by sex, the girls’ gains were not significant, but the boys’ were. Salerno advised teachers to be aware of the gains that can be made with as little as 10 minutes of additional computer time per day.

In a study of computer use for math word problems, Wizer (1995) studied the effects on 48 middle school students, 32 of whom received special education services. The students worked cooperatively on math word problems using a computer 10 to 15 minutes per day three times per week. Comparison of mean scores on pre and post math achievement tests showed
that all students made gains, with the non-disabled students making the
greatest improvements. Observation data showed that when the non-
disabled students used the keyboard to input data and used verbal
explanations of their methods, achievement was enhanced. However, this
result was not true for the students with learning and emotional disabilities.
These findings suggest a need for development of CAI programs tailored to
the needs of students with language-related learning needs.

Memory

Two studies present findings about the relationship between IT use
and human memory. Baker, Niemi and Herl (1994) investigated the
relationship between memory and hypertext applications. Twenty-four 11th
and 12th grade students in ACOT (Apple Classrooms of Tomorrow) classes
read texts from history and science that took about 15 to 25 minutes to read.
Then, the students created Hypercard stacks in the computer classroom,
covering a history topic and a science topic. They also completed another
(unspecified) assessment measure for comparison. Analysis of the Hypercard
stacks showed that the students used different Hypercard features for the
history and science stacks. Unfortunately, no information about the other
assessment measure is given for comparison. Baker, Neimi and Herl
concluded that the use of different Hypercard features for the different
content areas shows that students organize/process information differently according to the subject. This conclusion appears weak and the overall research design seems flawed because there is no control group or measure used and what data was collected for comparison is not reported. Their line of thinking is very intriguing and more studies that investigate the relationship among memory, processing and computer use are needed.

A second study involving memory has far more useful results. Sharp et alia (1995) investigated the relationship between the use of video cues and memory for stories among 18 kindergarten students from an inner-city school (Sharp, Bransford, Goldman, Risko, Kinzer & Nye, 1995). The subjects participated in story-telling sessions under three conditions: 1) helpful video, 2) minimal video, and 3) no video. The helpful video condition involved dynamic, motion video clips and the minimal video condition involved still clips; neither video included sound. Each subject listened to a total of nine stories, three in each condition. Subjects recalled significantly more story details in the helpful video and minimal video conditions. Interestingly, the helpful video clips made a difference if they were used at encoding (during the story) but not in post hoc attempts at recall. The authors concluded that dynamic, motion video made a difference in helping the subjects to develop mental models for story building and memory.
The successful use of video to foster encoding and recall of stories among non-readers provides an example of non-computer IT use that appears to be very promising. This contributes a great deal to our emerging understanding about the use of IT, even in simple forms like video, and encoding and memory. The study is particularly well-designed with a three way approach in which every subject experienced all conditions. Larger scale studies using this design would be very beneficial and hopefully contribute further to our understanding of the importance of visual cues in memory. This research has many implications for IT design because one of the hallmarks of many IT applications is the dynamic video it offers. A better understanding of how visual cues affect memory will help IT designers to create programs that meet the needs of many learning styles.

Problem-Solving

A large number of studies have investigated the role of IT in enhancing students' problem-solving skills. This is an area of great interest to educators, politicians and policy-makers because it is one of the skills that school reformers have faulted schools for not teaching (Thurow, 1992). To this end some educators have argued that students need more real world examples of problem-solving situations which are socially oriented and involve multiple resources (Wiberg & Carter, 1994). Morgan (1996) suggests
that computers can have an important role in fostering problem solving because they allow manipulation of information and "playing" with ideas. He points out that such approaches are supported by research into cognitive processes. A more novel approach is suggested by Shank, Ross, Covalt, Terry and Weiss (1994). Shank has published the Abductive Reasoning Tool (ART) software which is designed to foster both creative thinking and problem-solving through the use of syllogism. This software may offer another approach to instruction of higher-order thinking skills.

The Cognition and Technology Group at Vanderbilt University (CTGV) has conducted numerous studies into the use of IT and its role in promoting problem-solving skills (CTGV, 1993). Their research has focused on an approach known as situated cognition. Situated cognition involves organizing instruction around a certain event or situation that offers multiple learning contexts. For example, they have used laser discs to introduce a unit or lesson on American history that involved the students in problem-solving activities centered on the laser disc "anchor". Situated cognition is not exclusive to IT but their use of it takes advantage of IT, especially laser discs. They chose laser discs for their early studies because of their affordability and greater availability for many teachers and schools.

The group has found that while students enjoy this approach and mastery of skills is impressive during the instruction, the students are not
generalizing across projects and learning situations as well as might be expected or hoped. They plan to continue this research and will focus on ways to promote greater generalizing.

Alessi and Quinn (1994) have investigated the role of computers in hypothesis formation. The literature indicates that students who use multiple hypotheses in the design of an experiment get useful results more efficiently. The subjects in this study included 179 undergraduate student teachers. The subjects completed a computer-based task involving hypothesis generation and problem-solving. Results indicate that multiple hypothesis generation was more successful than single hypothesis approaches when the task presentation began with a low level of complexity. The method of hypothesis generation was not significant when the complexity of the task was high.

These findings suggest that students are more likely to use more efficient methods of hypothesis generation when task presentation is not too complex. This study is very limited and few conclusions can be made from the findings. There is evidence that students' approaches to problem-solving many be related to task presentation and further investigation of this is needed.

In another study, 121 second and fourth grade students worked in pairs to solve computer-based problems (Cardelle-Elawar & Wetzel, 1995).
The model for this study is known by the acronym IDEA: Identify, Define, Explore and Assess. This is a self-regulatory strategy designed to engage the students as partners in a question and answer dialog while solving problems. The students kept journals and were interviewed by the researchers. The teachers were also interviewed. Results from these data indicate that the method was successful in helping students monitor their own learning and problem-solving strategies. The results from this study are promising but the study design is too limited to conclude much about the role of the computers in the intervention. The computers were used as tools, but it is not clear if they were essential or if a non-computerized version of this project might be just as successful.

A similar program known as HOTS (Higher Order Thinking Skills) uses drill and practice software as a conduit for an interactive dialogue approach to helping at-risk students develop stronger metacognitive skills (Pogrow, 1993). The HOTS program involves using computers, problem-solving settings, dramatic techniques, Socratic conversations, and thinking skills development. Pogrow argues that computers do not teach, but serve as conduits for fostering important skills; the multi-sensory features that computers offer create a unique tool that enhances the use of certain skills. She also argues that computers can give students a "stage" for practicing skills before they have to use them publicly.
The HOTS program offers an innovative way to use IT to promote higher-order and problem-solving skills. More research on all these efforts is needed to determine the long-term benefits. At the very least, student exposure to computers in problem-solving contexts makes sense because of their widespread use in workplaces. Enabling students' access to computers to practice working with them as tools, particularly in collaborative ways can be a big step toward addressing the need for students to have strong problem-solving skills as they enter the workforce. The benefit for students with special needs is yet to be seen and research needs to include this population.

**Reading**

Research suggests the IT could have an important role to play in reading instruction, especially in programs for students with reading difficulties. Computers have had a role in expanding the understanding of various components of the reading process, including the measurement of eye movements (saccades) and reading styles (McConkie & Zola, 1987). Siegel and Davis (1987) have suggested that drill and practice programs may be very well suited to reading instruction because they offer practice in those skills that students need most to master. Drills can individualize instruction and provide reinforcement as well as offer continuously adaptive practice sessions. Torgeson and Barker (1995) suggest that drill programs can be
very useful for practice of phonological awareness, a key reading subskill. Their own study of drill programs for practice of these skills showed positive results, although they do not describe the study design.

Other research points to the benefits of using CAI for upper grades instruction as well. MacArthur and Haynes (1995) conducted a study comparing the use of traditional texts and hypermedia enhanced versions of the same text materials. Ten learning disabled students, ages 15 through 17, used a computer-based science text and a regular text to complete an assigned reading. The computer-based text was enhanced with speech synthesis, an on-line glossary, hyperlinks, and supplementary explanations. The students received significantly higher scores on reading comprehension tests of the material covered in the computer condition. Interviews with students showed that they preferred the computerized version. This study appears limited by poor design and low numbers, but the results suggest that further research is warranted.

Research into the use of computerized speech as a component of IT applications is very promising. There are three types of computer-generated speech (audio): 1) digitized, 2) linear-predictive coding, and 3) synthesized speech (Olson & Wise, 1987). Digitized speech produces the best quality sound but has several limitations. It is very time-consuming and expensive to produce and it takes up large amounts of computer memory. The digitized
speech that is incorporated into a given program will include only that which has been recorded and converted to digital form. For this reason thus many programs include only small chunks of such audio. Liner-predictive coding is a form of digitized audio that uses "short-cuts" in the digitizing process so that it takes up less memory and costs less to produce. More publishers are using this instead of digitized sound when a pre-recorded body of audio data is needed. Finally, there is synthesized speech. This is the most adaptive of the three forms of sound because it can be user driven. Synthesized speech is the use of the computer to generate sounds based on a pre-programmed model of speech production. Early synthesized speech was not as intelligible as digital sound but more recent synthesizers, such as Digital's DECTalk apparatus, have made it very intelligible and useful.

Hebert and Murdock (1993) conducted a study of vocabulary learning using digitized speech, synthesized speech and no sound support. Three sixth grade boys with language learning disabilities practiced learning vocabulary words in each of the three conditions. The results show that all of the subjects learned the words best when using either of the speech programs. Two of them did best with digitized speech, while the third did best with synthesized speech. Spafford and Grosser (1996) cite a number of reading readiness softwares that include audio support. In most cases, the student can click the mouse or use a touch screen to have the computer "say" an
unfamiliar word. Hebert and Murdock's study results are very promising and far more research into the outcomes of audio and speech support in reading programs is needed.

The use of audio and speech features in reading instruction for students with reading difficulties appears to be an important use of IT with such populations. Tallal and Merzenich (1996) have developed a computer program for students with dyslexia that focuses on practicing phonemic skills. Research studies using this prototype software have posted impressive gains for students with mild to severe language learning disabilities (Merzenich, Jenkins, Johnston, Schreiner, Miller & Tallal, 1996). In a series of two trials with 6 and 7 students respectively, the subjects made significant gains in language skills. The researchers argue that computers are natural tools for this type of instruction because they can be continuously adaptive, provide feedback, push students to new levels and students generally enjoy using them.

Critiques of the Merzenich et al. and Tallal studies have focused on the small sample size of the studies and the relative severity of the participants' language delays (Nash, 1996; Saltus, 1997). Lundberg (1995) summarized the results of similar language and reading-related CAI studies being done elsewhere. These findings suggest that speech synthesis and modification may indeed have a role to play in CAI programs for language development.
This research offers provocative uses for CAI in reading and language development and, hopefully, further research will continue to provide useful data on how best to help students with reading and language disabilities.

At the upper end of the educational spectrum, Ring (1994) has suggested that computers can be helpful tools for enhancing critical reading skills among college students. Ring argues that many students arrive at college unable to read critically; they fail to question texts, look for assumptions, analyze or synthesize what they read. She supports a constructivist approach to reading instruction that embraces critical interpretation of texts. She believes that computers can have a role in fostering such skills because they offer: 1) interactivity, 2) prompts that encourage good reading strategies (including non-linear browsing), and 3) a companion to paper texts which can make reading more social. Ring’s suggestions point to the importance of effective reading instruction practices at all age levels. Harrington-Lueker (1996) suggests that reading instruction of students with delays needs to incorporate a combined phonics-whole language approach. A number of CAI materials are available to complement such instruction (Bennett, 1997; Harrington-Lueker, 1996). While many such practices look very promising to educators and parents, more research on the long-term implications is needed.
School Life

Only one study of the effects of IT on the school life of students was found. It raises important questions about the social and personal implications of educational computer use. King (1995) investigated the effects of computers on students' relationships, gender interactions and overall sense of school climate. He used a computer anxiety index to measure suburban high school students' attitudes and perceptions over a nine month period. The results indicate that computers do not necessarily enhance students' school life experiences. Students were influenced by other variables, including time for computer use and the purposes of such use. The results also indicated the critical role of teacher modeling with regard to attitudes about computers.

The scope of this study is very limited but suggests that more investigation of students' attitudes and perceptions about computer use is justified. Students are not likely to get much out of IT if they do not believe it is beneficial and IT applications need to keep students' responses in mind. Such programs do not need to be all fun and games, but should incorporate awareness of students' fears, expectations and ability levels into their designs.
Training

A consistent reaction from teachers regarding the implementation of IT is that they feel they receive far too little training. Investigation of budget allocations for IT related expenses show that training is frequently neglected and some schools fail to allocate any money for training (Brown-Chidsey, 1995). Other variables related to training are also evident. A nationwide program of IT implementation in Great Britain showed that high levels of teacher involvement were critical to IT success (Brown, 1994). Getting teachers to try new or innovative approaches was difficult. Some teachers and administrators who were known for using innovative practices resisted using IT because it meant a shift in resource allocation. Teachers were far more likely to try IT approaches when thorough training was provided.

Two programs in the U.S. also point to the critical role of teacher training in IT success. Project CHOICE in New York state was partially funded by a grant from the U.S. Department of Education and run by the SUNY Institute of Technology at Utica/Rome (Bauder, Planow & Sarner, 1991). The focus of the program was to train teachers to integrate computers into their classrooms and to provide adequate support to the teachers as they do this. Results of progress were not reported, but will be worth seeing. The Washington D.C. school district has one of the most successful technology training programs found anywhere in education (Buchsbaum, 1992).
Borrowing practices from corporate models, the District's personnel, including teachers, support staff, aides, and administrators, have access to year-round training programs. The District spends over 2 million on training alone each year. All classroom teachers are required to pass a computer literacy course but most teachers go on to take more classes. The response from teachers has been enthusiastic and the training facility was recently expanded. There has been an increasing demand for more hardware in the classrooms as teachers seek to use their skills with students. No formal data has been reported yet, but administrators are hopeful that the investment in training will yield improved educational outcomes for students.

Baker and Danley (1996) investigated how CAI can be used as part of general teacher education programs. Elementary and secondary preservice teachers (N=57) took a course in special education practices that used computer based materials as the sole means of instruction. Their achievement was compared with 28 peers who took a traditional lecture and discussion version of the class. All students used the same text. Comparison of the students' attitudes about special education and knowledge base of facts showed no significant difference between the methods of instruction. While the control group size in this study was very small, the results suggest that more investigation of CAI for general teacher training may be worthwhile.
It is very clear that adequate training of teachers is an essential component for IT applications to be successful instructional tools. When training is provided, teachers have responded enthusiastically and the result is greater use of IT in the classrooms. While viewed as an additional expense to some, it is a critical step in making IT a worthwhile investment. Once teachers are turned on to IT use, they can serve as trainers for others. More research into successful training programs and their outcomes will help serve as a source of data as schools develop training programs. Failure to provide adequate training can waste the money invested into hardware that goes unused.

Usage Variables

Research into the ways that teachers are using computers in their classrooms provides more data on the human variables involved in IT use. Four studies provide insights into usage variables. Faseyitan and Hirschbuhl (1992) conducted a study of 257 university professors in Ohio. The subjects were chosen randomly and completed a survey about computer use and attitudes. Results indicate that use of technology differed significantly according to academic discipline. Those who use technology tend to be from technology-oriented disciplines and have positive attitudes toward technology. Non-significant variables included sex, rank, research
commitment, instructional policies, technical support and staff development. These results are not surprising and focus attention on ways of expanding IT use at the college level.

Hussein (1996) conducted a survey of Lebanese administrators, computer teachers, and science/math teachers regarding the use of computers in schools. These results showed a need for more systematic integration of computer use in schools and improved teacher training. Current uses tended to include basic skills and computer literacy. Min (1992) conducted a survey of special education administrators in Michigan to learn how computers were being used in special education. Results showed that both general and special educators were using computers for instruction. Of participating districts, 34% reported that they have a long range plan for special education uses of technology; these districts had a higher percentage of special education teachers using computers in the classroom. The primary uses were supporting instruction, tutoring, implementing Individualized Education Plan (IEP) goals and as a reward for student behavior.

Cohen and Spenciner (1994) conducted a survey of 381 special educators in Maine. Impressively, 71% of respondents reported that they use computers in their classrooms. However, the responses also indicated that the computers were used infrequently and in very traditional ways. Word processing was used only 11% of the time and cooperative use of computers
was very uncommon. Those teachers who had access and experience with assistive technologies were very supportive of its benefits. The results also showed that students with special needs used the computers in general education classes very infrequently.

These results serve to provide important data about variables influencing the use of IT by special educators, even though explanation for these patterns is lacking. That the computers tend to be used in very traditional ways shows that even when they are in the classrooms they may not have the intended impact. More investigation of this type from larger number of teachers will help to define the variables that influence teachers' use of computers and, hopefully, the directions that training programs need to take.

Bailey (1992) has noted the general shifts in how computers are being used for instruction. Once used for programming, they now serve for more routine tasks. Ellsworth (1994) surveyed New York City special educators to learn how they use technology for instruction. The most critical variable in usage patterns was teacher interest and initiative. A national study sponsored by the Office of Special Education Programs and Macro International (1997) indicates that technology is underused in special education programs. A number of ongoing research projects are investigating how IT can best serve students with special needs (Hauser, 1997).
projects will provide insights into the best uses of IT among exceptional students.

**User Control**

Studies of the features of individual computer programs indicate that the amount of control the user has over the program is related to the user's success with the program. Previous research has shown that, generally, greater learner control yields greater achievement from IT applications. Time on task is another related component and the number of features in a program influences the amount of time a user spends on a given component of a program. Hannafin and Sullivan (1995) investigated the relationship between user control and program features. In this study 274 ninth and tenth grade students in a rural high school used a computer-based geometry program. Most students had no prior knowledge of the program's content. The subjects were grouped by ability according to an annual achievement test. Four versions of the program were used and subjects were assigned randomly to the four groups. The four versions were: 1) learner control, 2) program control, 3) full features, and 4) lean features. Students used the program for three days and then took a post-test.

Results showed that subjects using the full program viewed considerably more screens that those using the lean version. In the lean
features condition, higher ability learners chose far more screen options than lower ability subjects. Learner control and full features subjects spent significantly more time with the program than did program control and lean features subjects. However, lean features subjects spent more time per screen than those in the full features group. On an attitude survey conducted after the post-test, learner control subjects reported that they liked the program more than program control subjects did. Overall, the learner control subjects scored higher on the post-test than the other groups.

Analysis of the data suggest that the subjects adjusted their study style to the conditions. Subjects in the lean features group spent more time per screen but the full features subjects used more options. As with other studies, higher ability students did better with the learner control program than lower ability subjects, perhaps because they need fewer options and more structure. This study is limited by the four-way non-matching design, but it does yield worthwhile data. The correlation of findings regarding user ability level and program type is important.

Cho (1995) investigated differences between program-controlled and learner-controlled hypertext applications. The results show that learner-controlled programs foster slightly more metacognitive thinking. There were also differences in effect for low and high-ability students. Similar to other such studies, Cho's work shows that lower ability students may not benefit
from learner controlled programs the way that higher ability students do. Cho theorizes that lower ability students need more structure to achieve stronger outcomes.

More research is needed, but it appears that students with lower ability do not benefit from too many features or control over the programs. IT designers need to bear this in mind as they design programs for students with special needs. Perhaps the best solution would be programs with many embedded features that can be turned on or off by the teacher, depending on the student's style and needs. Such programs could offer tremendous flexibility for students and teachers and be customizable for any student.

A final study of user control concerned levels of distractibility during computer tasks. Calvert (1993/4) investigated whether kindergarten and third grade children attend to computer applications or the television when both are available and whether one is a distracter to the other. The subjects were 24 children in grades kindergarten and 3. They were equally divided according to sex and grade. The subjects were taken individually into a quiet room in the school building where a computer and television were both set up and running. The television aired *School House Rock* clips. The subjects were told they could work on their choice of six computer programs for a 27 minute period. An adult researcher remained in the room to answer questions. All sessions were videotaped and the computer programs were all
familiar to the children. All but three of the subjects worked on the computer the entire time; the three were in kindergarten.

Results of the study show that the subjects attended to the computer tasks significantly more than to the television. The third graders attended to the computer tasks longer than the kindergartners. There were no significant differences by sex. This study is more interesting than informative but does indicate that even very young children are interested in using computers for school work and can stay focused on that work under certain conditions. There was no real outcome measure other than time and so the implications of this study are not readily apparent.

Writing

By far the largest number of studies of IT involve writing and composition. Overall, these studies suggest that using IT for writing tasks is beneficial. The use of computers for writing tasks is quite common and perhaps constitutes their most frequent use. Montague and Fonseca (1993) identified a number of benefits found in using computers for composition which included bypassing poor handwriting, ease of revision, possibility of synthesized speech and general positive attitudes about composing at the computer. Nelson (1994) recommends the use of computers in teaching topics
as diverse as poetry and parts of speech. She used the cut, copy and paste commands to teach about the flexibility of the English language.

Computers can also have a role in the social processes of composition. Moran (1994) used a networked computer lab at the University of Massachusetts to facilitate interactive journal writing activities. The computers allowed for interactive feedback among the students and with the professor. Susser (1993) has argued that not enough writing teachers take advantage of the options that such computer networks offer. A writing lab program for students with special needs in two Hartford, Connecticut public schools has had good success (Sweeney & Rucker, 1992). The lab consists of Macintosh networks with laser printers. Available softwares include word processing, database, spreadsheet and publications. Students usually attend two sessions in the lab each week. Student feedback indicates that they feel more empowered and motivated to write and enjoy publishing their work.

A similar program has been introduced in a Massachusetts middle school. The first five weeks of the course focus on basic computer skills, such as keyboarding and spelling. Students are able to work on assignments from their mainstream classes. The program incorporates other writing practices such as peer editing and conferencing. The students and their general education teachers have been very impressed with the improvements
students have made. A secondary benefit has been the improved communication between the special and general educators.

Typing, or keyboarding, is an important skill related to the use of computers for writing. A study that involved teaching an alternative typing method to three students with moderate learning disabilities showed that this method was no better than “hunt and peck” systems for using a keyboard (Koorland, Edwards and Doak, 1996). The systematic scanning method did not appear to be a replacement for teaching students touch typing. While this study’s very small size (N=3) limits its power, difficulty with typing ability needs to be considered when planning CAI-based writing instruction for students.

Two programs in Alaska demonstrate innovative uses of the computer designed to address the needs of rural students, especially those who are at-risk for school failure. The QUILL software program was introduced to rural Alaskan village schools as a way of enhancing student writing as well as communication among several rural schools (Bruce & Rubin, 1993). The QUILL program includes six pedagogical goals related to writing and composition:

1. Planning
2. Integration
3. Publishing
4. Meaningful Communication
5. Collaboration
6. Revision
The program included both word processing and electronic mail. The program has three modules: 1) Planner, 2) Library, and 3) Mailbag. The three modules are designed to be used together to foster brainstorming, composition, peer editing and feedback among students and teachers. Results of a three year study of the QUILL project showed that it was related to a greater process approach to writing, more editing, changes in teacher expectations and better student and teacher communication.

An outcome of the success of the QUILL project was the development of a prototype computer-based assessment tool for evaluating the products of the QUILL program. The result was CIWE (Computerized Instrument for Writing Evaluation). This software tool is designed to assess student writing by rating fluency, syntactic maturity, content development and organization of texts. Pilot testing of this program evaluated its effectiveness based on 13 variables composing four variables. The program's consistency was checked by comparing CIWE grades with scores assigned by veteran graders. Interrater reliability was quite strong at .95 and it proved to be reliable for multiple grade levels and change over time.

Both the QUILL and CIWE studies show that unusual teaching environments can produce novel and innovative approaches to instruction. Given the far distances between villages in rural Alaska, these approaches offer means of enhancing communication and quantifying data from diverse
sources. The very unique circumstances of the QUILL study prevent the results from being easily generalized but the results suggest that composing with computers can be very beneficial. While outcome data were not reported, the qualitative data provided show that computers can have a positive role in the writing process. The CIWE project presents another realm of IT application related to writing. While widespread use of computerized holistic grading is probably a long way off, the positive results of the study point to the need for further testing of the CIWE program.

Chambless and Chambless investigated the use of *Writing to Write*, a whole language based computer writing program. The program includes an audio component that "reads" words as they are typed in. The program also helps to organize students' ideas as they start to write, similar to the QUILL program. A large sample (N=1,194) of students in grades kindergarten through 2 participated in a study of the program. Students were randomly assigned to a *Writing to Write, Reading to Write* (a companion to the Writing program) or a control group. The subjects completed the Stanford Achievement Test as a pre and post-test activity. Results show that there was a significant increase in reading scores among students of the same strata (socioeconomic status (SES), race and sex) for both reading and writing. The results were stronger for writing.
This study is flawed by the use of the Reading to Write group because it is an entirely different program. Further, the design was too broad and did not consider the various components of the program and how each might affect the outcomes. Still, the results are worth following with more research. Meyers (1992) has also supported the use of whole-language based writing instruction using CAI for students with language delays. More research into this method is needed.

Repman, Cothern & Cothern (1992) conducted a study of the effects of student use of a computer for writing in a fourth grade classroom. One class of 22 students in a suburban elementary school participated in this year-long study. One Apple IIe computer and a printer were placed in the classroom at the start of the year. The word processor *Bank Street Writer* was installed and each student had 30 minutes per week to use the computer for school assignments. Working both individually and in teams, students published and illustrated 13 thematic books of their writings. Students' attitudes and perceptions were measured three times during the year, September, January and May, using an 11 item questionnaire. Results show that students' use of the computer for school tasks increased over the year. Student's computer ability did not change much but they did show increased positive attitudes about computers. The students preferred using the computers.
This study is very disappointing because it failed to consider other valuable data that could have been collected and utilized. No demographic data about the students was gathered and this creates very flat results. The previous experience of students with computers as well as the prevalence of home computers among the students were not reported. This data indicates that students preferred to write with computers, but why and how it affects writing was not investigated.

Two studies considered the differences between traditional paper/pen and computer composition. Langone, Willis, Malone, Clees & Koorland (1995) investigated whether students with learning disabilities showed improvement in composition of paragraphs when using pen/pencil or a computer. The sample included six subjects, all in the sixth grade. Results indicate that the different methods yielded highly individual results, but spelling was slightly better for the computer condition. All the students indicated that they preferred using the computer which may have a role in enhancing self-esteem.

Snyder (1993, 1994) investigated differences between pen/pencil and computers in students' paragraph construction. Subjects were 51 year 8 students at an all girls' school in Melbourne, Australia. The same teacher taught both a computer-based and traditional version of an English curriculum. Instruction included three forms of writing: narrative, argument
and report. The computer group met in the school's computer room for all sessions while the control class met in a traditional classroom. Students completed a survey before and after the intervention and 306 of the students' essays were graded by experienced English teachers using a holistic system. The computer group's writing tended to show fewer errors and their graded essays received overall higher scores. Interviews with the students and teacher indicate that the computer class was more student and writing-centered.

Another approach to the use of computers in writing and composition involves the use of hypertext programs. Wiebe and Dornsife (1994) have argued that using hypertext for composition transforms the entire process and product and creates more of a collage rather than a linear text. This approach can be potentially very liberating because it allows writers a means of embracing other ways of expressing ideas. Lohr, Ross and Morrison (1995) conducted a study of the use of HyperCard for developing a process approach to writing. The subjects were 16 junior high and 22 senior high school students. The students met four times per week for 50 minutes during their computer class over an eight week period. The focus of the computer class was writing. The students were given training to use the Hypercard program and a model story was shown to them. Data were collected using
observation, frequency counts of embedded features in their stacks, holistic grading of their stacks, student surveys, and student and teacher interviews.

Results indicate that two thirds of the students enjoyed using the computers for writing and 40% preferred the Hypercard program to traditional word processing. Of the embedded features, the students enjoyed using branching the most. Students' attitudes about writing in general did not change. The biggest complaint was the small page size. Importantly, 50% of the students felt that Hypercard helped to facilitate revision. The seventh grade students' behavior improved but the older students' behavior deteriorated. For most of the students this was their first experience with process writing and most did not take advantage of the problem solving tools in the program. This study provides some interesting information on how students use Hypercard for writing but it did not address its own question concerning a process approach to writing. More research on exactly what features students use and how they use them would be useful. This study also points to the importance of recognizing individual student writing styles. Only 40% of students preferred the Hypercard approach. Teachers may need to keep this in mind and offer instruction in both hypertext and word processing in order to allow students to choose which program to use.

Another study involving Hypercard included the use of voice input technology to help students with learning disabilities (Zhang, Brooks, Friedls
Zhang and colleagues developed a *Hypercard* stack designed to assist beginning writers with learning disabilities. Students can enter text by typing or saying a word. Words can be self-generated or selected from a list of 1000 words already entered into the program. The subjects included 33 students with writing-based learning disabilities, ranging in age from 7.7 to 13.2 years. Using the hypertext software, called ROBO-Writer, the students created texts that were evaluated on four criteria. The texts created with ROBO-Writer received significantly higher scores than those of matched students that were written with paper and pencil. One of the important variables in the gains students made was the time spent by students editing their work on the computers.

This study is difficult to interpret because there are gaps in several areas. The voice input technology was highlighted but not included in the study. The selection of students and their assignment to groups was ambiguously stated and the matching of controls was not explained. Nonetheless, the study does suggest that students with learning disabilities can benefit from use of IT tools for writing. Others have pointed to the increasing availability of voice input technology and further research on its use is needed (*Connector*, 1996).

Overall, the research on the use of IT for writing instruction points to a positive role for programs such as word processors and hypertext. Krendl and
Williams (1990) criticized early studies of IT writing applications, especially IBM's Writing to Read program. They felt that the studies were too short and did not disprove that time on task was the real variable in improving students' writing. This is an important criticism to keep in mind and further research needs to be rigorous and include long-term interventions. Still, the studies reviewed here point to an important role for computers in students' writing experiences.

Other Areas Needing More Research

A number of possibly important IT applications for students with special needs have been neglected in research studies. These include adaptive and assistive technology, artificial intelligence (AI), behavioral applications, pre-school use, programming, spelling, and social-related outcomes.

Adaptive and Assistive Technology. These technologies are compensatory aids which provide support systems for individuals with special needs. Reports indicate that use of such devices saves money for school districts and enables students to be mainstreamed. Studies of how these devices affect the learning process are lacking. One problem in doing such research is that populations of such students are very small; however, case studies are another research method that could be used. Larsen (1995) has identified characteristics of quality services and supports in IT for
students with special needs. These characteristics may serve as benchmarks in evaluating adaptive and assistive devices.

Goldenberg, et alia (1979, 1984) have focused attention on the potential benefits of communication devices for such students. These devices include computers that are specially fitted for use by individuals with both physical and developmental disabilities. Carey and Sale (1994) suggest that notebook computers could be a powerful tool for students with special needs because they are portable. Lee and Meyers have pointed to the use of computers, especially those with advanced audio capabilities for use with hearing impaired students. Such use could help to enhance oral and written language skills among such students. Another emerging with a possible use for students with special needs is virtual reality. Powers and Darrow (1994) have suggested that virtual reality could have a role in teaching abstract concepts as well as provide highly enriched practice opportunities.

Adaptive and assistive technologies have already been put to a number of positive uses with students with special needs (Holzberg, 1994, 1996; Milone, 1997). These technologies need to be considered as a part of treatment programs in more systematic ways and should be involved even during assessment stages (Weber & Demchak, 1996). Better understanding of the instructional aspects of such devices will help special and general
educators develop programs for such students that enhance both academic and social skills (Boyle & Korn-Rothschild, 1994).

**Artificial Intelligence.** Another emerging technology that may have important contributions to make to educational programs for students with special needs is Artificial Intelligence (AI). AI is the use of computers as true thinking tools that mimic human cognitive behaviors. Research on reading instruction has included investigation of how AI might have a role (Balajthy, 1987). More recent studies have focused on Artificial Neural Networks (ANN). ANN differs from traditional AI projects in that AI generally relies on "expert" systems, programmed with all possible answers. ANN technology seeks to mimic the micro-physiology of the brain by use of problem-solving patterns based on numerous previous examples of previous cases. The field of AI is worth watching for innovations that could be very useful IT applications for students with special needs.

**Behavioral Problems.** Use of computers as tools for teaching students with behavioral problems has not been widely investigated. A few case study reports and teacher anecdotes indicate that it could be a useful and effective approach with such students (Poirot & Canales, 1993/4; Ortega, 1995). One small program relied on using the computer as a reward for target behaviors (Keyes, 1994). Such use could be worthwhile, if students view computer time as a reward. It is important not to overuse such a system such that only the
"good" students end up using the computer while other students never get access. Behavioral problems need to be treated with a multilateral approach, of which IT applications may be one component.

