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The impact of computer-assisted mathematics instruction for secondary students with learning disabilities

Shirley A. Celentano
Rowan University

THE IMPACT OF COMPUTER-ASSISTED MATHEMATICS INSTRUCTION FOR SECONDARY STUDENTS WITH LEARNING DISABILITIES

by
Shirley Celentano

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ABSTRACT

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2001/02
Dr. Joy F.Xin
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The purposes of this explorative study were to (a) compare results of the mathematics achievement of a group of secondary students with learning disabilities with and without computer-assisted instruction (n = 10) ; and (b) examine student satisfaction with computer-assisted instruction. The participants, ages 14 -16 years old, were classified with SLD, or "Specific Learning Disability", and had mathematic performance significantly below grade level according to their IEPs. Procedure included ten weeks of teacher-direct instruction and ten weeks of computer-assisted instruction in the computer lab. A total of eight mathematic units were covered, four during each condition of the study. Students completed a questionnaire at the end of each unit and were assessed by written teacher-made tests. A single subject design was used to compare the mean unit scores of the baseline, or teacher-direct instruction, to computer-assisted instruction. Mean and standard deviation values were analyzed in regard to a Likert Scale pre- and post-survey questionnaire collecting data about student satisfaction in computer-assisted mathematics instruction. There was no significant difference between the baseline and computer-assisted mean unit scores or student satisfaction with computer-assisted instruction.

MINI-ABSTRACT

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The purposes of this explorative study were to (a) compare results of the mathematics achievement of a group of secondary students with learning disabilities with and without computer-assisted instruction (n = 10) ; and (b) examine student satisfaction with computer-assisted instruction. Using a single subject design and a Likert Scale questionnaire, data was collected and analyzed. The study revealed there was no significant difference between the baseline and computer-assisted instruction in regard to both mean unit scores and student satisfaction.

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Chapter 1

INTRODUCTION

Background

Computer-assisted instruction (CAI) refers to the computer technologies that assists the teaching and learning process (Mitra & Steffensmeir, 2000). CAI also means the computer programs that provide students with drill-and-practice exercises or computer visualizations of complex objects, or tutorial programs (Mitra & Steffensmeir, 2000). CAI was first introduced to elementary schools in the mid 1950s and early 1960s as a collaboration of educators at Stanford University. These early systems were limited to drill-and-practice (Mitra & Steffensmeir, 2000).

As personal computers and television technology grew, CAI systems were developed and used for higher learning skills including the Programmed Logic for Automatic Teaching Operations (PLATO) system and the Time-shared Interactive Computer-Controlled Information Television (TICCIT) system (Mitra & Streffensmeir, 2000). Both were developed and used from the late 1960s to the 1970s (Mitra & Strenffensmeir, 2000).

Computers and CAI continued to grow in the 1970s and 1980s. They were becoming more common in all school programs including those for students with disabilities (Cotton, 2001). In the late 1980s, almost all schools in the United

States owned at least one computer and by the early 1990s, the national average had risen to the ratio of one computer per 16 students (Cotton, 2001). A recent development of the Internet, a "consortium of interlinked computers", has had the most profound effect on CAI (Cuban & Kirkpatrick, 1998). The Internet has made it possible to connect millions of computers worldwide and give students huge store of information. According to Cotton (2001), it appears that the increase of using computer-assisted instruction has had significant effects on the instructional opportunities available to students. Over the past thirty years, studies have shown that an evidence of moderate effectiveness in the academic performance of students who use computers (Cuban & Kirkpatrick, 1998). In conclusion, computer-assisted instruction as a supplement to teacher directed instruction, can enhance learning and benefit students of different ages and abilities in different curricular areas (Braun, 1990; Kulik, 1983).

Statement of the Problem

Students with disabilities have great difficulty acquiring and retaining mathematical skills (Miller & Mercer, 1997). This difficulty can range from mild to severe that may vary in type and intensity (Garnett, 1996). As research showed, 6% of all school-age children have math learning problems (Crawley & Miller, 1989). Beginning in the elementary school setting, math disability may not be addressed until a child is referred because of reading difficulties (Garnett, 1996). These math disabilities may continue through secondary school into late adulthood, affecting the individual's daily living and vocational aspects (Garnett, 1996). Students with learning disabilities may also have math problems that cannot only affect learning outcomes and math performance in school, but also their career development (Garnett, 1996).

Math difficulty can range from mild to severe (Strang & Rourke, 1985). Poor recalling may be one problem. Students with learning disabilities are unable to develop efficient memory strategies and simply do not remember basic math facts (Garnett, 1996). Another problem may be poor computation and problem solving skills (Mercer & Miller, 1997). As statistics show, secondary students with mild disabilities attain math proficiency at the fifth and sixth grade level which is significantly lower than their peers (Cawley, Baker-Krocyznski & Urban, 1992). A third problem is language (Miller & Mercer, 1997). These students are confused by some mathematical technologies and often cannot make the connection between language concepts and mathematical symbols (Miller & Mercer, 1997). The other problem is visual-spatial-motor organization (Garnett, 1996). Deficits in these areas may have a profound effect on math achievement according to Garnett (1996), because the student can have difficulty with pictorial representations, as well as differentiating between numbers (Garnett, 1996). In conclusion, math disabilities may be isolated or in combination with other learning problems such as poor recalling, language deficiency, poor problem solving and computational skills, and / or visual-spatial–motor weaknesses.

In addition to the specific math deficits, many factors contribute to the poor math performance of students with learning disabilities (Miller & Mercer,

1997) . These include learning rate, retention, and student attitude, motivation, and cooperation (Miller & Mercer, 1997) . Because math disabilities are not identified in the early time of schooling, these students may not get the immediate instructional attention and remediation on time (Garnett, 1996; Kulik & Kulik, 1987) . They experience repeated math failures and spend an enormous amount of time learning remedial math and basic skills (Miller & Mercer, 1997) . As a result, student's attitude and motivation are affected. According to Jones, Wilson, & Bhojani (1997) , these students are less likely to participate and cooperate in regard to math learning activities, thus affecting learning rate and achievement. Because of poor memory, math retention may be affected as well (Miller & Mercer, 1997) . Math learning progress may be slow for these students. In fact, the average math scores of a twelfth grade student with learning disabilities are at high fifth grade (Cawley, Baker- Kroczynski, & Urban, 1992) . Low math achievement may be attributed to problems with students' retention, learning rate, attitude, motivation, as well as teacher's instruction.

Different instructional skills are practiced to teach math skills. Computer-assisted instruction (CAI) is suggested (Cotton, 2001) . According to Cotton (2001) , there is a direct relationship between CAI and student math learning outcomes. Computers and computer-assisted instruction can improve student motivation, student engagement, and provide immediate feedback to students (Cuban & Kirkpatrick, 1998) . As a result, these students learn more in less time and have a better attitude towards math and become more motivated in learning (Cuban & Kirkpatrick, 1998). In addition, programs such as word processors, spreadsheets, and database could be used to collect, organize, analyze, and transmit information (Cuban & Kirkpatrick, 1998). These are very useful to teachers and students in secondary math learning. Numerous studies have reported that CAI is successful in raising examination scores, improving student attitudes, and lowering the amount of time to learn certain math materials (Cuban & Kirkpatrick, 1998). While studies vary greatly, there seems to be substantial evidence that CAI can enhance learning at all educational levels (Cotton, 2001). However, there seems to be little research studying the direct relationship of CAI and the secondary student with learning disabilities in regard to student math achievement and outcomes.

