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**THE EFFECTS OF COMPUTER-ASSISTED INSTRUCTION ON
STUDENTS' ATTITUDE AND ACHIEVEMENT IN MATHEMATICS**

By
JIMMY L. CHOUFANI

A thesis
Submitted in partial fulfillment of the requirements
for the degree of Master of Arts
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of the Faculty of Arts and Sciences
at Haigazian University

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It only takes faith and perseverance to make our dreams come true...

Abstract

This study was initiated to determine if computer-assisted instruction contributes to an increase in mathematics performance of elementary school pupils in comparison to students who use the traditional assisted instruction method. The sample comprised 46 students who were subject to a pretest and posted after receiving CAI in mathematics. A T-test analysis of the results revealed a gain in the scores of the CAI group in compared to the results of the TAI. The results reveal that CAI contributes to the overall performance of students when Information Technology is integrated into the curriculum.

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Chapter one

Introduction

A. The Statement of the Problem and its Background

In recent years, most if not all Lebanese schools have diligently introduced computers and other information technologies to assist the learning experiences of their students. It is common to hear administrators and teachers speak of the integration of information technology applications in the curriculum to keep up with technological developments in education. In reality, however, there is very little evidence, if any at all, that information technology is truly being integrated in Lebanese schools. Such a challenge is not specific to Lebanon, but it is also prevalent in many other countries where ministries of education and schools are still struggling to integrate information technology in the curricula. The fact that millions of students now have access to computers in their schools, or that millions of students have access to the internet in school is a manifestation of the introduction of technology into education, but it reveals very little as to the integration of information technology in the curriculum.

The introduction of computers and connectivity into schools is certainly a significant development, but it is only a first step toward integration and does not constitute true integration of information technology in the curriculum (Lamb, 2001). In fact, if we look at the way things are in Lebanese schools today, we will realize that at best, schools

are barely introducing students to the basics of using computers and information technologies but are still facing numerous difficulties and challenges as they attempt to transform information technology into an integrated part of the curriculum.

B. Why IT Integration

Our world has changed dramatically over the past few years. Just a decade ago, providing students with accessibility in the classrooms was something that schools boasted about. Today, such accessibility is not only taken for granted, but it is almost considered a limitation if computers are not connected to learning intranets or to the internet. The fact is that technology has taken schools, society and the whole world by surprise (Morrison, 1998).

Not so long ago, a great number of students enjoyed their first moments with a computer at school. Today, many children have access to computers at home long before they come to school for the first time. Accordingly, this has created a serious burden on schools as more students now see the information technology available in school as far as less advanced than the information technology they have access to at home or even at an internet café (Lamb, 2001).

Yet, information technology is not just computers. It encompasses a very wide array of applications, in which the computer plays just a small role. In fact, the role of the computer has itself changed dramatically. It has evolved from a data storage and processing device into a powerful

tool that can be manipulated by the user to construct and produce information and knowledge. Reed and McNergney (2000) argue that technology alone does not constitute any form of real improvement to learning and that integrating IT into the curriculum requires much more than just piling up available technologies in school. True integration, they further argue, is that which empowers the curriculum with information technology in a way that “can stimulate the development of higher-order and problem-solving skills, and it can support collaborative, globalized learning”.

Schools, have so far done very little to cope with these changes. Information technology constitutes a challenge to schools today for a variety of reasons. To start with, information technology is not just about learning how to handle technology, but more importantly, learning how to handle information through technology, and this includes storage, processing, manipulating, and constructing information. Such needs are no longer bound by age or location, but have become part and parcel of our everyday lives (Lamb, 2001).

James Morrison (1998) points that there is a significant gap between the implementation of information technology in schools and the requirements and demands of information technology in the real world. He points out, for example, that most colleges and universities today have already integrated IT in their curricula and as many as 5% to 7% of any university or college students are seeking education through distance learning. At the same time, most corporations are rapidly relying on information technology in their functions, processes and strategies.

Hence, what is really happening is that a serious gap is occurring between what students learn in school and what is actually required of them at the levels of higher education as well as at work. Allowing this gap to grow means shifting the burden from schools to students. It also means that schools are playing a less significant role in the education and preparation of the student for real life. In a world where hundreds of millions of people are increasingly required to deal with information technology, the failure of schools to develop effective strategies to integrate information technology in their curricula becomes a critical problem that requires immediate intervention by governments and ministries of education (Reed, 2000).