**Pre-school Students.** The use of computers with pre-school age students is very understudied and educators would benefit considerably from better understanding of such uses. One reason that pre-school uses of IT are not better investigated is that pre-school education is not a systematic public program as K-12 education is. Finding sites with adequate IT resources may be difficult. Some early childhood educators feel that IT could be used effectively with these children both at home and school (Cements, Nastasi & Swaminathan, 1993; Tejada, 1995). Clearly, more research needs to be done to understand how IT fits into early childhood education.

**Programming and Spelling.** Surprisingly, no systematic studies of either programming uses or spelling programs using IT were found. However, some literature on spelling was discovered. Anderson-Inman and Knox-Quinn (1996) have begun a program for improving spelling using spell-checking features of word processors but data from this project are not available yet. Leong (1992) has argued that audio and speech features of reading programs could have an important role in spelling instruction, but no research on this has been done. More investigation of the use of IT for
spelling instruction is needed. The lack of data on programming uses is puzzling and deserves more attention.

**Social Effects.** While many of the IT programs discussed here have shown positive or non-negative social outcomes, research into the use of computers as tools for teaching or fostering students' social interactions is limited. Male (1993) has proposed a model for integrating students with special needs into general education classrooms that uses computers as a tool for social interaction. Believing that writing is basically a social task, MacArthur (1994) suggests the use of computers as tools for fostering peer editing and cooperative problem-solving in writing tasks. Wide-scale effectiveness of such approaches needs to be investigated.

The results of existing studies on the use of IT as a tool for students with special needs are generally very promising. While some of the studies are incomplete, the overall results point to positive outcomes for such uses of technology. Because IT is a very young field, more research is ongoing and will, hopefully, fill in the gaps mentioned here. IT applications can be very expensive, but when used according to established good practices, can make a real difference for students with special needs.
Summary and Conclusions from the Literature

What conclusions can be drawn from the literature reviewed here? Because IT is a very new field, much of the data is preliminary. In addition, the technologies keep changing and improving to create whole new media as CD-ROMs did a few years ago. The literature included in this review indicates that certain instructional applications and approaches are beneficial to some students and that further investigations are needed. To that end it makes sense for educators to use the practices that have been shown to be effective as a means of further testing them. In the process, modifications and enhancements will emerge and this will create even more innovations for researchers to study.

The results of the studies are rather mixed. Some yielded significant gains on test scores while others showed only minimal improvements. This raises again the issue of how the uses of IT are being measured. Most of the studies relied upon standardized test scores as a measure of effect and success. This reliance can be very misleading. Many of the studies reported that even when students' scores did not increase dramatically, students often enjoyed using the technologies and, in some cases, self-esteem increased. These outcomes are themselves important indicators of the so-called success of IT applications. In addition, it is worth considering that students' test scores are the product of many years of education and perhaps should not be
expected to improve after a few weeks or months with a computer. If we are expecting test scores to improve in such a manner, then we are expecting technology to be a panacea or magic wand that makes all the variables that led to those test scores disappear and good scores appear in their place. Technology is not Lake Wobegon; it will not make all the men handsome, women beautiful and children above-average.

What technology can do is provide additional instructional methods and creative outlets for students. In this regard it is a perfect match for special education. The hallmarks of special education are individualizing instruction and focusing on enhancing students' strengths while remediating weaknesses. It is this that IT does best. IT allows students to work not only at their own pace but with materials that are truly designed for their needs. Instead of completing worksheets days after other students, they can complete their own worksheets daily. Certain IT programs also foster problem-solving skills, a frequent focus of resource room programs. When used in conjunction with careful teacher planning, IT can be a tool for enhancing students' social interactions in ways that prepare them for workplace situations. Drill and practice programs can continue to serve as tools for remedial work that allow individualized practice.

Unfortunately, the literature reviewed here reflected that there are fewer studies of IT applications with students with special needs. Given the
strong potential that such programs offer, more research into how best to
design and implement IT programs for such students is needed. Hopefully,
as the field of instructional technology matures, more long-term studies will
provide better indicators of which applications will make the most difference.
A number of suggestions for future research can be made based on the
literature currently available. These recommendations for future study
include teacher and student efficacy, training, attitudes and beliefs, reform,
and funding as well as other issues.

Teacher and Student Efficacy

Following the work of Albert Bandura (1977, 1986) a considerable body
of research on teacher efficacy has shown a significant correlation between
teachers' sense of efficacy and student achievement (Benz, Bradley,
Alderman & Flowers, 1992), teachers' sense of commitment (Coladarci, 1992),
empowerment (Husband & Short, 1994), willingness to work with other
professionals (Morrison, Walker, Wakefield & Solberg, 1994), willingness to
work with students with special needs (Landrum & Kauffman, 1992), beliefs
about the causes of learning problems (Jordan, Kircaali-Iftar & Diamond,
1993; Gorrell & Trentham, 1992; Soodak & Podell, 1993), and bureaucratic
orientation. The abundance of data on the importance of teachers' beliefs
about their own abilities and the role of education in general points to the
importance of understanding and addressing teachers' beliefs about IT and the efficacy of technology in school settings. More research that investigates these relationships is needed.

Training

In order for IT applications to be useful at all, teachers need to know how to use them. Hunter and Garrison (1991) have pointed out that teachers will be far more likely to support and encourage use of effective IT applications if they believe they have a role in the selection, design and implementation of such programs. Unfortunately, most teachers enter their first jobs without any formal training in the use of IT applications (Tejada, 1995). Alabama, and some other states, have implemented training programs for teachers to learn how to use new technologies (McFadden & Johnson, 1993). Far more such training is very much needed. A 1995 survey of school districts from around the country indicated that 28% of schools do not spend any money on training, only 8% of the average technology budget goes to training and 16% of teacher are dissatisfied with the training they receive (Siegel, 1995). As Shockley (1992) pointed out, IT is not a panacea and will not be useful at all if it is not used appropriately. Training is a key to successful use of IT among students with all types of learning needs (Hofmeister & Thorkildsen, 1984).
Another component to the issue of teacher training is the initiative for educational reforms to accompany IT implementation (Rafferty, 1993). Many IT advocates envision its use integrated with entirely new approaches to instruction that are more learner-centered and inquiry based. If teachers who are accustomed to more traditional teaching methods are suddenly expected to use technology and teach in wholly new ways at the same time, they may rebel. Conscious awareness of the double expectations that these trends are placing on teachers is needed if lasting change is to occur (Marshall, 1995).

Reform

As mentioned, many IT advocates believe that the use of new technologies must go hand-in-hand with other educational reforms (Mehlinger, 1996). A common concern exist among politicians, business people, educators and the public that schools are not preparing students for the workplace (Thurow, 1992). Some teachers have feared that computers might replace them as technologies have done in other fields such as manufacturing (Sanger & Schostak, 1988). Sanger and Schostak have suggested that this is an underlying reason why some teachers have resisted computers and sought to control their use in schools. Other teachers have viewed computers as tools which help to re-define the student-teacher
relationship to that of a coach or facilitator rather than a parent-child encounter (Streibel, 1993).

Winn (1993) suggests that IT designers need to keep reform issues in mind when working on new products. Such programs can integrate technology with reform by: 1) including apprenticeship activities for students, 2) bringing "authentic" experiences into the classroom, and 3) incorporating activities that take place in the "real world". Other initiatives envision entirely new paradigms for school-based learning. These might include using the Internet as a key backbone of an educational infrastructure (Graves, 1994) or using computers in the home as part of the instructional time now spent in school (Debenham & Smith, 1994). Chris Whittle's schools-for-profit initiative creates a new corporate presence in schools that has an admitted technology bias (Rist, 1991).

In a discussion of how computers affect the reading process, Reinking (1987) suggested that the widespread use of technology in learning environments potentially changes the cognitive experience. Poplin (1995) has expanded this idea in a discussion of the basic paradigms which special education programs. She argues that traditional special education programs are essentially reductionist in that tasks are broken down into their smallest units. She suggests that computer and other technologies offer a new
paradigm which is holistic and focuses on the bigger scope of what we hope students will learn.

Poplin points to the potential of computers to "liberate" students from the reliance on language-based learning and incorporate more visual-based tasks and experiences. She argues that uses of technology in special education should focus on creativity, future goals, employment and life skills. These uses should be compensatory and assistive rather than corrective. This development will mandate a new curricula for students with special needs. All of these reform initiatives need to be given consideration as IT is placed in schools. The contexts of such placements and the pedagogical frameworks in which they are used are essential components of their ultimate success.

Funding

A frequent concern raised about IT is its cost. Hardware, software and especially network wiring is initially much more expensive than traditional instructional materials. Some researchers have attempted to rationalize these expenditures with cost benefit analysis, as done in industry (Tremblay, 1992; Massey & Zemsksy, 1995). Cost is clearly an issue that will affect the overall implementation of IT in schools (Church, 1989). There are also issues of equity which must be considered; a disproportionate number of wealthy schools have more IT equipment while schools in lower socioeconomic
neighborhoods have little or none (Mondoweney, 1996; Bulkely, 1995). This is a problem that will likely persist, given that federal and state expenditures for education are declining (Thurnburg, 1995). The scarcity of funds for technology in schools points to the importance of demonstrating the effectiveness of IT programs and maximizing the resources available.

Other Issues

Some critics have argued that the information revolution has created so much information that no one can possibly digest it (Moran, 1993). As a result, many people are not really "reading" anymore and many social conventions about communication are changing. Other critics fear the loss of privacy and the overstandardization that technology use can bring (Inose & Pierce, 1984). It seems that technology, including computers, are here to stay. Modern-day Luddites may not like this reality but educators must deal with it. An investigation of predicted future trends in special education found that initiatives such as inclusion and de-categorization are likely to continue (Putnam, Spiegel & Bruininks, 1995). In the same study, enhanced special education teacher training was also recommended. Strikingly, technology was not mentioned at all. The reason for this might be found in the choice of "experts" who participated in the study or in the fact that IT is only a minor variable in special education programs today. From the
standpoint of preparing students with special needs to be productive members of society, and the vast majority of such students are capable this, instruction in the use of technology is essential. The lack of this recognition in the Putnam, Spiegel and Bruininks study is puzzling.

The use of technology starts with instruction and familiarity and that work is best done in the schools. Given the evidence from the literature reviewed here, IT can be effective in boosting the grades, self-esteem and social skills of all students. Many of the studies showed that students with special needs benefited the most. Making certain that students with special needs have access to IT programs that serve their needs is an important part of preparing them to be successful members of society (Schimmel, 1993). As teachers become better trained and familiar with such technologies, they can look for, or even design, programs that meet the needs of their individual students. In the larger effort to promote the success of students with special needs, special educators can model effective problem-solving strategies and work cooperatively to develop best practices for students (Freed, 1996).

Technology alone is not enough (Wilford, 1993), but the integration of technology with good teaching, certain reforms and public support in the form of adequate funding can make a real difference for students with special needs. Given the lack of data related to students’ and teachers attitudes and beliefs about computer use in schools this study investigated such attitudes
and beliefs in an effort to learn how these variables relate to the overall question of how computers can best be used in schools.
CHAPTER III

STUDY METHODOLOGY

Overview

Following Pajares' (1992) recommendations for beliefs-oriented research, this study used both quantitative and qualitative data collection and analysis methods to learn more about students' and teachers' attitudes about the role of computers in special education. Using a quasi-experimental design with one experimental group and two non-equivalent control groups, the study addressed the research questions found in Chapter I. A pre and post-test design was used to learn how the implementation of a campus-wide technology plan is related to students' and teachers' beliefs about computer use.

The implementation of a campus-wide technology plan, involving the installation of new computers on the experimental school campus, served as the "treatment" method. Treatment effects were evaluated using pre and post-test measures. Quantitative data were gathered using a survey questionnaire and qualitative data were gathered with subject interviews. Copies of both the quantitative instruments and qualitative interview questions are in Appendices D and E, respectively.
The survey questionnaire was administered twice. First in October 1996 just at the start of the implementation of the treatment group's new computer network, and again at the close of the 1996-97 school year after the new computers had been used by students and faculty for school work. The qualitative data were collected using interviews with selected students and teachers; the interviews were conducted in the late spring of 1997, near the time of the post-test survey.

The data were analyzed by comparing the survey scores from the beginning and the end of the year, investigating relationships among the independent and dependent variables and reviewing the information from the interviews. Although the non-equivalency of the groups diminished the overall degree to which group differences can be attributed to the installation of IT, they do reflect real-world differences present among these schools and allow for a comparison of pre and post-test results as well as treatment/no treatment effects. Interpretation of the results included consideration of pre-existing differences among the non-equivalent groups.

Sites

The data were collected at three different schools: Riverview, a public elementary school with grades pre-k through six, Fairmont, a private boys'
boarding school for grades 6-9, and Wesley Academy, a private co-educational boarding school for grades 7-12. * All three schools are located in non-urban communities in the Northeast United States. All students and teachers at all three schools were asked to participate in the quantitative portion of the study, with the exception of the elementary school site, where only fifth and sixth grade students participated since they fall within the same grade range as the other participating students. At the start of the 1996-1997 school year, Riverview had 110 students in the fifth and sixth grades and 30 teachers, Fairmont had 250 students and 63 teachers in grades six through nine, and Wesley had 325 students and 47 teachers in grades seven through postgraduate; this created an overall sample size of N=825.

The sites were chosen because they are located in communities nearby the university where the researcher is affiliated and were in the beginning stages of adopting IT. Initially there were two experimental school sites selected, Riverview and Fairmont. Riverview was to have been an experimental site because it was scheduled to have its technology plan fully implemented by fall 1996. Due to scheduling and funding problems the computers were not installed at all during the 1996-1997 school year. Given that some data were already collected when it became clear that the

* School names are pseudonyms
computers would not be available, it was decided that the subjects at this site would serve as additional controls.

Experimental Site

The experimental site, Fairmont, is a middle grades boarding school. It was founded after World War I as a pre-prep school for boys going on to pre-college preparatory academies. The school admits boys, and a few girls, in grades six through nine. Approximately 25 percent of the students are day students from surrounding towns and the rest are boarding students. Of the day students, a small number (around 8%) are girls because the daughters of faculty and staff are permitted to attend the school.

On average, the school has a very diverse population with students from up to 30 states and 11 foreign countries. Of the 250 students who participated in the study, approximately 21 percent were international and not native English speakers (N=52). The school’s students represent a very diverse range of academic skill levels. Ten percent (N=26) of study year students had diagnosed learning disabilities (LD), 8% had Attention Deficit Hyperactivity Disorder (ADHD; N=19); four students had both a learning disability and ADHD. Although teachers were available to answer students’ questions related to the survey items during administration, none of the
teachers who assisted with administration reported that non-native English
speakers or students with LD had difficulty with the individuals items.

In addition, one student with a hearing impairment and one student
with physical disabilities attended the school in 1996-97. Overall the school’s
population of students with special learning needs was 16 percent, slightly
above the national average of about 12%. Students with special learning
needs are fully included in all regular classes, with the occasional exception
of a foreign language waiver being granted to students with language
learning disabilities. Most of the students with learning disabilities or
ADHD attend the school’s resource room program one period a day.
Additional academic support is provided when needed by privately hired
tutors. The school also has a number of students with very strong academic
skills, including students who have participated in nationally screened
programs for students identified as talented and gifted.

**Instructional Technology Program.** The treatment condition evaluated
in this study was the implementation of a campus wide technology plan
(Solberg, 1996). At the center of this plan was the installation of a campus-
wide wide area network (WAN). This WAN connected the classrooms, library,
faculty work areas, administrative offices, and dormitories on one network.
The backbone of the WAN is fiber optic cable that connects each building to
the main servers. Category five (UTP: 100mg/sec) data cabling was used
within buildings for individual workstation connections to support fast ethernet connections.

The existing computer lab was completely re-done and 14 new, network capable, Power Macintosh computers for student and faculty use were installed. During the study year the computer room was available for individual and class use throughout the class day and for individual student and faculty use during the afternoon study hall hour. It was also made available to boarding students during free times on weekends for academic projects. These computers provided a range of software, including Microsoft Word, Claris Works, HyperStudio, and several typing tutorials. Seven of the computer room computers were linked to the network, allowing Internet access for supervised use exclusively during elective periods. Three networked Macintosh LC II computers were installed in faculty work areas. These computers included Microsoft Word word processing software, Netscape (World Wide Web browsing software), and Pine electronic mail software.

The existing search station computers in the library, five Hewlett-Packard Vectra 4/66 series, were updated with new software for electronic database searches. An additional IBM Pentium series Internet station was added for student and faculty use. Four of the old computer room Macintosh LC II computers were placed in the library equipped with Microsoft Word and Internet software for student use.
All of the classrooms in the main classroom building were wired with category five data transmission cable for teachers to use to connect computers for classroom use. However, faculty were required to provide their own computers for such in-class activities. Two of the old computer room Macintosh LC II's were placed in the special education resource room; both included Microsoft Word and a typing program; one had Internet and e-mail access.

The remaining Macintosh computers were equipped with network cards as well as Microsoft Word and e-mail software and placed in the commons rooms of each dormitory. These computers were made available for student e-mail and word processing use during the students' free time and study halls. All faculty dormitory apartments were wired with network ports. Faculty were expected to provide their own computers. School assistance in the form of 30% of the purchase price was available.

A number of enhancements were also made to the administrative computing facilities at the school. 25 new IBM Pentium computers were purchased and most administrative personnel began using the network with the Windows '95 operating environment software. Training was made available for all computer-using faculty and staff over the course of the 1996-97 school year. Selected administrative support staff were sent to software specific training programs in August and October 1996. Faculty training was
arranged on an individual basis with the technology coordinator. Training sessions covered word processing skills, e-mail, and Internet communications.

No school-wide training for students was provided, however, individual faculty incorporated computer use and instruction in some of their classes. Student training in computer use was not provided because it was felt that the students would be able to learn how to use the new equipment from incidental learning and peer interactions. The English department established a computer literacy program for all students in the ninth grade. This program consisted of direct instruction in basic word processing skills by the computer teacher and the requirement that certain English assignments be completed using a word processor. In addition, computer related elective courses, ranging from typing, *Hyper Studio*, Internet use and computer rendering were offered throughout the school year. These programs were supported by one full time computer teacher and a full time computer coordinator. In addition, several students organized and taught two computer related classes with the support and supervision of faculty members.
Control Sites

Both Riverview and Wesley Academy served as control sites for this research. Both these schools had some computer facilities on campus but no new academically related equipment was installed during the 1996-97 school year.

**Riverview.** A public elementary school serving students in grades pre-kindergarten through 6 served as one of the control sites. As stated, this school was to have served as a second experimental site, however, the planned computer network was delayed by one year. This school was brand new in 1996-97, having opened its doors on 27 August with an enrollment of 393 students. Prior to this new construction, the town's elementary age students were served by two separate elementary schools from 1952-1996. Given the rising elementary age school population in the town, it was decided in 1994 to build a single site for these students.

The school was designed with the use of technology in mind. The necessary wiring to support academic and administrative computing was installed at the time of construction. The funding to purchase the necessary computer hardware and software was provided by a supplementary budget. As a result these items were not in place when the school opened.
Of the total population of students in grades preschool through six, 55 (14%) receive special education services, 39 (10%) are eligible for free or reduced cost lunches, and 24 (6%) are non-native English speakers. The school provides a range of special education services on site, ranging from mild to severe special needs. Where possible, inclusive educational practices are used to provide students with special needs an education in the least restrictive environment (LRE). Among the students who participated in the study 14 (13%) were identified as having special needs and were receiving special education services via an individualized education plan (IEP).

Existing computer resources from the two former elementary schools were brought over to the new school for the 1996-97 school year. These resources included several administrative computers and 14 stand-alone Commodore 64 computers which are located in the fifth grade math teacher’s classroom. In addition, all the other fifth and sixth grade teachers have one Apple IIe computer in their classrooms for student and teacher use. There was no appointed technology teacher, but one of the fifth grade teachers served as the unofficial coordinator for the building during the 1996-1997 school year.

Wesley Academy. The secondary school site was chosen for two reasons. First, this school has a well-established program for students with special needs and such students represent about 15% of the student body.
(N=49 students). Second, no additional computer resources were planned for the 1996-97 school year.

The secondary school is a co-educational private boarding school with traditions dating from before the U.S. Civil War. The school enrolls students in grades 7 through post-graduate year. Students in the middle school, grades 7 and 8, have their own program and separate classes and most middle school students are day students. The school attracts a diverse student body with an international student population of approximately 18\% (N=approximately 60). Specific information about subtypes of special needs was unavailable, however, the support program is designed for students with specific learning disabilities. Students with disabilities are fully included in all regular classes, with the exception of some language waivers. Specific learning needs are addressed during daily one-on-one sessions with the special education faculty members.

Existing technology resources included a computer lab with 12 Macintosh and 4 Power Macintosh computers. This lab was available for individual and class use throughout the class day and during study hall times during the study year. In addition, each department chair had a Power Macintosh or Macintosh computer in the departmental office. All the middle school classrooms had one Macintosh Classic or SE computer for student use. Most administrative offices had stand-alone computers.
The library had two single-user CD-ROM search stations and software for student and faculty use. The card catalog was not computerized. There was no central computer network or server. Modems were available for use by students with their own computers in the dorm and for department chairs to use for Internet connections. There was one part-time computer and technology coordinator.

Hypotheses

The unique opportunity to survey students and teachers at the inception of the new network provided a chance to investigate how such expanded computer services are related to students' and teachers' attitudes about computers. The research literature cited in the previous chapter suggests that installation of the expanded computer resources would be beneficial to students and may be related to certain student outcome measures such as grades, standardized test scores and overall attitudes about computers (Delcourt & Kinzie, 1994; Murphy, Coover & Owen, 1989). Given this evidence, hypotheses about the outcomes of the proposed treatment (expanded computer access) were:

1. Fairmont's pre-test scores < Fairmont's post-test scores.
2. Fairmont post-test scores > Riverview's and Wesley Academy's (control groups) post-test scores.
3. Riverview's and Wesley Academy's pretest scores = Riverview's and Wesley Academy's post-test scores.

A summary of the overall research design is found in Table 3.1.

Table 3.1. Summary of research design

<table>
<thead>
<tr>
<th>SITE</th>
<th>PRE-TEST</th>
<th>TREATMENT</th>
<th>POST-TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fairmont (Elementary)</td>
<td>Survey</td>
<td>Computers</td>
<td>Survey/Interviews</td>
</tr>
<tr>
<td>Riverview (Middle)</td>
<td>Survey</td>
<td>No Treatment</td>
<td>Survey/Interviews</td>
</tr>
<tr>
<td>Wesley Academy (Secondary)</td>
<td>Survey</td>
<td>No Treatment</td>
<td>Survey/Interviews</td>
</tr>
</tbody>
</table>

Pilot Study

A pilot study, using a prototype of the Computer Opinion Survey (COS) instrument, was conducted in May 1996 (Brown-Chidsey, 1996). Subjects included 78 students and 26 teachers. The data were analyzed using analysis of variance (ANOVA) procedures and the findings were used to revise the instrument and study design. Findings from the pilot study indicated that both students and teachers were generally very positive about the use of computers in schools. In the pilot study the same instrument was used with both students and teachers. This proved to be problematic because many students did not feel comfortable with the items relating to students with special needs. As a result the instrument was revised so that the wording of the questions related to students with special needs on the revised students'
survey was clearer. Also as a result of the pilot study, additional demographic questions were added to the design in order to collect more comprehensive data.

Selection of Subjects and Participant Consent

Subject selection was not random, but involved all the students and teachers at the three sites who were willing to participate, with the exception of an age-selected group at the elementary school. While enrollment at the two private schools is by admission only, these schools have traditionally admitted students with varying ranges of ability, including students with special needs. Thus, the population of students with special needs at these schools (15-16%) is near enough to the national average of 12% to make the results potentially generalizable to the overall population of students with special needs.

The parents of student subjects were contacted by mail to inform them of the survey at least two weeks before any data were collected. Passive consent for the survey portion of the data was assumed unless the parent(s) contacted the researcher. Both student and teacher subjects were informed of their right not to participate in the survey in the cover letter accompanying the survey. Consent for the interviews was obtained in writing from all
interview subjects. In addition, student interview subjects' parents were contacted and their written consent was obtained. The text of both parent letters are in Appendix A.

Survey Instrument

The attitude data were collected using a survey questionnaire. The questionnaire consisted of 26 Likert-type questions pertaining to the research questions. One additional question relating to whether the new computers enhanced student work was asked on the post-test survey at all three sites. Questions for the survey were written by the author based on other similar instruments found in the literature (Delcourt & Kinzie, 1993; Kinnear, 1995; Murphy, Coover & Owen, 1989; Olivier & Shapiro, 1993; Riggs & Enochs, 1993). Murphy, Coover and Owen's (1989) study used an instrument that measured subjects' computer competency. Their scale used Likert type questions about individual computer skills. Delcourt and Kinzie's study came closest to the research done here. Using Likert type questions, this study investigated teachers' beliefs and attitudes about using computers. The orientation of Delcourt and Kinzie's instrument was teacher-centered and did not include any questions about student outcomes. While such questions are predictive and speculative, they do point to the essence of teaching: helping
students. Items and item descriptions from the above studies were used in the creation of the items for this survey. The items created for the instrument used in this study concentrated on two categories not covered by previous research: 1) *general* attitudes and opinions held about the use of computers by students in schools, and 2) the use of computers by students with *special learning needs*.

The survey questions were initially reviewed by a panel of four experts familiar with this type of educational research. Several questions were amended or omitted as a result of consultation with these colleagues.

The pilot study (N=104) yielded additional data on the items themselves. An item analysis revealed that eight of the original 27 questions exhibited relatively low correlations with the total score (.04 or less) and these items were omitted from the final instrument. Other items and demographic questions were added to the instrument as a result of the limitations revealed in the pilot study, including more questions relating to computer efficacy and instructional methods. Further analysis of the items was conducted using feedback from graduate students in Special Education at a major university. Their suggestions were incorporated into the final survey instrument. A summary of these categories and their component questions is found in Table 3.2. Two items were not included in these categories. Item 26, which asked participants to rate their sense of whether
they feel students with special learning needs feel comfortable working with them, and item 27, a question related to whether new computers installed during the study year influenced student work are listed in Table 3.3.

Each item allowed for one of five Likert-type responses, ranging from 1, strongly disagree, to 5, strongly agree. The Likert scale format was chosen because of its use on earlier instruments (Delcourt & Kinzie, 1993; Murphy, Coover & Owen, 1989). The advantages of a Likert-type scale include its familiarity to subjects, relative ease of interpretation and its provision of reliable scores. A cover sheet preceded the survey and explained the general purpose of the survey and the researcher’s affiliation and included a statement of implied consent by respondents. The survey was organized into three sections and all responses were written on a separate machine readable answer sheet. Section I included instructions for completing the survey and basic demographic information about respondents, including name, sex, race, grade or subject taught, age, school, and, for teachers, teaching certificates held. Section II included additional demographic questions and questions related to subjects’ access to and experience with computers. Section III included the actual survey items.
<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>ITEMS</th>
</tr>
</thead>
</table>
| **General attitudes about the use of computers in schools** | 1. I feel comfortable with my ability to work on a computer.  
2. The thought of using a computer frightens me.  
3. I worry about using computers because I feel like I might break them.  
4. Computers are helpful tools for school assignments.  
5. There should be one or more computers in every classroom.  
6. Computers help make schools more connected to the “real world.”  
7. Computers provide information and resources not otherwise available in schools.  
9. Writing is easier for students when using a computer.  
10. Students who use computers for school work get better grades.  
12. Students should be required to learn how to use computers.  
13. Students should use computers regularly to do school-related work.  
14. Computers make it easier for students to succeed in school.  
15. Students receive enough training to use computers for school-related work  
16. Computers help students learn how to work together and solve problems cooperatively.  
17. Computers put pressure on students to learn more and get better grades.  
18. Computers take time away from students working together.  
19. Computers are a distraction to students and take time away from instruction.  
20. I believe most students/teachers feel comfortable with their ability to work on computers.**  
21. Students/teachers worry about using computers because they feel they might break them.** |
| **Attitudes about use of computers by students with special learning needs** | 22. Students with special needs believe that computers can help them to improve their grades.  
23. Students with special learning needs believe that computers can help improve the quality of their work.  
24. In general, students with special learning needs believe that computers can help them to compensate for their disabilities.  
25. Computers benefit students with special learning needs more than students without special learning needs. |

**worded so that students and teachers rated each other
Table 3.3. Items not included in category scores.

<table>
<thead>
<tr>
<th>Item</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>26S</td>
<td>(Student question) I feel comfortable working with students who learn differently than me.</td>
</tr>
<tr>
<td>26T</td>
<td>(Teacher question) Students with special learning needs feel comfortable working with me.</td>
</tr>
<tr>
<td>27</td>
<td>I believe that the new computers installed this year have helped students to improve the quality of their work.</td>
</tr>
</tbody>
</table>

Data Collection

The teacher surveys were distributed through faculty mailboxes at the three schools. The student surveys were handed out and collected by the author and her assistants during the students' math and English classes. The instrument took approximately twenty minutes to complete. Subjects were given a question booklet with a separate machine readable answer sheet. Specific instructions on how to fill out the survey were given in the question booklet. When needed, the researcher and her assistants provided assistance to those students who needed it.

As mentioned above, demographic data were collected to provide a number of independent variables for use in analysis. The independent variables for both students and teachers included: race, sex, age, native language, citizenship, computer ownership/access, computer skills (self-reported), frequency of computer use, years of computer experience, types of
computer use, grade/education, and special need/disability. For students at the experimental site, Fairmont, the students' socio-economic data based on financial aid status were also collected. Day-student/boarding status was collected for students at Fairmont and Wesley Academy. For the teachers, additional variables were: subject(s)/level(s) taught, years of teaching experience, existence of special need, professional development activities, Special educator status, and computer training.

After the survey was administered, an item analysis was conducted using Cronbach's alpha. These procedures showed that the 21 items related to general attitudes about the use of computers in schools had an internal reliability of .84. The two negatively worded general items (20 and 21) appeared to be pulling down the overall reliability of this scale. With these two items removed, the overall internal reliability of the general questions scale was .86. It was judged best to keep the 19 item general scale and use items 20 and 21 as individual outcome measures of participants' attitudes of student and teacher comfort level and worry about computer use. The four items related to attitudes and opinions about the use of computers by students with special needs had an internal reliability of .66. While this is low, removal of any items would have made the scale very small and it was decided to keep all four items as a single outcome measure. Items 20 and 21
were used as independent outcome measures of attitudes about student and teacher comfort with computers and levels of worry about computer use.

Data Analysis

The survey were compiled by computer from the machine readable answer sheets. These data were saved in ASCII text format on a computer disk by an independent optical scanning service at the University where the researcher is affiliated. Random responses in the data file were cross-checked against the actual answer sheets to make certain that the data transfer from the scannable forms to computer file format was accurate. Incomplete cases and those which appeared to reflect non-serious responses (e.g.: all one Likert scale response) were deleted. These data were analyzed using SPSS, version 6.1.2 (1994).

Procedures

Statistical procedures were matched to answer each of the four research questions. A listing of procedures by research question is found in Table 3.4 (all results are reported in Chapter V). Four outcome measures were used: 1) the sum of the items on the general attitudes scale (19 items), 2) the sum of the items on the special learning needs scale (4 items), 3)
student/teacher comfort with computers (item 20), and 4) student/teacher worry about computer use (item 21). Except where indicated, all tests for significance were at the .05 level.