Significance of the Study

Students with learning disabilities spend most of their learning time on very simple math skills (Jones, Wilson, & Bhojwani, 1997). They are bombarded with remedial math and basic skills because of low math scores resulting from many different math disabilities (Garnett, 1996). Their progress in school is very slow and they often only gain one year of math learning in every two years of school (Badian, 1983; Cawley & Miller, 1989). Because of slow progress and repeated math failures, motivation would be impacted. As a result, these students do not always attempt complex tasks or persist in independent work (Jones, Wilson, & Bhojwani, 1997). By the time, they graduate or drop out of high school, very few students with learning disabilities have the math skills necessary to function independently (Jones, Wilson, & Bhojwani, 1997). This may be explained by a variety of factors including low expectations of success, low motivation, and prior low achievements (Jones, Wilson, & Bhojwani, 1997).

It is important to evaluate instructional methods that can improve math achievement for students with learning disabilities, especially those in the secondary classrooms. These are the students who may have given up on math learning due to repeated failures in the past and lack of motivation to learn. In fact, many students with learning disabilities reach a mathematical standstill after 7th grade (Garnett, 1992; Grimes, 1977). What can be done to improve these alarming statistics? Although it is no longer a question of whether or not the US will use computers in classrooms, the question is how can we use computers to teach mathematics effectively (Cuban & Kirkpatrick, 1998). Can computer assisted instruction increase math achievement, math retention, and learning outcomes for students with learning disabilities specifically at the secondary level? Although an abundance of research has been conducted on the effect of computer-assisted instruction and learning in general, few studies have been done specifically in regard to secondary students with learning disabilities and math achievement (Badian, 1983; Jones, Wilson, & Bhojwani, 1997; Cuban & Kirkpatrick,1987; Cawley, Baker- Kroczynski, & Urban, 1992; Cawley & Miller, 1989; Cotton, 2001; Garnett, 1996). Little study has been done specifically in regard to secondary students with learning disabilities and math achievement (Cuban & Kirkpatrick, 1998). To date, most research is directed towards general education and the elementary students. Some studies report

mixed results in relation to the benefit of computer-assisted instruction at the secondary level. For example, computers may not always be used in the math classroom, or they may not be as beneficial as what we thought, stating their effectiveness decreases from the elementary to secondary level (Bracey, 1987). There are mixed findings and lack of substantial research at the secondary math level for students with learning disabilities (Bracey, 1987). The present study explores learning achievement and student outcomes with computer-assisted instruction. The objective of the study is to demonstrate the impact of CAI on overall math learning and achievement for the student with learning disabilities in the secondary educational setting.

Statement of the Purpose

The purposes of this study are to: (a) compare results of the math achievement of secondary students with learning disabilities with and without computer-assisted instruction; (b) examine student satisfaction with computer-assisted math instruction.

Research Questions

1. **Do secondary students with learning disabilities gain in math achievement using computer-assisted instruction?**
2. **Are secondary students with learning disabilities satisfied with computer-assisted math instruction?**

Chapter 2

LITERATURE REVIEW

Can computer assisted instruction be used to help the secondary student with learning disabilities acquire and retain math concepts? In pursuant to this question, three issues will be discussed. These include the math difficulties of the student with learning disabilities, the learning outcomes of computer-assisted instruction, and computer-assisted instruction for students with learning disabilities. A review of research will define, study, and analyze these issues to explore if computer-assisted instruction can be used to help secondary students with disabilities in mathematics learning.

Math Difficulties of Students with Learning Disabilities

Many students with learning disabilities have problems, including significant difficulty in acquirement and retention of computation skills (Miller & Mercer, 1997). However, seldom do math learning difficulties cause children to be referred for evaluation according to Garnett (1996), but rather students are referred almost exclusively based on their reading disabilities. As a result, few children are given substantive assessment and remediation on their achievement of math learning. Garnett (1996) reported that the combination of math failure throughout school, and math illiteracy in adult life could affect one's daily living and vocational aspects. This has been supported by Johnson and Balock (1987), as they mentioned the popular belief "it is not okay to be rotten at math" (page 3). Supporting these issues are research from Mercer and Miller (1992); Paulos (1989); who report that in today's world, mathematical knowledge, reasoning, and skills are just as important as reading ability. Students with disabilities may have math learning problems and their math disabilities need to be identified and addressed.

Because of unidentified math disabilities, one may believe that math-learning problems are not common. This is not true according to Garnett (1996) who reports that math disabilities are both common and significant. The statistics are alarming as evidenced in research. Badian (1983) indicated that math disabilities are just as serious as reading problems and 6 % of all school age children have math learning problems. Children of eight and nine with learning disabilities performed at about a first grade level in regard to math computation and application (Cawley & Miller, 1989). Fifth graders could only solve one third as many as problems as their peers without disabilities on timed tests (Garnett, 1996). Overall, students with learning disabilities tend to progress one year in mathematical knowledge for every two years of school attendance according to the researchers (Badian, 1983; Cawley & Miller, 1989; Garnett, 1996). In addition, Fleischner, Garnett, and Shepherd's (1980) studies forecast an even bleaker picture. They found that adolescents with learning disabilities reached a mathematical plateau after seventh grade and only made an average of one years growth during grades seven through twelve (Badian, 1983). Research

reported that the average math scores of twelfth grade students with learning disabilities were at high fifth grade (Cawley & Miller, 1989; Garnett, 1996). Similar studies find that secondary students with mild disabilities attain math performance at the fifth to sixth grade level and perform poorly on required minimum competency tests (Cawley, Baker- Kroczynski, & Urban, 1992; Strang & Rourke, 1985). In conclusion, math difficulties are both prevalent and significant for the primary as well as the secondary student with learning disabilities. No matter when math disabilities are identified, these learning problems represent definite math deficits that need serious instructional attention and remediation. Only then, will students with learning disabilities have continued mathematical success.

Students with learning disabilities have math difficulties that range from mild to severe (Garnett, 1996). These math-learning problems can manifest themselves in different types of math disabilities (Badian, 1983; Strang & Rourke, 1985). Although researchers agree that there are various types of math disabilities, they do not always concur on the descriptions of these math deficits. It is evident that students with learning disabilities do experience math difficulties, and these math difficulties or disabilities may vary in type and intensity (Garnett, 1996).

<u>Types of Mathematical Disabilities</u>

The most common math deficit for children with learning disabilities is memorizing basic number facts in all operations (Fleischner, Garnett, &

Sheperd, 1982; Strang & Rourke, 1985). According to Garnett (1996) students with this problem seem unable to develop efficient memory strategies, and continue to solve basic number operations such as in $4 + 2 = 6$, or $2 \times 2 = 4$, by counting fingers, pencil marks, or other items. They simply do not remember addition facts or multiplication tables, even with the most primary numbers (Garnett, 1996). For some students with learning disabilities, this may be their only notable math difficulty. If this is the case, some visual and/or technological aid should be provided to the student, because the problem is memory but not the student's understanding of the math operation (Garnett, 1996; Fleischner, Garnett, & Shepherd, 1996; Smith, 1994; Steen, 1987). It is recommend that these students be allowed to use the aids until they master the skills.

Another math difficulty for children with learning disabilities is arithmetic weakness (Garnett, 1996). Miller and Mercer (1997) found that students lack of arithmetic or computation skills are consistent to have problems. Children with this math deficit are "reliably unreliable" (Garnett, 1996, p. 5) in paying attention to operational signs and number signs. Sequencing steps in complex operations are also a major problem (Miller & Mercer, 1997). Although these students know math concepts, they have difficulty in math computation (Miller & Mercer, 1997). Children with arithmetic weakness and poor computation skills may also have problems mastering basic number facts (Jones, Wilson, & Bhojani, 1997). In these cases, often these students are bombarded with remedial math and prolonged instruction in the basic skills (Garnett, 1996;

Jones, Wilson, & Bhojani, 1997; Steen, 1987). Students' motivation and attitudes toward math may be affected, as well as learning outcomes (Jones, Wilson, & Bhojani, 1997). While these skills are necessary and need to be improved, it is important to expose children with learning disabilities to mathematics application and practice (Jones, Wilson, & Bhojani, 1997). There is more to math than "right-answer reliable calculating" (Garnett, 1996, p. 4), students with memory, computation, and basic arithmetic deficits should be allowed to experience higher-level thinking in mathematics.