C. Obstacles, Solutions & Responsibilities

Private Schools and public as well, face massive difficulties in trying to incorporate and integrate information technology into their curricula. One of the biggest obstacles is financial in nature but it also arises from the nature of technology itself. Over the past fifteen years, technological development has been so rapid to the extent that it has made catching up an extremely costly and inefficient process. Already facing funding problems without the challenges of IT, schools are unable to catch up because new technology soon becomes obsolete long before the costs of acquired technology have been covered (Morrison, 1998). Not surprisingly, schools have found themselves between a rock and a hard place; if they invested immediately to catch up, they soon found themselves forced to upgrade or replace existing technologies at higher

costs; if on the other hand they waited to acquire more advanced technologies at lower costs, they risked a lower learning curve for their current students.

A more problematic issue, also related to the nature of technology, lies in the fact that most teachers are not familiar with modern information technology. Most technological developments have taken place over the past ten to fifteen years (Lamb, 2001). Thus, the majority of teachers in their mid-30s or older are scantily familiar with the information technologies that prevail today. On the other hand, children and adolescents have been increasingly exposed to advanced technologies at a more rapid pace. Consequently, it is ironical that many students in Lebanese schools today tend to have more knowledge of or familiarity with information technology than their teachers. This in turn is a discouraging factor for teachers who feel challenged by information technology and thus express their unwillingness to learn, acquire new skills or master new information technologies.

Additionally, coping with new information technology is very costly and stressful for teachers; especially older teachers who have missed the technological revolution of the 1990s as they were already too busy doing their jobs. This is less of a problem for younger teachers who had already been exposed to information technology in their adolescence or during their college years. Furthermore, there is also the fact that many teachers may not be enthusiastic about new technology and prefer to rely on traditional methods. This could be the result of the fact that older people

may be intimidated by new technology or dramatic changes in the workplace (Starr, 2001).

Starr (2001) argues that teachers are not the only party to blame in the failure of schools to integrate information technology in the curriculum. According to her argument, the problem really starts at the top, that is, with principals and administrators. Even in many schools where teachers have the knowledge and skills to handle information technology in the classroom, negative attitudes from administrators often make implementation difficult or fruitless. Starr argues that one cause of the problem is that most administrators simply do not have the knowledge of or familiarity with information technology and also prefer to stay away from the problems of such technology. With such negative attitudes, teachers lack support to properly implement information technology and more importantly, many teachers do not feel obliged to learn or train to gain better knowledge.

Despite these problems and challenges, solutions are already available. To start with, while it is true that investment in the latest information technology remains a costly step, the reality is that technology has already stabilized in many ways. For example, rather than having a lifecycle of just a few months, computer technologies now have lifecycles that can last for several years, and instead of replacement, upgrades are available. This does not mean that information technology has become inexpensive, but it means that funding decisions are more rationalized and the technology itself has become more reliable. In addition to this, corporations developing both software and hardware

have already begun to build partnership relations with educational authorities and schools. Such programs do not only make technology more readily available at lower costs, but it also enables schools to acquire training programs, purchase tailored products that satisfy their specific needs, and integrate information technology into their curricula in much easier ways and under much more favorable conditions (Snyder, 2003, p.1).

Secondly, it is necessary to redefine the role of administrators in the integration of information technology in the curriculum. Moral or administrative support cannot be sufficient. According to Starr (2001), administrators have to be role models for teachers and students at the same time. Administrators have to be knowledgeable and skilled at information technology, and more importantly, they should be fully aware of the role, function and influence of information technology in the curriculum. Furthermore, administrators have a serious responsibility of creating a positive climate in their schools and among teachers toward the integration of information technology in the curriculum. Hence, integration of IT into the curriculum should really mean the integration of IT into the entire schooling system, not just inside the classroom or in learning activities.

Thirdly, there is no alternative to the teacher's role in the integration of IT in the curriculum. This perhaps remains the biggest obstacle to the process as discussed above. Needless to say, several solutions are available. First of all, schools should be committed to continuous improvement programs, not only to train teachers on how to

deal with the challenges of IT in the curriculum, but also on involving them in the integration of IT in the curriculum. After all, without integration by teachers, IT will not be more than added technology to the curriculum. Thus, spending on the training and preparation of teachers, involvement in changing the perceptions and attitudes of teachers, and encouragement of teachers to play a more active role in integrating IT in the curriculum are all necessary to transform the teacher from a potential barrier or burden to an asset in the process of integrating IT in the curriculum.

In its effort to make teachers more involved in IT integration, the Canadian Ministry of Education (1996) has pinpointed several roles that teachers should be prepared and encouraged to play in the process. First of all, teachers should not only master information technology applications, but they should also be able to predict and organize the outcomes in terms of learning objectives. Secondly, they should be able to set appropriate developmental objectives with students and administrators. Thirdly, they should create opportunities that students can use to explore and learn on their own with supervision from teachers, focusing on technological tools such as computer-based and computer-linked equipment, and on processes such as constructing flow charts, storyboarding and writing documentation.