Table 3.4. Research questions and methods used

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Procedures Used</th>
<th>Data Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Do attitudes and opinions about student computer use in schools differ among teachers and students with and without special needs?</td>
<td>One-way analyses of variance by school and group using pre and post-test mean scores on four scales</td>
<td>Pre-test: N=661, Post-test: N=550</td>
</tr>
<tr>
<td>2. Are race, sex, age, education/grade, native language, citizenship, computer access/ownership, computer skills, socioeconomic status, special need (disability), teaching experience, and teaching certificates held related to the attitudes and opinions of teachers and students with and without special needs regarding student computer use in schools?</td>
<td>Separate multiple regression for students and teachers</td>
<td>Pre-test: N=661</td>
</tr>
<tr>
<td>3. Do perceptions about the general use of computers in schools and the quality of student performance differ among teachers and students with and without special needs both before and after installation of computers throughout the schools?</td>
<td>Repeated Measures analysis of variance comparing mean scores on General scale by group (student with or without LD or teacher)</td>
<td>Combined Cases N=410</td>
</tr>
<tr>
<td>4. Do the attitudes and opinions of teachers and students with and without special needs about the use of computers by students with special learning needs change following the installation of computers throughout their schools?</td>
<td>Repeated Measures analysis of variance comparing mean scores on Special Needs scale by group (student with or without LD or teacher)</td>
<td>Combined Cases N=410</td>
</tr>
</tbody>
</table>

One-way analysis of variance procedures (ANOVA) were used to compare the means by school and group (e.g.: student with or without learning disability (LD) or teacher) on each category score. Post-hoc tests
using Games-Howell procedures were used to determine where significant
differences among the schools, students with and without learning
disabilities, and teachers were while controlling for differences in sample
sizes among the groups among the groups. The Games-Howell procedure was
used because it controls for heterogeneity of variance in unequal sample sizes
(Howell, 1992)

Simultaneous multiple regression equations were used to discern
which of the variables from research question two were predictors of outcome
scores based on the pre-test survey. Due to a small teacher sample size
(N=73), the regression procedures were run separately for the teacher and
student groups. For all subjects the variables were: race, sex, age, native
language, computer ownership/access, computer skills (self-reported),
frequency of computer use, years of computer experience, types of computer
use, grade/education, and special need/disability. For students at Fairmont,
socio-economic data based on financial aid status was also a variable. Day
student/boarding status was considered for students at Fairmont and Wesley
Academy. For the teachers, additional variables were: subject(s)/level(s)
taught, years of teaching experience, professional development activities,
special educator status, and formal computer training.
In order to maintain appropriate variable to sample size ratios for the regression equation (10n:k) the variables were categorized into two groups: demographic and computer-related. These sets of variables were entered listwise for each of the four outcome measures for each of the groups (students with LD, students without LD, and teachers). Those variables which entered the equation as significant up to the .10 level were then reentered, again using the demographic and computer-related groupings, to determine which factors were the greatest predictors of the participants' scores on the four outcome measures.

Questions three and four were addressed using repeated measures analyses of variance (ANOVA). A three-way repeated measures model was applied to investigate differences among school and student/teacher groups. There was insufficient homogeneity of variance in this model and results could not be interpreted. Therefore, within and between group differences in mean score from pre to post test on the four outcome scales were compared among schools, between all students with and without learning disabilities as well as between students at Fairmont, and among teachers.
Interview Data

In addition to the quantitative data obtained with the survey, qualitative data were collected from selected subjects. The purpose of the qualitative data was to “flesh out” and give additional meaning to the quantifiable data concerning computer use in schools. Because beliefs and attitudes are very difficult to assess (Pajares, 1992) and there are no “right” or “wrong” beliefs, the use of qualitative data offered a means of clarifying what subjects really meant in their responses on the survey by placing it in a social context (Coffey & Atkinson, 1996; Kvale, 1996). The qualitative approach taken here was not meant to offer a random or alternative interpretation of the quantitative data, but instead, it provided further insights into teachers' and students' beliefs and attitudes concerning computer use in schools.

It is the open-ended nature of qualitative data that sets it apart from the quantitative portion of this study. The survey questionnaire forced subjects to respond in a very limited fashion to the researcher's statements about the role of computers in special education. The interview process allowed selected subjects to generate their own statements and ideas about such use and offers twelve (one for each interview subject) alternative ways to understand and evaluate the role of computers as tools for students with special needs. The qualitative data were both compared to and synthesized.
with the quantitative data (Kvale, 1987), with the goal of finding common themes and correlations as well as incongruencies that expose clearer understandings of students’ and teachers’ attitudes and opinions about the role of computers in the education of students with special needs.

Two teachers and two students from each school (N=12) were interviewed by the researcher using structured interviewing techniques (Marshall & Rossman, 1995; Seidman, 1991). Subject selection for the interviews was guided by the goal of learning what the use of computers for school work means in everyday terms for these twelve individuals. The researcher discussed the selection of interview subjects with administrative personnel at each school. Once a pool of interview candidates was made, the researcher reviewed these subjects’ responses on the pre-test survey. Twelve candidates for interviews were selected with the goal of interviewing individual teachers and students with very positive or negative attitudes about computer use in schools. Other variables such as sex and age of subjects were also considered.

Both the student and teacher interview subjects were asked in person by the researcher if they were willing to participate in an interview. Eleven of the twelve interview nominees agreed to participate; one alternate was chosen to replace a teacher who felt he did not have time to be interviewed. All interview subjects provided their written consent to participate in the
interviews and the parents of student subjects also provided their written consent (copies of consent forms and parent letter in Appendices A and B).

The potential student interview subjects' parents were contacted first in writing by the researcher to request permission for their child to be interviewed. A follow-up phone call was made to clarify the interview purposes and procedures and to answer any further questions. Each interview subject met personally with the researcher to go over the written consent form and to discuss the interview process in a session prior to the actual interview.

The interviews were conducted at each subject's school during a time mutually convenient to the researcher and subject. Interviews were scheduled so that students did not miss any instructional time, except when teacher permission was obtained in advance. The interviews were conducted in a quiet, distraction-free setting including empty classrooms and offices. This allowed for interview sessions in which the interviewer had the full attention of the students and teachers. If the interviews had been held in classrooms or dormitories other ancillary data might have also been gathered, but could have negatively influenced the participants attention to the questions. The subjects were reminded of the estimated duration of the interview at the start of the sessions. The student interviews took approximately 45 minutes and teacher interviews about one hour.
The structure of the interviews followed an adapted version of Seidman's (1991) three-stage interviewing model. This model involves organizing the interview questions around three stages of information gathering:

Stage I: focused life history
Stage II: the details of experience
Stage III: reflection on the meaning

Each interview progressed through these three stages, using guiding questions that were designed to elicit subjects' experiences, opinions and suggestions concerning students' use of computers in schools and whether such use is different for students with special needs. Interview guide questions were used to structure the interviews. The guiding questions are found in Table 3.5.

Each interview session started with these questions, but other follow-up questions were asked as appropriate. The researcher focused on learning how each interview subject experienced the use of computers in schools, especially regarding students with special learning needs. The terms that the subjects used in these descriptions served as anchors for summarizing and expanding on each subjects' responses to the interview questions. The researcher was sensitive to the subjects' individual cognitive style and
provided note paper for subjects to draw or write on during the interview if it helped them address the questions.

All interview sessions were audiotaped by the researcher using a portable micro-cassette recorder (Corrie & Zaklukiewicz, 1995). The audiotapes were transcribed by the researcher. Accuracy of transcription was

Table 3.5. Interview guide

<table>
<thead>
<tr>
<th>Stage</th>
<th>Questions</th>
</tr>
</thead>
</table>
| I: Focused History of Background and Computer Use | 1. From you survey, I know a little about your background. What else would you like to tell me about yourself?  
2. What do you think of when you think of computers?  
3. When and how did you first use a computer? |
| II: Details of Experience                  | 4. Describe for me a situation in which you have [used a computer for school work (or) watched a student use a computer for school-related work].  
5. How have your own computer skills influenced your use of computers for school-related work?  
6. What is your sense of how students in general view the use of computers in schools? |
| III: Reflection on the Meaning             | 7. How do computers change schools or individual classrooms?  
8. What do you think computers offer students with special needs?  
9. What do you see as the future of computers and other technologies in schools in terms of providing inclusive work environments? |
checked by having another typist transcribe portions of three interviews. Comparison of the matched transcripts showed .98 agreement between typists.

Subject Characteristics

General information about the interview subjects is found in Table 3.6. A total of six students and six teachers were interviewed, including seven males and five females. While half (3) of the students were identified as having a learning disability, only one teacher reported having a special need. The teachers represented a variety of teaching disciplines, with math being the only one repeated in the group.

<table>
<thead>
<tr>
<th>Table 3.6. Interview subject characteristics*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>Students</td>
</tr>
<tr>
<td>Darren</td>
</tr>
<tr>
<td>Nathan</td>
</tr>
<tr>
<td>Frances</td>
</tr>
<tr>
<td>Stewart</td>
</tr>
<tr>
<td>Michelle</td>
</tr>
<tr>
<td>Paul</td>
</tr>
<tr>
<td>Teachers</td>
</tr>
<tr>
<td>Ms. Robbins</td>
</tr>
<tr>
<td>Mr. Carter</td>
</tr>
<tr>
<td>Ms. Thom</td>
</tr>
<tr>
<td>Mr. Miller</td>
</tr>
<tr>
<td>Mr. Parker</td>
</tr>
</tbody>
</table>

* The names used here are pseudonyms.
For the students, years of experience using computers varied with age, however all reported that they began using computers between ages five and eight. For teachers, years of experience was more varied, ranging from 6 to 20 years. Of note, most of the teachers began using computers as soon as they were available in the early 1980s. The exception was Ms. O'Donnell, who began using them in conjunction with her job six years prior to this study. Also notable, the more experienced computer-using teachers had all used computers for instruction as soon as was possible, generally within a year of learning how to use them.

Information concerning the interview subjects' sense of their computer skills was taken from their survey responses. None of the subjects reported having no computer skills, but they did indicate a wide range of skill level, from poor to excellent. The teachers who were interviewed were slightly more skilled than the students, perhaps a reflection of their age and general interest in using computers for school-related tasks.

Interview Profiles

The above data provided very general information about the interview participants. The following interview profiles give more background information about each participant. These profiles provide data that serves as the individual context for each participant's computer-related experiences.
Student Profiles

Darren. "So many possibilities." Darren was 14 years old and in the ninth grade, his second year attending Fairmont, when the interview was conducted. He had chosen to attend a boarding school because his father's work with an international corporation involved overseas postings. CH and his family have lived in Southeast Asia, Africa, and Europe as a result of his father's work. With the exception of the second and third grades in the United States, Darren attended English language international schools through the sixth grade and then came to the United States as a boarding student starting in the seventh grade.

Darren described his school experiences as generally positive, reporting that he has always enjoyed school. Darren had no history of a learning disability or school problems. He enjoyed his time at the international schools but described them as being small. He appreciated the chance to attend boarding schools which have larger student populations. Darren reported that he has always been a fairly successful student, reporting that "I like to learn".

Nathan. "It's harsh!" In contrast to Darren, Nathan offered a very different view of the role of computers for helping students with different learning needs. Nathan was fifteen at the time of the Interview and was completing his ninth grade year at Fairmont. Nathan had attended
Fairmont for four years, starting in the sixth grade, taking advantage of the school's academic support services to deal with his dyslexia. Both of Nathan's parents are teachers and he was a day student at Fairmont. Nathan's parents were teaching at a boarding school on the West coast when he was born. When Nathan was two, the family moved to the Northeast to another boarding school, leaving there when Nathan was in the first grade to work at their current boarding school not far from Fairmont.

Frances. "I can see kids working all together." At the time of the interview Frances, a sixth grade girl from Riverview with no history of learning problems, was 12. She was a very busy student who participated in a number of activities in and out of school. Frances had attended the public schools in her town since Kindergarten. She was a member of the school band and chorus, served on the student council, and participated regularly in ballet, figure skating, and soccer programs in the local community. Frances reflected a very positive and upbeat attitude about school, reporting that she likes her classes, especially math.

Stewart. "unmeasureable things". Stewart, a twelve year old boy, was in the sixth grade at Riverview when the interview was conducted. He had attended the public schools in this town since first grade. A good student, Stewart was also very involved in a gymnastics program in the local community which involved training three hours daily, five days a week.
Stewart immediately showed his strong interest in computers, revealing a high level of expertise. He spoke primarily of the uses of computers for school and home tasks but also made mention of specific needs for computers at his school.

Michelle. “It was really frustrating.” Michelle, a 14 old girl in eighth grade at Wesley Academy, expressed ongoing frustration about computers. In her first year at Wesley Academy at the time of the interview, Michelle had attended public schools in two Northeast communities prior to choosing Wesley Academy for the eighth grade. This choice was made as a result of her mother’s frustration with Michelle’s lack of progress at the local middle school.

Michelle was identified as having Attention Deficit Hyperactivity Disorder (ADHD) in fourth grade. She was first treated with stimulant medication, which, she reported, had helped her concentrate better, but made her depressed. Her mother, a physician, discovered that Michelle was not taking her medication and an alternative medication was found which does not create the depressive side effects. Michelle reported that she likes her new school very much. She enjoys the small classes and finds that “I can’t get away with not answering questions and not being part of things.”

Paul. “It’s a good thing.” The oldest student interviewed was 18 year old Paul, a young man in his senior year at Wesley Academy. He had
attended public schools through fifth grade, displaying some evidence of learning difficulties. As a result he went to a private school for sixth grade but went back to public school for seventh, where he was identified as having a learning disability. He attended another boarding school for eighth and ninth grade and enrolled at Wesley Academy as a boarding student in grade ten. Paul revealed in his interview that he selected Wesley Academy because it offered the best financial aid package in addition to the academic skills support program.

Teacher Profiles

Ms. Robbins. “You’ve got to have the hardware.” Ms. Robbins, a veteran teacher at Fairmont shared many insights about the role of technology in education. With 30 years of French and Spanish teaching experience, 24 of them at Fairmont, Ms. Robbins had witnessed many innovations related to technology in education. Eager to integrate technology with her teaching, Ms. Robbins made use of the earliest personal computers and used them to create practice drills for her students. She found these exercises helpful for the students, but they required regular access to the computers in order for the students to make use of them.

Mr. Carter. “The word processor is a savior.” Mr. Miller was in his fourth year of teaching math at Fairmont at the time of the interview. He
came to teaching out of a love for working with kids and a willingness to try new things. A religion major in college, Mr. Miller also had a strong interest in computers when he began teaching. Most of his computer skills were self-taught, although he took a programming course taken in sixth grade. He eagerly incorporated computers into his teaching as much as possible.

Ms. Thom. "It should be student-centered." Ms. Thom, a sixth grade science teacher, knew she wanted to be a teacher from an early age. In her fifth year at Riverview, Ms. Thom shared her strong sense of what it means to be a good teacher throughout the interview. With experience teaching at several schools since her start in the mid-1970's, Ms. Thom shared her belief in the importance of student-centered instruction.

Having taken computer programming during pre-service teacher training, Ms. Thom eagerly learned more about computers when personal computers became available in the 1980's. When she began her current position, Ms. Thom took advantage of a university sponsored in-service training program to integrate computers into science instruction. Early projects included using an Internet connection to collaborate with science students at other schools in research projects. In addition, other Internet resources were utilized, including weather information. Ms. Thom's interview focused on both the uses of computers as well as how they can best be incorporated into instruction.
Mr. Miller. "We really need to show them." Mr. Parker, a fifth grade math teacher, has many years of experience with computers in education. In the course of his 22 years of teaching, he has worked hard to incorporate computers into his classrooms as much as possible. Having taken computer programming classes in the late 1970's, Mr. Parker eagerly integrated personal computers into his classroom as soon as they became available.

Ms. O'Donnell. "Having the access is the most important thing." A veteran teacher, Ms. O'Donnell, a special educator at Wesley Academy, was still fairly new to computers when interviewed. She began her teaching career as an elementary grade teacher. Eventually, she worked in the Title I program which led her to seek training in special education. She had worked at Wesley Academy as a learning specialist for 14 years. Ms. O'Donnell began using computers as part of her work six years earlier and at first the use was primarily for paperwork. In time, she observed that her students could benefit from using word processing for writing and she incorporated computer use into her academic support programs.

Mr. Parker. "I try to have my students be aware of ...connections." Mr. Carter, an English teacher with five years of experience at Wesley Academy, focused on how computers can help students develop new and innovative connections across disciplines. Mr. Carter began teaching at Wesley Academy right after graduate school, focusing on American and English
literature. Mr. Carter's computer experiences dated back to his own childhood when his family purchased their first computer in the 1980's. His schools did not have computers so his exposure to them was limited to home use until his sophomore year of college when he inherited an older computer to use for writing papers. He reported that from then on the computer became a primary tool for his writing and organizing activities.

**Interview Analysis**

The interview data were analyzed using Glaser and Strauss' (1967) open coding procedures. This approach is based on the use of a "grounded" method of generating theoretical understandings about the interview data (Glaser & Strauss, 1967). This method relies on the emergence of categories and properties directly from the data rather than the use of *a priori* external categories (Glaser & Strauss, 1967:36ff; see also Glaser, 1992 for further explanation). For example, the statement by Darren "I mostly played games on the computer" was coded as uses — games. This approach follows Seidman's (1991) suggestion that analyzing qualitative data is essentially a process of meaning-making. As such, the form and process of such analysis cannot be predicted but must evolve from the data at hand. The method used here is largely positivist in orientation in that it seeks to identify recurring
themes as a way of comparing the subjects' descriptions of computer experiences with the survey responses and conclusions (Silverman, 1993).

The transcripts were analyzed by the researcher and also by an outside reader experienced with this form of research in order to ensure the reliability of the interpretation of the data (Silverman, 1993; Wolcott, 1994). Both readers used the same methods and procedures of analysis. Both readers looked at each transcript individually and coded the data without knowledge of what the other coder was doing. As recommended by Kvale (1996), Mason (1994) and Wolcott (1990) the readers first read through all the interview transcripts, then organized the data by assigning very general categories and themes to the texts. The focus of the interpretation of the interview data was on key words or phrases which were repeated by individuals or several of the interview subjects (Dey, 1993). Large chunks of text might be initially coded in regard to a central theme and then recoded later with greater attention to individual precision. An example from Darren's interview was:

I was six or seven when we first got our computer. My brother was really young and he didn't even bother the computer. I played games a lot on it: Space Quest, something like Move Runner, really old corny games most but they pretty much started me off on a computer gaming career (Darren, April 1997).
A first read of the above passage might lead to a general code of first computer experiences but a more complete analysis showed other codes such as uses, games, age, family involvement and applications. Next, each reader labeled all transcripts with codes generated from her reading of the material. Once all the transcripts were labeled with these codes, each reader created a list of codes and subcodes that represented the labels assigned to the texts.

After having created separate code lists from the data, the readers conferred and compared their codes. The researcher's code list consisted of six main coding categories: applications, applications in special education, instruction, social, attitudes, and, needs. Each of these main categories had a number of subcategories. The second reader developed four main coding categories: uses, uses for learning disabled students, downside of computers, and needs. Again, each of these categories was accompanied by subcategories. For example, the researcher's subcodes for the above passage were uses – games, family, and applications. The second raters subcodes were games, programs, and age.

Through discussion and consensus, a combined coding list was generated for use by both readers (Miles & Huberman, 1994), with a new code category developed: experience. This code list is found in Table 3.7.
Table 3.7. Codes and subcodes

<table>
<thead>
<tr>
<th>Code</th>
<th>Subcodes</th>
</tr>
</thead>
</table>
| 1. Applications of Computers | 1.1 Assignments  
1.2 Calculator  
1.3 Communication  
1.4 Editing (spelling)  
1.5 Games  
1.6 Organization  
1.7 Programming  
1.8 Research  
1.9 Teacher Prep.  
1.10 Tools |
| 2. Applications in Special Education | 2.1 Alternative Instruction  
2.2 Assessment/exams  
2.3 Assistive Technology  
2.4 Editing (spelling)  
2.5 Organizing  
2.6 Remediation  
2.7 Research  
2.8 Writing |
| 3. Instructional Uses | 3.1 Alternative presentation  
3.2 Assignments/drills  
3.3 Fosters problem solving  
3.4 Instructional assistant  
3.5 Integration of computers  
3.6 Student-centered  
3.7 Teacher as facilitator |
| 4. Positive Attitudes | 4.1 Beneficial to all  
4.2 Classroom behavior  
4.3 Cost effective comm.  
4.4 Easier  
4.5 Enjoyable  
4.6 Faster  
4.7 Job preparation  
4.8 Legibility  
4.9 Professional  
4.10 Readability  
4.11 Work quality |
| 5. Negative Attitudes | 5.1 Breakable  
|                       | 5.2 Costly  
|                       | 5.3 Debilitating  
|                       | 5.4 Fear  
|                       | 5.5 Frustrating  
|                       | 5.6 Lack of resources  
|                       | 5.7 Less human contact  
|                       | 5.8 Less personal  
|                       | 5.9 Loss of other skills  
|                       | 5.10 Not useful/boring  
|                       | 5.11 Resistance to change  
| 6. Other Attitudes   | 6.1 Computers common  
|                       | 6.2 Increases educational quality  
|                       | 6.3 Teachers still needed  
|                       | 6.4 Unlimited potential  
| 7. Social            | 7.1 Enhances communication skills  
|                       | 7.2 Fosters cooperation  
|                       | 7.3 Gender differences  
|                       | 7.4 More student-teacher discourse  
|                       | 7.5 Need personal contact  
|                       | 7.6 Prevents human interaction  
|                       | 7.7 Self-centered students  
| 8. Resource Needs    | 8.1 Access  
|                       | 8.2 Hardware  
|                       | 8.3 Money  
|                       | 8.4 Personnel  
|                       | 8.5 Software  
|                       | 8.6 Training  
|                       | 8.7 Typing  
| 9. Experience        | 9.1 Family/Home  
|                       | 9.2 School  

the agreed code list was .86. Through discussion and consensus, disagreements on code assignments were resolved by the two readers.

Once the transcripts were fully coded in agreement by both readers, a third outside reader, a college-level instructor, read three randomly selected transcripts and coded them using the revised common code list. Agreement between the paired coding and the third reader was .80. The final interpretation of the interviews involved the development of five main
Reliability and Validity of Qualitative Data

The qualitative methodology used here employed an open coding approach based on Glaser and Strauss’ (1967) Grounded Theory. However, as Glaser (1992) has pointed out, the subsequent data creates an hypothesis, not irrefutable, conclusive data. Still, the reliability and validity of these findings are important (Kirk & Miller, 1986). In general, the reliability and validity of qualitative data can be evaluated based on six criteria (Leininger, 1994):

- credibility
- confirmability
- meaning-in-context
- recurrent patterning
- saturation
- transferability

A systematic approach to checking the above features of the data set is to use triangulation (Jick, 1983; Miles & Huberman, 1994). This method involves checking each component of the data against other parts. In addition, the methods of data analysis can be cross-checked against other methods. This
process examines the overall consistency of the data as a way of determining internal and external reliability as well as overall validity.

Jick's (1983) model for triangulation suggests that triangulation can be done on a continuum, from simple to complex. This study used relatively complex methods in that convergent validation measures were applied. Convergent validation involves examining both within-group and between-group data sets from several angles to determine if the data collected is consistent (reliable) and if it measures what is intended (valid).

Reliability was checked by having two outside raters code the interview data using the same methods used by the researcher. This provided a way to compare and cross-check the categories and themes of responses as interpreted by the researcher and the outside readers. Two methods were used to check the reliability of the transcript data. The use of selected sample dual transcription provided a verification of transcript accuracy. In addition, selected interview subjects were given transcripts of their interviews to review. No changes to the typed transcripts were requested.

The validity of the qualitative data were verified by comparison with the quantitative data. This is the critical third point of triangulation. The
convergence of the interview responses was compared with the quantitative findings. Presentation and discussion of these findings is found in Chapter V.
CHAPTER IV

RESULTS FROM THE SURVEYS

Subject Characteristics

Analysis of the data obtained from the surveys showed that there were some statistically significant differences among the responses given by participants. General demographic characteristics will be presented, followed by analyses of subjects' scores on each of the four outcome measures. Except where indicated, all tests for significance were at the .05 level.

Subject Demographics

Approximately 81% of the total possible subjects at the three schools participated in either the pre or post-test survey. Group sizes for the pre and post-test survey are given in Table 4.1. In all, a total of 594 students and 73 teachers participated in the pre-test survey, the largest response group. On the post-test survey 497 students and 58 teachers participated. There were a

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>594</td>
<td>497</td>
<td>374</td>
</tr>
<tr>
<td>Teachers</td>
<td>73</td>
<td>58</td>
<td>36</td>
</tr>
<tr>
<td>Total</td>
<td>667</td>
<td>555</td>
<td>410</td>
</tr>
</tbody>
</table>
total of 410 combined cases for participants who completed both surveys, a response rate of 61% based on the original number of participants. In total, 374 students (63% of original) and 36 teachers (49% of original) completed both the pre and post-test surveys.

Data taken from the largest sample of surveys (Table 4.2), the pre-test, showed that the majority of subjects (S=484, T=73) were U.S. citizens and English was their first language (S=480, T=73). All of the teachers who

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Pre-test</th>
<th></th>
<th>Post-test</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Students</td>
<td>Teachers</td>
<td>Students</td>
<td>Teachers</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>U.S. Citizens</td>
<td>484</td>
<td>81</td>
<td>73</td>
<td>100</td>
</tr>
<tr>
<td>English as first language</td>
<td>480</td>
<td>81</td>
<td>73</td>
<td>100</td>
</tr>
<tr>
<td>Learning-disabled</td>
<td>101</td>
<td>17</td>
<td>13</td>
<td>18</td>
</tr>
<tr>
<td>Race:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African/African-American</td>
<td>42</td>
<td>07</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Asian/Asian-American</td>
<td>75</td>
<td>13</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Caucasian</td>
<td>397</td>
<td>69</td>
<td>73</td>
<td>100</td>
</tr>
<tr>
<td>Hispanic/Latino/a</td>
<td>32</td>
<td>05</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>47</td>
<td>08</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sex:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>184</td>
<td>31</td>
<td>39</td>
<td>53</td>
</tr>
<tr>
<td>Male</td>
<td>410</td>
<td>69</td>
<td>34</td>
<td>47</td>
</tr>
</tbody>
</table>

participated were Caucasian. Among the students 42 African/African-
Americans (7%), 75 Asian/Asian-Americans (13%), 32 Hispanic/Latino/a (5%), and 397 (67%) Caucasians participated. There were 47 (8%) participants whose race was not given. Sex differences were fairly uneven for students because of the participation of students from a primarily all-boys' school; 184
(31%) girls and 410 (69%) boys completed surveys. Among teachers, 39 (53%) women and 34 (47%) men participated.

All of the teachers were asked to indicate whether they had a learning disability or other special need. On the pre-test, 13 (17%) of teachers reported that they had some form of special need. For unknown reasons a higher rate of teachers with special needs participated in the post-test survey (N=18). Given that survey distribution methods were identical for both the pre and post-test administrations, it is unclear why more teachers with special needs participated in the post-test survey. Student data indicating the presence of a learning disability or other special need were collected separately and integrated with the survey data. About 17 percent of students who participated in both the pre- and post-test surveys were identified as having some form of special learning need. Participation rates in the post-test survey were lower for both students and teachers. The exceptions were the higher rate of teachers with special needs mentioned above and the participation of one non-Caucasian teacher.

Information relating to the distribution of participants by school is found in Table 4.3. The numbers of participants from each school were fairly proportional to the subject populations at each school. Riverview had the smallest number of students because only two grades, fifth and sixth, were surveyed. The 84 students who participated in the pre-test represented 76%
of the total number in grades five and six. At Fairmont 81% (N=203) of the students participated in the pre-test, while at Wesley 94% (N=307) of the students participated in the pre-test.

Table 4.3. School distribution (sample sizes)

<table>
<thead>
<tr>
<th>School</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Students</td>
<td>Teachers</td>
</tr>
<tr>
<td>Riverview</td>
<td>84</td>
<td>24</td>
</tr>
<tr>
<td>Fairmont</td>
<td>203</td>
<td>29</td>
</tr>
<tr>
<td>Wesley Academy</td>
<td>307</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>584</td>
<td>73</td>
</tr>
</tbody>
</table>

Student Characteristics

Data pertaining to student subjects is found in Tables 5.4 through 5.6. Of the 505 private school students, 55% (N=279) were boarders and 45% (N=226) were day students. The overall total of day students, including the public school students (N=84) was 310, making this group the majority. At Fairmont, data reporting the students' financial aid status were independently collected and integrated with the survey results. During the 1996-97 school year, 55 (22%) of the participating students at Fairmont received academic financial aid. The grade range of participating students is also found in Table 4.4. The largest number of students per grade was 117, in ninth grade. This was the result of the ninth grade overlap at Fairmont and Wesley Academy. As can be seen in tables 4.5 and 4.6, a larger percentage of non-Caucasian students participated at Fairmont. Given that the distribution of non-Caucasian students was about even at both private
Table 4.4. Student characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day Students</td>
<td>226</td>
<td>159</td>
</tr>
<tr>
<td>Boarding Students</td>
<td>279</td>
<td>228</td>
</tr>
<tr>
<td>Financial Aid Recipients*</td>
<td>55</td>
<td>49</td>
</tr>
</tbody>
</table>

Grades:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Five</td>
<td>45</td>
<td>38</td>
</tr>
<tr>
<td>Six</td>
<td>67</td>
<td>59</td>
</tr>
<tr>
<td>Seven</td>
<td>72</td>
<td>65</td>
</tr>
<tr>
<td>Eight</td>
<td>92</td>
<td>88</td>
</tr>
<tr>
<td>Nine</td>
<td>117</td>
<td>112</td>
</tr>
<tr>
<td>Ten</td>
<td>41</td>
<td>40</td>
</tr>
<tr>
<td>Eleven</td>
<td>74</td>
<td>41</td>
</tr>
<tr>
<td>Twelve</td>
<td>67</td>
<td>36</td>
</tr>
<tr>
<td>Post-graduate</td>
<td>19</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>584</td>
<td>477</td>
</tr>
</tbody>
</table>

*Fairmont only

Table 4.5. Pre-test student data for learning disability, race, and sex by grade

<table>
<thead>
<tr>
<th>Variable</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Learning Disability (LD)</td>
<td>9</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>African/African-American</td>
<td>0</td>
</tr>
<tr>
<td>Asian/Asian-American</td>
<td>1</td>
</tr>
<tr>
<td>Caucasian</td>
<td>30</td>
</tr>
<tr>
<td>Hispanic/Latino/a</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>11</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>22</td>
</tr>
<tr>
<td>Male</td>
<td>22</td>
</tr>
</tbody>
</table>

Table 4.6. Post-test student data for learning disability, race, and sex by grade

<table>
<thead>
<tr>
<th>Variable</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Learning Disability (LD)</td>
<td>4</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>African/African-American</td>
<td>1</td>
</tr>
<tr>
<td>Asian/Asian-American</td>
<td>0</td>
</tr>
<tr>
<td>Caucasian</td>
<td>35</td>
</tr>
<tr>
<td>Hispanic/Latino/a</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>17</td>
</tr>
<tr>
<td>Male</td>
<td>21</td>
</tr>
</tbody>
</table>
schools, and similar survey administration methods were used at all schools, the greater participation at Fairmont may have been the result of these students' greater familiarity with the researcher.

Teacher Characteristics

Teacher-specific data are reported in Tables 4.7 through 4.9. These

Table 4.7. Teacher characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degrees held:</td>
<td></td>
</tr>
<tr>
<td>Some college</td>
<td>1</td>
</tr>
<tr>
<td>Bachelor's</td>
<td>10</td>
</tr>
<tr>
<td>Some graduate work</td>
<td>23</td>
</tr>
<tr>
<td>Master's</td>
<td>35</td>
</tr>
<tr>
<td>Doctorate</td>
<td>2</td>
</tr>
<tr>
<td>Part of day spent teaching students with special needs:</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>18</td>
</tr>
<tr>
<td>25%</td>
<td>25</td>
</tr>
<tr>
<td>50%</td>
<td>10</td>
</tr>
<tr>
<td>75%</td>
<td>5</td>
</tr>
<tr>
<td>100%</td>
<td>15</td>
</tr>
<tr>
<td>Special Education Teachers</td>
<td>16</td>
</tr>
<tr>
<td>Number of Professional Development activities attended each year:</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>4</td>
</tr>
<tr>
<td>1-2</td>
<td>44</td>
</tr>
<tr>
<td>3-4</td>
<td>18</td>
</tr>
<tr>
<td>5 or more</td>
<td>7</td>
</tr>
<tr>
<td>Number of years teaching:</td>
<td></td>
</tr>
<tr>
<td>Less than 2</td>
<td>1</td>
</tr>
<tr>
<td>2-5</td>
<td>14</td>
</tr>
<tr>
<td>6-10</td>
<td>9</td>
</tr>
<tr>
<td>11-15</td>
<td>16</td>
</tr>
<tr>
<td>15 or more</td>
<td>32</td>
</tr>
</tbody>
</table>

data show that the majority of participating teachers had attended some graduate courses or held a Master's degree. Two participants held the doctorate. These results also show that most of the teachers spent less than
Table 4.8. Teaching areas and levels

<table>
<thead>
<tr>
<th>Teaching Area/Grade</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-kindergarten – 3</td>
<td>5</td>
</tr>
<tr>
<td>Grades 4-6</td>
<td>7</td>
</tr>
<tr>
<td>Middle School</td>
<td>4</td>
</tr>
<tr>
<td>English, 7-12</td>
<td>12</td>
</tr>
<tr>
<td>Math, 7-12</td>
<td>8</td>
</tr>
<tr>
<td>Science, 7-12</td>
<td>6</td>
</tr>
<tr>
<td>Foreign Language</td>
<td>5</td>
</tr>
<tr>
<td>Social Studies/History</td>
<td>4</td>
</tr>
<tr>
<td>Art</td>
<td>2</td>
</tr>
<tr>
<td>Music</td>
<td>2</td>
</tr>
<tr>
<td>English as a Second Language</td>
<td>2</td>
</tr>
<tr>
<td>Special Education</td>
<td>9</td>
</tr>
<tr>
<td>Librarian</td>
<td>1</td>
</tr>
<tr>
<td>Technology Specialist</td>
<td>2</td>
</tr>
<tr>
<td>Administrator</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 4.9. Teacher certifications held*

<table>
<thead>
<tr>
<th>Certificate</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Childhood Education</td>
<td>5</td>
</tr>
<tr>
<td>Elementary Education</td>
<td>25</td>
</tr>
<tr>
<td>Middle School</td>
<td>5</td>
</tr>
<tr>
<td>English as a Second Language</td>
<td>4</td>
</tr>
<tr>
<td>English, 7-12</td>
<td>5</td>
</tr>
<tr>
<td>History/Social Studies, 7-12</td>
<td>2</td>
</tr>
<tr>
<td>Geography, 7-12</td>
<td>2</td>
</tr>
<tr>
<td>Math, 7-12</td>
<td>3</td>
</tr>
<tr>
<td>Science, 7-12</td>
<td>4</td>
</tr>
<tr>
<td>Modern foreign Language</td>
<td>3</td>
</tr>
<tr>
<td>Latin and Classics</td>
<td>1</td>
</tr>
<tr>
<td>Art</td>
<td>2</td>
</tr>
<tr>
<td>Music</td>
<td>1</td>
</tr>
<tr>
<td>Health/Physical Education</td>
<td>3</td>
</tr>
<tr>
<td>Moderate Special Needs</td>
<td>4</td>
</tr>
<tr>
<td>Hearing and Language</td>
<td>1</td>
</tr>
<tr>
<td>Reading Specialist</td>
<td>2</td>
</tr>
<tr>
<td>School Psychologist</td>
<td>1</td>
</tr>
<tr>
<td>Principal</td>
<td>3</td>
</tr>
</tbody>
</table>

*total exceeds N because some teachers have more than one certificate

50% of their day teaching students with special needs (N=43). However, only 18 of the 73 teachers reported working with such students during none of the
day, reflecting a fairly high level of integrated instruction at these three schools. Sixteen special education teachers participated in the survey.