A third learning problem is language disability (Miller & Mercer, 1997; Jones, Wilson, & Bhojani, 1997; Garnett, 1996; Miller & Mercer, 1997). According to Garnett (1996), language disabilities can interfere with math learning. Miller and Mercer (1997); Jones,Wilson, and Bhojani (1997) report that students with learning disabilities are often confused by the terminology in math thus having difficulties in following directions and doing complex computations. Language skills are crucial to math achievement because of the connection between language concepts and mathematical symbols (Miller & Mercer, 1997). In addition, language skills are needed to recall and use the many rules, steps, and math facts necessary in mathematical computation (Strang & Rourke, 1985). For example 73 x 96 = ? In this problem alone, there are thirty-three steps a student must use to get the correct answer (Strang & Rourke, 1985). Reading and language problems can also interfere with the learning disabled student's ability to solve word problems (Smith, 1994). These students lack the skills necessary to process, understand, and solve word

problems (Smith, 1994). For students with learning disabilities, language deficits may be an isolated problem or combined with other math deficits.

Another, less common, math disability is visual-spatial-motor organization (Garnett, 1996). According to Garnett (1996), difficulties in these areas may have a profound effect on math skills, and result in a weak understanding of math concepts. Students can have a very poor "number sense" (Garnett, 1996, p. 5) and difficulty with pictorial representations (Garnett, 1996; Miller & Mercer, 1997; Strang & Rourke, 1985). Other indications of visual-spatial-motor difficulties are poorly controlled and writing, the inability to follow and keep place on a worksheet, and / or the difficulty in writing across a paper in a straight line (Miller & Mercer, 1997). Another characteristic of visual-spatial deficit is displayed by the child who has problems differentiating between numbers, e.g., 6 and 9; or 17 and 71 (Miller & Mercer, 1997; Strang & Rourke, 1985). In addition, students with greatly impaired conceptual understanding often have substantial motor deficits and "are presumed to have right hemisphere brain dysfunction" (Strang & Rourke, 1985, p. 2). These motor disabilities may result in a student writing numbers illegibly, slowly, and inaccurately (Miller & Mercer, 1997). Often these students have difficulty writing numbers in small places or keeping them in line in arithmetic classes. Although, not as prevalent as other math difficulties, visual-spatial-motor difficulties do exist among children with learning disabilities, and only when the children have long-term remedial attention, will they have a chance for math success (Babbitt & Miller, 1997; Miller & Mercer, 1997). In conclusion,

students with learning disabilities may have difficulty acquiring and retaining math skills. These math deficits may be combined with other learning problems or be isolated. Often, math disabilities are only identified when reading problems occur, and the child is referred. Math disabilities are both common and significant and range from mild to severe. Many factors contribute to math difficulties, and these deficits usually begin in elementary school and continue through secondary education into adulthood. Math disabilities can, not only affect learning outcomes and math performance in school, but also the daily living skills and vocational opportunities of the student.

Computer-Assisted Instruction (CAI)

The following review of research will analyze the relationship between computed-assisted instruction and the student with learning disabilities. The main focus will be on learning achievement and student outcomes. Educational computer applications will be discussed as they relate to computer-assisted instruction or CAI.

Definitions

To interpret the research findings, a common computer vocabulary is needed. Because many terminologies are used and disputed, teachers and researchers are often confused by information about CAI and other learning activities involving computers (Kulik, 1983; Kulik, Bangert, & Williams, 1983). Below is a list of definitions by Cotton (2001) that were compiled from Bangert-Drowns et al., (1985), Badian (1983), Goldman and Pellegrino (1987),

Grimes (1977), and Rupe (1986). Cotton (2001, p. 4) writes, "these definitions represent commonly accepted (though certainly not the only) definitions of these terms":

Computer-based education (CBE) and computer-based instruction (CBI).

CBE and CBI are the broadest terms and can refer to virtually any kind of computer use in educations settings, including drill and practice, tutorials, simulations, instructional management, supplementary exercises, programming, database development, writing using word processors, and other applications. These terms may refer either to stand-alone computer learning activities or to computer activities which reinforce material introduced and taught by teachers.

Computer-assisted instruction (CAI).

CAI is a narrower term and most often refers to drill-and-practice, tutorial, or simulation activities offered either by themselves or as supplements to traditional teacher directed instruction.

Computer-managed instruction (CMI).

CMI can refer either to the use of computers by school staff to organize student data and make instructional decisions or to activities in which the computer evaluates students' test performance, guides them to appropriate instructional resources, and keeps records of their progress.

Computer-enriched instruction (CEI).

CEI is defined as learning activities in which computer (1) generate data at the students' request to illustrate relationships in the models of social or physical reality, (2) execute programs developed by the students, or (3) provide

general enrichment in relatively unstructured exercises designed to stimulate and motivate students (Cotton, 2001).

There is a relationship between computer based learning and student outcomes (Cotton, 2001). According to Braun (1990); Gore, et al., (1989); Kulik (1987); Robertson, et. al,. (1987); Roblyer, et. al., (1988), computer-assisted instruction, when used as a supplement to traditional-directed instruction can enhance learning. CAI may be "beneficial to students of different ages and abilities and for learning in different curricular areas" (Cotton 2001, p. 2). This includes students with disabilities (Badian, 1983; Cawley, et. al., 1992; Cotton, 2001; Okolo, Bahr, & Reith, 1993). Both teachers and administrators show remarkable agreement in their assessment of the benefits of computers and other technologies for students with learning disabilities (Babbitt, & Miller, 1997; Braun, 1990; Cotton, 2001; Strang & Rourke, 1985). Student achievement, learning rate, retention of learning, student attitude, and other variables can be improved by computer-assisted instruction in classrooms; especially for those with disabilities (Cotton, 2001; Okey, 1985; Roblyer et. al., 1988). CAI and computer technology can improve the delivery of instruction for the students with learning disabilities by allowing them to proceed at their own pace (Babbitt & Miller, 1987). An increase in academic performance, due to a greater self-concept, may also be realized (Babbitt & Miller, 1997; Bialo & Sivin, 1980; Braun. 1990). In addition, there is often an improvement in motivation and cooperation for the learning disabled students because of a better attitude towards learning and academic achievement (Cotton, 2001).

Student Achievement

Computer-assisted instruction results in greater student achievement than traditional instruction alone (Cotton, 2001). This finding is supported by the research of Kulik, Kulik, and Bangert-Drowns (1985). In their analysis, 32 studies of the comparative effects of computer-based and computer-assisted instruction and non-CBI, non-CAI were researched. They found that computer-assisted instruction had a significant, positive effect on student achievement. Similarly, Okey (1985) reviewed nine studies using meta-analyses on the effectiveness of computer-assisted instructions, and reported that CAI was effective in promoting learning, particularly when used to supplement traditional teacher directed instruction. In several studies, students with learning disabilities, mental retardation, hearing impairments, language disorders, and/ or emotional disorders showed greater achievements levels with computer-assisted instruction alone (Bialo & Slivin, 1990). Cotton (2001) reports in her analysis of research, "that some handicapped CAI students even outperform their conventionally taught non-handicapped peers" (p. 3).