D. Making IT Integration Happen

The fact remains, however, that making the integration of IT in the curriculum is and will remain a daunting challenge in its own right. After

all, very few are the teachers, principals and schools that have gone through the integration process before. Reed and McNergney (2000) have recommended a process of several steps to facilitate the integration of IT in the curriculum.

The first step involves identifying the authenticity of IT applications, that is, assuring that they relate to real life situations and problems and that they can be used to enhance the skills and abilities of students to deal with reality. Moreover, proper integration also requires that students not only be listeners or watchers while using technology, but active participants who will explore, interact, and implement (Reed & McNergney, 2000).

Secondly, it is necessary to integrate those IT applications that will create a constructivist approach to education. Thus, an appropriate IT application should be "a tool that can help teachers and students become co-learners who collaboratively construct knowledge" (Reed & McNergney, 2000). In other words, real integration of IT in the curriculum is a process that allows both teachers and students to be engaged in education through a partnership form that allows both to learn and to encourage the other to learn.

Thirdly, teachers and administrators have to carefully evaluate the consequences of IT applications on the learning environment as a whole. As a result, they have to carefully identify the learners and their role, the instructors and their role, the overall impact on the learning environment, and the nature of technical opportunities and limitations that the

applications that they are dealing with (Reed & McNergney, 2000, p. 1).

implementation will affect on the classroom and on learners at the same time (Reed & McNergney, 2000).

Fourthly, a crucial test for the effectiveness of IT applications intended for integration in the curriculum lies in the value that such integration would add to content. IT applications in general can be classified into two categories. The first category includes those applications which are drill-and-practice oriented and which primarily provide students with opportunities to learn through repeated practice. The second category, on the other hand, are open-ended and exploratory in nature, allowing students to pursue opportunities of learning in unlimited ways. It is the IT applications that fall in this second category that should be the focus of attention, especially since these are closer to the challenges of real life today (Reed & McNergney, 2000).

In the fifth step, it is necessary to identify the various tools that will be required in implementation. These include the nature of the technological applications, their quality in comparison to other learning tools, the time their integration will require, and the degree to which they are stimulating and interesting (Reed & McNergney, 2000).

Finally, any integration process requires enabling teachers and administrators to assess and measure the outcomes. More specifically, teachers should focus on measuring and assessing the performance of students as they engage with information technology applications. Moreover, students too should be involved in the assessment process and they should be taught and trained to assess themselves and the applications that they are dealing with (Reed & McNergney, 2000, p.1).

E. Need for Study

Integrating information technology applications in the curriculum is currently one of the most urgent questions and challenges that schools face all over the world. Information technology (IT), primarily involving the application of computers in the educational setting, is perceived by educators and the public in countries throughout the world as capable of having a significant effect on the developing child. The study of this effect -- what mediates it and how it may be channeled to the best advantage of the child -- is a topic of major interest to researchers, teachers, and educational decision makers.

Despite this extensive interest in the impact of computers in education, it remains difficult to draw conclusions from the experiences that are occurring. This is partly because the IT field is continually changing in its characteristics; but more importantly it is because "the effect" of computer use cannot be expressed in a straightforward fashion, but instead must be considered in the context of the complicated network of variables in which the use is embedded (Collis, 1988; McGee, 1987; Salomon, 1990). These variables include characteristics of the computer use itself, such as software types and design aspects, as well as hardware variations. They also include variables related to various characteristics of the students and teachers involved, and of teacher decision making, including how effectively the teacher integrates computer use into a meaningful learning experience for the child. The social interaction between student and student and between teacher and student also influences the impact of computer use in school (Feldman,

1989; Tharp, 1989). In addition, school, regional, and national culture also are part of the system of influences, as culture in its various manifestations embeds and shapes the system and the subsequent result of computer use (Peled, Peled, & Alexander, 1989).

Challenges pertaining to limited financing, technological limitations, shortage in skills, and organizational difficulties are all issues that need to be addressed seriously and rapidly. In less than two decades, unexpectedly fast changes in technology have resulted in changing the nature of burdens that schools and ministries of education face in unprecedented ways. On the other hand, the solutions are available but require focused attention, dedication and the mobilization of all kinds of resources.

Despite these challenges, there is a consensus that research into the impact of computer use on children's cognitive functioning must be done, but done in a way that is sensitive to the system of variables that shape and are shaped by it. I believe that the success of schools in integrating information technology applications in the curriculum will be directly related to and predictive of the success of schools of playing an effective role in education over the coming decades.