Most of the teachers (N=62) reported participating in one to four professional development activities each year. Only four reported participating in none and seven reported attending five or more per year. Data relating to years of teaching experience showed the respondents to be a highly experienced group of teachers. Forty-eight of the participants had more than ten years of teaching experience. The largest single subject area represented was English. This was perhaps due to the fact that English teachers at Wesley Academy helped in conducting the survey. The second largest group was special education teachers, who were perhaps more inclined to participate because of their interest in the research questions. Twenty-five of the participants held elementary teaching certificates. The next largest groups were English and Early Childhood Education at five each.

Pre-test Computer-Related Characteristics

The subjects reflected a range of computer-related experiences. Overall, they were an experienced group with ongoing regular access to computers (see Table 4.10). A strong majority of students (91%) and teachers (99%) reported that they had regular access to a computer.
Computer ownership was reported for 82% of students and 90% of teachers. For both students and teachers the most widely used applications were word processing, followed by educational programs and e-mail. Fewer subjects used spreadsheets and databases.

Table 4.10. Subjects' computer-related characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Pre-test</th>
<th></th>
<th>Post-test</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Students</td>
<td>Teachers</td>
<td>Students</td>
<td>Teachers</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Regular access to a computer</td>
<td>538</td>
<td>91</td>
<td>72</td>
<td>99</td>
</tr>
<tr>
<td>Own a computer</td>
<td>485</td>
<td>82</td>
<td>66</td>
<td>90</td>
</tr>
<tr>
<td>Types of application used:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Database</td>
<td>143</td>
<td>24</td>
<td>26</td>
<td>36</td>
</tr>
<tr>
<td>Education Programs</td>
<td>392</td>
<td>66</td>
<td>41</td>
<td>56</td>
</tr>
<tr>
<td>Electronic Mail</td>
<td>358</td>
<td>61</td>
<td>40</td>
<td>55</td>
</tr>
<tr>
<td>Spreadsheets</td>
<td>180</td>
<td>30</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
<td>Word Processing</td>
<td>528</td>
<td>88</td>
<td>66</td>
<td>90</td>
</tr>
<tr>
<td>Where computer skills were learned:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Don’t use them</td>
<td>2</td>
<td>003</td>
<td>2</td>
<td>03</td>
</tr>
<tr>
<td>Home/Self/Friends</td>
<td>386</td>
<td>65</td>
<td>37</td>
<td>51</td>
</tr>
<tr>
<td>Work/Office</td>
<td>7</td>
<td>01</td>
<td>17</td>
<td>23</td>
</tr>
<tr>
<td>School</td>
<td>172</td>
<td>29</td>
<td>16</td>
<td>22</td>
</tr>
<tr>
<td>Other</td>
<td>27</td>
<td>05</td>
<td>1</td>
<td>01</td>
</tr>
<tr>
<td>Years of computer experience:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>6</td>
<td>01</td>
<td>2</td>
<td>03</td>
</tr>
<tr>
<td>Less than 1 year</td>
<td>39</td>
<td>07</td>
<td>2</td>
<td>03</td>
</tr>
<tr>
<td>1-2 years</td>
<td>111</td>
<td>19</td>
<td>5</td>
<td>07</td>
</tr>
<tr>
<td>3-5 years</td>
<td>238</td>
<td>40</td>
<td>17</td>
<td>23</td>
</tr>
<tr>
<td>Five or more years</td>
<td>200</td>
<td>34</td>
<td>47</td>
<td>64</td>
</tr>
<tr>
<td>Frequency of use:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td>8</td>
<td>01</td>
<td>4</td>
<td>05</td>
</tr>
<tr>
<td>Once in a while</td>
<td>81</td>
<td>14</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Monthly</td>
<td>59</td>
<td>10</td>
<td>3</td>
<td>04</td>
</tr>
<tr>
<td>Weekly</td>
<td>209</td>
<td>35</td>
<td>25</td>
<td>34</td>
</tr>
<tr>
<td>Daily</td>
<td>237</td>
<td>39</td>
<td>34</td>
<td>47</td>
</tr>
<tr>
<td>Formal computer training</td>
<td>N/A</td>
<td>N/A</td>
<td>48</td>
<td>65</td>
</tr>
<tr>
<td>Self-rating of computer skills:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>6</td>
<td>01</td>
<td>2</td>
<td>03</td>
</tr>
<tr>
<td>Poor</td>
<td>39</td>
<td>07</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Fair</td>
<td>220</td>
<td>37</td>
<td>33</td>
<td>45</td>
</tr>
<tr>
<td>Good</td>
<td>232</td>
<td>39</td>
<td>25</td>
<td>34</td>
</tr>
<tr>
<td>Excellent</td>
<td>97</td>
<td>16</td>
<td>4</td>
<td>05</td>
</tr>
</tbody>
</table>
A majority of students and teachers indicated that they learned to use computers at home, by self-teaching, or from friends. Twenty-nine percent of students reported that they learned to use computers at school. Among teachers, 17% indicated that they learned to use them in the workplace, while 16% had taken special classes. As stated, this was a largely experienced computer-using group, and 34% of students and 64% of teachers reported having used computers for five or more years.

Frequency of computer use was also high, with 39% of students and 47% of teachers using them daily. 35% and 34% of students and teachers, respectively, reported using computers weekly. Only 25% of students reported using computers monthly or less, with 1% of students claiming to use them never. Among teachers, 19% reported monthly or less computer use with 5% indicating they never use computers. Participating teachers were asked whether they had received any formal training in computer use during their teacher training in college or during in-service workshops; 65% responded that they had received such training.

Most students and teachers rated their own computer skills as either fair or good, with students giving themselves higher ratings than teachers. 37% of students reported their computer skills as fair while 39% indicated their skills are good. Sixteen percent of students rated their skills as excellent. Among teachers, the largest number reported their skills as fair
(45%) while 34% rated their skills as good. Only 5% of teachers indicated that their computer skills were excellent.

Data Analysis

Comparisons by School

Comparison of the mean scores for each school on the pre and post-tests surveys using one-way analysis of variance procedures (ANOVA) for each outcome measure shows that there were significant differences on several outcome measures (Tables 4.11 and 4.12). On the pre-test, these differences were significant on the general, special needs, and comfort measures. There were not significant differences on the worry item. On the
Table 4.12. Summary of one-way ANOVAs for each outcome measure by school

<table>
<thead>
<tr>
<th>Scale</th>
<th>Pre-test</th>
<th>Post-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SS</td>
<td>df</td>
</tr>
<tr>
<td>General</td>
<td>69161.08</td>
<td>619</td>
</tr>
<tr>
<td>Special Needs</td>
<td>5016.228</td>
<td>649</td>
</tr>
<tr>
<td>Comfort</td>
<td>709.278</td>
<td>653</td>
</tr>
<tr>
<td>Worry</td>
<td>759.395</td>
<td>658</td>
</tr>
</tbody>
</table>

*p<.05

Post-test, differences on the general and comfort measures were significant, with worry approaching significance at p=.051.

Post-hoc tests using Games-Howell procedures were conducted to correct for heterogeneity of variance among the groups. These tests showed that on the pre-test the significant differences on the general scale were between Fairmont and Riverview as well as between Wesley and Riverview. On the special needs scale, the significant differences were between Fairmont and Riverview only. The comfort item showed significant differences between Fairmont and Riverview as well as Wesley and Riverview. On the post-test measures, the significant differences were between Riverview and Fairmont as well as Riverview and Wesley on the general scale. None of the post-hoc comparisons for comfort were significant using the Games-Howell adjustment.

Comparisons among Students and Teachers

Similar comparisons were made among the three groups of participants: students with learning disabilities (LD), students without...
learning disabilities and teachers. Means and standard deviations for these
groups for the pre and post-test are found in Table 4.13. Analysis of variance
(ANOVA) results showed that the only significant differences among these
groups were for the worry item (Table 4.14). Post hoc tests for both the pre

Table 4.13. Means and standard deviations for each scale by student and
teacher groups (students with LD, students without LD, teachers)

<table>
<thead>
<tr>
<th>Group</th>
<th>General</th>
<th>Special Needs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Students with learning disabilities</td>
<td>67.2</td>
<td>10.6</td>
</tr>
<tr>
<td>Students without learning disabilities</td>
<td>67.8</td>
<td>8.8</td>
</tr>
<tr>
<td>teachers</td>
<td>70.9</td>
<td>12.8</td>
</tr>
</tbody>
</table>

Table 4.13. Continued

<table>
<thead>
<tr>
<th>Group</th>
<th>Comfort</th>
<th>Worry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Students with learning disabilities</td>
<td>3.2</td>
<td>1.1</td>
</tr>
<tr>
<td>Students without learning disabilities</td>
<td>3.2</td>
<td>.90</td>
</tr>
<tr>
<td>teachers</td>
<td>3.2</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Table 4.14. F and P values for analysis of variance comparisons among
student and teacher groups for each scale

<table>
<thead>
<tr>
<th>Group</th>
<th>Pre-test</th>
<th></th>
<th>Post-test</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SS</td>
<td>df</td>
<td>F</td>
<td>p*</td>
</tr>
<tr>
<td>General</td>
<td>72039.67</td>
<td>619</td>
<td>2.75</td>
<td>.060</td>
</tr>
<tr>
<td>Special Needs</td>
<td>5064.124</td>
<td>649</td>
<td>.60</td>
<td>.550</td>
</tr>
<tr>
<td>Comfort</td>
<td>719.037</td>
<td>653</td>
<td>.30</td>
<td>.740</td>
</tr>
<tr>
<td>Worry</td>
<td>741.339</td>
<td>658</td>
<td>9.28</td>
<td>.000</td>
</tr>
</tbody>
</table>

*p ≤ .05

and post-test results using Games-Howell indicated that the significant
differences were between teachers and students with and without LD;
there were no significant differences between the two student groups. Because Fairmont, the experimental site, is an all boys school, an additional one-way ANOVA was conducted to see whether the lack of significant differences between students with and without LD was being masked by the girls from Riverview and Wesley. These results showed no significant differences between the responses of boys with and without LD.

Predictors of Attitudes among Students and Teachers

In order to learn which variables best predict students’ and teachers’ attitudes about computer use in schools, multiple regression procedures were used. In order to maintain sufficient sample to variable ratios, the variables were categorized into two groups: demographic and computer-related. These groups of variables were entered simultaneously into the regression equation for each of the four outcome measures by group (students with LD, students without LD, and teachers). Those variables which accounted for little of the variance were then excluded and the remaining variables were reentered into the equation to evaluate which ones were the best predictors of the participants’ attitudes. These results are summarized in Tables 4.15 through 4.20.

Specific Predictors. Computer-related variables tended to be better predictors of attitudes toward computers than demographic variables.
Among the students with LD, there were no demographic predictors for the general scale. The variables regular access to computers, less than one year of computer experience, poor computer skills, and having learned to use a computer at school were significant predictors, each having negative regression weights. The only significant demographic predictor on the special needs scale was Hispanic race (i.e.: Hispanics having more positive attitudes), but this may be invalid because of a small number of Hispanic students with LD (N=7). As with the general attitudes scale, Less positive attitudes about the use of computers by students with special needs were predicted by regular access to computers, computer use of less than one year and having never used computers. On the teacher comfort item, age, African-

Table 4.15. Multiple regression results for students with LD: Predictors from demographic variables

<table>
<thead>
<tr>
<th>Scale</th>
<th>Variable</th>
<th>b</th>
<th>SE</th>
<th>T</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>None</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Attitudes</td>
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<td>1.805</td>
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<tr>
<td></td>
<td>Race: Hispanic</td>
<td>3.206</td>
<td>1.238</td>
<td>2.589</td>
<td>.011</td>
</tr>
<tr>
<td>Special Needs</td>
<td>Age</td>
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<td>.002</td>
</tr>
<tr>
<td>Attitudes</td>
<td>Race: African-American</td>
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<td>1.120</td>
<td>3.269</td>
<td>.003</td>
</tr>
<tr>
<td></td>
<td>Boys</td>
<td>1.567</td>
<td>1.100</td>
<td>1.424</td>
<td>.164</td>
</tr>
<tr>
<td></td>
<td>Day student</td>
<td>1.058</td>
<td>.434</td>
<td>2.434</td>
<td>.021</td>
</tr>
<tr>
<td></td>
<td>Financial aid**</td>
<td>-.921</td>
<td>.529</td>
<td>-1.742</td>
<td>.091</td>
</tr>
<tr>
<td></td>
<td>Grade in school</td>
<td>-1.144</td>
<td>.350</td>
<td>-3.264</td>
<td>.003</td>
</tr>
<tr>
<td>Comfort</td>
<td>English</td>
<td>.593</td>
<td>.422</td>
<td>1.406</td>
<td>.164</td>
</tr>
<tr>
<td>(N = 82)</td>
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<td>.241</td>
<td>-.880</td>
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<tr>
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<td>Race: Hispanic</td>
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<td>1.238</td>
<td>2.589</td>
<td>.011</td>
</tr>
<tr>
<td></td>
<td>Boys</td>
<td>1.567</td>
<td>1.100</td>
<td>1.424</td>
<td>.164</td>
</tr>
<tr>
<td></td>
<td>Day student</td>
<td>1.058</td>
<td>.434</td>
<td>2.434</td>
<td>.021</td>
</tr>
<tr>
<td></td>
<td>Financial aid**</td>
<td>-.921</td>
<td>.529</td>
<td>-1.742</td>
<td>.091</td>
</tr>
<tr>
<td></td>
<td>Grade in school</td>
<td>-1.144</td>
<td>.350</td>
<td>-3.264</td>
<td>.003</td>
</tr>
</tbody>
</table>

*p≤.05   **Fairmont data only
American race, and being a day student predicted higher ratings of teachers' comfort with computers. Grade in school was related to more negative ratings of teachers' comfort level; the youngest students rated the teachers as having more comfortable skills. For the students with learning disabilities, the only significant predictor of teacher worry about breaking computers was whether a student had taken a special class to learn how to use computers, in

<table>
<thead>
<tr>
<th>Scale</th>
<th>Variable</th>
<th>b</th>
<th>SE</th>
<th>T</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Attitudes</td>
<td>Regular access to computers</td>
<td>-12.920</td>
<td>5.508</td>
<td>-2.346</td>
<td>.022</td>
</tr>
<tr>
<td>(N = 87)</td>
<td>Database use</td>
<td>4.967</td>
<td>2.846</td>
<td>1.745</td>
<td>.085</td>
</tr>
<tr>
<td>Multiple R: .617</td>
<td>Computer use of less than one year</td>
<td>-23.830</td>
<td>8.090</td>
<td>-2.945</td>
<td>.004</td>
</tr>
<tr>
<td>R Square: .380</td>
<td>Poor computer skills</td>
<td>-16.947</td>
<td>4.296</td>
<td>-3.945</td>
<td>.000</td>
</tr>
<tr>
<td>Computer use of less than one year</td>
<td>Spreadsheet use</td>
<td>5.560</td>
<td>2.830</td>
<td>1.964</td>
<td>.053</td>
</tr>
<tr>
<td>Never use computers</td>
<td>Use computers once in a while</td>
<td>18.894</td>
<td>10.750</td>
<td>1.758</td>
<td>.083</td>
</tr>
<tr>
<td></td>
<td>Learned to use computers at school</td>
<td>-3.704</td>
<td>3.587</td>
<td>-1.033</td>
<td>.305</td>
</tr>
<tr>
<td>(N = 87)</td>
<td>Regular access to computers</td>
<td>-4.145</td>
<td>1.699</td>
<td>-2.439</td>
<td>.017</td>
</tr>
<tr>
<td>Special Needs Attitudes</td>
<td>Database use</td>
<td>1.107</td>
<td>.750</td>
<td>1.476</td>
<td>.144</td>
</tr>
<tr>
<td>(N = 94)</td>
<td>Computer use of less than one year</td>
<td>-4.194</td>
<td>2.047</td>
<td>-2.049</td>
<td>.043</td>
</tr>
<tr>
<td>Multiple R: .373</td>
<td>Poor computer skills</td>
<td>-2.278</td>
<td>1.328</td>
<td>-1.714</td>
<td>.090</td>
</tr>
<tr>
<td>R Square: .139</td>
<td>Never use computers</td>
<td>-7.888</td>
<td>3.797</td>
<td>-2.080</td>
<td>.041</td>
</tr>
<tr>
<td>Comfort</td>
<td>Monthly computer use</td>
<td>-1.577</td>
<td>1.524</td>
<td>-1.035</td>
<td>.304</td>
</tr>
<tr>
<td>(N = 93)</td>
<td>Computer use of more than five years</td>
<td>-.427</td>
<td>.237</td>
<td>-1.797</td>
<td>.076</td>
</tr>
<tr>
<td>Multiple R: .240</td>
<td>Spreadsheet use</td>
<td>-.361</td>
<td>.247</td>
<td>-1.462</td>
<td>.147</td>
</tr>
<tr>
<td>R Square: .058</td>
<td>Took a special class to learn how to use computers</td>
<td>.841</td>
<td>.295</td>
<td>2.849</td>
<td>.005</td>
</tr>
<tr>
<td>Worry</td>
<td>Learned to use computers at school</td>
<td>1.224</td>
<td>.788</td>
<td>1.552</td>
<td>.124</td>
</tr>
<tr>
<td>(N = 95)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple R: .313</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R Square: .098</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p ≤ .05
which case they were more likely to believe that teachers worry that they might break a computer.

Table 4.17. Multiple regression results for students without LD: Predictors from demographic variables

<table>
<thead>
<tr>
<th>Scale</th>
<th>Variable</th>
<th>b</th>
<th>SE</th>
<th>T</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Age</td>
<td>-.806</td>
<td>.720</td>
<td>-1.119</td>
<td>.264</td>
</tr>
<tr>
<td>Attitudes</td>
<td>Grade</td>
<td>-.198</td>
<td>.748</td>
<td>-.265</td>
<td>.791</td>
</tr>
<tr>
<td>(N = 444)</td>
<td>Boys</td>
<td>-2.388</td>
<td>1.089</td>
<td>-2.193</td>
<td>.029</td>
</tr>
<tr>
<td></td>
<td><strong>Special Needs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grade in school</td>
<td>-.381</td>
<td>.232</td>
<td>-1.644</td>
<td>.102</td>
</tr>
<tr>
<td></td>
<td>Financial Aid**</td>
<td>-1.033</td>
<td>-.164</td>
<td>-2.103</td>
<td>.037</td>
</tr>
<tr>
<td></td>
<td>Wesley Academy</td>
<td>8.493</td>
<td>.237</td>
<td>2.965</td>
<td>.004</td>
</tr>
<tr>
<td></td>
<td><strong>Comfort</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Race: Black</td>
<td>.179</td>
<td>.181</td>
<td>.988</td>
<td>.324</td>
</tr>
<tr>
<td></td>
<td><strong>Worry</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Race: Black</td>
<td>.070</td>
<td>.198</td>
<td>.327</td>
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</tr>
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<td></td>
<td>Age</td>
<td>-.109</td>
<td>.077</td>
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<td>.154</td>
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<tr>
<td></td>
<td>U.S. citizenship</td>
<td>-.333</td>
<td>.147</td>
<td>-2.264</td>
<td>.024</td>
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<td>Race: Hispanic</td>
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<td>.254</td>
<td>1.586</td>
<td>.114</td>
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<tr>
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<td>Grade in school</td>
<td>.131</td>
<td>.085</td>
<td>1.537</td>
<td>.125</td>
</tr>
<tr>
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<td>Day student</td>
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<td>.126</td>
<td>1.909</td>
<td>.057</td>
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<tr>
<td></td>
<td>Wesley Academy</td>
<td>.124</td>
<td>.149</td>
<td>.832</td>
<td>.406</td>
</tr>
</tbody>
</table>

*p ≤ .05  **Fairmont data only

For students without LD, sex was a significant predictor of general attitudes about computers, with males having lower attitude scores. Additional predictors with negative weights were computer use that ranged from never to once in a while to monthly to weekly. Other computer-related predictors among students without LD were use of educational programs, use of games, and good to excellent computer skills, all of which had positive regression weights. On the special needs scale, being from Wesley Academy
Table 4.18. Multiple regression results for students without LD: Predictors from computer-related variables

<table>
<thead>
<tr>
<th>Scale</th>
<th>Variable</th>
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<th>SE</th>
<th>T</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>General Attitudes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(N = 460)</td>
<td>Regular access to computers</td>
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<td>1.534</td>
<td>-1.920</td>
<td>.055</td>
</tr>
<tr>
<td>Multiple R: .560</td>
<td>Don't know how to use computers</td>
<td>-19.809</td>
<td>10.391</td>
<td>-1.906</td>
<td>.057</td>
</tr>
<tr>
<td>R Square: .314</td>
<td>Education program use</td>
<td>2.393</td>
<td>.959</td>
<td>2.496</td>
<td>.013</td>
</tr>
<tr>
<td></td>
<td>Use of games</td>
<td>3.619</td>
<td>1.263</td>
<td>2.866</td>
<td>.004</td>
</tr>
<tr>
<td></td>
<td>Excellent computer skills</td>
<td>9.121</td>
<td>1.418</td>
<td>6.432</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Good computer skills</td>
<td>4.849</td>
<td>1.009</td>
<td>4.805</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>No computer skills</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Use computers monthly</td>
<td>-3.807</td>
<td>1.612</td>
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<td>Never use computers</td>
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<td>Use computers once in a while</td>
<td>-9.009</td>
<td>1.566</td>
<td>-5.751</td>
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<tr>
<td></td>
<td>Weekly computer use</td>
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</tr>
<tr>
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<tr>
<td>(N = 484)</td>
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</tr>
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<td>Multiple R: .264</td>
<td>Computer ownership</td>
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<td>.332</td>
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<tr>
<td>R Square: .070</td>
<td>Excellent computer skills</td>
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<td>.361</td>
<td>2.637</td>
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<td>No computer skills</td>
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<td>.067</td>
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<tr>
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<td>Use of spreadsheets</td>
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</tr>
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<td>Use computers once in a while</td>
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<tr>
<td></td>
<td>Weekly computer use</td>
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<td>.273</td>
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<td>(N = 490)</td>
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<td>-3.388</td>
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</tr>
<tr>
<td>R Square: .033</td>
<td>Word processing use</td>
<td>-.254</td>
<td>.150</td>
<td>-1.696</td>
<td>.091</td>
</tr>
<tr>
<td></td>
<td><strong>Worry</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(N = 489)</td>
<td>Database use</td>
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<td>.140</td>
<td>-3.103</td>
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<td>Spreadsheet use</td>
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<td>Learned to use computers at school</td>
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<td>.480</td>
<td>-1.469</td>
<td>.143</td>
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<tr>
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<td>Word processing use</td>
<td>-.226</td>
<td>.154</td>
<td>-1.467</td>
<td>.143</td>
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*p < .05
Table 4.19. Multiple regression results for teachers: Predictors from demographic variables

<table>
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<th>Scale</th>
<th>Variable</th>
<th>b</th>
<th>SE</th>
<th>T</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Attitudes</td>
<td>Bachelor’s degree</td>
<td>5.171</td>
<td>2.902</td>
<td>1.782</td>
<td>.079</td>
</tr>
<tr>
<td>(N = 71)</td>
<td>1-2 prof. development activities per year</td>
<td>-6.214</td>
<td>3.454</td>
<td>-1.799</td>
<td>.077</td>
</tr>
<tr>
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<td>3-4 prof. development activities per year</td>
<td>-5.631</td>
<td>3.769</td>
<td>-1.494</td>
<td>.140</td>
</tr>
<tr>
<td>Multiple R: .298</td>
<td>No prof. development activities per year</td>
<td>-5.297</td>
<td>5.319</td>
<td>-.996</td>
<td>.323</td>
</tr>
<tr>
<td>R Square: .089</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special Needs Attitudes</td>
<td>Some graduate classes</td>
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<td>.478</td>
<td>-2.243</td>
<td>.022</td>
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<td>Riverview</td>
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<td>-3.349</td>
<td>.001</td>
</tr>
<tr>
<td>Multiple R: .454</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R Square: .206</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comfort</td>
<td>Grade teaching</td>
<td>.070</td>
<td>.028</td>
<td>2.424</td>
<td>.018</td>
</tr>
<tr>
<td>(N = 69)</td>
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<td>.104</td>
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<td>Multiple R: .532</td>
<td>Male</td>
<td>.414</td>
<td>.229</td>
<td>1.808</td>
<td>.075</td>
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<td>R Square: .283</td>
<td>Special education teacher</td>
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<td>.262</td>
<td>2.870</td>
<td>.006</td>
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<td>Wesley Academy</td>
<td>-.502</td>
<td>.222</td>
<td>-2.256</td>
<td>.028</td>
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<tr>
<td>Worry</td>
<td>Age</td>
<td>.019</td>
<td>.007</td>
<td>2.622</td>
<td>.011</td>
</tr>
<tr>
<td>(N = 65)</td>
<td>1-2 prof. development activities per year</td>
<td>.266</td>
<td>.158</td>
<td>1.680</td>
<td>.098</td>
</tr>
<tr>
<td>Multiple R: .426</td>
<td>11-15 years of teaching</td>
<td>.313</td>
<td>.184</td>
<td>1.704</td>
<td>.094</td>
</tr>
<tr>
<td>R Square: .182</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<.05

was linked with more positive attitudes about the benefits of computer use by students with special needs while being a financial aid recipient (Fairmont only) was linked with more negative attitudes about the benefits of such use. Excellent computer skills and spreadsheet use predicted more positive attitudes about the use of computers by students with special needs and using computers once in a while predicted more negative attitudes among these students. Only excellent computer skills was a significant predictor on the comfort item for students without LD and here students reporting such skills rated their teachers as less comfortable with computers. Regarding
student ratings of teacher worry about computer use, U.S. citizenship was linked with attitudes that teachers do not worry about breaking computers.

Table 4.20. Multiple regression results for teachers: Predictors from computer-related variables

<table>
<thead>
<tr>
<th>Scale</th>
<th>Variable</th>
<th>b</th>
<th>SE</th>
<th>T</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General Attitudes</strong> <em>(N = 73)</em></td>
<td>Regular access to computers</td>
<td>9.728</td>
<td>8.345</td>
<td>1.166</td>
<td>.248</td>
</tr>
<tr>
<td></td>
<td>Education program use</td>
<td>3.881</td>
<td>1.957</td>
<td>1.984</td>
<td>.051</td>
</tr>
<tr>
<td></td>
<td>Games use</td>
<td>3.630</td>
<td>2.099</td>
<td>1.730</td>
<td>.088</td>
</tr>
<tr>
<td></td>
<td>Computer ownership</td>
<td>7.909</td>
<td>3.310</td>
<td>2.389</td>
<td>.020</td>
</tr>
<tr>
<td></td>
<td>Poor computer skills</td>
<td>-5.100</td>
<td>3.117</td>
<td>-1.636</td>
<td>.106</td>
</tr>
<tr>
<td><strong>Special Needs Attitudes</strong> <em>(N = 72)</em></td>
<td>Regular access to computers</td>
<td>4.753</td>
<td>1.898</td>
<td>2.504</td>
<td>.015</td>
</tr>
<tr>
<td></td>
<td>Games use</td>
<td>.540</td>
<td>.501</td>
<td>1.077</td>
<td>.285</td>
</tr>
<tr>
<td></td>
<td>Use computers once in a while</td>
<td>-2.149</td>
<td>.830</td>
<td>-2.589</td>
<td>.012</td>
</tr>
<tr>
<td></td>
<td>Weekly computer use</td>
<td>-.563</td>
<td>.499</td>
<td>-1.128</td>
<td>.263</td>
</tr>
<tr>
<td></td>
<td>Learned to use computers at work</td>
<td>1.353</td>
<td>.559</td>
<td>2.419</td>
<td>.018</td>
</tr>
<tr>
<td><strong>Comfort</strong> <em>(N = 72)</em></td>
<td>Regular access to computers</td>
<td>-2.014</td>
<td>.903</td>
<td>-2.229</td>
<td>.029</td>
</tr>
<tr>
<td></td>
<td>Games use</td>
<td>-.652</td>
<td>.235</td>
<td>-2.767</td>
<td>.007</td>
</tr>
<tr>
<td></td>
<td>Learned to use computers at work</td>
<td>.466</td>
<td>.237</td>
<td>1.969</td>
<td>.053</td>
</tr>
<tr>
<td></td>
<td>Education program use</td>
<td>.358</td>
<td>.217</td>
<td>1.653</td>
<td>.103</td>
</tr>
<tr>
<td></td>
<td>Computer use of less than a year</td>
<td>1.337</td>
<td>.593</td>
<td>2.253</td>
<td>.028</td>
</tr>
<tr>
<td></td>
<td>Computer ownership</td>
<td>-.828</td>
<td>.362</td>
<td>-2.284</td>
<td>.026</td>
</tr>
<tr>
<td></td>
<td>Spreadsheet use</td>
<td>.441</td>
<td>.237</td>
<td>1.859</td>
<td>.068</td>
</tr>
<tr>
<td><strong>Worry</strong> <em>(N = 72)</em></td>
<td>Regular access to computers</td>
<td>-2.410</td>
<td>.827</td>
<td>-2.913</td>
<td>.005</td>
</tr>
<tr>
<td></td>
<td>Games use</td>
<td>-.170</td>
<td>.189</td>
<td>-0.998</td>
<td>.373</td>
</tr>
<tr>
<td></td>
<td>Learned to use computers at work</td>
<td>.424</td>
<td>.193</td>
<td>2.201</td>
<td>.031</td>
</tr>
<tr>
<td></td>
<td>Computer training</td>
<td>-.289</td>
<td>.175</td>
<td>-1.654</td>
<td>.103</td>
</tr>
<tr>
<td></td>
<td>Poor computer skills</td>
<td>.431</td>
<td>.288</td>
<td>1.497</td>
<td>.139</td>
</tr>
<tr>
<td></td>
<td>Never use computers</td>
<td>-1.182</td>
<td>.427</td>
<td>-2.768</td>
<td>.007</td>
</tr>
</tbody>
</table>

*p<.05
Database use by students predicted their attitude that teachers would worry about computer breakage, while excellent computer skills and spreadsheet use were negative predictors of teacher worry.