Learning Rate

Student learning rate is faster with computerized assisted instruction than with conventional instruction, thus enabling students to achieve at higher levels (Cotton, 2001; Kulik & Kulik, 1987; Mercer & Miller, 1992). Some studies reported that with computer-assisted instruction students learned the same amount of material in less time than students with traditional instruction and

others found that they learned more skills in the same time (Kulik & Kulik, 1987; Steen, 1987). While researchers do not readily agree on how much the learning rate increases, Capper and Copple (1985) indicated "CAI users sometimes learn as much as 40 percent faster than those receiving traditional, teacher-directed instruction" (p. 338). This is a great advantage to the learning disabled children who may be below grade level. Increased learning rates will provide opportunities for children with disabilities, to perhaps, catch-up with their non-disabled peers.

Retention of Learning

Memory and retention are often a problem with students with learning disabilities who have difficulty developing "efficient memory strategies" (Garnett, 1996, p. 5). Can CAI be used to improve learning retention for students in general, as well as those with disabilities? According to comparative studies by Kulik (1986); Kulik, Bangert, and Williams (1983), retention of content knowledge using CAI is superior to that following traditional instruction alone. It seems that not only does computer-assisted instruction help students of all abilities learn better and faster, it also assists retention of learning more than students receiving traditional instruction alone.

Student Attitudes

Research evidenced that computer-assisted instruction enhanced student attitudes toward many aspects of education (Cotton, 2001; Kulik, 1983). This

includes opinions toward the use of computers, course content, quality of instruction, and school in general (Bialo & Sivin, 1990; Braun, 1990; Cotton, 2001; Roblyer, Castine, & King, 1988) . In addition, student self-esteem and self-concept is often improved (Cotton, 2001; Kulik, 1983; Mevarech, Stern, & Levita., 1987; Robertson, et. al., 1987) . Students like working with computers because there is immediate, objective, and positive feedback (Rupe, 1986; Robertson, et al., 1987) . Computers do not embarrass students who make mistakes (Robertson, et al., 1997) . Therefore, student's interest continues to grow and flourish. When students are more likely to participate in math activities and math achievement increases as a result (Cotton, 2001; Robertson, et al., 1987) . Positive attitudes towards learning math, as well as learning in general, increased (Bialo & Sivin, 1990; Cotton, 2001; Robertson et al., 1997) . This is especially important for students with learning disabilities who may have struggled with learning math and experienced failure in the past.

Other Variables

Computer-assisted instruction has been extensively researched in regard to student achievement, learning rate, learning retention, and student attitudes especially for the general education population. Some researchers investigated CAI's affect on other variables including student attendance, motivation, cooperation, and collaboration. Overall, it was found that with computer-assisted instruction students had better attendance in school, more cooperative, and higher rates of task behavior than traditionally instructed students (Bialo &

Sivin, 1990; Capper & Copple, 1985; Kulik, Bangert, & Williams, 1983; Mevarech, Stern, & Levita, 1987; Rupe, 1986) . Little research has been done in regard to these specific variables for students with learning disabilities.

In summary, when computer assisted instruction is used as a supplement to conventional instructional methods, student achievement is greatly improved. This improvement includes learning rate, retention of learning, student attitudes, attendance, motivation, cooperation, and / or collaboration. Overall, the students taught by computer-assisted instruction, show a more positive attitude about school in general and show greater achievement, than students who are traditionally instructed without a computer. Interestingly, these findings are true for students at different ages and with different abilities across the various curriculum areas.

CAI in Mathematics for Students with Learning Disabilities

Many students with learning disabilities and difficulties struggle in learning mathematical concepts. They have trouble remembering basic math facts, calculating, understanding mathematics symbols and solving word problems. Often the student with learning disabilities has a history of math failure. Computer software, with its color, graphics, sound, and activity can capture the attention of students to persist in activities (Babbitt & Miller, 1997; Kirkpatrick & Cuban. 1998) . When children with learning disabilities use appropriate technology, they enjoy learning more and make gains in mathematics performance (Babbitt & Miller, 1997) . As a result, learning rate and student

achievement in math may be increased. Several effective math interventions were identified for students with learning disabilities (Babbitt & Miller. 1997). Goldman and Pellegrino (1987) ; Okolo, Bahr, and Ruth (1993) found that CAI has been an effective tool for mathematics instruction. Computers and the appropriate CAI can help students with learning disabilities to minimize their disabilities and maximize their learning strengths (Babbitt & Miller. 1997). When it takes place, these children have greater math success as well as overall learning. According to Babbitt and Miller (1997), "computer-based solutions represent the future in educators' efforts to help students with learning disabilities achieve in school up to their potential" (p. 94).

Computer-based Solutions and Software

Computer software is a tool in effective math instruction and learning. Depending on the design and context, software can do a variety of tasks such as presenting new subject matter, reinforcing previously learned skills, or offering problem solving skills (Garnett, 1992). Each of these formats can enhance mathematica instruction and be used effectively by students with learning disabilities (Biala & Sivin, 1980; Braun, 1990; Cotton, 2001; Garnett, 1992). Computers can be used to support traditional teacher-direct instruction. The courseware that the computers utilize is called software and may be classified in four categories: drill and practice, tutorial, games, and simulations (Garnett, 1992).

Drill and practice refers to software that reinforces previously learned

Skills (Fleischner, Garnett, & Shepherd, 1982). It is assumed that context has been taught and the software's purpose is to provide practice and reinforcement. For many children with learning disabilities, repetition and reinforcement is a crucial step in learning and mastering skills according to Bracey (1987). Computers and CAI can give these students the practice they need while also maintaining their attention. There are two common features of drill and practice: namely branching and feedback (Badian, 1983; Bialo & Sivin, 1980; Mercer & Miller. 1992). As math questions are presented, the program will branch to easier or more difficult tasks depending on the students' response to the problem, (Mercer & Miller, 1992). Feedback confirms accurate responses and includes additional practice if the student answer is wrong. Children like working with computer because they get immediate objective feedback and are not embarrass by making mistakes. The software of drill and practice allows students with learning disabilities to work privately and provide feedback immediately (Cotton. 2001). Babbitt and Miller (1986) recommend selecting software that indicates a range in which a correct answer should lie, rather than a program that simply indicates a wrong answer, for the student with learning disabilities. Software should also help these children solve the math problem on their own (Babbitt & Miller, 1997). A good example is "Fraction Fireworks" (Babbitt & Miller, 1997), because the program incorporates an interesting feedback technique. When the students select the correct fraction, an exciting firework celebration appears.

Tutorials are computer programs that teach new skills, new concepts, or new programs that teach new skills, new concepts, or new learning processes (Bracey, 1987). Selecting the correct tutorial is important because many students with learning disabilities get confused if the same task is presented in different ways (Babbitt & Miller, 1997). The content and procedures of the tutorial should match those being taught in school. Learning style of the children with learning disabilities should also be considered (Smith, 1994). They recommend selecting instructional content that is clear and in logical sequential steps. A good tutorial program also includes follow-ups or drill and practices activities, which is vital to the retention of math skills for students with learning disabilities.

Some drill and practice and tutorial math programs have record keeping capabilities so that keep track of student responses through the lesson (Babbitt, & Miller, 1997; Smith, 1994). This is a great advantage to learning disabled students because it helps them understand their mistakes and set realistic goals (Babbitt & Miller, 1993; Okolo, Bahr, & Reith, 1993). This feature can be used by the teacher who wants to monitor the child's success in learning math and plan the student's individualized educational program (Babbitt & Miller, 1997; Okolo. Bahr, & Reith. 1993).