F. Purpose of the Study

Time and advancements in the field of information technology have not served, however, to settle debates raised among both researchers and practitioners regarding the effectiveness of the use of computer - assisted instruction on student achievement. The questions

posed in such discussions are usually some variation on the same theme: "What difference has computing made in our schools?" or "Has instruction been enhanced through the use of computers in our schools?" This research will not resolve this issue. But is an attempt to explore the effects of Computer-Assisted Instruction on students' achievement in mathematics.

Currently very few studies comparing Computer Assisted Instruction (CAI) and Traditional Assisted Instruction (TAI) are reported and published in the Middle East Region. The advantage of this study is the fact that it is being conduct in Lebanon where the use of computer in the educational domain is spreading and gaining the support of educational authorities.

....
students to be contributing members of a progressive society in order to complete this task and restore credibility to education, we must pursue the necessary reforms in the educational system that will enable the students to meet the challenges of our changing and developing world and the spread of information technology into all aspects of life (Davis, 2005).

In an attempt to address this issue we must move toward a curriculum model built on technology while maintaining a program that can provide a warm and positive school environment, be sensitive to the needs of children and continues to place the classroom teacher in the role of diagnosing and prescribing appropriate instruction. This curriculum should integrate computer – assisted instruction to achieve its objectives

Chapter Two

Review of Literature

The dramatic changes occurring in our economy and society cause one to stand back and consider what we are teaching in our schools and how we are presenting the subject matter. One begins to wonder if our classrooms are truly staying abreast of our rapidly changing world. Are we supplying today's students with the skills for an era that is quickly leaving us, or are we equipping these young minds with the technical knowledge necessary to meet the challenge of a fast-paced, high-tech and information-oriented world?

It is apparent that we as educators have attempted to address these needs but have fallen short of achieving our goal of preparing students to be contributing members of a progressive society. In order to complete this task and restore credibility to education, we must pursue the necessary reforms in the educational system that will enable the students to meet the challenges of our changing and developing world and the spread of information technology into all aspects of life (Davis, 2005).

In an attempt to address this issue we must move toward a curriculum model built on technology while maintaining a program that can provide a warm and positive school environment, be sensitive to the needs of children and continues to place the classroom teacher in the role of diagnosing and prescribing appropriate instruction. This curriculum should integrate computer – assisted instruction to achieve its objectives

and equip the students with the necessary knowledge of information technology at the same time.

There are many reasons why computer - assisted instruction has been effective. The computer provides immediate responses and practice for the child learning a skill. Struggling students interface with the computer and practice a skill without embarrassing situations in the classroom. Interaction with a multi-sensory format provides motivation and a positive attitude toward learning (Case & Truscott, 1999; Forcier, 1999).

A. Computer – Assisted Instruction (CAI)

There is no doubt that technology has become incorporated into our school systems. Computers are used not only as a means of helping schools analyze data, computers have become a pervasive tool toward optimizing student learning. For example, students are regularly using the Internet to gather and assimilate information for use in research assignments. They are preparing "electronic" presentations using computer presentation programs and LCD projectors. They are using word processing programs to create various other reports. Students are even using spreadsheets to increase their experiences with mathematical concepts. In addition, many schools have incorporated interactive computer - assisted instruction into their program to provide students opportunities to master specific educational objectives or standards. The new information revolution in the classroom is now in a unique situation where it can permanently alter the method of instruction. Several authors

(Dede, 1987, 1993; Issing, 1994; Large et al., 1995; Melmed, 1994 Park and Hannafin, 1993; Sammons, 1995; Zack, 1995) have stressed the importance of technology- assisted instruction by means of electronic messaging, hypermedia, multimedia presentations and specially designed computer programs.

Computer programmers have been able to create computer - assisted instruction programs that have served to increase student learning by affecting cognitive processes and increasing motivation. Current research shows the mechanisms by which computer programs facilitate this learning: (1) personalizing information, (2) animating objects on the screen, (3) providing practice activities that incorporate challenges and curiosity, (4) providing a fantasy context and (5) providing a learner with choice over his/her own learning.

1. Personalizing information

Personalizing information allows computer - assisted instruction to increase learner interest in the given tasks (Padma and Ross, 1987) and increase the internal logic and organization of the material (Anderson, 1984; Ausubel, 1968; Mayer, 1975; Rumelhart and Ortony, 1977). New information can be more easily integrated into existing schema if a student's name or other familiar contexts appear in a problem.

2. Animating Objects on the Screen

The animation of objects involved in the explanation of a particular concept, for example, Newton's First Law of Motion, increases

learning by decreasing the cognitive load on the learner's memory thereby allowing the learner to perform search and recognition processes and to make more informational relationships (Reiber, 1991).