For teachers, computer ownership was a significant predictor of more positive general attitudes about computers. Regarding the benefits of the use of computers by students with special needs, having taken some graduate classes and being a teacher from Riverview were related to more negative attitudes about the use of computers by students with special needs. Similarly, using computers once in a while had a negative weight while regular access to computers and having learned to use a computer at work were connected with more positive attitudes about the use of computers by these students. For teachers, grade level where teaching, being a special education teacher, regular access to computers, having used a computer for less than a year, and use of computer games were predictors of teachers' sense that students feel comfortable using computers. However, being a teacher at Wesley, having regular access to computers, and use of computer games predicted more concern about students' comfort level. Similarly, regular access to computers, and having never used a computer, were connected to less worry about students breaking computers while teacher age and having learned to use a computer at work predicted concern with student worry over computer use.
Comparisons of Pre and Post-Test Scores

Comparisons of participants’ scores on the pre and post-tests were conducted using repeated measures analysis of variance (RMANOVAs). For these tests, a combined set of survey data which included those subjects who completed both the pre and post-test survey was used (N=410). Within and between-subject comparisons were made by school, between students with and without LD and among teachers by school.

School. Means and standard deviations by school are given in Table 4.21. Results of RMANOVAs show that within school changes were significant only for the special needs scale. Games-Howell post-hoc tests showed that the significant pre to post-test differences on the special needs scale were for Riverview where the school mean went down from 13.5 to 12.2. Between-school differences were significant for the general and worry Measures showing that the significant differences seen among the schools at pre-test remained at post-test (Table 4.22; Figures 4.1 through 4.4).

<table>
<thead>
<tr>
<th>School</th>
<th>General</th>
<th>Special Needs</th>
<th>Comfort</th>
<th>Worry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Riverview (N=71)</td>
<td>74.1</td>
<td>72.2</td>
<td>13.5</td>
<td>12.2</td>
</tr>
<tr>
<td></td>
<td>(8.99)</td>
<td>(9.36)</td>
<td>(3.02)</td>
<td>(2.69)</td>
</tr>
<tr>
<td>Fairmont (N=176)</td>
<td>65.2</td>
<td>66.2</td>
<td>12.6</td>
<td>12.4</td>
</tr>
<tr>
<td></td>
<td>(11.99)</td>
<td>(10.84)</td>
<td>(2.74)</td>
<td>(2.56)</td>
</tr>
<tr>
<td>Wesley Academy (N=143)</td>
<td>67.6</td>
<td>68.2</td>
<td>12.9</td>
<td>12.9</td>
</tr>
<tr>
<td></td>
<td>(10.99)</td>
<td>(10.72)</td>
<td>(2.96)</td>
<td>(2.70)</td>
</tr>
</tbody>
</table>
Table 4.22: Results from RMANOVA for within and between-school differences from pre to post-test

<table>
<thead>
<tr>
<th>Scale</th>
<th>Within-school comparisons</th>
<th></th>
<th>Between-school comparisons</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SS</td>
<td>df</td>
<td>F</td>
<td>p*</td>
</tr>
<tr>
<td>General</td>
<td>4.495</td>
<td>1</td>
<td>4.22</td>
<td>.707</td>
</tr>
<tr>
<td>Special Needs</td>
<td>49.119</td>
<td>1</td>
<td>5.00</td>
<td>.001</td>
</tr>
<tr>
<td>Comfort</td>
<td>2.024E-02</td>
<td>1</td>
<td>.819</td>
<td>.874</td>
</tr>
<tr>
<td>Worry</td>
<td>.571</td>
<td>1</td>
<td>.809</td>
<td>.435</td>
</tr>
</tbody>
</table>

*p<.05

Figure 4.1. Pre and post-test means by school for general attitudes scale
Figure 4.2. Pre and post-test means by school for special needs scale
Figure 4.3. Pre and post-test means by school for comfort item
Figure 4.4. Pre and post-test means by school for worry item
Students with and without LD. Comparisons of change over time between students with and without LD were conducted for all students and for those from Fairmont (Tables 4.23 and 4.24). RMANOVA results for all students showed that the only significant changes from pre to post-test were on the general attitudes scale. For students with LD, the score on the general attitudes scale went up just less than a point from pre to post-test (64.6-65.5) but for the students without LD, the score went up just over two points (65.0 – 67.1). In order to see if these changes were related to the computer network condition, the same comparisons were made for the Fairmont students. Among students at Fairmont, there were no significant
changes within or between student groups from pre to post-test on any of the four measures (Tables 4.25 and 4.26).

Table 4.25. Mean scores (standard deviations) for each pre and post-test scale for Fairmont students with and without LD

<table>
<thead>
<tr>
<th>School</th>
<th>General</th>
<th>Special Needs</th>
<th>Comfort</th>
<th>Worry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Students with learning disabilities (N=34)</td>
<td>64.6 (14.66)</td>
<td>65.5 (12.24)</td>
<td>12.4 (3.09)</td>
<td>12.4 (2.88)</td>
</tr>
<tr>
<td>Students w/o learning disabilities (N=125)</td>
<td>65.0 (11.76)</td>
<td>67.1 (10.92)</td>
<td>12.9 (2.78)</td>
<td>12.2 (2.57)</td>
</tr>
</tbody>
</table>

Table 4.26. Results from RMANOVA for within and between group differences from pre to post-test for Fairmont students with and without LD

<table>
<thead>
<tr>
<th>Scale</th>
<th>Within-group comparisons</th>
<th>Between-group comparisons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SS</td>
<td>df</td>
</tr>
<tr>
<td>General</td>
<td>110.636</td>
<td>1</td>
</tr>
<tr>
<td>Special Needs</td>
<td>7.555</td>
<td>1</td>
</tr>
<tr>
<td>Comfort</td>
<td>2.048E-02</td>
<td>1</td>
</tr>
<tr>
<td>Worry</td>
<td>4.151E-02</td>
<td>1</td>
</tr>
</tbody>
</table>

*p≤.05

Teachers. Evaluation of the RMANOVA results for teachers showed that when all teachers were grouped together the only significant changes were on the comfort item (Tables 4.27 and 4.28; Figures 4.5 through 4.8).

When teachers’ scores were compared by school, comfort remained the only significant within and between-school teacher difference (Table 4.29). Games-Howell post-hoc tests indicated that it was the teachers at Wesley Academy whose comfort score had changed significantly, going from 2.56 to 3.22.
Table 4.27. Mean scores (standard deviations) for each pre and post-test scale for teacher by school

<table>
<thead>
<tr>
<th>School</th>
<th>General</th>
<th>Special Needs</th>
<th>Comfort</th>
<th>Worry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>All teachers</td>
<td>71.7 (12.8)</td>
<td>70.6 (7.9)</td>
<td>13.3 (3.5)</td>
<td>12.8 (1.9)</td>
</tr>
<tr>
<td>(N=36)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riverview</td>
<td>72.4 (8.7)</td>
<td>71.4 (6.69)</td>
<td>12.7 (1.93)</td>
<td>12.3 (1.32)</td>
</tr>
<tr>
<td>(N=9)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fairmont</td>
<td>69.8 (5.77)</td>
<td>69.4 (5.83)</td>
<td>13.3 (1.48)</td>
<td>13.1 (1.83)</td>
</tr>
<tr>
<td>(N=18)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wesley Academy</td>
<td>74.8 (7.80)</td>
<td>70.6 (7.54)</td>
<td>12.7 (2.14)</td>
<td>13.9 (.866)</td>
</tr>
</tbody>
</table>

Table 4.28. Results from RMANOVA for differences from pre to post-test for all teachers

<table>
<thead>
<tr>
<th>Scale</th>
<th>Pre to post-test comparisons</th>
<th>df</th>
<th>F</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>SS 24.014</td>
<td>1</td>
<td>2.343</td>
<td>.135</td>
</tr>
<tr>
<td>Special Needs</td>
<td>4.500</td>
<td>1</td>
<td>2.006</td>
<td>.165</td>
</tr>
<tr>
<td>Comfort</td>
<td>2.347</td>
<td>1</td>
<td>5.805</td>
<td>.021</td>
</tr>
<tr>
<td>Worry</td>
<td>.125</td>
<td>1</td>
<td>.179</td>
<td>.674</td>
</tr>
</tbody>
</table>

*p<.05

Table 4.29. Results from RMANOVA for within and between-teacher differences from pre to post-test for teachers by school

<table>
<thead>
<tr>
<th>Scale</th>
<th>Within-school comparisons</th>
<th>Between-school comparisons</th>
<th>df</th>
<th>F</th>
<th>p*</th>
<th>df</th>
<th>F</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>SS 31.227</td>
<td>SS 98.379</td>
<td>1</td>
<td>3.011</td>
<td>.092</td>
<td>1</td>
<td>1.187</td>
<td>.318</td>
</tr>
<tr>
<td>Special Needs</td>
<td>5.689</td>
<td>3.417</td>
<td>1</td>
<td>2.492</td>
<td>.124</td>
<td>1</td>
<td>1.063</td>
<td>.357</td>
</tr>
<tr>
<td>Comfort</td>
<td>2.222</td>
<td>6.187</td>
<td>1</td>
<td>5.455</td>
<td>.026</td>
<td>1</td>
<td>5.928</td>
<td>.006</td>
</tr>
<tr>
<td>Worry</td>
<td>8.88E-02</td>
<td>2.08E-02</td>
<td>1</td>
<td>.124</td>
<td>.727</td>
<td>1</td>
<td>.040</td>
<td>.961</td>
</tr>
</tbody>
</table>

*p<.05
Figure 4.5. Pre and post-test means for students with LD, students without LD, and teachers for the general attitudes scale
Figure 4.6. Pre and post-test means for students with LD, students without LD, and teachers for the special needs scale.
Figure 4.7. Pre and post-test means for students with LD, students without LD, and teachers for the comfort item.
Figure 4.8. Pre and post-test means for students with LD, students without LD, and teachers for the worry item.
Overall Sense of Change

In addition to comparing participants' results from the pre and post-test responses, an additional item was included on the post-test survey that investigated students' and teachers' sense of how computers had influenced school work during the experimental year. This question was a positively worded statement investigating the role of computers in the quality of student work:

I believe that the new computers installed this year have helped students to improve the quality of their work.

This item was targeted primarily at the experimental group, but was asked of all subjects, to investigate differences among the groups. Responses to this item indicated that students, as a group, felt that computers improved work quality more than teachers did (Table 4.30). In fact, the teacher mean was quite near the midpoint, reflecting uncertainty about the influence of computers on students' work. A two-way analysis of variance (ANOVA) for school by group (student or teacher) indicated that there were significant differences among participants' responses to this question (Table 4.31).

Table 4.30. Means and standard deviations by group and school for change item

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>370</td>
<td>3.338</td>
<td>.048</td>
</tr>
<tr>
<td>Teachers</td>
<td>36</td>
<td>3.194</td>
<td>.131</td>
</tr>
<tr>
<td>Fairmont</td>
<td>184</td>
<td>3.560</td>
<td>1.104</td>
</tr>
<tr>
<td>Riverview</td>
<td>74</td>
<td>3.378</td>
<td>.8868</td>
</tr>
<tr>
<td>Wesley</td>
<td>148</td>
<td>3.007</td>
<td>.4123</td>
</tr>
</tbody>
</table>
Table 4.31. Two-way analysis of variance (ANOVA) results of group by school for change question

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Sum of Squares</th>
<th>F</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error</td>
<td>303.69</td>
<td>400</td>
<td>.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>1.28</td>
<td>1</td>
<td>1.28</td>
<td>1.69</td>
<td>.194</td>
</tr>
<tr>
<td>School</td>
<td>5.38</td>
<td>2</td>
<td>2.69</td>
<td>3.54</td>
<td>.030</td>
</tr>
<tr>
<td>Group by School</td>
<td>.74</td>
<td>2</td>
<td>.37</td>
<td>.49</td>
<td>.616</td>
</tr>
<tr>
<td>Total</td>
<td>331.08</td>
<td>405</td>
<td>.82</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<.05

In order to learn which differences in scores among the schools were significant, post-hoc comparisons were conducted using Fisher’s least significant difference (LSD) tests. The LSD procedure involves separate t-tests using mean sum of squares as the error term. These tests indicated that the significant differences on the change item responses were between Fairmont and Wesley.

Table 4.32. Post-hoc comparisons of between school differences on change item using Fisher’s LSD

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Mean Difference</th>
<th>SE</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fairmont Riverview</td>
<td>.15</td>
<td>.130</td>
<td>.250</td>
</tr>
<tr>
<td>Fairmont Wesley</td>
<td>.97</td>
<td>.464</td>
<td>.038</td>
</tr>
<tr>
<td>Riverview Wesley</td>
<td>.82</td>
<td>.473</td>
<td>.085</td>
</tr>
</tbody>
</table>

*p≤.05

Discussion

Comparisons by School and Group

Comparisons of the scores obtained by the three schools on the four outcome measures showed that there were significant differences in general
attitudes about computer use in schools, use of computers by students with special needs, how students and teacher rate each others' computer comfort level as well as reciprocal ratings of student and teacher worry about computer use. Post-hoc tests showed that Riverview differed from both Fairmont and Wesley Academy on several measures. Of note, the scores for Riverview were higher than the other schools on all four measures. Related factors may be that Riverview had the youngest students and was supposed to have received a new computer network during the study year.

Nonetheless, the existence of these differences between the schools suggests that school environment may be an important factor in students and teachers attitudes about computers.

ANOVA results for comparisons among students with and without learning disabilities and teachers showed significant differences between both the student groups and the teachers on the worry item; the students and teachers rated each other's worry abut breaking computers significantly differently. Overall, students and teachers do not appear to have significantly different attitudes about computer use in schools, however their ratings of each other's comfort level points to possible differences in likelihood of using computers. The significant differences on the comfort measure may reflect different perceptions about student and teacher efficacy with
computers that could influence how students and teachers approach computer-related tasks in school.

Interestingly, the ANOVA results and post-hoc tests showed that there were no significant differences in the overall attitude scores of students with and without learning disabilities. This result suggests that, while students with learning disabilities may have unique learning needs, their attitudes about computers may be no different than non-disabled peers. Given the positive effects of computer-based instruction (CBI) for students with LD, it appears that inclusive instructional practices which incorporate computer-based activities could be a parsimonious way to ensure full inclusion of students with learning disabilities in the least restrictive environment of the general education classroom while providing instruction (e.g.: CBI) shown to be effective for such students. As will be discussed below, the results of the regression equations provided additional information about differences in the attitudes of students with and without LD.

Predictors of Computer Attitudes

Variance estimates from the multiple regression equations showed that variance was accounted for by computer-related variables more than demographic ones. Interestingly, the predictors among students with and without LD were different. For students with LD, there were more negative
predictors and for students without LD more positive ones. For example, the most significant predictors of attitudes among students without LD were variables that revealed using computers more often, while the most significant predictors for students with LD were ones that revealed less frequent use. This finding suggests that students with LD may formulate their attitudes about computers more on what they don’t experience than what they do. Conversely, students without LD may base their attitudes on their computer experiences. Although there were no overall significant differences in the attitude scores between the student groups, the regression data suggest subtle differences in how the students developed their attitudes about computers. Notably, the most frequent predictors of students’ attitudes were computer-related variables which schools can influence.

Teacher variance was more homogenous across all four measures, perhaps an indicator of the greater similarities among the teachers in general. Similar to the students, the teacher attitude predictors were primarily computer-related and not demographic. As with students, teachers’ attitudes may be able to be influenced by school-mediated policies about computers. For example, whether a teacher has regular school-based access to a computer in her classroom may contribute to attitudes about their use.

Overall, the attitude predictors which emerged from the regression equations were linked to the subjects’ personal experiences with computers.
A few variables stand out as counter-intuitive to this general finding. For example, among students with LD, regular access to computers was a negative predictor of attitudes on both the general and special needs scales. For these students, having learned to use computers at school was also a negative predictor. These findings are puzzling and suggest that the computer experiences of students with LD may be qualitatively different from those without LD. Possibly, just having access to computers is not sufficient for these students and more training and direction in their use is needed for them to develop positive attitudes about computer use in schools.

The most puzzling demographic predictors were age and grade. However, these may have been a function of school because Riverview, which had the youngest students, had the most positive attitude scores on all measures. Possibly, younger students are more familiar or enthusiastic about computer use, but such a speculation needs to be confirmed with future research. Race was a predictor in two cases, suggesting that the attitudes of students from non-white backgrounds should be given more careful attention by teachers and those who implement computer-based curricula. Students who received financial aid at Fairmont were predicted to have less positive attitudes about computer use by students with special needs. This finding may be related to access to computer resources and needs more inquiry as well. Similarly, U.S. citizenship was a negative predictor of teacher worry.
about breaking computers among student's without learning disabilities. This finding suggests that students from the U.S. have more confidence in their teachers' computer skills. Together, these three diversity related variables (race, financial aid/SES, and citizenship) suggest that school personnel need to be more aware of the needs of students from different language, socioeconomic and cultural backgrounds when designing computer-related activities.

The computer-related variables were much stronger predictors of both students' and teachers' attitudes about computer use in schools. These can be summarized as factors related to four types of computer experiences: 1) access to computers (including ownership), 2) where computer skills were learned, 3) how long computers have been used, and 4) participants' level of computer skill. In addition, one of the teachers’ demographic predictors, having taken some graduate level classes, fits more closely in the experience groupings because it is a factor which can be adjusted by personal choices and actions. Together, these variables suggest that the experiences that students with and without LD and teachers have using computers are the most important predictors of their attitudes about computers.

This finding is not surprising, but it is important. If students' and teachers' attitudes about computers are best predicted – even shaped – by their computer experiences, and, if schools also appear to influence computer
attitudes, how schools include and implement computer-related activities and instruction is very likely to influence students and teachers' computer attitudes and sense of efficacy. Given the evidence for the positive effects of computer-based instruction for students with and without special needs, improving attitudes and likelihood of computer use appears to be a worthwhile endeavor.

Changes Over Time

Repeated measures analysis of variance (RMANOVA) across school, student, and teacher groups showed that, while there were some changes in attitudes over the course of the study, these were not related to the treatment condition of a new computer network. The comparisons showed that school may be related to changes in general and special needs-related computer attitudes over time but these changes were not specific to the treatment condition at Fairmont. Comparisons within and between students with and without LD showed that there were minimal differences in the changes in attitudes among these students during the study year. Given that there were no significant changes between the student groups at Fairmont, it appears that the treatment condition did not influence the attitudes of students with LD differently than those without. The overall similarities in changes
between the student groups suggests that having a learning disability is not related to how students view computers.

The teacher attitude changes offer important suggestions for how to proceed with further study and practice. The only significant change among the teachers was related to their improved ratings of student comfort with computers. As with the students, the teacher changes were not linked with the treatment condition, but suggest that school environment in and of itself and/or the passage of time could be a factor in changing teachers' perceptions of student comfort with computers. The teachers' ratings of student comfort with computers went up at all three schools across the year. Logically, such a change may be a factor in teachers' willingness to use computers for instruction. If teachers' perceptions of students comfort with computers are influenced by school environment and time, it appears that capturing or instructing teachers about students' attitudes and comfort level, and matching teachers' comfort level to that of students may be an important component of providing the necessary training to prepare them to use computers for instruction.

**Change Question.** It appears that differences among responses to the change question were due to school rather than group. Of interest, Fairmont participants reported the biggest change, followed by Riverview; Wesley Academy reported virtually no change. Unlike the repeated measures
results, these findings reflect the research hypotheses. Fairmont, the experimental site, experienced an infusion of new technology from which students and teachers at that school reported an increase in the quality of students’ work.

Riverview was supposed to have had an infusion of new technology but the planned lab and network were delayed. Thus, less change in quality was reported at this site. That any improvement was seen at this control site is remarkable. The only new innovation implemented during the study year was the use of a World Wide Web page by selected fifth and sixth grade students and teachers. This page was teacher created and maintained on her home-based computer because no suitable hardware was available at the school. Thus, students and teachers at Riverview reported gains from very minimal improvements to computer resources.

Wesley Academy responses to the change question were quite neutral indicating that there was little change to the quality of student, or perhaps, that they were unsure of a change in quality. This latter reason is possible because this school did not have any major new technology installed during the study year and therefore the question may have caught some participants off guard, leading them to give a “not sure” response. Overall, it appears that, according to the responses to change item, the experimental condition -- the installation of a campus-wide computer network -- had the expected
result of being related to students' and teachers' perceptions of the relationship of the quality of student work with computer use. However, this finding contradicts the results from the repeated measures analysis of variance and suggests that participants had an overt sense of a change in work quality even though componential evaluation of such change was not reflected in the pre and post-test scale score comparisons.

Summary

The findings from this survey suggest that there are some differences in the computer-related attitudes of students with and without LD, but these were not linked with the treatment condition of a computer network. There were, however, significant differences in the attitudes of students and teachers by school, suggesting that school may be an important factor in the development of students' and teachers' attitudes about computers. Evaluation of both demographic and computer-related variables suggested that computer-related experience is the most important predictor of students' and teachers' attitudes about computers. Subtle differences among the predictors for students with and without LD suggested that students with LD may base their attitudes more on what they do not experience than what they do. There was also evidence that school personnel need to examine more carefully the potential differences in the computer attitudes and experiences
of students from diverse language, socioeconomic and cultural backgrounds.

Data concerning the changes in students' and teachers' attitudes over the course of the school year when a computer network was installed at the Fairmont campus showed that the treatment condition was not related to changes in students' and teachers' computer-related attitudes. However, differences in student and teacher ratings of each others' worry about breaking computers and changes in teachers' ratings of student comfort with computers suggest a need for more teacher training which matches teacher experience and comfort with that of students so that teachers will be more likely to use CBI and students will be more likely to learn from it.

Importantly, the lack of significant difference between the attitudes and changes in attitudes among students with and without LD suggests that students with LD can take part in CBI in the general education classroom alongside their non-disabled peers. Such practices allow for inclusive educational approaches which focus on maintaining the least restrictive environment for all students. Additionally, inclusive instruction using CBI allows for resources to be allocated for hardware, software, and teacher training, which will likely further enhance the actual use of computer-based instruction. Given the literature evidence that CBI is especially effective for students with LD and other special needs, optimizing its use appears to be an important effort for students with special learning needs.
CHAPTER V

RESULTS FROM THE INTERVIEWS

Introduction

The interviews provided information which complemented the survey data. Application of the categories generated using grounded methods revealed a number of common themes in the interview texts (Glaser & Strauss, 1967; for methodology, see chapter III above). A discussion of the categories will be followed by exploration of the themes and patterns found in the interviews.

Data Analysis

The interviews revealed a great deal about how the participating students and teachers think about computer use in schools. A summary of incidence data for the categories found in the interview transcripts is found in Table 5.1. The teachers' transcripts yielded a greater number of codable selections (370) compared with the students (253). The applications of computers in schools was a recurrent theme in both student and teacher interviews, comprising one third of the total categorized passages. Students referred to computer applications a little more frequently than teachers did.
Table 5.1: Incidence and percentage of interview codes for all students, students with learning disabilities (LD), students without learning disabilities (LD), teachers, and all subjects

<table>
<thead>
<tr>
<th>Code</th>
<th>All Students</th>
<th>Students with LD</th>
<th>Students w/o LD</th>
<th>Teachers</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Applications of computers</td>
<td>91</td>
<td>36</td>
<td>48</td>
<td>53</td>
<td>43</td>
</tr>
<tr>
<td>Applications in Special Education</td>
<td>18</td>
<td>07</td>
<td>9</td>
<td>50</td>
<td>9</td>
</tr>
<tr>
<td>Instructional uses</td>
<td>9</td>
<td>04</td>
<td>5</td>
<td>55</td>
<td>4</td>
</tr>
<tr>
<td>Positive attitudes</td>
<td>44</td>
<td>17</td>
<td>18</td>
<td>41</td>
<td>26</td>
</tr>
<tr>
<td>Negative attitudes</td>
<td>40</td>
<td>16</td>
<td>33</td>
<td>86</td>
<td>7</td>
</tr>
<tr>
<td>Other attitudes</td>
<td>13</td>
<td>05</td>
<td>6</td>
<td>46</td>
<td>7</td>
</tr>
<tr>
<td>Social</td>
<td>16</td>
<td>06</td>
<td>6</td>
<td>38</td>
<td>10</td>
</tr>
<tr>
<td>Resource needs</td>
<td>22</td>
<td>09</td>
<td>8</td>
<td>36</td>
<td>14</td>
</tr>
<tr>
<td>Experience</td>
<td>62</td>
<td>25</td>
<td>30</td>
<td>48</td>
<td>32</td>
</tr>
<tr>
<td>TOTAL</td>
<td>253</td>
<td>100</td>
<td>163</td>
<td>100</td>
<td>152</td>
</tr>
</tbody>
</table>

All of the categories identified could be found in both students’ and teachers’ transcripts, but the incidence of their appearance varied by group. Similarly, there were frequency differences among the category statements seen between the interviews of students with and without learning disabilities. From the nine categories, subcategories were derived which reflected more specific trends in the interviews. Individual subjects’ category and subcategory data as well as student and teacher aggregate data are found in Appendix G.
Students with Learning Disabilities

Comparison of the responses of those students with learning disabilities and those without showed that for most categories all the students' interviews reflected similar themes and patterns. Mentions of Applications, Applications in Special Education, Instructional uses, Other attitudes, and Experience were all fairly evenly distributed between the two groups of students. Slightly greater differences were seen in the Positive Attitudes, Social, and Resource needs categories with students having learning disabilities not mentioning these areas as often as those students without learning disabilities.

The greatest differences between the interviews of students with and without learning disabilities was the mention of Negative attitudes. The students with learning disabilities spoke far more often of negative attitudes about computers than did those students without learning disabilities. Of the total number of Negative attitude codes applied, 86% of these were found in the interviews of students with learning disabilities. Nonetheless, the students with learning disabilities also spoke of positive experiences with computers and gave examples of how they had benefited from computer use.
Category Descriptions

The following categories of statements were identified in the participants' interviews texts: 1) *Applications of computers* included statements in which purposes and products of computers are described; 2) *Applications in Special Education* involved descriptions of situations in which computers are used specifically by students with special needs; 3) *Instruction* refers to statements about how computers are used as part of teacher-directed instruction in schools; 4) *Positive attitudes* and 5) *Negative attitudes* mark comments indicating how the participants feel or think about computers; 6) *Other attitudes* indicated statements which reflected attitudes and beliefs but which were not clearly positive or negative; 7) *Social* statements reflected how computers influenced interpersonal relationships (including student-student and student-teacher interactions); 8) *Resource Needs* marked comments about material items (hardware, software) and financial resources (training, personnel) required or desired by the participants; and, 9) *Experience* comments indicated where and in what milieu computer use was occurring, for example, at home or school, as well as, those statements indicating what past encounters shaped subsequent interactions with computers.

Analysis of the categories and subcategories of statements led to the identification of five major themes (see Figure 5.1) in the interviews which
Figure 5.1: Interview themes about computer use by students with learning disabilities.
represented the statements the participants made about computer use in schools. Figure 5.1 shows the five major themes and their inter-relationships. Items from the Special needs applications category were regrouped into the Applications of computers and Instructional uses themes. Positive, negative, and other attitudes were grouped together as an Attitudes theme. Experience and Social were combined as a more general experience theme. Resource needs were taken as an independent theme. These themes point to the ways that teachers as well as students with and without special needs view contemporary computer use in schools.

**Themes**

Many themes and patterns were identified in the interviews. Importantly, there were several areas of overlap which appeared as passages were coded. These overlapping themes suggest that the participants viewed computers as holding several functions or roles in schools and in special education. Synthesis of the categories of statements found in the interviews led to identification of the five main themes related to the use of computers by students with special learning needs. Each theme is divided into branches. Applications of computers includes both academic and entertainment uses. Instructional uses involves both student skills and pedagogy (teaching methods). Attitudes incorporates positive, negative, and
other (neutral) attitudes. Personal experiences with computers involves home and school-based experiences. Resource needs include computers as well as personnel. Together, these five themes appear to surround the use of computers by students with special learning needs. The themes are interactional and each one contributes to the use of computers by students with special needs through the shaping of personal experiences.

The interviews themselves provide the best evidence of these interrelationships regarding computer use by students with special learning needs. For example, how computers were used was influenced by one’s attitudes, but these attitudes also shaped computer use. How, and if, computers were used by students and teachers was related to their positive and negative attitudes about computers as well as past experiences of computer use at home and school.

Use was also highly influenced by the availability of computer resources, including hardware, software, support personnel, and training. All of these factors contributed to the ways that the interview participants experienced the use of computers by and for students with special learning needs. As represented by the students and teachers who participated in the interviews, applications, instruction, attitudes, experiences, and resource needs are all important elements of the use of computers by students with special learning needs.
Applications of Computers

"It has many uses" - Darren, ninth grade student, April 1997

Assignments. Both students and teachers spoke often of how helpful computers were for completing school assignments. Nathan commented that:

...for an English assignment...it depends upon the quantity.. I don’t know, there’s like this set line in my brain, it depends on how important the assignment is and how big the assignment is for both English and history... (Nathan, ninth grade student, April 1997).

Still, Nathan differentiated between when computers were and were not helpful for particular assignments based on the length of the writing to be done. Stewart mentioned the convenience of computers for completing homework in that they “help me a lot, because in my papers, I type fast to get them done...” (Stewart, April 1997). Teachers also talked about how they preferred to have students use computers for written assignments because it makes them easier to read. Mr. Parker noted how “it’s easier for me to read a printed page than a hand-written page” (Mr. Parker, April 1997).

Programming. Fewer students spoke about using computers for programming, but teachers did comment on this use. Mr. Miller noted how his students used a simple programming language, Logo, to learn geometry:

Then, I’d have them write a program where they’d put four or five squares on the screen in different locations, and the idea that they have to get the turtle to pick up the pen, now which is the turtle facing, before they make the square...and it would come out crooked. But they would be able to sit here and work in teams, with a partner, and
to hear the discussion going on, I think we need to turn right 45 degrees before... A lot of thinking going on (Mr. Miller, April 1997).

While Mr. Miller mentioned saw programming as an important learning tool for students, Stewart mentioned “I would like to learn more programming skills, so I can write programs and stuff” (stewart, sixth grade student, May 1997).

Teacher Preparation. The teachers commented on how they have used computers to prepare for instruction.

I use computers almost exclusively for preparation. There’s very little specific computer use in my classes because we do not have the resources. However, I do all my lesson planning on the computer. I do all my printouts of handouts, all the handouts I give except for what I photocopy come from the computer. I keep track of my grades on computers (Mr. Parker, May 1997).

Ms. Robbins talked about how she has used the computer to gather internet resources to share with her students.

I use the Internet, for instance, as a reference because, as I’ve said, that are a lot of good things for language out there and the embassies and the cultural programs that are put out by the governments are very good (Ms. Robbins, April 1997).

In general, the teachers seemed interested in learning how they could use computers as ways of preparing the presenting innovative lessons.

Tools. Darren, and others, referred to computers as “tools.” When asked what this meant, Darren responded that “computers are tools with
many uses that offer so many possibilities” (April, 1997). This sense of the potential of computers was echoed in fifth grade math teachers Mr. Miller’s view that “they are tools to get papers out the door and to perform those tasks that teachers set them on” (Mr. Miller, fifth grade math teacher, May 1997). Both students and teachers made reference to how computers could used as tools for learning in schools. There was an open-ended quality to these descriptions, reflecting a sense that computers are not limited to a few uses but could be used for, as sixth grader Stewart put it, “unmeasureable things” (Stewart, sixth grade student, May 1997).

Communications. Both the students and teachers talked about enjoying using computers for communications. Frances envisioned that students could use computers to interact with students from other schools and countries.

If you have a pen pal, or if your school is working on a whole other country and you want to get information, or you want to talk to someone for an interview, so you will be able to talk to them...I can sees kids working all together, like the whole class working on a huge project for their whole school (Frances, sixth grade student, April 1997).

By contrast, Michelle preferred to use computers for personal communication with friends. “I find that there are so many things I can do with computers. I can go on American Online and talk to so many people and it ‘s changed just what I do daily” (Michelle, eighth grade student, May, 1997). Paul
appreciated the availability of modems on the computers at his school so he could use them for research: “I use computers mostly for research projects, to look stuff up” (Paul, twelfth grade student, May 1997).

Teachers also mentioned the benefits of computers for communications access. Ms. O’Donnell had used them with her students to obtain information for research reports.

Within the last couple of years I’ve been much more aware of the American Online, the access as far as gaining information. I was in the library yesterday with one of my ninth graders who needed some additional information on the Kimono dragon...certainly the students are really starting to use that as a tool for gaining information (Ms. O’Donnell, special education teacher, May 1997).

For the teachers, computers offered a way to communicate for school assignments. For students, they were valuable for both school work and personal recreation and entertainment.

Games. Both students and teachers made mention of the prevalence of computer games. All of the students felt that using computers for games is widely practiced among the students at these schools. Games were described by most students as enjoyable, often serving as a reward for completing school work. Darren referred to his computer “gaming career” (ninth grade student, April, 1997). When asked what he meant, Darren indicated that he found computer games to be a healthy challenge for his mind and that he took pride in how his expertise at these games had improved over time.
Darren also mentioned that computer games were a family activity in his home, a connection between computer uses and attitudes and experiences.