Another category of computer software is education games. These games can be used to introduce new math skills to the students with learning disabilities or reinforce previously learning skills. Educational games use a content format that allows the learner to compete with the program or with other students (Bracey, 1987; Smith, 1994). Students work towards a directed goal by applying accepted mathematics rules and principals (Smith, 1994). There is a sense of accomplishment and success for students with learning disabilities as they complete these goals, thus increasing motivation and attitude towards mathematics learning.

Simulations are programs that place students in real life situations, where they can test alternative solutions to a problem. Computer-based simulators are often used to "present situations that are too difficult or dangerous to recreate and experience in real life", (Bracey, 1987, p. 22). Selecting software that simulates real-life problems is the most effective program for teaching mathematics to the students with learning disabilities to explore more than one way to solve a problem (Babbitt & Miller, 1997). The best mathematic programs are those that allow "multiple roads to problem solution" (Babbitt & Miller, 1997, p. 101) ..

Problem solving software can use a variety of skills and information to complete the simulation. Often it is designed for two or more students working together. This feature can have academic and social benefit for the student with learning disabilities (Babbitt & Miller, 1997; Cotton, 2001; Miller & Mercer, 1997). Grouping students with complementary skills or strengths can also enhance mathematics learning by cooperative efforts (Cotton, 2001; Miller & Mercer, 1997).

Recommendations for Selecting Software

Math computer software should have simple screen displays because the students with learning disabilities are often distracted by too much stimuli coming at them at the same time (Babbitt & Miller, 1997). Busy and crowded screens will take away from the math idea being presented. Staying attentive is crucial to learning and any tool that keeps the student's focus is helpful to children with learning disabilities.

Software should match mathematical concepts being taught in class especially in computation, so that students with learning disabilities do not become confused. Also programs with small increments between levels are recommended (Babbitt & Miller, 1997; Bracey, 1987). Math software that makes large jumps in difficult is not beneficial to students with learning disabilities (Babbitt & Miller, 1997). Care must be taken in selection so that the children can proceed from one math level to another with smooth successful steps.

Choosing math software that can be easily modified for teaching students with learning disabilities are also suggested. Some students are motivated by speed whereas others are not. When selecting math programs speed, number of problems, and math levels that can be easily adjusted should be considered. Students with learning disabilities may have varying math abilities; the number of problems as well as the difficulty can be modified to meet their needs (Babbitt & Miller, 1997).

Math software that has built in instructional aids has been shown to be very effective. For example, counters, number lines, base-ten blocks, hundreds charts, or fraction strips (Babbitt & Miller, 1997). These "virtual models" can be used by the student to represent a given problem and then go on to solve it (Babbitt &

Miller, 1997; Bracey, 1987; Capper & Copple, 1985). Mathematics software by Sunburst is a good example and is recommended for students with learning disabilities (Babbitt & Miller, 1997).

Another highly regarded computer program is "Math Companion" from Visions Technology, because of the many features beneficial to children with disabilities and learning problems (Babbitt & Miller, 1997). These options include controlling the number of items on a page, selecting a single or multiple objective(s), producing problems with procedural hints, showing examples on the page, selecting alternating graphics, producing answer help with problems worked out, and providing estimation lines (Babbitt & Miller. 1997). Not only can this comprehensive software create individualized math activities that relate directly to math objectives, it can modify type size, style, and problem orientation (horizontal and vertical) as well (Babbitt & Miller, 1997). These features of the "Math Companion" are very helpful and can be used to modify the screen for students that may have visual, spatial, and / or motor difficulties (Miller & Mercer, 1997). According to Babbitt & Miller (1997), this "user friendly software" makes it easy to select options and change a math problem by "just a click of the mouse" (Babbitt & Miller, 1997, p. 106).

Computer software is not a total solution for accommodating children's math disabilities and learning problems, but an instructional tool to be used by the teacher. Computers and software can capture and hold the attention of students with learning disabilities with all the color, animation, graphics, and sound (Babbitt & Miller, 1997). As a result, the children will persist in math

activities and learn more. Because of the interactive qualities of computers, software makes it possible for math activities to be both exciting and imaginative and be used in "paired" activities to facilitate learning. Computer programs can be modified to fit a student's mathematics level and individual pace. Students' math lessons are presented in clear and concise language with plenty of reinforcements and practice skills. In addition, systems can keep track of individual progress to help the teacher make adjustments. Problem solving skills are increased with educational math games and simulations that can elate math activities to the real world. Most importantly, appropriate computer software can help the students with visual-spatial-motor difficulties by modifying the size, alignment, and location of text. All of these software features can be used to enhance mathematics learning for the students with learning disabilities.

Summary

A broad review of literature summarized the math difficulties of the student with learning disabilities and the use of computer assisted instruction as a supplement to traditional teacher-direct instruction to enhance mathematics learning and increase overall student achievement.

CAI, along with the appropriate computer software, can improve instruction for children who have learning disabilities. These difficulties may include math recall, arithmetic weakness, computation skills, attention deficit, and visual-spatial-motor difficulties that also may affect student attitude, motivation, cooperation, collaboration, and attendance. Because of unidentified math

disabilities children can struggle for years with math learning problems and often experience failure. Computers and CAI provide them with an opportunity for meaningful and successful learning. Therefore, learning mathematics with computers becomes fun, and most importantly positive. The interactive nature of the computer software engages the students and increases their focus and motivation. As a result, students with learning disabilities are more apt to be attentive and persist in math activities. Thus, an improvement in mathematics learning and student achievement might be improved. In conclusion, computer assisted instruction, when properly used as a supplement to traditional teacher directed instruction, along with appropriate computer software, can enhance learning of students with disabilities by providing a meaningful tool to assist them be successful in learning mathematics.

Chapter 3

METHOD

Samples

Students

Ten 9th grade special education students, ages 14 – 16 years old, and attending a medium size regional high school in a rural northeastern region of the United States participated in the study, (see Table 1) . All the students were in an Intermediate Math Resource Class, entitled Math 1. The instruction was conducted in the 3rd period, 9:15-9:59am, Monday through Friday for the entire school year. Each class lasted 44 minutes in a room for special education programs with a total capacity of 12. The Math 1 Intermediate Resource Class was following the curriculum of the Math 1 regular education class. Students used the same *Pre-Algebra* textbook, curriculum, and calculators as the regular students. All participating students were identified as learning disabled by the school district personnel using state eligibility standards, (see Table 2) . The students had IEP goals and objectives in mathematics. According to their IEPs, math performance was significantly below grade level resulting placement in the math resource class because small class size and individualized attention were recommended for all of these students.

Table 1

Age and Gender Distribution of the Participating Students

Students	Age	Gender Male	Female
1	15	x	
2	14	x	
3	14	x	
4	16		x
5	16	x	
6	15	x	
7	14		x
8	14	x	
9	15		x
10	15	x	
Total		7	3

Teachers

The Intermediate Math 1 Resource Class was taught by a secondary education teacher with 17 years total teaching experience, and two of the years in special education. The teacher has a BA degree in secondary education plus a teaching certificate and special education. Her continuous study includes 38 graduate credits in special education and a strong undergraduate background in the math and sciences. The teacher also serves as the special education teacher in the Math I Inclusion class, which has a total of 33 students including 13, classified as learning disabled. Prior experience with the Math I curriculum and the textbook, *Pre-Algebra* by Prentice Hall, includes two years as both a resource and inclusion teacher. Total math classes taught by the teacher over the past two years were 6 and the remaining classes were in the Sciences. Along with the teacher, there was also teacher's assistant with 16 years experience working in special education classes.