3. Providing Practice Activities

Computer - assisted instruction increases motivation by providing a context for the learner that is challenging and stimulates curiosity (Malone, 1981). Activities that are intrinsically motivating also carry other significant advantages such as personal satisfaction, challenge, relevance, and promotion of a positive perspective on lifelong learning (Keller and Suzuki, 1988; Kinzie, 1990).

4. Providing a fantasy context

A fantasy context increases learning by facilitating engagement (Parker and Lepper, 1992; Malone, 1982). Fein (1981) and Signer (1987) have also found, apart from using computer programs, that involvement in fantasy is often highly intrinsically motivating.

5. Providing a learner with choice over his/her own learning.

Providing students with choice over their own learning provides learner-controlled instruction, which contributes to motivation. Increased motivation in turn increases student learning (Kinzie, Sullivan and Berdel, 1988). Also, program-controlled instruction, as opposed to learner-controlled, may get in the way of the learner by requiring the learner to study all of the given subject matter rather than only the elements the learner needs (Mayer, 1964). Further, learner-

controlled instruction makes it possible for individuals to make certain choices in an activity and to affect certain outcomes. As a result, the individual feels competent and self-determining, and the activity has greater personal meaning and intrinsic interest (De Charms, 1968; Lepper, 1985). Tennyson (1980, 1981) found learner control to be instructionally effective when individuals were given remarks on their performance in relation to program criteria. Further, learner control results in more positive attitudes toward the instruction (Hurlock, Lahey, and McCann, 1974).

Generally speaking, when applying the previously mentioned principles students' performance is directly influenced. But whether this is valid to completing tasks and exercises in mathematics is the question that we will be addressing in the next section.

B. Computer- Assisted Instruction in Mathematics

Computer - assisted instruction (CAI) continues to play a critical role in the teaching and learning of science and mathematics concepts (Brown & Boshamer, 2000; Chang, 2002). Computer simulations that address high-level thinking skills have been shown to improve student motivation and achievement in mathematics and science (Wenglinisky, 1998). However, the number of CAI studies in science and mathematics are scarce (Brown & Boshamer, 2000; Chang, 2002), and the results of studies that do exist have confounding research findings (Chang, 2000).

Schofield (1981) demonstrated a degree of incompatibility in simultaneously maximizing pupils' cognitive and affective outcomes in

elementary school mathematics. In contrast, computer - assisted instruction (CAI) incorporates elements that should facilitate accomplishing both goals. Schofield's study was conducted to investigate the impact of CAI on the mathematical achievement and self-concept. Schofield (1981) reported research findings demonstrating an inverse relationship between mathematics achievement and pupil attitudes toward mathematics. This evidence was interpreted as "consistent with the contention that there is a degree of incompatibility in maximizing both cognitive and affective outcomes in children (Bennett, 1976; Good, Biddle & Brophy, 1975) at least in the grades 4-6 level in the area of mathematics". The explanation suggested for this lack of compatibility was based on the assumption that the attainment of high pupil achievement requires "adherence to a well-organized curriculum and the exertion of pressure on children to apply themselves continually during class periods to tasks leading to content mastery; it does not entail commensurate concern for the pupil's enjoyment of classroom activities and intrinsic interest in learning or for the pupil's feelings of self esteem and emotional adjustment".

Positive pupil outcomes in the cognitive and affective domains do seem quite incompatible when considering teacher-centered, whole-class instruction in classrooms with 30 or more children. It is probably a particularly unlikely contingency for elementary school subjects such as mathematics, which demand frequent drill and practice to achieve mastery. It seems that most teachers are simply incapable of exerting pressure on children to master content and, at the same time,

demonstrating genuine active concern for their personal development and attitudes toward school-related activities. Thus, for many teachers employing standard instructional techniques in mathematics, the assertion regarding the incompatibility of furthering pupils' cognitive and affective development is definitely relevant (Issing, 1994)

Computer - assisted instruction (CAI) is another instructional practice that seems to hold promise for the simultaneous enhancement of pupils' cognitive and affective development. The most basic usage of computers in mathematics instruction is in the area of drill and practice as a supplement to the regular curriculum. Characteristics of CAI, such as a curriculum specially tailored to the individual pupil's level and rate of achievement, immediacy and accuracy of feedback-correctives, and multisensory modes of informational input and output, create more positive conditions for drill and practice than is possible in the typical classroom (Page, 2002). Several educational psychologists (e.g., Bloom, 1976) have argued that these characteristics are particularly relevant to the academic success of low achieving children. The sense of success and progress engendered by these characteristics of CAI should foster pupils' willingness to invest efforts to master the subject matter. Furthermore, teachers may be partially freed from the perceived need to exert constant pressure on the pupil to master content since interaction with the computer should provide the pupil with the necessary drill and practice to achieve mastery. The reduction in perceived need to exert academic pressure on pupils may allow teachers to invest greater efforts

in classroom processes which foster enhanced affective development of pupils.