While most students spoke of computer games in positive terms, Nathan referred to them many times with great disdain. He saw them as "a bad use of time" (ninth grade student, April 1997). When asked why, he said he gets frustrated when "kids are just playing their computer games when they could be doing so many better things even like reading a book...it's like hitting your head against a wall..." (April 1997). While Nathan's views on computer games were quite strong, they did not appear to reflect those of the other students with learning disabilities. Michelle spoke of how her attitudes about computers changed in third grade because "the games were funner [sic]" (Michelle, eighth grade student, May 1997). Nathan's negative stance on games was the exception among students and it reflected more closely the views that the teachers held about computer games.

Several teachers reported that they do see some positive use for computer games as long as the games are limited and educational in nature. Sixth grade teacher Ms. Thom suggested that computer games might be phased out in schools, to be saved for home use:

I would think if you limit the amount of time that the games are being played, in fact, at some point, don't even have them on, and if we're going to be networked, we could control that, and then with specific reasons...I think if the curriculum is developed around going in there...
[the computer lab] for specific reasons, I don't think it will be used as a lab just for fun game time, which I don't think it should be used as. Because that can be done at home (Ms. Thom, May 1997).

Mr. Carter reflected a stronger anti-game sentiment, suggesting that student use of games was a real misuse of computer resources:

And then there are students who just have no idea, just how to load their, not even load their, just how to play their games. Access their games and play them. And it's disturbing when kids walk through the door with a Pentium 200 megahertz computer with 2 mgs of RAM and 17" monitor ...they don't know how to save a word processing document to their hard drive. They really have no idea. But, boy, can they play Dune 3 and shoot 'em up and kill 'em! (Mr. Carter, math teacher, April 1997)

Mr. Miller suggested using students' interest in games as a starting point for teaching students about computers: “they really want to play games on the computers. And this is where we really have to show them what other things computers can do” (Mr. Miller, fifth grade teacher, May 1997). While the sentiments about computer games were highly mixed, it was clear that such games are on the minds of both students and teachers when they think about computer use in schools. Of note, there were no differences by sex among the students about computer games. Despite popular attention to how much boys love to play computer games, both the boys and girls revealed similar enjoyment computer games.
Instructional Uses

“The word processor is a savior.” -Mr. Carter, math teacher, April 1997

Writing/Editing. While there was strong agreement that computers, and the word processing software they offer, had changed the experience of writing for many students, in particular those with learning disabilities, the perceptions of the quality of that experience did vary. Special educator Ms. O'Donnell told the story of how much using a computer had helped one of her students.

One [student] that came to mind, which is probably the most dramatic, is an eighth grade student who came to us with a motor output disorder and has significant problems actually getting his thoughts on paper. Very short sentences; minimum; very sloppy. And yet with a superior intellect. Verbally, has wonderful complex language, and certainly it was a case of trying to get him involved in the process of trying to get those thoughts in the written form. ...And we even started initially with he would dictate and I would type. And, of course, his language was so rich that it was just getting his thoughts down on the computer. And over the course of a year it was just the process of weaning him from my doing the typing to his doing more of the typing and editing and learning to use it as a tool, to the point where, in fact, he came by today to type during one of his study halls. So, he typed up one of his papers today, in that sense, independent (Ms. O'Donnell, special education teacher, May, 1997).

Other teachers also reported how much computers have helped students with learning disabilities improve their writing. Mr. Carter, a math teacher and advisor, gave very high praise for the role of computers in helping one if his students.
...A couple of my advisees have had learning disabilities and have also had real difficult times writing down their ideas, in finishing a question or finishing a series of questions from a history book or an English book. And for them, the word processor is just a savior. And having them use strategies like having them write down anything they can think of, here's question number one, write down anything you can, or I'll type it in for them. And they'll just have a huge list... they'll just have random ideas but they're on paper and it's something they can do something with. So word processing has definitely been a savior for learning disabled kids who have difficulty learning, otherwise they stare at an empty page for a long time (Mr. Carter, math teacher, April 1997).

The students with learning disabilities were not as enthusiastic about computer use for writing. Nathan and Michelle revealed that they feel that writing on a computer is less personal, even though it does help create a more presentable document. Particularly with regard to poetry, Michelle indicated that:

...I like to draw it from me or, I don't feel that I can get really my input, you know like “that's what I did” if I do it on computer. When you do it on computer it's final. You can't have the little cross out marks, you can't have, you know the little extras. But what you can do is to save it and then go back into it. But I find that if I have my little book then I can pull my book out and curl up into a blanket and write (Michelle, eighth grade student, May 1997).

Michelle did see the benefit of being able to go back and edit saved work, but found computer composition to be less connected to her. Nathan echoed this sentiment. In relating his views about using computers in general for creative work Nathan compared to computer art to painting:
I feel like Michelangelo painting the chapel, it’s more a part of him and it’s personal, just like writing, just like handwriting something is personal, when someone does it on the computer, it’s harsh and just like typing something is harsh, it’s...I like, like, being personal with people, like really getting into good conversations with them... (Nathan, ninth grade student, April 1997)

Nathan also recalled that using computers for writing was not always a pleasant experience. While he does appreciate the value of being able to type a paper quickly, earlier experiences with computers still linger in his mind.

I was just thinking this year how I’ve had to do substantial papers for history and stuff and now I can just sit down and just type it. And where, I think my typing ability is up to about standard, as fast as writing by hand, or maybe a little bit more, so I can just sit down and write it and I don’t agonize over it like I used to (Nathan, April 1997).

Continuing, Nathan added: “I used to associate writing a big paper with using a computer and using a computer with pain” (April 1997). When asked why he associated computers with pain, Nathan recalled an early computer use experience:

Because when I wrote that report in fifth grade it just took forever. And just using it [the computer] took hours and hours and hours and just using it was very boring and I wasn’t, I just, I had trouble focusing on it and stuff like that (Nathan, April 1997).

Both Nathan’s and Michelle’s experiences with using computers for writing revealed aspects of computer use not evident among the teachers who
generally praised them for how they can help students with learning
difficulties.

One English teacher, Mr. Parker, held a more mixed view of using
computers for creative writing. He suggested that with practice and
experience, computers can be used for all types of writing, even poetry, but
that it also changes the experience.

For a long time I wrote all my poetry in a book. I did not use a
computer for the poetry. I very rarely compose poetry on a computer
and I think that may just be traditional. I don't see why, there's really
no...logical reason why poetry cannot be composed on a computer. I
think there are some neat things that can be done writing outside
where everyone does not have access to a laptop. A lot of...when the
weather's nice I do a lot of outside writing experience and different
types of writing experiences where people are moving around and
writing in different areas and calling for some sort of reflection
between themselves and their surroundings (Mr. Parker, English
teacher, May 1997).

Speaking from the experience of both a writer and teacher, Mr. Parker
suggested that using computers for writing can be beneficial in some regards,
but that it also changes the writing experience.

Spell checkers were the most mentioned feature of computers that can
help students with learning disabilities. Almost all of the participants
mentioned how using a spell checker benefits the writer and improves the
quality of the final written product. As Nathan pointed out, “I'm a terrible
speller and to use like a spell checker is incredibly helpful” (Nathan, ninth
grade student, April 1997). In creating a list of computer-related wishes for
his school, Stewart listed spell-checkers: “I would have updated writing programs with spelling checkers and grammar checkers” (Stewart, sixth grade student, April 1997). Still, several students and teachers also mentioned that many students do not use spell-checkers efficiently or properly. Frances suggested that some students do not use them as they could; “[Be]cause we all have computers but I’m not sure that they use spell-check...[Be]cause they don’t know about it” (Frances, sixth grade student, May 1997). Mr. Parker agreed with this suggestion and commented that:

Most of my students know how to use the spell check. Most of them, maybe not most of them, a lot of them, a lot of the time, use spell check in lieu of proofreading which is perhaps an example of an unmeaningful spell check. Um, I think it helps many of them to go through the spell check and have it turn in a paper with the belief that it's complete because it went through spell check not being aware that there are other types of editing and proofreading steps that need to be taken that the spell check makes similar error to what we do (Mr. Parker, May 1997).

Mr. Parker’s reflection hinted at a need for more systematic instruction of spell-checking and editing practices in schools as well as more teacher insistence that students use these computer tools in their writing.

Problem-Solving/Organizing/Researching. Ms. Thom suggested that computers can be important instructional tools because:

...the children are controlling the research. I’m guiding it, but they’re controlling it. They’re actually becoming science researchers, which is what you want them to do. You want them to question and seek out answers and find techniques to do it so that basically they’re doing the scientific method that I wanted them to learn. It should be student-
centered. I'm just the facilitator (Ms. Thom, sixth grade teacher, May 1997).

These sentiments about how computers fit into instruction were also echoed by Mr. Parker who saw computers as excellent tools for organizing thoughts for writing. Mr. Parker envisioned that “I could take an essay and say well, you need to work this out here and here’s where the organization is...” (Mr. Parker, May 1997).

Student-Centered vs. Teacher-Centered Pedagogy. Similar to Ms. Thom’s vision of student-centered instruction, the ways that the participants described the role of computers in instruction reflected more student-focused instructional practices. Nathan, however, reflected a different perspective. He remembered the reading teacher who worked with him in fourth and fifth grades, recalling that “she was more of a friend than a teacher” (Nathan, ninth grade student, April 1997). Nathan recalled:

“Because having Mrs. C. emotionally support me through things, and I was telling you how it was more fun, and I think it wouldn’t be as good, and I think this would be a bad use of the computer. It brings a kid up and he’s not socially mature and not experienced, like, people are going to become, if computers continue like taking time away from people interacting, people are going to become like socially stupid” (Nathan, April 1997).

Nathan feared a day when classrooms are full of computers and teachers are not as engaged in teaching. Ms. Thom, too, did not want computers to replace teachers:
Well, what I hope never happens is that it replaces teachers. Because then, we’re going to become some robot society. I mean I really...because that personal component is important. Because kids won’t get fired up about a computer. They won’t make you excited about something (Ms. Thom, May 1997).

Michelle commented on how having computers in the classroom changes the discourse between students and teachers:

...it’s sort of like change of environment to go up to the computer room. And it’s pretty much like a real classroom, it’s just what we use on a special occasion...there’s questions asked about how to do things instead of like how to say it. And there’s questions, should I press this or will it erase that paper, or should I type this in? There’s extra things asked or needed for what you happen to be working on in a computer classroom. You have that special interplay. And if the teacher doesn’t know you’re out of luck. You need someone who has knowledge on that (Michelle, eighth grade student, May 1997).

Michelle also pointed out the need for trained personnel in the computer classroom, suggesting that teachers are still needed, if for different reasons.

Mr. Miller offered a vision for the future in which computers become fully integrated into the curriculum:

[M]y overall goal and the way I see it is not to compartmentalize computer education, “okay, it’s the fifth grade so they should get the computer course,” so you have English and history and spelling and then there’s the half hour for computers, and so “yes, in fifth grade we have a computer requirement, and in sixth grade we have the same but we go a little farther,” ...the way that I think we’re going to successfully incorporate computers into the curriculum is to start young and do it across the board so there could be a computer component to every class (Mr. Miller, fifth grade teacher, April 1997).
Remediation. Mr. Miller’s vision of having computers as part of all parts of the curriculum speaks to the connection between instruction and needs. Instead of computer-related instruction that is based on what computer resources are available, he points to designing a curriculum and finding the computers needed for that program. This approach also resonates with Mr. Parker’s goal of using computers to individualize instruction for students:

I think that the software program can check for understanding before proceeding by asking some key questions, and if the student is reading disabled you may have to have voice activated programs and therefore you need your headsets. But I think it really slows them down and can identify problem areas, and once problem is identified, I think it can present the material in a different way to circumnavigate that, or side step that problem (Mr. Parker, English teacher, May 1997).

Mr. Parker sees computers as valuable not just for the use of students with special needs but also to make teachers more available to work directory with these students. Similar to Ms. Thom, Mr. Parker viewed computers as part of an educational philosophy in which the teacher should be a facilitator and the instruction should be student-centered. He viewed computers as part of this approach in that he saw:

... the potential for the teacher becoming more of a facilitator rather than a lecturer, or dictator as they are called in the classroom. And it was a nice way for the kids to practice concepts at their own pace and with limited adult supervision. That would free me up to work with kids who really needed me one-on-one (Mr. Parker, English teacher, May 1997).
Importantly, this method suggests that computers are not seen as the best teachers for students with learning needs. Instead, Mr. Parker suggested that computers are tools for use by all students, but that teacher expertise is still important and necessary in the classroom.

Frances, a student without a learning disability, noted that computers could help students with “dyslexia, they can teach them the ABC’s and vowel sounds” (Frances, sixth grade student, May 1997). Michelle, a student with ADHD, explained how computers help students with special learning needs: “You have to be up straight and giving full attention” (Michelle, May 1997).

In response to the questions related to how computers might benefit students with special learning needs, the interviewed students spoke most often of the role of assistive technology in helping such students. Their responses tended to be non-specific, but reflected a sense that assistive devices, including computers, could serve a compensatory function for students with special needs, especially learning disabilities.

As with the general applications of computers, writing was the most frequently teacher-mentioned application of computers specifically for students with special needs; it was mentioned almost as much as writing in general. Similarly, organizing was the second most common theme related to special needs uses, and it was closely followed by assistive technology.

Together these features of computers were identified by teachers as
important compensatory aids for students with disabilities. Overall, when compared to students, teachers spoke of more specific applications of computers that are well-suited to the unique learning needs of individual students.

“It’s harsh.” –Nathan, ninth grade student, April 1997

Attitudes

Positive and Negative. The students and teachers made many statements reflecting both positive and negative attitudes about computers. The parity of the number of the students’ positive and negative statements is striking but also reflects a dichotomous mindset which was seen in several of the students’ interviews: “It was fun, but it was confusing” (Frances, May 1997). Many of the students and teachers described feeling both enjoyment and frustration when using computers; they revealed jointly held positive and negative opinions, neither of which seemed to overpower the other. Even the most enthusiastic computer users reported feeling frustration and negativity with computers at times. Michelle reported that “our computer, it’s a nice computer, but it always acts up...so I get easily frustrated with computers” (May 1997).

Despite having longer overall interviews, the teachers revealed fewer positive and negative attitudes about computers. Of interest, their positive
and negative statements were about as evenly distributed as the students' statements. Positive statements slightly outnumbered negatives but failed to indicate strong attitudes in either direction. This could be related to a different mindset among the teachers which included their tendency to remain more focused on specific questions during the interview. Alternatively, the difference between students’ and teachers’ positive and negative statements could be a reflection of their different perceptions of computers themselves, a possibility which is supported by the survey data and which will be further explored below.

**Enjoyable/Easier/Faster/Work Quality.** The most common positive attitudes that were expressed in the interviews included beliefs that computers make tasks easier, are enjoyable to use, make work go faster, and improve the quality. These attitudes often described the uses that students mentioned. Computers were reported to make writing easier and faster and many students expressed how they enjoyed using computers for games and other tasks. Frances noted that “...it made it easier” (May 1997). Stewart, a student without learning disabilities, connected computers with benefits for students with learning difficulties: “maybe for kids with learning disabilities, [we] might get bigger monitors...so that the typing would be bigger and it would be easier for them to read” (Stewart, sixth grade student, May 1997).
Mr. Parker also viewed computers as "fun" for students, but he saw them as having other possibilities as well: "...the kids really see it as a fun thing to play with, they really need to see how it can be used to make their lives easier" (Mr. Parker, English teacher, May 1997). Frances mentioned that using a computer for writing was both faster and easier "because, it made it easier than writing it all up because you have it on a piece of paper and it you lose that then you have it on your computer." She also talked about using the spell-checker "'cause I don't want to get in trouble" (Frances, sixth grade student, May 1997). When asked about why this prevents her from getting in trouble, Frances indicated that it improves the quality of her papers and leads to better grades.

As with writing, the technical qualities of computers can offer greater ease for writing and producing written work. Mr. Parker shared the story of a student who benefited from how computers can change the display of writing.

Last year in the advanced placement English class there was one girl with learning disabilities in language. And she was an incredibly hard worker and my fall final was a particularly difficult one because it required a lot of thinking on different planes and a lot of drawing connections between disparate objects, disparate objects, disparate themes. She was able to, by typing the exam, one, slow herself down so she could take enough time, also I came in at one point and she had written about a paragraph and then gotten very confused as to what she had written. Simply by taking her word processor from single spacing to triple spacing she was able to sort out the ideas and make it less complicated. So that was a point where I was able to, simply by
manipulating the computer clear things up for her (Mr. Parker, English teacher, May 1997).

From Mr. Parker's perspective, using a computer for writing made it possible for this student to complete an important task much more easily. However, the students with learning disabilities offered a different view.

**Breakable/Costly.** Among the negative attitudes, several participants noted that computers are breakable and costly. Nathan mentioned that “they’re breakable” (Nathan, ninth grade student, May 1997). Stewart noted that it’s inconvenient to be without computer: “when my dad takes it in to get fixed, I have a whole bunch of things due tomorrow and I need my computer to print them out” Stewart, sixth grade student, April 1997). Ms. Robbins pointed out that many administrators share the concern with cost because “it’s a big investment and they don’t want to blow money on them” (Ms. Robbins, April 1997).

**Frustrating.** Among the negative attitudes expressed by students the most frequent were frustration and fear. These themes showed that the students and teachers did not see computers as all good. In particular, such attitudes indicated that there were identified drawbacks to computers which must be understood alongside the positive aspects. Citing frustration and other less-than-pleasant experiences, the students with learning disabilities offered a different picture of the convenience of computers. As a group these three students shared stories suggesting that working with computers is not
always easy and fast. Michelle revealed fairly negative attitudes about computers, referring to them as frustrating many times. Michelle’s first computer experience was in first grade and she recounted that she didn’t like it because “you couldn’t look at the keys” (Michelle, eighth grade student, May 1997). She also mentioned that at the time she was not on medication and perhaps that added to her frustration. Michelle found her next experience, at a new school in third grade, to be better. She indicated that she still gets frustrated when the computer cannot keep up with her typing but that she’s learned “it’s not the end of the world” (Michelle, May 1997). Showing a sense of the good and bad aspects of computers, Michelle revealed that “…in a way it just helps me feel like I can organize it better without having to look over it a lot of times...” (May 1997).

As mentioned above, Nathan recalled how using a computer can also make the task take much longer. He also recalled long hours of time spent alone when he was supposed to be working on learning to type after school. These hours he remembered as “boring” and “not useful” because he could not see how he was ever going to type fast enough anyway. Nathan revealed that he had a very negative attitude about computers for several years because of his memory of being forced to learn to type by himself after school. Paul mentioned that for him typing a paper on a computer was very difficult at first because: “well, I was pretty slow” (Michelle, eighth grade student,
May 1997). Although all three of these students saw the benefit of using computers for writing in order to produce higher quality work, they shared experiences of “pain,” “frustration,” and long hours in getting to a point where computers were truly useful for writing tasks. This was different from the other students who were interviewed who did not reveal such feelings of fatigue or frustration in the process of learning how to use a computer for school work.

**Fear.** Using the language of fear, French teacher Ms. Robbins showed that among some of the teachers, there was mention of more than just frustration with computers. Some of the teachers spoke of a real fear of computers. Ms. Robbins revealed: “I think there’s a lack of knowledge and understanding on the part of those who decide the budget to understand what the stuff is for” (Ms. Robbins, April 1997). At the other end, she also observed that some administrative personnel are so intimidated by the costs that they are too afraid to invest in any technology.

I see a lot of people very hesitant, from talking through people [at conferences] a lot of restrained interest, or interest but waiting to see, particularly concern about how it’s going to be used, what is going to be accessible, what parent reaction might be, how it’s going to be abused...it’s also a big investment that I don’t think they want to blow...and sometimes the situation of the technology being so new that you don’t know what is the best buy. At the next conference one of the “possible topics is “Is there life after Mac?” That’s how scared they are... (Ms. Robbins, French teacher, April 1997)
Mr. Miller pointed to a lack of teacher training as the source of resistance to using computers more widely in schools. He suggested that schools need to "help teachers learn how to use [computers]... feel comfortable taking risks in the classroom, feel comfortable going out and looking at a software magazine and trying some stuff out..." (Mr. Miller, fifth grade teacher, May 1997). Mr. Miller viewed teacher training as the first step in really using computers educationally. As with Mr. Carter, Mr. Miller felt that the next important step is for the teachers to train students and help students learn how to do more than just play games with computers.

Less Personal/Loss of Skills. While holding a more extreme position than the other students, Nathan offered a comment about the potential negative effects of computer use by students, suggesting that "people are going to be socially stupid" (May 1997). In general, The students revealed slightly more interest and concern with the social components of computer use than did teachers. In particular, several students mentioned a concern with having to share computers when using them for class work. Frances said that "I think it's easier to have your own computer because it's hard to switch when you're right in the middle of a paper and it's someone else's turn" However, Frances also conceded that "when you're doing a project with a partner or with a group, then you want to share a computer" (Frances, April 1997). There was relatively little mention of differences between the
ways that boys and girls differ in computer use. Michelle noted that “in my computer classes the boys sort of don’t what to do it, because it was boring” (Michelle, May 1997). There were no other indications that the students found significant differences in the ways that boys and girls make use of computers.

Other Attitudes. Two other attitudes about computers were common in the interviews. Several students and teachers spoke of the potential of computers. Darren suggested that computers make an “equal offer to everybody. It’s just a matter of whether someone is willing to look at stuff like that. There are so many possibilities” (Darren, April, 1997). Though vaguely defined, this appeared to mean that computer have much to offer schools. Mr. Parker indicated that computers offer opportunities for innovative instruction but that teachers are still needed too. “I’m wondering how we guide them. What do we want to do with computers? It seems to me such an open space” (Mr. Parker, English teacher, May 1997).

*It was boring.* -Nathan, April 1997

Personal Experience

While Nathan’s early experiences with computers were not stimulating, Mr. Parker suggested the importance of using computers as creativity tools that offer new ways of looking at familiar things. Drawing
from his own experience in college and graduate school, Mr. Parker reflected that:

...perhaps one of the most, one of the ways that influenced me was with a computer search, um, you can type in anything and you'll be expecting different things along that subject but every once in a while something random pops in by a strange connection. So perhaps because I've used computers to research starting in college and with those computers turning up random things I've begun at some subconscious level begun to look for random things (Mr. Parker, English teacher, May 1997).

Mr. Parker's observation of how computers can foster novel associations offers a glimpse of how unique individual experiences with computers can shape assumptions and expectations.

Home Experiences. Several of the participants revealed how much their past experiences with computers had shaped their ideas about how computers should be used in schools. All of the students indicated that they currently own a computer and made reference to experiences and opportunities that having their own computers offered. For example, Darren and Stewart reported how "fun" it was to learn how to use the computers owned by their families, often asking questions of their parents and spending long hours investigating and learning about the many things a computer can do. Frances and Nathan mentioned that although their families own several computers, getting access to them alongside other family members was often
difficult. Frances hinted at the importance of getting personal computer time, saying: "I find time" (Frances, sixth grade student, May 1997).

**School Experiences.** These students also spoke of school situations involving computers which shaped their ideas about how computers should be used. However, the school-based experiences were less intimate and appeared less "fun". Both Frances and Stewart, who attended the same school, mentioned not liking having to share a computer with another student, wishing for more personal time with the school computers. Paul also mentioned how students' views about using computers for school work were shaped by their lack of access to them. "I don't think they really [like them]...the majority I guess wouldn't like it as much 'cause like a lot of kids in this school don't have computers, yet they're asked to do a lot of their projects on computers" (Paul, twelfth grade student, May 1997).

The teachers, too, offered evidence from personal experience about computing. Impressively, all these teachers had opted to incorporate computers into their professional work, suggesting that they understood computers to have a role in schools. These experiences with computers, including the negative experiences of frustration reported by some, revealed how perceptions and conceptions of computer use are shaped by past encounters. However, there was also a clear sense among both students and teachers that school can mediate experience by providing access to resources
and instruction. All the interview participants offered memories of past school-based computer encounters which served as examples – good or bad – of the role of computers in schools.

“We don't have them in the classroom” Ms. Robbins, French, April, 1997

Resource Needs

Using a sports metaphor, Mr. Miller spoke of his personal disappointment with not having adequate computer resources for the students at his school. “All excited for the game and knock on the door and it's locked...” (Mr. Miller, fifth grade teacher, May 1997). Similarly, Ms. Robbins indicated what she felt was the critical missing piece of technology at her school: “we don’t have them in the classroom” (Ms. Robbins, French teacher, April, 1997). In general, the teachers included more statements related to specific computer needs or “wishlist” items than did the students. The teachers were more specific about what types of computer-related equipment or services were needed and made more frequent mention of the high costs associated with computer purchasing and maintenance.

Hardware/Software. Ms. O’Donnell offered a poignant comment about the importance of sufficient computer resources: “Having access is the most important thing.” (Ms. O’Donnell, special education teacher, May 1997); without access, students are unable to benefit from these technologies. Given
that students and teachers develop their beliefs and attitudes about computers in part from personal experience, the nature of those experiences will be shaped by the computer resources that are available. Material computer needs were articulated primarily by the teachers, but some of the students also spoke to this issue, including Paul who pointed out that “a lot of kids don’t have computers, yet they’re asked to do a lot of their projects on computers. We have computers, but only during certain times, and if you’re not allowed to use the computers you’re allowed to hand-write it” (Paul, May 1997). Hardware and training were the two most mentioned needs. Without adequate resources, it is impossible to develop programs for students that incorporate computer technologies.

Interestingly, most of the needs-related comments in the interviews were related to student access rather than teacher access. Ms. O’Donnell emphasized the importance of “the students being able to gain information and access in their dorms or certainly in the classrooms” (Ms. O’Donnell, May 1997). This suggests that the interview participants understand that students are the most needy group regarding school computer resources and that future purchases should be pointed in their direction.

Money/Staff/Training. There were differences between the needs estimates at the experimental school and the other sites. At Fairmont, there was less concern with hardware and more calls for training and instructional
support. At Riverview and Wesley Academy, both students and teachers were eager for more hardware which could be used by students. This result suggests that the availability of basic computer resources in a school, such as Fairmont had, did not diminish a sense of computer needs, but shifted the focus toward more complex, applications-oriented concerns. Overall, there was a general call for more training resources at all the schools. Mr. Carter reflected that:

I don’t think that there are the teachers right now to teach them effective strategies to use the computers. I don’t think the teachers have the know how. They haven’t been exposed to new strategies. They’re just not educated on how to use the computer and so they don’t pass on the knowledge (Mr. Carter, April 1997).

Similarly, Stewart noted that most of his teachers lacked the skills to use computers for more than word processing: “They just let you use the computers as an option for doing your papers (Stewart, May 1997).

School Computer Cultures

Taken together, the students and teachers from each school offered glimpses of the computer cultures present at each school. The descriptions they shared help to provide pictures of the ways that computers are being used at each site.

Riverview. “The potential’s here but the equipment is antiquated.” (Mr. Miller, fifth grade teacher, May 1997). As Mr. Miller mentioned, both
students and teachers at Riverview were concerned about the lack of up-to-date computer resources at their school. Attention to resource needs was an important theme at this school. Also noticeable was that participants from Riverview made the largest number of mentions of the instructional uses of computers, indicating another strong theme at this school. This theme was interlaced with hopes for the arrival of their new computer equipment so they could use it with the students. Both the students and teachers at Riverview appeared very eager to use computers more actively in classes. There was also a strong sense of cooperation and collaboration among students and teachers to make the computers they had be available for as many students as possible.

Fairmont. "Many people are afraid to change to computers" (Darren, ninth grade student, April 1997). As suggested by Darren, statements about issues of changes related to computer use were often seen in the interviews of Fairmont students and teachers. Striking was the finding that Fairmont had a much larger number of negative responses than the other schools. Fear was a recurring theme at Fairmont and suggests that the presence of a computer network is not necessarily related to improved attitudes or willingness to use computers. Alternatively, the negative statements at Fairmont need to be considered alongside the relatively low number for Riverview. Nonetheless, fear was a key theme at Fairmont and points to
enduring issues that may follow after the installation of new computer equipment.

Wesley Academy. “A teaching tool for working with the students” (Ms. O’Donnell, special education teacher, April 1997). As summarized by Ms. O’Donnell, the main theme at Wesley Academy was how the computer has been used by and for students as a learning tool. Both students and teachers from Wesley shared examples of how computers have been used for assignments in ways that make learning easier for students. In particular, there was a focus on how computers can make the overall curriculum more accessible to students. Interestingly, Wesley Academy participants revealed the fewest number of needs statements, despite having received minimal updated equipment in recent years.

The interview data revealed that participants' attitudes and opinions about computer use were related to their school environments. This makes sense in that how these students and teachers had previously used computers shaped their sense of future potential usefulness. This school influence complements the survey data and suggests that how schools incorporate computer use into instruction may have an important effect on the attitudes and opinions that students and teachers hold about computers and whether they are likely to use them for school-related work.
Discussion

An overriding theme which is present in all of the interviews is accessibility (Boscardin, 1997). This sense of accessibility is found in the specific references to the computer resource needs of students and teachers as well as in the general spirit or rationale for the use of computers in general. These interviews suggest that computers are useful for students with learning disabilities (as well as other students) because they offer ways of access to learning experiences that might be otherwise unavailable. Examples from the interviews suggesting how computers enhance accessibility included writing, reading, slower-paced instruction, individualized instruction, and student-centered instruction. All of these provide points of contact or entry (access) by students into learning tasks that would otherwise be more difficult or impossible.

What Was Not Said. Interestingly none of the students or teachers who were interviewed questioned the presence of computers in schools. Even Nathan, who was the most cautious about the role of computers, agreed that they are important for certain school-related tasks such as writing. What was not said about computers in the interviews is as important as what was said. The students and teachers who participated in the interviews did not question the presence of computers in their schools. There appeared to be silent agreement that computers offer something of value to schools and
students. The silent concurrence that computers have a reason to be in schools reflects the purposefulness of their role.

All the interview participants shared many applications and uses for computers in their school-related work. These applications of computers were influenced by the other four major interview themes and each person offered a unique perspective on the place of computers in schools. There was a compelling sense in both what was and was not said that computers provide students with innovative and alternative points of access to school-based learning experiences. It is the accessibility that computers offer to students with special learning needs that best supports their use in schools. By making it possible for students with such needs to participate as fully as possible in general education classrooms, computers appear to have an important role in delivering special education services.

The pervasiveness of writing in the interviews showed that students and teachers are using computers for writing tasks fairly regularly. In many cases, participants spoke of how computers have helped to enhance writing, especially for students with special learning needs. Games were also frequently mentioned, however, not always with support. Of note, all the students mentioned computer games in their interviews and all but one viewed them favorably. Teacher reaction to games was more negative, with three teachers indicating a belief that computer games are not beneficial for
students. Clearly games are an important part of what computers offer for most of these students and their role in education needs further investigation. Some participants referred to "good" games or those which are educational and perhaps these might have a role in computer-related instruction.

The interview data indicated that most of the participating students and all of the participating teachers have generally positive attitudes about computers. In several cases, these attitudes were mediated by existing negative variables. However, except in one case, Nathan, the positive aspects of computers were seen to outweigh the negatives. The participants did not seem to have difficulty holding contradictory beliefs about computers and were comfortable with the pairing of positive and negative qualities. Of note, the three students with learning disabilities had less positive attitudes about computers than those without disabilities. In each case, these students expressed greater frustration with learning to use a computer and were more equivocal about what role computers should have in programs for such students. This finding is very important because it has implications for how enthusiastic students with special needs might be about working with computers. At a minimum, teachers should learn how such students feel about computers and address student-specific discomfort and anxiety before and during the implementation of computer-assisted instruction. The one
teacher who reported having a special need did not express any difficulty with learning to use a computer. Other excerpts suggested that computer use is related to students' overall cognitive style, for example Michelle who was easily frustrated and Paul who tended to be a passive user. More investigation of how computer use relates to students' cognitive style would be worthwhile.

The most salient finding from the interview data was the connection between participant attitudes and prior experience. As with the survey data, these students and teachers revealed a relationship between their prior computer-related experiences and their current attitudes and opinions about their use. It was clear that many of the participants had developed their attitudes and opinions about computers from their past experiences, consciously or perhaps unconsciously. Additionally, many spoke about how home computer access influenced their interest in computers. While this finding may seem overly obvious, it is not always addressed in policy and practice. Some individuals may find learning to use a computer generally difficult, however, the extent and duration of difficulty can be mediated by instruction and support. More importantly, it should not be assumed that just putting computers in classrooms is going to lead to their effective and immediate use. Similar to the evidence that use relates to cognitive styles, how students and teachers use computers appears to be related to a number
of personal variables, some of which could be mediated by schools. Given the positive role of home-based computer experiences, offering more access to all students through the schools could also help to provide more equitable computer opportunities for all students. School influence was also touched upon in several interviews. The lack of sufficient computer resources was a common theme from all the participants at Riverview and half of those from Wesley Academy. For these individuals, the amount and type of computer resources that these schools did or did not have was a shaping variable in how they were using computers for school related work and reflects the survey data which pointed to the important role that schools can play in influencing students’ and teachers’ attitudes and opinions about computers. In addition, student and teacher training is also needed so that the even the most basic of computer features such as spell-checking can be used effectively.