Table 2

Participating Students' Classification and Programs

Students	Classification	Areas of IEP Objectives	Program
1	SLD	math and reading	Resource 80%
2	SLD	math and reading	Resource 80%
3	SLD	math	Resource 40–80%
4	SLD	math, reading, and language	Resource 40-80%
5	SLD	math, language, and behavior	Resource math
6	SLD	math	Resource 80 %
7	SLD	math, reading, and language	Resource 80%
8	SLD	math and language	Resource 80%
9	SLD	math, reading, and language	Resource 80%
10	SLD	math and behavior	Resource 80%

<u>Research Design</u>

A single-subject design with the A-B format was used in this study. During the A condition, or baseline, 4 teacher-made unit tests were provided and students' scores were recorded. During the B condition, or treatment, the computer-assisted instruction was introduced and 4 teacher-made unit tests were provided as well as students' scores collected. In addition, students completed a 14 point written questionnaire in the form of a Likert scale at the end of each unit (see Appendix A). The randomized form used a stem of 5 directions in which the

respondent indicated the degree of agreement in regard to each of the statements in the questionnaire. Each direction was assigned a numerical value and was used to collect data accessing student motivation, participation, cooperation, and self-concept in the Intermediate Math I Resource Class.

Instructional Setting

The study was conducted in two settings, the resource classroom and the computer lab located in the school's media center. The resource classroom is located in the special education area of the school at the far end of the hall. It is a small room that has the capacity for twelve students, a teacher, and a teacher's aid. The room is located on an exterior wall and has three large windows exposing the outside physical education areas. There is little student traffic outside the classroom that includes fluorescent lighting, a room length chalkboard, and no computers.

The school media center is a high traffic area located at the center of the school. The computer lab is a separate glass enclosed room within the media center. There are no windows and the computer room can be viewed from any location in the media center. Equipment includes 15 computer stations, one printer, and a mini teacher's workstation including a portable white-board. The computer lab is climate-controlled and includes fluorescent lighting.

The students spent a total of ten weeks in the resource room, with 44 minutes of instruction 5 times a week. During this time, teacher-direct instruction was provided. From this, the baseline, was established. Next, computer-assisted instruction was introduced to the students. This B condition,

or treatment, ran for ten weeks. The computer-assisted instruction also included 44 minutes of instruction 5 times a week.

Instructional Materials

Instructional materials included both teacher-made and textbook related commercially produced materials. The classroom instruction was teacher-direct instruction including drill-and-practice accommodating the different degree of math abilities among the students. Instruction in the computer lab included two power-point presentations, and computer programs developed by the teacher.

PROCEDURES

The study was implemented in the participating students' special education resource math class for two marking periods including 8 units over twenty weeks. Each unit was approximately 2.5 weeks depending on content and the school calendar. Students completed a questionnaire at the end of each unit and were assessed by written teacher-made tests.

Instructional procedure

Procedure of math instruction in the baseline condition, or teacher-direct instruction, was conducted the same way for the ten weeks, except for evaluation days. It started with a five-minute pre-class assignment that reviewed the previous day's objectives or introduced the lesson. The written assignment was collected by the assistant, graded, discussed and returned to the students as the teacher checked homework. The next ten minutes was used to correct homework problems and answer student questions. Homework and pre-class grades were

used to compute the marking period averages, but not the unit scores for this study. Following homework, there was teacher direct-instructionl for 15 minutes, followed by ten minutes of student practice. The last four minutes of the class was used to summarize the math objectives of the class and to assign homework. (see Appendix B) for a sample lesson plan.

Instruction in the computer lab was structured in a similar fashion to that of the teacher-direct instruction. During the first five minutes, pre-class activities included an oral review of the previous day's math objectives or introduced the computer program. Homework was checked, and evaluated in the same procedure as with the baseline. However, the remaining part of the class was used forstudent-individualized instruction by the computer programs. Each student worked at his or her own pace, following the directions and completing the practice problems as instructed to do so. Homework was assigned through the computer programs. Students who finished ahead of time were allowed to play mathematical games on the computer. (see Appendix C) for a sample lesson plan.

Measurement procedure

Baseline scores were achieved from teacher-direct instruction in the resource classroom during the first marking period. Treatment scores were determined from computer-assisted instruction in the computer lab. The teacher and assistant were the same for both settings. During the twenty-week study, one day a week was used for remediation and assessment purposes including written tests and questionnaires. It was determined the students had a working

knowledge of computers and the Internet by the media center staff. All of the participants had previous computer training, in the media center, as part of their 9th grade English classes, Fall 2001.

Dependent Measures

Measures on student achievement from written unit tests were recorded during the twenty-week period. The teacher-made unit tests included 25 items assessing mathematical computation, reasoning, and mathematical written expression. Each item was worth 4 points, for a total score of 100 per unit test.

Student satisfaction was measured by a 14-item questionnaire that was given at the end of each unit. The randomized questionnaire was designed as a Likert Scale and offered 5 directions for each statement. Numerical values were assigned for the answers, in which (5) represented always, (4) almost always, (3) sometimes, (2) almost never, and (1) never.

RELIABILITY

Measurement Reliability

Unit scores were determined by written tests and analyzed by test-retest and criterion-referenced methods. The teacher-made unit tests assessed the students' knowledge of direct instruction during the first ten weeks and computer-assisted instruction during the second ten weeks.

Procedure Reliability

Instructional time, testing format, questionnaires, classrooms, and staff were the same throughout the study. The computer-assisted instruction was held in the computer lab every Monday, Tuesday, Wednesday, Thursday, and Friday of the second 10-week period, except when prohibited by the school calendar. Mondays and Fridays were used to access the students by written evaluations, provide individualized instruction, complete make-up work, and answer questionnaires whenever appropriate. The same procedures were followed in the study of teacher-direct instruction during the first ten weeks, or baseline, of the study.

Chapter 4

RESULTS

Mathematics Achievement

Unit scores were analyzed in a single subject, A – B design, comparing teacher-direct instruction to computer-assisted mathematics instruction, whereby the baseline or A condition, represents the teacher-direct instruction and the treatment, or B condition, represents the computer-assisted instruction. Descriptive data is presented in Table 3, Table 4, and Table 5 . There was no significant difference between baseline and computer-assisted scores.

Student Satisfaction

Mean and standard deviation values were analyzed in regard to a fourteen point randomized Likert Scale questionnaire collecting data about student satisfaction in teacher-direct and computer-assisted mathematics instruction. Descriptive data is presented in Table 4, whereby pre-survey represents the baseline conditions or teacher instruction, and post-survey represents the computer-assisted instruction. A T-test was used to analyze the difference between the pre-and post-survey mean scores per item of the Likert Scale. There was no significant difference between the baseline and computer-assisted scores.