Brown and Boshamer (2000) conducted a study of more than 100,000 elementary and middle school students in North Carolina. A pretest-posttest design was used to determine the effect of using CAI as a supplement to regular classroom instruction in mathematics. The software program that was used with these students was FUNdamentallyMATH (Brown & Boshamer, 2000). Results of a paired t-test showed that fourth graders who used CAI had significantly higher scores on the posttest than fourth graders who did not have CAI ($p = .001$). Furthermore, female students made significant improvement on the posttest after using the CAI program ($p = .041$). In addition, findings revealed a 17% jump in algebra percentile scores for students using CAI ($p = .005$).

Research has shown that students are highly motivated to complete computer simulations in mathematics and science (Page, 2002; Wenglinsky, 1998). Computer modules and simulations can provide students with individualized instruction (Learner – Centered) and scaffolds so that students can work and learn on their own (Krajcik, Soloway, Blumenfeld, & Marx, 1998).

C. Learner-Centered Design

Soloway, Guzdial, & Hay (1994) suggest a learner-centered software design (LCD) as one avenue to use the power of computers for learning Mathematics. Using ideas from educational psychology (Rogoff, 1990), LCDs utilize scaffolding features--software components that can assist students with learning a new task. For example, the software may outline a set of investigative tasks for learners, or learners may be asked to document their ideas by writing notes. The scaffold represented in the software are not the software features, they are the interactions seen between each feature and a particular student. According to Bruner (1986), a scaffold "lends consciousness to a child who does not have it on his own" (p. 74). For a scaffold interaction to occur, the feature must tap into the students' Zone of Proximal Development (ZPD). ZPD is the distance between the actual development level as a result of independent problem solving and the level of potential development while problem solving under adult supervision or in collaboration with highly capable peers (Vygotsky, 1978). Learner-centered software designs generally include scaffolding features that assist learners as they engage in activities beyond their normal ability. LCD can be used to support the learning of underachieving students.

In addition to the learner-centered software design, CAI can provide an opportunity for learners to interact with the computer in an environment that facilitate learning in an attractive design.

D. Anchored Interactive Learning Environments

The design principles of Anchored Interactive Learning Environments (AILE) include generative learning to create storylines for meaningful problem solving, video-based presentations, narratives, complex problems, embedded data design, opportunities for transfer, and links across the curriculum (Crews, Biswas, Goldman, & Bransford, 1997; Goldman et al., 1996). This tool supports graphics, animation, sound effects, narration, and drag-and-drop features to engage students in interactive learning. Student learning is anchored to the storyline of both real and imagined characters. Scaffolding is offered to help the students solve any number of problems in a pressure free atmosphere.

E. Problem-Solving Based Computer - Assisted Instruction

Chang (2002) conducted a study that compared the implementation of CAI and traditional instruction. The participants included 294 tenth-grade high school students in Taiwan. Problem-Solving Based Computer - Assisted Instruction (PSCAI) was developed and used to emphasize a five-step problem solving process that included: (1) presenting the problem, (2) planning the solution, (3) collecting the necessary information, (4) carrying out the plan, and (5) evaluating the results. PSCAI was compared with lecture-Internet-discussion- instruction (LIDI), which stressed lectures, use of textbooks and supporting materials, and occasional Internet usage and after-Internet discussions. A pretest-posttest experimental design was used with the eight classes.

Students in both types of classes were assessed with Achievement Test. The ANOVA was used to analyze the posttests. The results of the posttest suggested that students taught with PSCAI scored higher but not significantly higher than students in the LIDI group. However, the PSCAI group scored significantly better on an attitude survey towards Mathematics than the LIDI group. Results also showed evidence of positive effects on students' knowledge of Mathematical concepts. Chang (2000) concluded that different modes of instruction are needed to improve students' problem-solving ability and achievement.

F. Regional Research (Kingdom of Saudi Arabia)

The only available published research in the field of using CAI in the Middle East is a study done by B. Yushau, M.A. Bokhari, and D.C. J. Wessels (2004) from the King Fahd University of Petroleum and Minerals. In their Study, it was found that the attitude of teachers and students towards Computer Assisted learning (CAL) was positive. A majority of the students believed that they had benefited from the software, and the software indeed "aided" them in learning mathematics. The teachers enjoyed generating quizzes and tests using Test Bank, and the students enjoyed the use of Online testing to do their quizzes. Based on the findings of this experiment, the software was recommended for adoption in all mathematics courses of the Prep-Year Mathematics Program.