Summary

Taken together, the interviews provided important additional information concerning the role of computers in special education. The experiences shared by the interview participants were unique and individual but also had some common themes. Using grounded theory methods, several main categories of information were identified in the participants’ words. Of
these, five major themes (Applications of computers, Attitudes, Instructional uses, Personal experiences with computers, and Resource needs) appeared as significant contributing factors in the experiences and beliefs that these students and teachers held about computer use by and for students with special learning needs.

The interview data provided information that largely confirmed what was found in the surveys. Experience using computers was described by participants as a shaping variable in how they use computers for school-related work. Generally, these students and teachers viewed computers as a positive addition to schools and felt they have a special role for students with special learning needs. Overall, the interview participants reflected a sense of optimism and support for the role of computers to help students with special learning needs and suggested that they expect to see computers have an important and lasting role in helping students with special learning needs find success in school.
CHAPTER VI

DISCUSSION AND CONCLUSIONS

General Findings

As indicated by the literature review, computers and other forms of instructional technology (IT) have been shown to be effective components of instruction for students with and without special learning needs. Importantly, significantly greater improvement in student achievement has been observed in certain IT applications with students having a variety of special needs, including physical and cognitive impairments. Less understood is the role of students’ and teachers’ attitudes and opinions about computers and how these attitudes influence the use of computers for school-related work.

This study investigated how the implementation of a campus-wide computer network was related to students’ and teachers’ attitudes and opinions about the use of computers, in general, and by students with special learning needs. In addition, the study looked at whether these attitudes and opinions differed in relation to a number of variables, including sex, age, race, grade, school, computer ownership, computer access, computer skills, variety of computer uses, learning disability, financial aid for students, as well as
teaching area, professional development participation, and teachers' experience teaching students with special needs.

Both the survey and interview data suggested a model of computer attitudes which is based on the quality of prior computer experiences. This model suggests that students and teachers develop beliefs and attitudes about computer use through the interconnection of attitudes and experiences. The interviews indicated that students' and teachers' attitudes about computers are related to five general themes: applications, instruction, attitudes, resource needs, and personal experiences. The survey data revealed very similar themes; it was the students' and teachers' past experiences that most predicted their attitudes. The boundaries among these five themes are fluid and dynamic. Attitudes are influenced by uses and vice versa. Similarly, needs and resources shape uses and attitudes and inform perceptions of needs. A summary of how the data fit the research questions will be followed by discussion of the findings in the context of the five themes.

Question 1: Differences Among Students and Teachers

The survey and interview data offer preliminary answers to the research questions asked at the outset. The response to the first question, do attitudes and opinions about computers differ among students with and without special needs as well as teachers appears to be largely no. However,
there are qualifiers which must be added to that answer. Overall, the survey data indicated no significant differences between students with and without LD related to computer use by students with special needs. But, the regression results and the students with learning disabilities who participated in the interviews expressed less enthusiasm for computer use than their peers and their comments suggest that awareness of individual students' attitudes would be important for teachers to know.

It appears that students with LD may have qualitatively different computer experiences than students without LD. This may be the result of the fact that many students with LD have traditionally spent instructional time in resource rooms where computer-based instruction may or may not be offered. Importantly, students with LD are likely to receive special instruction in language and writing and therefore be separated from non-disabled peers for activities that could involve computer usage. The evidence from the surveys and interviews, especially Nathan's and Michelle's experiences, indicates that separate specialized instruction in language and writing, which incorporates computers, may be providing substantially different computer experiences than students in general education language arts classrooms are receiving. No previous studies comparing the computer attitudes of students with and without learning disabilities as well as teachers were found. A closer examination of what types of programs and
computer skills instruction is offered in resource rooms or to students with LD in inclusive settings is needed to discern why students with and without LD appear to have qualitatively different computer experiences.

**Question 2: Predictors of Attitudes**

The second research question, which asked which variables are related to students’ and teachers’ attitudes and opinions about computers was answered by both survey and interview data. These results showed that students’ and teachers’ attitudes and opinions about the role of computers in special education were related to several key variables. Of these the most significant were school and computer experience/expertise. The interviews supported these results, especially the importance of school and experience, by showing how the participants’ computer attitudes were shaped by their prior computer experiences.

The finding that computer attitudes were best predicted by computer access and ownership, frequency of previous computer use, computer skill level, and where computer skills were learned, was not surprising and was consistent with the findings of King (1996), Proctor and Burnett (1996), Riggs and Enochs (1993), and Olivier and Shapiro (1993). As with many things, practice makes a difference in one’s interest, skill, and attitude about engaging in an activity. Nonetheless, this finding also has implications for
policy decisions. If students and teachers develop their attitudes and opinions about computer use in part from the experiences and exposure they have to such technology, it is important for schools to develop computer-related curricula and training programs that allow students and teachers to develop stronger computer skills and practice using these skills in meaningful ways. As with the work of Moore, Reith and Ebeling (1994), Siegel, Good and Moore (1996), and Yaghi (1996) these data support the important role of training for students and teachers.

The finding that students from Fairmont who received financial aid were less supportive of the use of computers by students with special needs is more puzzling and it bears further investigation. Students receiving scholarship assistance may have other attitudes and opinions about the role of computers in schools which were not explored in this study. Importantly, there is a need for more attention to the computer-related needs of students from diverse language, socioeconomic, and cultural backgrounds. A majority of the students in this study, including those from non-white and non-English speaking backgrounds, had home access to computers. As also seen in the work of Riggs and Enochs (1993), if students have regular access to computers in the home but their attitudes are related to school and personal variables it seems that, as with teachers, schools are in a position to influence how students think about and use computers. Taking into account students'
home experience, which may include using computers which are technically superior to the ones at school (e.g.: students from Riverview), may be important.

Questions 3 and 4: Impact of the Computer Network

Answers to research questions three and four, whether the experimental condition of a new computer network was related to students’ and teachers’ general and special needs computer attitudes and opinions, are somewhat less clear. Similar to the findings of Kinnear (1995), the pre and post-test survey results showed that the experimental condition of installing a campus-wide computer network at Fairmont was not significantly related to changes in students and teachers attitudes about either general or special needs computer use. In other words, the mere presence of a state of the art computer network on a school campus was not connected to significantly more positive or negative attitudes about computers or their role in helping students with special learning needs, at least as measured by the four outcome measures on the survey instrument.

The lack of significant effects from the new computer network perhaps may be explained by lack of time. Possibly, the eight month duration of the study was too short for students and teachers to experience meaningful changes that influenced their attitudes about computers. Alternatively, the
students and teachers may have been accustomed to the presence of computers in their homes and society in general that their increased presence at school did not seem anomalous. It may be that computers have become so ubiquitous in modern industrial society that they have become a commonplace expectation and not a remarkable sight.

Nonetheless, the findings from the last item on the post-test survey, the question about changes in student work quality, showed different results from the pre and post-test survey data. On this item, the teachers reported little significant change over the year, but the students indicated they did see significant change. Importantly, the students at Fairmont reflected the biggest computer-related change in student work quality. The contradictory nature of the survey scale and change item findings is intriguing because it seems to indicate a difference in overt and covert measures of change.

These results perhaps reflect the difference between anticipated results and actual results. It could be that the students had developed some sort of response set which included a script for computers improving student achievement. Therefore, they responded to the item by affirming a positive change. The teachers' responses, however, showed they did not see any significant change in the quality of student work attributable to computers. This contradiction also suggests that students' perceptions of computers and the change they offer may be as important as the real changes they bring in
terms of influencing how students think about computers. Pajares (1996) noted that attitudes are hard to measure because a change in behavior does not always reflect a change in belief. As suggested by Pajares (1996), a comparison of the results from the pre and post-test items and the change question suggests that there was a discrepancy between the students' overt attitudes and actual behaviors about computers.

Five Themes

The five themes seen in the interviews provide a tentative model for understanding how students with and without LD as well as teachers develop their attitudes about computer use in special education. The themes overlap with the findings from the surveys and offer a starting point for conceptualizing how students and teachers develop their attitudes and beliefs about computers. Understanding these beliefs is important because it is in working with the “human” aspects of computer use that educational practices will change.

Applications of Computers

Both the students and teachers who participated in this study appeared to accept the presence of computers in schools as normal. None of the survey or interview results suggested that there was any sentiment
which questioned the legitimate role of computers in schools. An example of this was found in the presence in the survey results of specific applications such as word processing or spreadsheet use as predictors of computer attitudes. The discriminatory ability of different types of computer applications suggests that these programs have sufficient presence in schools to be seen as normal in those environments. Similarly, the interviews revealed certain applications as standard, especially word processing, and the participants spoke of them with the understanding that they were accepted — even essential — computer applications for schools.

While there is not a great deal of information about specific computer applications in the literature about attitudes, in this present study there are findings which suggest that further investigation of specific applications is needed. For example, like King (1995) this study found that the students spoke of how using computers increased the efficiency of assignment completion. Similar to Kinnear’s (1995) work, the interviews provided indicators that both students and teachers view the workplace usefulness of computer skills as one important reason for their inclusion in school settings. It is unclear from this and previous work whether there are important differences among the specific applications that students and teachers are using in schools which relate to either likelihood of student use or actual
student achievement outcomes. Thus, what types of applications students are using in schools need further investigation.

One type of computer application that needs to be explored is computer games. Similar to the findings of Proctor and Burnett (1996), in this study use of computer games was a predictor of attitudes for several groups and outcome measures. All of the interview participants spoke of computer games in one way or another. Importantly, all of the students reflected their strong enjoyment of computer games while all of the teachers spoke of them in primarily negative ways. This finding raises the issue of what types of computer applications teachers are most likely to choose and which ones students are most likely to enjoy using. It appears that these choices may not coincide and could lead to either conflict or less than expected results from computer-based instructional activities. More investigation of the role of computer games in students' learning is needed.

**Instructional Uses of Computers**

There were many examples of the instructional uses of computers seen in this study. As revealed by survey item 27 (the change item), the surveys showed students as seeing computers to be more helpful for improvements in student work than teachers did. Apparently, the students viewed computers as related to improving student achievement. The surveys also showed that
the teachers' ratings of students' comfort with computers went up over the course of the year, perhaps suggesting that teachers have a different concern about how computers influence the school environment. The interviews revealed that both students and teachers see many instructional uses for computers, both in regard to students' skills and pedagogy. This finding resonates with the sense of expectancy for computers which has long been associated with beliefs about their use in schools (Bork, 1997).

That there would be a continued hope and expectation that computers will be beneficial in schools fits with many cultural assumptions about computers. They are highly valued (consider their price) pieces of equipment which are seen as linked with increased productivity and efficiency. It is, therefore, logical that many would expect computers to make schools, like workplaces, more efficient and productive. Since education is largely publicly funded in the United States, the aim of making it as cost-effective as possible is also understandable. Further, research evidence, as cited in the literature review above, shows that computers have been linked to significant effects for students in both general and special education.

The students' responses to the change item as well as the interview data support King's (1995) findings that the outcome or product of computers influences attitudes about them. It seemed that students appreciated how computers made assignments faster and easier to complete but did not
comment much on the other skills they learned or used by using computers. There are several possible reasons for this. First, it could be that students take computer skills for granted. Any child born and raised in the United States since 1980 has literally grown up with computers and is likely to have a base knowledge of their attributes that is greater than many of their teachers. As a result, such students may not notice or need to attend to the sub-skills necessary to use computers and can focus on the end product created. It may be that teachers are concerned with the necessary skills needed to use computers because they are in the process of learning cognitively what the students learned by association.

In essence, teachers may be teaching, or trying to teach, skills which students do not need to know, and are missing out on what students really want to learn from and with computers. Examples of this were seen at Fairmont where students initiated and taught advanced computer courses in design and rendering while teachers continued to offer such staples as keyboarding. If there is indeed a discrepancy between what students seek to know and what teachers are teaching, this could be an additional explanation for why students with LD are having qualitatively different experiences with computers from their peers. Perhaps, like with language development, such students need slower-paced instruction to learn skills like reading which their peers appear to learn with little effort.
The interview data also suggested that there is a need for greater student training in computer use. Kinnear (1995) and Cohen and Spenciner (1994) found that computers tended to be used for reading and writing enrichment or reward activities but not for general instruction. Riggs and Enochs (1993) found that students' content-area skills were not linked to computer efficacy, suggesting that computer-based instruction may need to include specific skills in both the content and process. Several of the interviews supported this finding in recommending that students receive far greater training in relevant computer skills that fit with the instructional goals of the teacher and class. Moore, Rieth, and Ebeling (1994), Siegel, Good, and Moore (1996), and Yadhi (1996) all suggested that far greater teacher training is essential for appropriate and meaningful instructional uses of computers to occur, a sentiment echoed by the presence of experience variables as predictors of computer attitudes and among the calls by students and teachers for greater teacher training. Logically, greater teacher training may need to precede student training, however, students may need different training which is related to the specific content area skills being taught.

Marsh (1995) found that computers helped to ensure that elementary age students with special needs received the instructional accommodations they needed. Several of the interviewed teachers as well as the students with
learning disabilities also spoke of how computers helped such students find success in the general education classroom. It appears that there was consensus among the students and teachers in this study that computers are valuable tools for accommodation. This sentiment was rooted in the experiences of both students and teachers who had personal anecdotes of how computers had helped themselves or those with disabilities be able to find greater access and success in the general education curriculum. Overall, both the students and teachers valued the instructional role of computers. Nonetheless, the data also suggested a need for evaluation and refinement of what computer skills are taught and how computer-based instruction is implemented.

Attitudes about Computers

The surveys indicated that there were few differences among students with and without learning disabilities and teachers concerning their attitudes about computers in schools. However, there were significant differences in the attitudes of the participants by school. Schools are in a position to shape students' learning experiences which, in turn, will likely influence their attitudes about learning. The interviews confirmed this by showing how the individuals' personal learning experiences with computers were an important defining force in how they viewed computers. It appeared
that the mere presence of the new computers on the Fairview campus was not sufficient to change students' and teachers' attitudes; their attitudes were shaped by experience.

King's (1995) study partially complements this finding in that students' attitudes about computers appear to be influenced by many factors of which personal experience is one. Kinnear (1995) found that younger children were more positive about computers, a result very much confirmed by this study. The students from Riverview (grades 5 and 6) were among the youngest who participated in this study. They consistently came across as much more positive than those at the other schools in every measure on the surveys and in the interviews. This apparent youthful enthusiasm could be the result of the Riverview students having had primarily recreational experiences with computers by using them at home or as a reward in their classes. These students tended to have far better home computers than school ones and may have been accustomed to using computers mostly for games. In addition, these students probably had less experience than their older peers with using computers for secondary level tasks such as writing long papers. Together, the collective computer experiences of younger students could be contributing to their more positive attitudes on the survey and interviews.
Proctor and Burnett’s (1994) work showed that students’ hands-on use of computers was related to more positive attitudes, a result seen in both the surveys and interviews. The recurrence of the nature and quality of past experience as a factor in student attitudes was seen many times; for example, the hands-on experience factors were the primary predictors of computer attitudes and served as context for accounts of computer usage in the interviews. Riggs and Enochs (1993) found that students’ home access to computers was a significant predictor of computer attitudes among students. This result was not seen in either the survey or interview data but could be explained by the fact that because such a large majority of students had computers either at home or in their dorms rooms, it was not a discriminating variable.

As noted above, several studies have found that computer training is related to more positive teacher attitudes about computers. This was true among the teachers who participated in this study, however, the quality of that training was not investigated. Both on the surveys and in the interviews, the nature of prior training with computers was seen as an important variable in teachers’ attitudes but the precise nature of the training was not revealed. This is an area where far greater research is needed. Given the evidence that teachers welcome computer training, it
seems to be important to learn what types of training are needed and how frequently it needs to be given.

While it is clear that students' and teachers' attitudes about computers are influenced by many factors, the survey and interview data suggest two important findings which need to be confirmed or refuted by further inquiry. First, there do not appear to be significant differences in the overall attitudes that students with and without learning disabilities have about computers. This is despite subtle differences in the variables which predict students' attitudes. Possibly, students with LD are as influenced by the same general school environment variables as their peers such that their overall attitudes about computers are not that different. However, students' attitudes do appear to be related to their experiences, which connects with the second important finding: students' and teachers' attitudes about computers do appear to vary significantly by school. In the case of the students who participated in this study, it appears to be the specific experiences that students and teachers have using computers that influence their attitudes. For example, the attitudes of students without LD were predicted by the experiences they had of using computers more often.

By contrast the attitudes of students with LD were predicted by non-experience factors like how infrequently they had used them. This subtle difference was also seen in the interviews where the students with LD spoke
of how they were more frustrated with computers and found them harder to
use or chose not to use them. If schools can shape students' attitudes about
computers to some degree, it seems that there needs to be more investigation
of exactly what types and how much computer experience students with LD
are having and how these can be turned into successful experiences. This
approach fits with instructional methods that seek to identify students'
strengths and weaknesses and provide teaching which focuses on students'
having more experiences of success (Kameenui & Carnine, 1998)

Personal Experiences with Computers

This theme overlaps considerably with attitudes but deserves separate
attention because of the location and nature of the experiences which
influenced attitudes. The surveys showed that computer-related experience
variables were more predictive of attitudes about computers but these were
apparently shaped by the locale of such experiences which tended to be either
school or home. The role of the location of the experience showed that it was
experience by access that influenced the participants' attitudes. Kinnear's
(1995) year-long study revealed that there were few changes in students
attitudes after computers had been in their classrooms for a year. Possibly,
this could have been the effect of too short a time to measure such effects, but
it could also be confirming that the presence of computers in a classroom or
school is not, by itself, related to changes in students' attitudes about computers (Cohen & Spenciner, 1993).

Proctor and Burnett (1993) and Riggs and Enochs (1992) found that school-based computer experience was linked with improved attitudes about computers. Again, the studies by Moore, Rieth and Ebeling (1994) as well as Siegel, Good and Moore (1996) showed that teachers' training experiences were related to their attitudes and use of computers. The results of the surveys and interviews from this study fit more closely with Kinnear's (1995) findings. These data show that students' and teachers' attitudes about computers were not influenced by the presence of computers in school, but instead, were linked with the personal experiences of the students and teachers. It appears that it is not the presence of computers but how they are used that influences students' and teachers' attitudes. Seemingly, it is not just seeing the computers, but one's individual sense of success or failure with it's use that influences one's attitudes. Such a finding fits with Bandura's (1977, 1986) work on self-efficacy.

Kinnear's (1995) study did not identify such personal experience variables, even though it included interviews. The Kinnear (1995) study did, however, focus on the influence of the school setting as a factor in the students' attitudes about computers. This finding resonates with the survey and interviews by confirming the role of school environments in shaping
students’ and teachers’ attitudes; schools appear to have a significant potential to influence students’ and teachers’ experiences of computers which then shape their attitudes. By contrast, the Proctor and Burnett (1994) and Riggs and Enochs (1993) found significant changes in students’ attitudes. All of these studies have in common that the attitudes of students and/or teachers were influenced and changed by the personal experiences they had with computers in schools. Therefore, it appears that there is growing evidence that the manner in which schools use computers shapes how students and teachers feel about them.

Resource Needs

While access to computers was not always a predictor of more positive attitudes, most of the participants had some sort of regular computer access and, thus, some computer resources were available to all who participated. The interviews, however, were filled with references to computer resource needs, including hardware, software, training, and personnel. Cohen and Spenciner’s (1993) work showed that just putting computers in classrooms was not linked with changes in computer attitudes or use, suggesting that just providing hardware and software may not be sufficient for students and teachers. This was echoed many times in the interviews when both students and teachers called for far more training of students and teachers so that
computer resources could be optimized. Training resources have been called for by many of the previous studies as well (Riggs & Enochs, 1993; Moore, Rieth & Ebeling, 1994; Siegel, Good & Moore, 1996; Yaghi, 1996).

The issue of differential resource needs by sex was seen in Kinnear's (1995) study in the finding that boys and girls used computers differently and that competition for computer time was an issue in some classrooms. Murphy, Coover, and Owen (1989) found this to be true in an earlier study as well. It is difficult to tell from the survey and interview data in this current study whether differences by sex were present because so many more boys participated. However, male sex was a negative predictor of general attitudes among students without learning disabilities. The interviews revealed no significant differences between males and females, although one of the girls did mention her sense that girls are more serious about computer use than boys. There were no significant differences between men and women teachers on the survey. Possibly, there are differences between the sexes concerning computer attitudes, but more research is needed to learn this. If confirmed, attention to the different access and resource needs of boys and girls needs to be addressed.

Ferreting out computer resource needs from this and previous studies is difficult because such equipment is part of the research and, thus, somewhat taken for granted. Still, the frequent mentions of computer
resource needs, especially for training, were seen in the interviews as issues at all the schools, even Fairmont which had a new computer network. The qualitative difference among the schools was what types of resources were needed. Those with fewer computers saw that as the first step, but all participants reported that adequate training was an essential resource for both students and teachers. There was also little mention of specific programs or applications which were needed. While word processing was universal, some teachers longed for better instructional programs. The persistence of the need for adequate computer training for students and teachers fits with the literature on educational technology. Compared with the previous research, the findings from the surveys and interviews suggest that all schools, regardless of computer resource level, need ongoing training in how to best use computers for effective instruction.

It is also possible that the resource needs articulated by the interview subjects were a reflection of larger cultural values. The computer industry seeks to improve the performance of equipment regularly and a computer “generation” is less than 18 months. It could be the case that schools, like other social institutions, are susceptible to the marketing of the computer industry and have convinced themselves that whatever equipment they have is outdated and needs replacement because it is no longer the fastest and best. This hypothesis would fill an “if you build it they will come” model for
technology in schools. However, some schools, like Riverview, are still making their very old computers useful for some classroom purposes, suggesting that if resources are scarce, outdated equipment can suffice.

Connecting the Findings

Variables related to previous experiences with computers and computer skill level, as well as the pre-existing school environment, emerged as the most important factors in students' and teachers' attitudes and opinions about computers. While adding a computer network to a school did not change attitudes significantly, the school environment appeared as a significant shaping variable on the students' and teachers' attitudes and opinions from the start. Similarly, the interview data, though more limited, indicated that how individual students and teachers had used computers in the past was influential in their attitudes about them now as well as how they were using them for present school-related work. The participants also pointed out that computers have positive and negative qualities and how teachers integrate them into classes and how students use them is the most important variable in their ultimate usefulness and helpfulness.

The data revealed that the students and teachers who participated in this study felt that computers have a special role for students with learning difficulties because they provide ways to individualize instruction and take
advantage of practice and feedback which promote acquisition of skills. For these students and teachers, computer access/ownership, computer skills, frequency of computer use, types of computer use, and school were significant predictors of attitudes about computers in schools. However, as noted, the nature of the experiences which predicted the attitudes of students with LD were different from those of students without LD. It was less frequent computer use that predicted the attitudes of students with LD. This finding serves to support the differential quality of computer experiences in shaping attitudes.

Schools were also seen to have a role in differentiating the attitudes of students and teachers relating to computer use in special education. In describing ways that computers had been used as tools for students with special needs, the participants revealed how school support for such practices, by providing the equipment and encouraging innovation, was critical to successful use of computers as compensatory and assistive tools for individual students. A recurrent theme was how school-related factors can shape students' and teachers' attitudes about computers. This is quite significant because of two realities. First, children spend a great deal of time in schools with the purpose of learning. It appears that schools have the chance to shape the computer learning experiences of students by addressing and customizing the instruction and support they receive in the use of
computers. Such an approach to instruction fits with the school reform visions of those who have supported the use of computers as part of overall efforts at fundamental change in how schools are run (Bork, 1997; Blackhurst, 1997).

Second, through federal and state special education laws (e.g.: the Individuals with Disabilities Education Act: IDEA) schools are given the mandate of helping students with special needs by identifying their instructional needs and providing individualized instruction to meet those needs. If schools can shape computer attitudes, then they can also likely shape the computer experiences which students have in schools. Therefore, it appears that schools need to look into what kinds of computer-related instruction and experiences their students with special needs are involved in and offer additional computer-related instructional opportunities to those students who may have been neglected in the past.

**Limitations**

This study was influenced by the participation of intact groups of students and teachers at each school. This aspect of the design is recognized but hard to get around when conducting school-based research. Limitations of the study include the possibility of researcher bias, especially at the middle school site where she was an employee. The study was designed around the
use of the researcher's workplace because of the potential benefit from ancillary data and the availability of more comprehensive data.

The subjects in this study were non-equivalent and, although controlled for in the pre-test procedures, there are a number of confounding variables that limit the extent to which the results of this study can be generalized to other populations. The students' home environments, even at the boarding schools, may have influenced any change in opinion they had about computer use in schools. School environment was also problematic because of the possibility of teacher effects; some teachers were enthusiastic about computers and other were not, thus, even the treatment sub-groups may have had varied experiences. Differences among the types of hardware and software being used in the new computers created another confounding variable. Even at the individual schools, not all students were using uniform equipment, creating the potential of machine effects.

The characteristics of both the student and teacher subjects must also be recognized as a possible limiting variable. Their differences with regard to race, sex, age, culture, personality, and experience can create classroom interactions which may have influenced the outcomes of this study. This study is limited in the same way that many such studies are, in that, the conclusions may not be generalizable beyond the three specific schools in the study. While these schools offer a sample of students and teachers who have
different backgrounds and experiences, they bring with them the biases of their own experiences and may not represent the beliefs and attitudes of students and teachers at similar schools in other communities.

Finally, the results from this study may have been influenced by the duration of the research. The data were collected from October through May of one school year. This eight month period may not have been a sufficient amount of time for effects from the new computer network to have occurred. Due to the newness of the technology involved, there are no longitudinal studies of the effects of computer technology on attitudes as well as achievement. Collis et al. (1996) have found evidence that computers may have beneficial effects on students' school achievement and call for more long-term studies. The Apple Classrooms of Tomorrow (ACOT) project offers some evidence of long-term effects and suggests that the changes possible with computers will be slow (Sandholtz, Ringstaff & Dwyer, 1997). Possibly the computer “treatment” used in this study will have effects on students’ and teachers’ attitudes over a longer time period. Ongoing research into the long-term effects of computers on schools is needed so that short-term results are not misinterpreted as indicators that that computers do not influence the learning environment.
Suggestions for Future Research

Given the positive evidence from previous literature about the efficacy of instructional technology, it seems important for schools of education to prepare teachers to use such technology in effective ways. A first step is to help them to feel comfortable with the technology and provide them with training to use specific programs for instruction. In particular, this study’s results point to a need to investigate how graduate level programs and those preparing special educators are including such training in their curricula. These teachers, who work most directly with students having special learning needs or in administrative positions, need to know the benefits of technology and be able to make policy and instructional decisions that incorporate appropriate computer-related activities into instruction.

Together with the finding that greater experience and expertise were related to more positive attitudes and opinions about computers, the lack of effects seen in the experimental condition suggests that schools may need to put more energy into how computers are used in order to make the most of their investment in such technologies. It appears that it may be important for school personnel to look for ways to enhance students’ and teachers’ attitudes and opinions by offering expanded access and training in how to use computers most effectively for school work.
The results from this study offer starting points for future research. There need to be more investigations of specifically what programs and computer applications are most beneficial for students with special needs. In addition, further study of exactly how students with LD and other special needs are currently using computers in schools would reveal what other factors may be contributing to their attitudes and why these attitudes differ from those of non-disabled peers. More study of the computer experiences of students from diverse language, socioeconomic, and cultural backgrounds will yield important data about how computers are understood in other linguistic and cultural traditions. Finally, replication or refutation of the results of this current study will provide additional evidence of the reliability and validity of these findings and their importance for special and general educators.

**Conclusions**

How can schools make the most of computer resources for students with special learning needs? First, school personnel need to recognize the role they have in shaping students’ and teachers’ attitudes, opinions, and ultimately usage, of computers. How schools include computers, train students and faculty to use them, and embrace an inclusive approach to education is a critical variable in the way that computers will ultimately be used as learning tools for students with special needs. The findings from this
study support prior research which shows that the most critical variable in the effective use of technology among students with special needs is the quality and duration of instruction and experience (CEC Today, 1997; Ellsworth, 1994).

Schools need to work toward equitable and regular access to computers by all students. This is difficult because of the high costs of hardware, software and support personnel. However, it is clear from the literature and the interview data that computers can be very beneficial tools for students and, therefore, it is important for schools to make a sincere effort to acquire computer resources that can be used by all students. In some cases, individual students will need unique computer resources and special education personnel must not overlook incorporating such devices into individualized education plans when appropriate. While not essential for all students, in some cases, such technology can make a critical difference in the education of individual students (CASE/TAM, 1997).

The use of computers needs to be integrated with the overall curriculum so that students are able to apply computer-related skills and learning within the context of other learning and activities. Given that the study data indicated that students' and teachers' attitudes about computers are related to frequency of use and skill level, it makes sense to incorporate computer-related practice into instruction. This will give students greater
exposure and familiarity with computers as well as increase their skill level over time. Then, the computer-related activities that teachers introduce are more likely to have the intended learning outcome because students’ (and teachers’) computer efficacy will be enhanced.

When introducing new computer skills and activities, students with special learning needs may need additional support and guidance. All students should not be expected to learn computer-related skills in the same way and students should not be penalized for requiring more time and practice to master specific skills. If students are penalized or pushed too quickly, or not given adequate support and guidance, the computer lessons may become associated with displeasure and lead to negative attitudes such as those expressed by Nathan and Michelle. Nonetheless, the survey results showed that the computer attitudes of students with and without learning disabilities were not significantly different and that computers can be used as part of inclusive instructional practices.

As pointed out by several of the interviewed teachers, appropriate computer software applications are needed. In addition to students’ and teachers’ attitudes about computer use, computer-assisted instruction is also dependent upon the quality of programs available. Teachers need to insist on high quality and relevant programs and help to create appropriate computer-related instruction. If appropriate software products and teachers willing to
use them are not available, schools should not waste money on computer resources that will not be used. Computer technology is very expensive and there are other instructional tools that could be purchased instead.

The results suggest that there needs to be consideration of the types of computer-related instruction that student-teachers in special education are receiving in teacher education programs. These teachers in particular need to be armed with the latest information and training in how to use computers effectively to help students with learning difficulties. This is also true of those who serve in administrative positions. Finally, ongoing research into computer-related and computer-assisted instruction is needed. Such studies need to continue to investigate the outcomes of specific products and approaches as well as look into the methods and programs which are most effective. To that end, students and teachers need ongoing preparation and training to use computers in known and innovative ways so that effective resources will be actively used in classrooms. This research should study how computers relate to the achievement of all students, but incorporate attention to how students with special learning needs are affected by such instruction. The ultimate goal is to figure out how to make the most of computers for all kinds of learners.
APPENDIX A

PARENT LETTERS
Dear Parent(s):

I am writing to ask your permission for your son or daughter to participate in a research study I am conducting at [blank] school. I am a doctoral student in the School of Education at the University of Massachusetts at Amherst. The focus of my study is the use of computers in schools and how they can help students and teachers.

The research will consist of a survey questionnaire concerning students' opinions about computers. All the questions are very general. In addition, students will be asked to respond to several demographic questions which will help me analyze the data. School personnel have reviewed the survey and given their approval for its use. I will be happy to mail or fax you a copy of the survey and demographic questions.

The survey will be distributed twice, once at the start of the year and again at the end, to help provide data about changes in students opinions over the year. Some students, selected randomly, will be asked to participate in interviews which will focus on their experiences using computers in schools.

All the results of this research will be reported anonymously and all the data will be grouped together so that individual students' responses will not be singled out. Students will not be compelled to participate if they do not choose to do so, and there is no penalty for not participating.

Consistent with the guidelines of the Human Subjects Review Committee at the University of Massachusetts, I will assume that I have your permission to include your son or daughter in the research unless I hear from you otherwise. I can be reached at the following address and phone/fax numbers, or via e-mail:

Rachel Brown-Chidsey, M.A., M.A.T.
Eaglebrook School
Deerfield, MA 01342

Phone: 413/774-7411
Fax: 413/772-2394
rchidsey@educ.umass.edu

I will be happy to answer any further questions you have regarding my research. Thank you for your cooperation and permission.

Sincerely,

Rachel Brown-Chidsey, M.A., M.A.T.
Dear [parent],

As a follow up to the survey questionnaire [name] completed for me earlier this year, I would like to interview [him/her] to learn more information about [his/her] attitudes concerning the use of computers in schools. This interview will take approximately 30 minutes and will be scheduled so that it will not conflict with any school activities. I have enclosed a copy of the interview questions for your review. I ask that you not share these with [name] so that [his/her] responses will not be influenced by previously seeing the questions.