Table 3
Unit Scores of Math Achievement

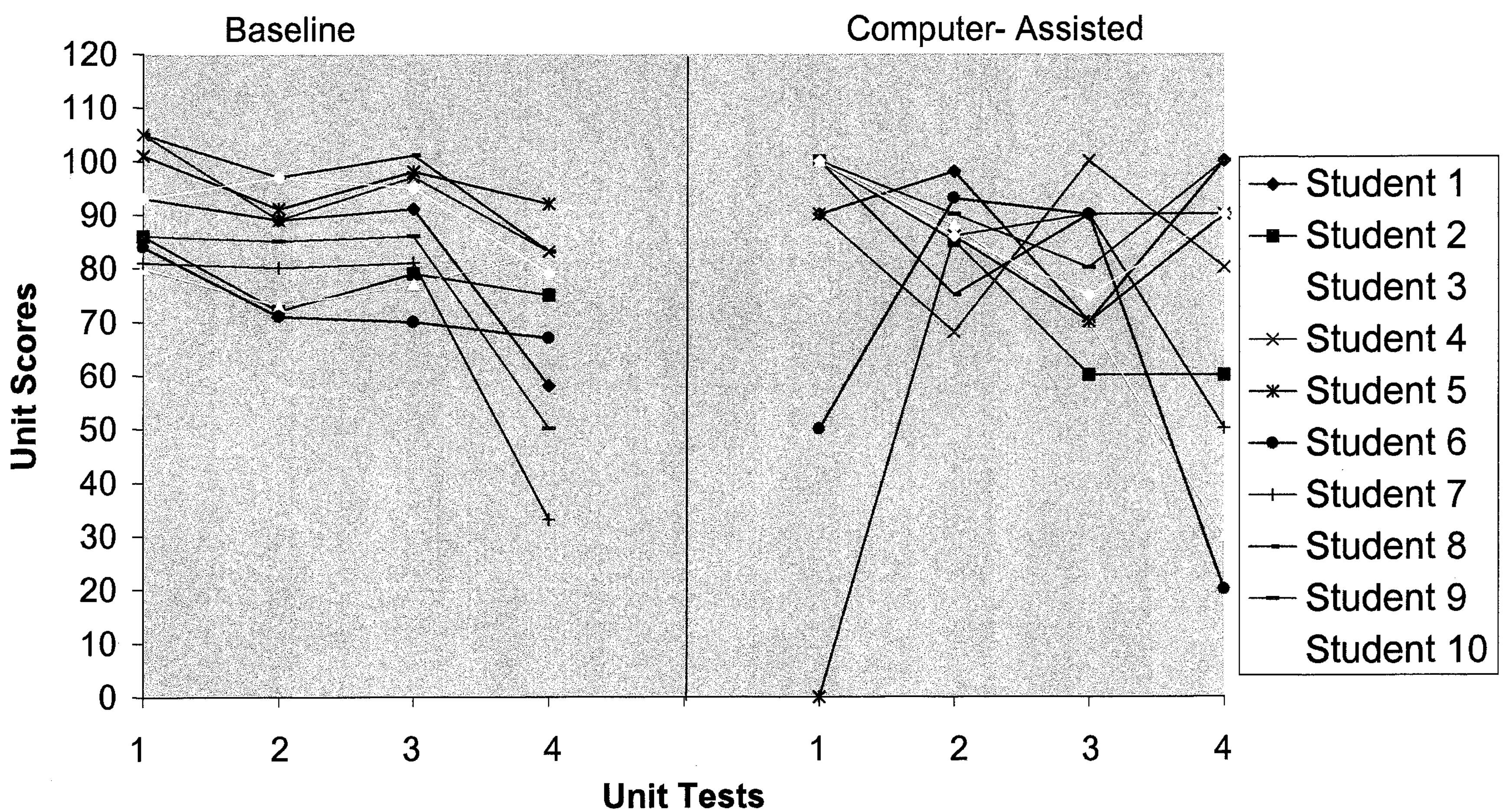

Table 4

Mean Item Scores of Student Satisfaction Pre- and Post-Survey

Survey Items	Pre-Survey		Post-Survey	
	Mean	SD	Mean	SD
1. I think math is important.	3.80	3.35	3.95	0.73
2. I am interested in what we are learning in math class.	3.85	1.13	3.20	0.83
3. I like coming to math class.	4.10	0.81	3.70	1.51
4. I am prepared for math class.	3.80	1,03	3.75	0.95
5. I complete my homework.	3.80	1.03	3.75	1.37
6. I study before a test or quiz in math.	3.85	1.31	2.9	0.96
7. I feel motivated to learn math.	3.10	1.05	3.58	0.87
8. I participate in math class.	3.85	0.94	3.98	0.68
9. I follow the math lesson.	3.35	1.16	3.93	1.03
10. I help other students in the math class.	3.45	1.16	3.08	0.71
11. I like to work with other class members in math.	3.65	1.07	3.90	0.76
12. I feel confident about learning math	3.80	0.82	3.85	0.76
13. I get good grades in math class.	3.80	0.75	3.78	0.67
14. Math is one of my favorite subjects.	3.40	1.39	3.33	0.71

Table 5

T – test on Pre- and Post-Survey

Sample Size	Mean		T	P
	Pre	Post		
10	3.60	3.61	.79	.44

Chapter 5

DISCUSSION

Over the past years, studies of computer use in classrooms have produced mixed results (Bracey, 1997; Cotton, 2001; Kirkpatrick & Cuban, 1998; Kulik, 1998; Okolo, Bahr, & Reith, 1993; Rupe, 1986). They have found evidence of moderate effectiveness, minimum effectiveness, and no effectiveness of all (Kirkpatrick & Cuban, 1998). There is a lack of substantial research at the secondary mathematics level for computer use by students with learning disabilities (Bracey, 1997; Kirkpatrick & Cuban, 1998). Most studies have been directed towards general education and the elementary students (Bracey, 1997; Kulik & Kulik, 1987). The purpose of the present investigation was to compare results of mathematics achievement of secondary students with learning disabilities with and without computer-assisted instruction, and to examine student satisfaction with computer-assisted instruction. No significant difference was found between teacher-direct instruction and computer-assisted instruction in regard to mathematics achievement and student satisfaction.

The first research question examines the gains in mathematics achievement for secondary students with learning disabilities. No significant differences were found between the mean unit scores of the students in the baseline or the computer-assisted treatment. The overall mean for teacher direct-instruction was 83.3 with a standard deviation of 10.17, whereas the overall mean for the computer-assisted instruction was 79.72 with a standard deviation of 11.07 (see Table 3). Such results indicate that other factors may be involved. Teacher influence, method of measurement, student motivation, and learning environment are some of the factors that affect the result of a single study investigating computer use and mathematics achievement, according to Kirkpatrick and Cuban (1998).

The second research question examines student satisfaction with computer-assisted mathematics instruction. There was no significant difference between the mean pre- and post-survey items. During the teacher-direct instruction or pre-survey conditions, the overall mean was 3.60. In the computer-assisted instruction or post-survey treatment, the overall mean was 3.61. There was a .01 difference between the two. The T-score was .79 and the P-value was .4 (see Tables 4 and 5). The results were not consistent with many of the studies that reported students had slightly better attitudes towards school, instruction, and subject matter when computers were used in the classroom (Cotton, 2001; Jones, Wilson, & Bhojwani, 1994; Kirkpatrick & Cuban, 1998; Norris, 1993). This may be due to the learning environment, teacher role, or computer program used in the present study. Other factors may be the individual student's attitude toward education, as well as the specific learning disability.

There are some limitations to this study. First, the size and scope of sample students in the research, are limited. The study would be more effective if two math classes were available, with an increased number of participants. Second,

there were limitations due to the instructional setting. There were no computers in the regular resource classroom. As a result, the students had to travel to the computer lab in the media center and check-in, resulting in a loss of instructional time each day. Although the lighting and climate were optimum in the computer lab, there were many distractions. Participants could look out of the glass-enclosed room at any given moment to see large numbers of students in the media center. Therefore, keeping the students on task was a problem. Another limitation of the study may be the individual students reading ability. Because of the large discrepancy in the language, reading, and comprehension aptitudes of the participating students, scores may not have indicated true mathematics achievement and satisfaction of the individual students. For example, if the student misinterpreted a question on the computer program, written test, or questionnaire, they may have responded incorrectly, thus affecting the measurement of the study. Last, the statistical analysis of the study was limited, due to the small sample size of ten. Given the limitations of the present study, more will need to be done to evaluate the impact of computer-assisted instruction on overall mathematics learning and achievement for the student with learning disabilities in the secondary educational setting.