The result shows some improvement in student attitude toward CAL. In past evaluations of CAL, the question "CAL is a waste of time"

was strongly agreed by almost all students. This was not the case in current survey. In general, the results indicate that in the opinion of the students, the Larson CD contains many useful and interesting exercises that helped them better understand mathematics. And teachers indicated that students' performance was noticeably improved during the program. Contrary to the past when students were requesting the abolition of CAL because "it is a waste of time", the majority of the students requested an increased utilization of the CAL program (Yushau B., Bokhari M.A., and Wessels D.C. 2004).

G. Conclusion

Although, there is a dearth of research on the effects Computer – Assisted instruction in Mathematics, and more over only one published work was found relating to the implementation of CAI in the Middle East. We need to take into consideration that in some studies the results were confounding, as in Chang (2002).

Roblyer (1989) captures the essence of the debate regarding the effectiveness of computer -based instruction when she asks, "How much do computers actually improve instructional methods, and, consequently, student achievement?" The question assumes even greater significance when visits to so many schools using computers for instruction reveal dissatisfaction or disagreement among the faculty and administration concerning their real benefits. There is an increasing likelihood that convincing answers to questions of effectiveness are going to be

demanded by decision-makers before they approve additional expenditures.

The change to the 'new system' is highly dependent on perceptions of people and will elicit different reactions, some of which will be positive and some negative. The modern age has seen technological change and its eventual acceptance. However, when we ask instructors to change their method of instruction which they have been practicing for a long time we are more likely to face immediate rejection than passive acceptance.

A word of caution accompanies much of the literature warning educators to focus on the targeted instructional goals and not be 'enchanted' by the entertainment that makes software packages so appealing (Case and Truscott, 1999; Sherry, 1996). While this multi-sensory approach is highly motivating for young readers, the instructional purpose is to enable them to become better learners. Educators should choose the types of software and technological resources carefully in order to maximize learning without being entangled in the 'bells and whistles'.

According to Dockstader (1999) the benefits of using computer – assisted instruction include "an intrinsic need to learn technology ... motivation increases engagement time ... students move beyond knowledge and comprehension and into application and analysis ... and students develop computer literacy by applying various computer skills as part of the learning process". As Ray and Wepner (2000) suggest, the question as to whether or not technology is the valuable educational

resource we think it is may be a debatable point since it is such an integral part of our lives. However, the question concerning the most productive methods of using technology in the classroom still needs to be addressed. Therefore, the purpose of this study was to investigate the effects of computer - assisted instruction on fourth grade students' mathematics skills development. Specifically, this study investigated the impact of the Achieve Math and Science Grade 3 - 6 (The learning Company) on fifth and sixth grade students' mathematics skills development.

Based on the above research findings, the following hypothesis have been derived and tested in the present study, they are:

H1: Computer-Assisted Instruction (CAI) employed as a supplement to traditional mathematics instruction increases mathematics performance in elementary school pupils relative to students who do not use CAI.

H2: Computer-Assisted Instruction (CAI) employed as a supplement to traditional mathematics instruction contributes to a positive attitude of elementary school pupils towards mathematics in relative to students who do not use CAI.

Chapter Three

Methodology

A. Sample

The participants in this study included 56 (N = 56) Grade 5 and 6 students from a school located in the Maten area with an age average of 9 and 11; gender was equally distributed among the classes. Two different math teachers taught the classes, but the same teacher was responsible for both test groups. Of the total number of students 28 were scheduled into computer – assisted instruction (CAI) class and the remaining students were subject to Traditional – assisted instruction (TAI). The students in both classes were classified into 3 groups as low achievers, middle achievers and high achievers based on their first term grading period results. Then the test group members in each class were randomly chosen from these three groups.

B. Research design and Procedure

A pretest-posttest, control-group experimental design was conducted in both classrooms. The participants in both the experimental (CAI) and comparison (TAI) groups were tested and surveyed immediately before and after the 6-weeks treatment. During that period, each group received an equivalent amount of instructional time and was provided with similar materials and assignments. The CAI-group instruction was done in a computer lab, while the TAI – group instruction took place in a traditional

classroom setting. The teacher supplied both groups with similar instructional materials through lectures and comparable activities. Therefore, not only was the scope of the content covered by the two groups similar to each other and equivalent relative to the posttest but also students' invested time on task was controlled between the groups.

C. Analysis

The data included pretest and posttest scores from approximately six weeks after the end of the first semester to the end of the second semester. At the beginning of the period, students were instructed to enter their own user identification number. This required the students to start at the beginning of the program and work sequentially through the lessons. The computer program allowed for storage of all student data and results. Thus, the data that were analyzed for this study included the pretest and posttest scores for all students who completed both the pretest and posttest. The type of instructional program in which the school placed the students was also used

D. Statistical Tests and Instruments

A comparison of pretest and posttest scores was made for all students and a comparison of pretest and posttest gains was made among the types of student programs. Thus program type was the independent variable and pretest and posttest scores for the students was the dependent variable.