I have already contacted [name] and s/he has expressed interest in participating in the interview. However, in order for me to schedule and conduct the interview, I will need your written consent. Please sign and date the attached permission form and return it me in the enclosed stamped, addressed envelope. I appreciate your prompt response so that I can get the interview scheduled soon.

If you have further questions concerning this interview, I can be reached by telephone at 413-774-9222 and by e-mail at rchidsey@educ.umass.edu. I thank you for your support and permission.

Sincerely,

Rachel Brown-Chidsey, M.A., M.A.T.

enclosure
APPENDIX B

PARTICIPANT AND PARENT INTERVIEW CONSENT AGREEMENTS
CONSENT FOR VOLUNTARY PARTICIPATION

I volunteer to participate in this qualitative study and understand that:

1. I will be interviewed by Rachel Brown-Chidsey using a guided interview format consisting of nine or more questions.
2. The questions I will be answering address my views on issues related to the use of computers in schools by students. I understand that the primary purpose of this research is to identify opinions, attitudes and practices that are related to the use of computers in school by students with special needs.
3. The interview will be tape recorded to facilitate analysis of the data.
4. My name will not be used, nor will I be identified personally in any way at any time. I understand that it will be necessary to identify participants in the dissertation by position and affiliation (e.g., a department chair at a secondary school said...)
5. I may withdraw from part or all of this study at any time.
6. I have the right to review material prior to the final oral exam or other publication.
7. I understand that results from this survey will be included in Rachel Brown-Chidsey’s doctoral dissertation and may also be included in manuscripts submitted to professional journals for publication.
8. I am free to participate or not without prejudice.
9. Because of the small number of participants, approximately twelve, I understand that there is some risk that I may be identified as a participant in this study.
10. I may obtain a copy of the results of this study from the author once it is completed.

Researcher’s Signature  Date  Participant’s Signature  Date
Study of teachers' and students' attitudes concerning the use of computers in schools by students

PARENT'S CONSENT FOR INTERVIEW PARTICIPATION

I agree to allow my child _____________________________ to volunteer to participate in this qualitative study and understand that:

1. My child will be interviewed by Rachel Brown-Chidsey using a guided interview format consisting of nine or more questions.
2. The questions s/he will be answering address her or his views on issues related to the use of computers in schools by students. I understand that the primary purpose of this research is to identify opinions, attitudes and practices that are related to the use of computers in school by students with special needs.
3. The interview will be tape recorded to facilitate analysis of the data.
4. My child’s name will not be used, nor will s/he be identified personally in any way at any time. I understand that it will be necessary to identify participants in the dissertation by position and affiliation (e.g., a seventh grader at a secondary school said...)
5. My child may withdraw from part or all of this study at any time.
6. I have the right to review material prior to the final oral exam or other publication.
7. I understand that results from this survey will be included in Rachel Brown-Chidsey’s doctoral dissertation and may also be included in manuscripts submitted to professional journals for publication.
8. My child is free to participate or not without prejudice.
9. Because of the small number of participants, approximately twelve, I understand that there is some risk that my child may be identified as a participant in this study.
10. I may obtain a copy of the results of this study from the author once it is completed.

_________________________  __________________________  __________________________
Researcher’s Signature  Date  Parent’s Signature  Date
APPENDIX C

IMPLIED CONSENT STATEMENTS
COMPUTER OPINION SURVEY
Teacher Version

My name is Rachel Brown-Chidsey and I am a middle school teacher and a doctoral student at the University of Massachusetts at Amherst. I am conducting a survey of students' and teachers' attitudes and opinions concerning the use of computers in schools. The survey will be conducted twice: at the beginning and end of the 1996-97 school year.

This study is completely voluntary and you can choose whether or not to participate. This survey is not connected to any of your work and whether you participate or not will not affect your job in any way. You will not be penalized for not participating. Your responses are confidential and all data will be reported anonymously and in aggregate (grouped together). I will use your name only as a way of coding and comparing the responses from each of your surveys. Your name will not be shared with anyone else. Results of the survey will be available to all participants by request. The survey takes about 15 minutes to complete.

Your informed consent to participate in the study under the conditions described above is assumed by your completing the questionnaire and submitting it to the researcher or her assistant.

Do not complete the questionnaire or hand it in if you do not understand or agree to these conditions. Thank you for your time.

Rachel Brown-Chidsey, M.A., M.A.T.
COMPUTER OPINION SURVEY

Student Version

My name is Rachel Brown-Chidsey and I am a middle school teacher and a doctoral student at the University of Massachusetts at Amherst. I am conducting a survey of students' and teachers' attitudes and opinions concerning the use of computers in schools. The survey will be conducted twice: at the beginning and end of the 1996-97 school year.

This study is completely voluntary and you can choose whether or not to participate. This survey is not connected to any of your classes and whether you participate or not will not affect your grades in any way. You will not be penalized for not participating. Your responses are confidential and all data will be reported anonymously and in aggregate (grouped together). I will use your name only as a way of coding and comparing the responses from each of your surveys. Your name will not be shared with anyone else. Results of the survey will be available to all participants by request. The survey takes about 15 minutes to complete.

Your informed consent to participate in the study under the conditions described above is assumed by your completing the questionnaire and submitting it to the researcher or her assistant.

Do not complete the questionnaire or hand it in if you do not understand or agree to these conditions. Thank you for your time.

Rachel Brown-Chidsey, M.A., M.A.T.
APPENDIX D

DEMOGRAPHIC QUESTIONS AND SURVEY INSTRUMENTS
COMPUTER OPINION SURVEY
Teacher Version A

This survey has three sections. Section I asks for background information, Section II asks for information about your computer skills and other experiences, and Section III includes items related to your opinions and attitudes about computers, their use in schools, and their use by students with special learning needs.

Please respond to all the items on the answer sheet given to you. Use only a number 2 pencil. Please give only one response per item. Some items may seem to have more than one answer but I am interested in learning your one, closest, response. Please do not write on the question sheets.

SECTION I: Please complete the following items on side 1 of the answer sheet.

NAME: Print your last and first names and your middle initial or name then fill in the corresponding circles beneath each letter.

SEX: Fill in either Male (M) or Female (F)

GRADE OR EDUCATION: Fill in the number from the following list that best matches the subject or level you now teach or your current job description. Fill in only 1.

0) none/other
1) grades pre-k through 3
2) grades 4-6
3) middle school generalist
4) ESL/Bilingual (any level)
5) Special Needs (any level)
6) English (7-12)
7) Math (7-12)
8) Science (7-12)
9) Foreign Language (7-12)
10) Social Studies/History (7-12)
11) Library Media Specialist/ Librarian (any level)
12) Technology Specialist (any level)
13) Guidance Counselor/Psychologist (any level)
14) Music Education (any level)
15) Art Education (any level)
16) Administration (any level)

BIRTH DATE: Fill in the circles for the month, day and year you were born.

Please turn over and continue.
In the box labeled **IDENTIFICATION NUMBER**: fill in the lettered boxes A-J with up to 5 of the following codes that correspond to any and all teaching certificates you currently hold or will have within the next 6 months. Each code takes up two lettered spaces.

You can write in up to 5 codes.

01) Early Childhood  
02) Elementary  
03) Middle School  
04) English as a Second Language (any level)  
05) English (7-12)  
06) History/Social Studies (7-12)  
07) Geography (7-12)  
08) Math (7-12)  
09) Science (7-12)  
10) Modern Foreign Language (any level)  
11) Latin and Classical Humanities (7-12)  
12) Business (7-12)  
13) Behavioral Sciences (7-12)  
14) Drama (any level)  
15) Art (any level)  
16) Music (any level)  
17) Speech (any level)  
18) Health/Physical Education (any level)  
19) Home Economics (7-12)  
20) Industrial Arts (7-12)  
21) Children with Moderate Special Needs (all levels)  
22) Children with Severe Special Needs (all levels)  
23) Children with Hearing and Language Disorders  
24) Children with Special Needs: Vision and/or Audition  
25) Consulting Teacher of Reading  
26) Generic Consulting Teacher  
27) Unified Media Specialist  
28) Guidance Counselor  
29) Guidance Director  
30) School Psychologist  
31) Director of Pupil Personnel Services  
32) Principal  
33) Administrator of Special Education  
34) Supervisor/Director  
35) Superintendent

**SPECIAL CODES**: Write in the square under **K** the code for your school as follows:

1) Eaglebrook School  
2) Hadley Elementary School  
3) Wilbraham-Monson Academy

Please go to the next page.
SECTION II: Please answer the following general questions starting with answer number 1 on side 1 of the answer sheet. Use only a number 2 pencil and fill in each circle completely. Please fill in only one response for each question.

Race/ethnic background:
1) African/African-American
2) Asian/Asian-American
3) Caucasian/White
4) Hispanic/Latino/a
5) Other

Are you a United States citizen? 1) Yes 2) No

3. Is English your first or native language 1) Yes 2) No

4. Do you own a computer? 1) Yes 2) No

5. Do you have regular access to a computer? 1) Yes 2) No

6. How do you rate your computer skills?
1) None 2) Poor 3) Fair 4) Good 5) Excellent

7. How often do you use a computer?

8. Where did you learn to use a computer? (choose only one)
1) Don’t use them 2) Home/Self/Friends 3) Work/Job
4) School/Special classes 5) Other

9. How long have you been using computers?
1) Never 2) Less than a year 3) 1-2 years 4) 3-5 years 5) More than 5 years

10. Do you use a computer for word processing? 1) Yes 2) No

11. Do you use a computer for educational programs? 1) Yes 2) No

12. Do you use a computer for games? 1) Yes 2) No

13. Do you use a computer for database management? 1) Yes 2) No

14. Do you use a computer for spreadsheets? 1) Yes 2) No

15. Do you use a computer for e-mail/Internet/Web? 1) Yes 2) No

Please turn over and continue
16. What is the highest educational degree you completed or are about to complete?
1) Some college 2) Bachelor's degree 3) Some graduate classes
4) Master's degree 5) Doctorate

17. How frequently do you participate in professional development activities such as conferences, courses or other activities?
1) Never 2) 1 to 2/year 3) 3 to 4/year 4) 5 or more/year

18. Do you spend any part of your day as a Special Education Teacher?
1) Yes 2) No

19. How many years of teaching experience do you have? (complete even if you are not now in a teaching role)
1) Less than 2 2) 2-5 3) 6-10 4) 11-15 5) More than 15

20. Do you consider yourself to have a learning disability or other special need that has influenced your educational experiences?
1) Yes 2) No

21. Have you participated in any computer training, including workshops and/or college level courses?
1) Yes 2) No

22. During how much of your day do you teach students with special needs, including those in mainstreamed and resource room settings?
1) None 2) 25% 3) 50% 4) 75% 5) 100%

Please go to the next page.
SECTION III: Please respond to the following statements, filling in the circles on your answer sheet starting with number 51 in the section below the line on side 1. Please fill in only one answer for each item.

51. I feel comfortable with my ability to work on a computer.

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52. The thought of using a computer frightens me.

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53. I worry about using computers because I feel like I might break them.

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54. Computers are helpful tools for school assignments.

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55. There should be one or more computers in every classroom.

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56. Computers help make schools more connected to the “real world.”

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57. Computers provide information and resources not otherwise available in schools.

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58. Computers make school fun for students.

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59. Writing is easier for students when using a computer.

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Please turn over and continue.
60. Students who use computers for school work get better grades.

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61. Computers encourage student imagination and creativity.

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62. Students should be required to learn how to use computers.

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63. Students should use computers regularly to do school-related work.

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64. Computers make it easier for students to succeed in school.

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65. Students receive enough training to use computers for school-related work.

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66. Computers help students learn how to work together and solve problems cooperatively.

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67. Computers put pressure on students to learn more and get better grades.

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68. Computers take time away from students working together.

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69. Computers are a distraction to students and take time away from instruction.

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Please go to the next page and continue.
70. I believe most students feel comfortable with their ability to work on computers.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

71. Students worry about using computers because they feel they might break them.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

Please use the following definition to answer the remaining questions:

Students with special learning needs are students who get extra help and support during the school day in order to succeed in school. These students include those with physical disabilities, learning disabilities and behavioral problems. An example of extra help would be having more time for homework and tests.

72. Students with special learning needs believe that computers can help them to improve their grades.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

73. Students with special learning needs believe that computers can help improve the quality of their work.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

74. In general, students with special learning needs believe that computers can help them compensate for their disabilities.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

75. Computers benefit students with special learning needs more than students without special needs.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

76. Students with special needs feel comfortable working with me.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

Thank you for your time.
COMPUTER OPINION SURVEY
Teacher Version B

This survey has three sections. Section I asks for background information, Section II asks for information about your computer skills and other experiences, and Section III includes items related to your opinions and attitudes about computers, their use in schools, and their use by students with special learning needs.

Please respond to all the items on the answer sheet given to you. Use only a number 2 pencil. Please give only one response per item. Some items may seem to have more than one answer but I am interested in learning your one, closest, response. Please do not write on the question sheets.

SECTION I: Please complete the following items on side 1 of the answer sheet.

NAME: Print your last and first names and your middle initial or name then fill in the corresponding circles beneath each letter.

SEX: Fill in either Male (M) or Female (F)

GRADE OR EDUCATION: Fill in the number from the following list that best matches the subject or level you now teach or your current job description. Fill in only 1.

0) none/other
1) grades pre-k through 3
2) grades 4-6
3) middle school generalist
4) ESL/Bilingual (any level)
5) Special Needs (any level)
6) English (7-12)
7) Math (7-12)
8) Science (7-12)
9) Foreign Language (7-12)
10) Social Studies/History (7-12)
11) Library Media Specialist/Librarian (any level)
12) Technology Specialist (any level)
13) Guidance Counselor/Psychologist (any level)
14) Music Education (any level)
15) Art Education (any level)
16) Administration (any level)

BIRTH DATE: Fill in the circles for the month, day and year you were born.

Please turn over and continue.
In the box labeled IDENTIFICATION NUMBER: fill in the lettered boxes A-J with up to 5 of the following codes that correspond to any and all teaching certificates you currently hold or will have within the next 6 months. Each code takes up two lettered spaces.

You can write in up to 5 codes.

01) Early Childhood
02) Elementary
03) Middle School
04) English as a Second Language (any level)
05) English (7-12)
06) History/Social Studies (7-12)
07) Geography (7-12)
08) Math (7-12)
09) Science (7-12)
10) Modern Foreign Language (any level)
11) Latin and Classical Humanities (7-12)
12) Business (7-12)
13) Behavioral Sciences (7-12)
14) Drama (any level)
15) Art (any level)
16) Music (any level)
17) Speech (any level)
18) Health/Physical Education (any level)
19) Home Economics (7-12)
20) Industrial Arts (7-12)
21) Children with Moderate Special Needs (all levels)
22) Children with Severe Special Needs (all levels)
23) Children with Hearing and Language Disorders
24) Children with Special Needs: Vision and/or Audition
25) Consulting Teacher of Reading
26) Generic Consulting Teacher
27) Unified Media Specialist
28) Guidance Counselor
29) Guidance Director
30) School Psychologist
31) Director of Pupil Personnel Services
32) Principal
33) Administrator of Special Education
34) Supervisor/Director
35) Superintendent

SPECIAL CODES: Write in the square under K the code for your school as follows:

4) Eaglebrook School
5) Hadley Elementary School
6) Wilbraham-Monson Academy

Please go to the next page.
SECTION II: Please answer the following general questions starting with answer number 1 on side 1 of the answer sheet. Use only a number 2 pencil and fill in each circle completely. Please fill in only one response for each question.

Race/ethnic background:
1) African/African-American
2) Asian/Asian-American
3) Caucasian/White
4) Hispanic/Latino/a
5) Other

Are you a United States citizen?
1) Yes
2) No

Is English your first or native language?
1) Yes
2) No

Do you own a computer?
1) Yes
2) No

Do you have regular access to a computer?
1) Yes
2) No

How do you rate your computer skills?
1) None
2) Poor
3) Fair
4) Good
5) Excellent

How often do you use a computer?
1) Never
2) Once in a while
3) Monthly
4) Weekly
5) Daily

Where did you learn to use a computer? (choose only one)
1) Don’t use them
2) Home/Self/Friends
3) Work/Job
4) School/Special classes
5) Other

How long have you been using computers?
1) Never
2) Less than a year
3) 1-2 years
4) 3-5 years
5) More than 5 years

Do you use a computer for word processing?
1) Yes
2) No

Do you use a computer for educational programs?
1) Yes
2) No

Do you use a computer for games?
1) Yes
2) No

Do you use a computer for database management?
1) Yes
2) No

Do you use a computer for spreadsheets?
1) Yes
2) No

Do you use a computer for e-mail/Internet/Web?
1) Yes
2) No

Please turn over and continue
16. What is the highest educational degree you completed or are about to complete?
   1) Some college    2) Bachelor’s degree    3) Some graduate classes
   4) Master’s degree    5) Doctorate

17. How frequently do you participate in professional development activities such as conferences, courses or other activities?
   1) Never    2) 1 to 2/year    3) 3 to 4/year    4) 5 or more/year

18. Do you spend any part of your day as a Special Education Teacher?
   1) Yes    2) No

19. How many years of teaching experience do you have? (complete even if you are not now in a teaching role)
   1) Less than 2    2) 2-5    3) 6-10    4) 11-15    5) More than 15

20. Do you consider yourself to have a learning disability or other special need that has influenced your educational experiences?
   1) Yes    2) No

21. Have you participated in any computer training, including workshops and/or college level courses?
   1) Yes    2) No

22. During how much of your day do you teach students with special needs, including those in mainstreamed and resource room settings?
   1) None    2) 25%    3) 50%    4) 75%    5) 100%

Please go to the next page.
SECTION III: Please respond to the following statements, filling in the circles on your answer sheet starting with number 51 in the section below the line on side 1. Please fill in only one answer for each item.

51. I feel comfortable with my ability to work on a computer.

1 2 3 4 5
strongly disagree disagree undecided agree strongly agree

52. The thought of using a computer frightens me.

1 2 3 4 5
strongly disagree disagree undecided agree strongly agree

53. I worry about using computers because I feel like I might break them.

1 2 3 4 5
strongly disagree disagree undecided agree strongly agree

54. Computers are helpful tools for school assignments.

1 2 3 4 5
strongly disagree disagree undecided agree strongly agree

55. There should be one or more computers in every classroom.

1 2 3 4 5
strongly disagree disagree undecided agree strongly agree

56. Computers help make schools more connected to the “real world.”

1 2 3 4 5
strongly disagree disagree undecided agree strongly agree

57. Computers provide information and resources not otherwise available in schools.

1 2 3 4 5
strongly disagree disagree undecided agree strongly agree

58. Computers make school fun for students.

1 2 3 4 5
strongly disagree disagree undecided agree strongly agree

59. Writing is easier for students when using a computer.

1 2 3 4 5
strongly disagree disagree undecided agree strongly agree

Please turn over and continue.
60. Students who use computers for school work get better grades.

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61. Computers encourage student imagination and creativity.

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62. Students should be required to learn how to use computers.

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63. Students should use computers regularly to do school-related work.

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64. Computers make it easier for students to succeed in school.

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65. Students receive enough training to use computers for school-related work.

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66. Computers help students learn how to work together and solve problems cooperatively.

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67. Computers put pressure on students to learn more and get better grades.

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68. Computers take time away from students working together.

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69. Computers are a distraction to students and take time away from instruction.

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Please go to the next page and continue.
70. I believe most students feel comfortable with their ability to work on computers.

    1  strongly disagree  2  disagree  3  undecided  4  agree  5  strongly agree

71. Students worry about using computers because they feel they might break them.

    1  strongly disagree  2  disagree  3  undecided  4  agree  5  strongly agree

Please use the following definition to answer the remaining questions:

Students with special learning needs are students who get extra help and support during the school day in order to succeed in school. These students include those with physical disabilities, learning disabilities and behavioral problems. An example of extra help would be having more time for homework and tests.

72. Students with special learning needs believe that computers can help them to improve their grades.

    1  strongly disagree  2  disagree  3  undecided  4  agree  5  strongly agree

73. Students with special learning needs believe that computers can help improve the quality of their work.

    1  strongly disagree  2  disagree  3  undecided  4  agree  5  strongly agree

74. In general, students with special learning needs believe that computers can help them compensate for their disabilities.

    1  strongly disagree  2  disagree  3  undecided  4  agree  5  strongly agree

75. Computers benefit students with special learning needs more than students without special needs.

    1  strongly disagree  2  disagree  3  undecided  4  agree  5  strongly agree

76. Students with special needs feel comfortable working with me.

    1  strongly disagree  2  disagree  3  undecided  4  agree  5  strongly agree

77. I believe that the new computers installed this year have helped students to improve the quality of their work.

    1  strongly disagree  2  disagree  3  undecided  4  agree  5  strongly agree

Thank you for your time.
This survey has three sections. Section I asks for background information, Section II asks for information about your computer skills and other experiences, and Section III includes items related to your opinions and attitudes about computers, their use in schools and their use by students with special learning needs.

Please respond to all the items on the answer sheet given to you. Use only a number 2 pencil. Please give only one response per item. Some items may seem to have more than one answer but I am interested in learning your one, closest, response. Please do not write on the question sheets.

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NAME: Print your last and first names and your middle initial or name then fill in the corresponding circles beneath each letter.

SEX: Fill in either Male (M) or Female (F)

GRADE OR EDUCATION: Fill in the circle for the grade you are now in.

BIRTH DATE: Fill in the circles for the month, day and year you were born.

IDENTIFICATION NUMBER: Leave these boxes and circles empty.

SPECIAL CODES: Write in the square under K the code for your school as follows:

1) Eaglebrook School
2) Hadley Elementary School
3) Wilbraham-Monson Academy

Please turn over and continue.
SECTION II: Please answer the following general questions starting with answer number 1 on side 1 of the answer sheet. Use only a number 2 pencil and fill in each circle completely. Please fill in only one response for each question.

1. Race/ethnic background:
   1) African/African-American 2) Asian/Asian-American
   3) Caucasian/White 4) Hispanic/Latino/a 5) Other

2. Are you a United States Citizen? 1) Yes 2) No

3. Is English your first or native language? 1) Yes 2) No

4. Do you own a computer? 1) Yes 2) No

5. Do you have regular access to a computer? 1) Yes 2) No

6. How do you rate your computer skills?
   1) None 2) Poor 3) Fair 4) Good 5) Excellent

7. How often do you use a computer?

8. Where did you learn to use a computer? (choose only one)
   1) Don’t use them 2) Home/Self/Friends 3) Work/Job
   4) School/Special classes 5) Other

9. How long have you been using computers?
   1) Never 2) Less than a year 3) 1-2 years 4) 3-5 years 5) More than 5 years

10. Do you use a computer for word processing? 1) Yes 2) No

11. Do you use a computer for educational programs? 1) Yes 2) No

12. Do you use a computer for games? 1) Yes 2) No

13. Do you use a computer for database management? 1) Yes 2) No

14. Do you use a computer for spreadsheets? 1) Yes 2) No

15. Do you use a computer for e-mail/Internet/Web? 1) Yes 2) No

This question is for students at boarding schools only:

16. Are you a day student or a boarder? 1) Day Student 2) Boarder

Please go to the next page and continue.
SECTION III: Please respond to the following statements, filling in the circles on your answer sheet starting with number 51 in the section below the line on side 1. Please fill in only one answer for each item.

51. I feel comfortable with my ability to work on a computer.

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52. The thought of using a computer frightens me.

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53. I worry about using computers because I feel like I might break them.

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54. Computers are helpful tools for school assignments.

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55. There should be one or more computers in every classroom.

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56. Computers help make schools more connected to the “real world.”

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57. Computers provide information and resources not otherwise available in schools.

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58. Computers make school fun for students.

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59. Writing is easier for students when using a computer.

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Please turn over and continue.
60. Students who use computers for school work get better grades.

1  strongly disagree  2  disagree  3  undecided  4  agree  5  strongly agree

61. Computers encourage student imagination and creativity.

1  strongly disagree  2  disagree  3  undecided  4  agree  5  strongly agree

62. Students should be required to learn how to use computers.

1  strongly disagree  2  disagree  3  undecided  4  agree  5  strongly agree

63. Students should use computers regularly to do school-related work.

1  strongly disagree  2  disagree  3  undecided  4  agree  5  strongly agree

64. Computers make it easier for students to succeed in school.

1  strongly disagree  2  disagree  3  undecided  4  agree  5  strongly agree

65. Students receive enough training to use computers for school-related work.

1  strongly disagree  2  disagree  3  undecided  4  agree  5  strongly agree

66. Computers help students learn how to work together and solve problems cooperatively.

1  strongly disagree  2  disagree  3  undecided  4  agree  5  strongly agree

67. Computers put pressure on students to learn more and get better grades.

1  strongly disagree  2  disagree  3  undecided  4  agree  5  strongly agree

68. Computers take time away from students working together.

1  strongly disagree  2  disagree  3  undecided  4  agree  5  strongly agree

69. Computers are a distraction to students and take time away from instruction.

1  strongly disagree  2  disagree  3  undecided  4  agree  5  strongly agree

Please go to the next page and continue.
70. I believe most teachers feel comfortable with their ability to work on computers.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

71. Teachers worry about using computers because they feel they might break them.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

Please use the following definition to answer the remaining questions:

Students with special learning needs are students who get extra help and support during the school day in order to succeed in school. These students include those with physical disabilities, learning disabilities and behavioral problems. An example of extra help would be having more time for homework and tests.

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1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

73. Students with special learning needs believe that computers can help improve the quality of their work.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

74. In general, students with special learning needs believe that computers can help them compensate for their disabilities.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

75. Computers benefit students with special learning needs more than students without special needs.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

76. I feel comfortable working with students who learn differently than me.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree
COMPUTER OPINION SURVEY
Student Version B

This survey has three sections. Section I asks for background information, Section II asks for information about your computer skills and other experiences, and Section III includes items related to your opinions and attitudes about computers, their use in schools and their use by students with special learning needs.

Please respond to all the items on the answer sheet given to you. Use only a number 2 pencil. Please give only one response per item. Some items may seem to have more than one answer but I am interested in learning your one, closest, response. Please do not write on the question sheets.

SECTION I: Please complete the following items on side 1 of the answer sheet.

NAME: Print your last and first names and your middle initial or name then fill in the corresponding circles beneath each letter.

SEX: Fill in either Male (M) or Female (F)

GRADE OR EDUCATION: Fill in the circle for the grade you are now in.

BIRTH DATE: Fill in the circles for the month, day and year you were born.

IDENTIFICATION NUMBER: Leave these boxes and circles empty.

SPECIAL CODES: Write in the square under K the code for your school as follows:

4) Eaglebrook School
5) Hadley Elementary School
6) Wilbraham-Monson Academy

Please turn over and continue.
SECTION II: Please answer the following general questions starting with answer number 1 on side 1 of the answer sheet. Use only a number 2 pencil and fill in each circle completely. Please fill in only one response for each question.

2. Race/ethnic background:
   1) African/African-American
   2) Asian/Asian-American
   3) Caucasian/White
   4) Hispanic/Latino/a
   5) Other

2. Are you a United States Citizen?
   1) Yes
   2) No

3. Is English your first or native language?
   1) Yes
   2) No

4. Do you own a computer?
   1) Yes
   2) No

5. Do you have regular access to a computer?
   1) Yes
   2) No

6. How do you rate your computer skills?
   1) None
   2) Poor
   3) Fair
   4) Good
   5) Excellent

7. How often do you use a computer?
   1) Never
   2) Once in a while
   3) Monthly
   4) Weekly
   5) Daily

8. Where did you learn to use a computer? (choose only one)
   1) Don’t use them
   2) Home/Self/Friends
   3) Work/Job
   4) School/Special classes
   5) Other

9. How long have you been using computers?
   1) Never
   2) Less than a year
   3) 1-2 years
   4) 3-5 years
   5) More than 5 years

10. Do you use a computer for word processing?
    1) Yes
    2) No

11. Do you use a computer for educational programs?
    1) Yes
    2) No

12. Do you use a computer for games?
    1) Yes
    2) No

13. Do you use a computer for database management?
    1) Yes
    2) No

14. Do you use a computer for spreadsheets?
    1) Yes
    2) No

15. Do you use a computer for e-mail/Internet/Web?
    1) Yes
    2) No

This question is for students at boarding schools only:
16. Are you a day student or a boarder?
    1) Day Student
    2) Boarder

Please go to the next page and continue.
SECTION III: Please respond to the following statements, filling in the circles on your answer sheet starting with number 51 in the section below the line on side 1. Please fill in only one answer for each item.

51. I feel comfortable with my ability to work on a computer.

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52. The thought of using a computer frightens me.

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53. I worry about using computers because I feel like I might break them.

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54. Computers are helpful tools for school assignments.

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55. There should be one or more computers in every classroom.

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56. Computers help make schools more connected to the “real world.”

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57. Computers provide information and resources not otherwise available in schools.

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58. Computers make school fun for students.

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59. Writing is easier for students when using a computer.

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Please turn over and continue.
60. Students who use computers for school work get better grades.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

61. Computers encourage student imagination and creativity.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

62. Students should be required to learn how to use computers.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

63. Students should use computers regularly to do school-related work.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

64. Computers make it easier for students to succeed in school.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

65. Students receive enough training to use computers for school-related work.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

66. Computers help students learn how to work together and solve problems cooperatively.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

67. Computers put pressure on students to learn more and get better grades.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

68. Computers take time away from students working together.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

69. Computers are a distraction to students and take time away from instruction.

1 strongly disagree  2 disagree  3 undecided  4 agree  5 strongly agree

Please go to the next page and continue.
70. I believe most teachers feel comfortable with their ability to work on computers.

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71. Teachers worry about using computers because they feel they might break them.

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Please use the following definition to answer the remaining questions:

Students with special learning needs are students who get extra help and support during the school day in order to succeed in school. These students include those with physical disabilities, learning disabilities and behavioral problems. An example of extra help would be having more time for homework and tests.

72. Students with special learning needs believe that computers can help them to improve their grades.

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73. Students with special learning needs believe that computers can help improve the quality of their work.

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74. In general, students with special learning needs believe that computers can help them compensate for their disabilities.

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75. Computers benefit students with special learning needs more than students without special needs.

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76. I feel comfortable working with students who learn differently than me.

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77. I believe that the new computers installed this year have helped students to improve the quality of their work.

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APPENDIX E

INTERVIEW GUIDE QUESTIONS
### INTERVIEW GUIDE QUESTIONS

1. From your survey, I know a little about your background. What else would you like to tell me about yourself?

2. What do you think of when you think of computers?

3. When and how did you first use a computer?

4. Describe for me a situation in which you have [used a computer for school work (or) watched a student use a computer for school-related work].

5. How have your own computer skills influenced your use of computers for school-related work?

6. What is your sense of how students in general view the use of computers in schools?

7. How do computers change schools or individual classrooms?

8. What do you think computers offer students with special needs?

9. What do you see as the future of computers and other technologies in schools?
APPENDIX F

INTERVIEW CODES
Study of Computers in Schools:  
Interview Coding Summary

Subject:__________________  Rater:__________________

Applications
Assignments  
Calculator  
Communication  
Editing (spelling)  
Games  
Organization  
Programming  
Research  
Teacher Prep.  
Tools

Applications in Special Education
Alternative Instruction  
Assessment/exams  
Assistive Technology  
Editing (spelling)  
Organizing  
Remediation  
Research  
Writing

Instruction
Alternative presentation  
Assignments/drills  
Fosters problem solving  
Instructional assistant  
Integration of computers  
Student-centered  
Teacher as facilitator

Positive Attitudes
Beneficial to all  
Classroom behavior  
Cost effective comm.  
Easier  
Enjoyable  
Faster  
Job preparation  
Legibility  
Professional  
Readability  
Work quality
Negative Attitudes
- Breakable
- Costly
- Debilitating
- Fear
- Frustrating
- Lack of resources
- Less human contact
- Less personal
- Loss of other skills
- Not useful/boring
- Resistance to change

Other Attitudes
- Computers common
- Increases educational quality
- Teachers still needed
- Unlimited potential

Social
- Enhances communication skills
- Fosters cooperation
- Gender differences
- More student-teacher discourse
- Need personal contact
- Prevents human interaction
- Self-centered students

Needs
- Access
- Hardware
- Money
- Personnel
- Software
- Training
- Typing

Experience
- Family/Home
- School
APPENDIX G

INCIDENCE OF SURVEY CODES
Table G.1. Incidence of codes in student interview data

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Cuban, L. (1995). Reality bytes: Those who expect technology to change schools will have to wait. Electronic Learning, 14(8), 18.


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Technology is underused in special education. *CEC Today, 4(1),* 1,5,15.