APPENDICES

Appendix A: Computer-Assisted Instruction Questionnaire

Student # : __________________________Unit # : _______Date: _________________

Directions: **read each statement carefully and check the box that is the most accurate response.**

Statements	Always	Almost Always	Sometimes	Almost Never	Never
1. I think math is important.					
2. I am interested in what we are learning in math class.					
3. I like coming to math class.					
4. I am prepared for math class.					
5. I complete my homework.					
6. I study before a test or quiz in math.					
7. I feel motivated to learn math.					
8. I participate in math class.					
9. I follow the math lesson.					
10. I help other students in the math class.					
11. I like to work with other class members in math.					
12. I feel confident about learning math					
13. I get good grades in math class.					
14. Math is one of my favorite subjects.					

Appendix C: Sample Lesson Plan of Computer-Assisted Instruction

Chapter 9.1 - Introduction to Geometry

Schedule

Regular daily schedule. Single period of 44 minutes in computer lab.

Objectives

The students will be able to understand geometric concepts, symbols, and vocabulary.

Motivate

Draw a point, line, plane, ray, and segment on the whiteboard. Ask students if they can identify the symbols and to find examples in the room. (Pre-class activity)

Teach

Students will open power-point presentation on 9.1 on individual computers and follow computer program, taking notes and doing example problems as directed. (Instruction)

Assess

Class exercises listed on computer program. Homework, # 1-14 on p. 364 of textbook. (Student practice)

Closure

Ask students to identify the basic geometric figures taught in 9.1.

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Closure

Ask students to identify the basic geometric figures taught in 9.1.

References

Babbitt, B. C., & Miller, S.P. (1997). Using hypermedia to improve mathematics problem-solving skills of students with learning disabilities. In K. Higgins & R. Boone (Eds.), *Technology for students with learning disabilities* (pp. 91-108). Austin, TX: Pro-Ed.

Badian, N. A. (1983). Arithmetic and nonverbal learning. In Myklebust, H.R., (Ed.), *Progress in Learning Disabilities.* Volume V. New York: Grunt & Stratton.

Bangert-Drowns, R. L., Kulik, J. A., & Kulik, C. C. (1985). Effectiveness of Computer-based education in secondary schools. *Journal of Computer-Based Instruction*, 12, 59-68.

Bialo, E., & Sivin J. (1990). *Report on the effectiveness of microcomputers in schools.* Washington, DC: Software Publishers Association.

Bracey, G. W. (1987). Computer-assisted instruction. *Electronic Learning.* 7, 22-23.

Braun, L. V. (1990). *TEST (Technologically enriched schools of tomorrow).* Final report recommendations for American educational decision makers. Eugene, OR: The International Society for Technology in Education.

Capper, J., & Copple, C. (1985). *Computer use in education: Research review and instructional implication*, Washington, DC: Center for

Research into Practice.

Cawley, J. F., Baker-Kroczynski, S., & Urban, A. (1992). Seeking excellence in mathematics education for students with mild disabilities. *Teaching Exceptional Children,* 24, 40-43.

Cawley, J. F., & Miller, J. H. (1989). Crosssectional comparisons of the mathematical performance of children with learning disabilities: Are we on the right track ? *Journal of Learning Disabilities*, 22, 250-259.

Cotton, K. (2001). Computer-assisted instruction. In (SIRS), *School Improvement Series*, 10, 1-19. Retrieved November 15, 2001 from Northwest Regional educational laboratory, www.nwrel.org/scpd/sirs/.

Fleischner, J. E., Garnett, K., & Shepherd, N. (1982). Proficiency in arithmetic basic fact computation by learning disabled and nondisabled children. *Focus on Learning Problems on Mathematics*, 4, 4-55.

Garnett, K. (1992). Developing fluency with basic number facts: Intervention for students with learning disabilities. *Learning Disabilities Research & Practice,* 7, 210-216.

Garnett, K. (1996). Math learning disabilities. *Learning Disability Newsletter,* 10, 1-8.

Goldman, J., & Pellegrino, J. W. (1987). Information processing and microcomputer technology: Where do we go from here? *Journal of Learning Disabilities,* 20, 336-340.

Grimes, D. M. (1977). *Computers for learning: The uses of computer-*

assisted instruction (CAI) in California public schools.

Sacramento, CA: California State Department of Education.

Johnson, D., & Balock, J. (1967). *Adults with learning disabilities: Clinical studies.* Orlando, FL: Grunt & Stratton.

Jones, E.D., Wilson, R., & Bhojwani, S. (1997). Mathematics instruction for Secondary students with learning disabilities. *Journal of Learning Disabilities,* 30, 151- 163.

Kirkpatrick, H,. & Cuban, L., (1998). Computers make kids smarter----right? *Technos Quarterly for Education and Technology,* 7, 1-12.

Kulik, J. A. (1983). Synthesis of research on computer-based instruction. *Educational Leadership,* 41, 19-21.

Kulik, J. A., Bangert, R. L., & Williams, G. W. (1983). Effects of computer-based teaching on secondary school students. *Journal of Educational Psychology,* 75, 19-26.

Kulik, J. A., & Kulik, C. C. (1987). *Computer-based instruction: What 200 evaluations say.* Paper presented at the annual convention of the association for educational communications and technology. Atlanta, GA: Northwest Regional Educational Laboratory. (ED 285 521).

Mercer, C. D., & Miller, S. P. (1992). Teaching students with learning problems in math to acquire, understand, and apply basic math facts. *Remedial and Special Education,* 13, 19-35, 61.

Mevarech, Z. R., Stern, D., & Levita, I. (1987). To cooperate or not to cooperate in CAI: That is the question. *Journal of Educational Research,* 80, 164-167.

Miller, S. P., & Mercer, C. D. (1997). Educational aspects of mathematics Disabilities. *Journal of Learning Disabilities,* 30, 47-56.

Mitra, A., & Steffensmeier, T. (2000). Changes in students attitudes and student computer use in a computer-enriched environment. *Journal of Research on Computing in Education,* 32, 417-433.

Okey, J. R. (1985). *The effectiveness of computer-based education: A review.* Paper presented at the annual meeting of the National Association for Research in Science Teaching. (ED 257 677).

Okolo, C. M., Bahr, C. M., & Reith, H. J. (1993). A retrospective view of computer-based instruction. *Journal of Special Education Technology,* 12, 1-27.

Paulos, J. A. (1989). The odds are you're innumerate. *The New York Times Book Review,* January 1, 1989.

Robertson, E. B., Ladewig, B.h., Strickland, M. P., & Boschung, M. D. (1987). Enhancement of self-esteem through the use of computer-assisted instruction. *Journal of Educational Research*, 80, 314-316.

Roblyer, M. D., Castine, W. H., & King, F. J. (1988). *Assessing the impact of computer-based instruction: A review of recent research.* New York: Haworth Press.

Rupe, V. S. (1986). *A study of computer-assisted instruction: Its uses, effects, advantages, and limitations.* South Bend, IN: Indiana University.

(ED 282 513).

Smith, C. R. (11994). *Learning disabilities: The interaction of learner, task, and setting* (3rd ed.). Boston: Allyn & Bacon.

Steen, L. A. (1987). Mathematics education. : A predictor of scientific competiveness. *Science,* 237, 251-252, 302.

Strang, J. D., & Rourke, B. P. (1985). Adaptive behavior of children who exhibit specific arithmetic disabilities and associated neuropsychological abilities and deficits. *Neuropsychology of Learning Disabilities.* New York: The Guilford Press.