The study identified a potential problem with using the pretest and posttest scores. There may have been a substantial correlation between pretest scores and posttest scores. That is, pretest scores per se may have been a good indicator of pretest and posttest gains. It is reasonable to expect, for example, that students with low pretest scores will tend to make greater absolute gains from the pretest to the posttest than students with high pretest scores who have less room for absolute gains. Therefore, a test that could control for the possible regression effects between pretest scores and posttest scores was needed.

Thus, the ANOVA test was performed for comparing the pretest and posttest gains among the different groups of students. A computer program called SPSS was used to run the ANOVA to determine if a difference in pretest and posttest gains existed among the groups of students and to identify the specific groups of students that differed.

Also, a dependent t-test was performed with the SPSS program for the 46 students who comprised the sample to determine if the computer-assisted -instruction program, Achieve Math and Science Grade 3 - 6 (The Learning Company), made a significant contribution toward overall student learning.

E. Limitations

Harris (1985) coined the term cyber phobia, an aversion or anxiety caused by technology. Technology aversion is not an uncommon problem. A survey by Dell Computer Corporation revealed 55% of the population harbors fear of some form of technology (Hogan, 1994).

Another survey found that 36% of people who use computers at their office feel that their skill levels are inadequate (Donoho, 1994).

Do these numbers reflect phobia of teachers? Maybe not, but we have to realize and recognize that instructors may harbor some form of fear or anxiety to use technology in their classrooms where they are focus of the student's attention.

a. Teachers' Readiness

Teachers participating in this study were of different computer literacy level. The grade five teacher was not ready to implement the CAI plan due to her lack of expertise in computer usage. That is why one teacher, who is the computer and math (grade 6) teacher at the same time, was responsible for providing the computer-assisted instruction for both groups.

b. Students Readiness

Although students who participated in this study were exposed to formal computer training for at least 3 years, they faced some difficulties when they first used the special mathematics computer software. Some orientation and training on how to use the software was needed.

c. Financial Limitations

It is needless to mention that in order to implement a computer – assisted instruction in Lebanese schools would require a sizable investment at the level of hardware and computer lab setup. As well as the necessary training for teachers who might feel threatened with

the introduction of Information Technology into classroom daily routines.

d. Language Limitations

The computer software used was designed for students of native English speakers, thus some students required assistance at certain stages due to difficulty in comprehending some of the audio remarks and instructions produced by the computer software.

Part 1 – Student Achievement

A. Treatment and Control Groups

To conduct this study, two groups of students were compared based on a pretest and posttest scores after the implementation of a Computer - Assisted Instruction program in mathematics. Following is the Statistical Data of the group:

Table 4.1 - Grade Level

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid grade 4	20	50.0	50.0	50.0
grade 5	20	50.0	50.0	100.0
Total	40	100.0	100.0	

Chapter Four

4.2 - Achievement Level

Results

The results of this study are reported in two parts to answer the research questions. The first part focuses on analysis of students achievement during CAI program and analysis of student pretest and posttest results. The second part of this section addresses the change in attitude of the students towards the subject matter after using CAI based on subjects' responses to a questionnaire.

Part 1 – Student Achievement

A. Treatment and Control Groups

To conduct this study, two groups of students were compared based on a pretest and posttest scores after the implementation of a Computer – Assisted Instruction program in mathematics. Following is the Statistical Data of the group:

Table 4.1 - Grade Level

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid grade 6	26	56.5	56.5	56.5
grade 5	20	43.5	43.5	100.0
Total	46	100.0	100.0	

4.2 - Achievement Level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	high achievers	17	37.0	37.0	37.0
	medium achievers	16	34.8	34.8	71.7
	low achievers	13	28.3	28.3	100.0
	Total	46	100.0	100.0	

4.3 - Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	32	69.6	69.6	69.6
	female	14	30.4	30.4	100.0
	Total	46	100.0	100.0	

4.4 - Instructional Method

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	CAI	23	50.0	50.0	50.0
	TAI	23	50.0	50.0	100.0
	Total	46	100.0	100.0	

B. Results and Data Analysis

The data included pretest and posttest scores from approximately one week after the start of the second semester to the end of the second semester (approximately 67 days). Students were instructed to enter their own user identification number and name. This required the students to start at the beginning of the program and work sequentially through the lessons. The computer program allowed for storage of all student data including pretest and posttest results.

All students were started at the same level which was relative to the grade level program, the fifth and sixth grade level. Students that finished the first level during the course of the semester were moved to the second level, but without taking the results of the second level into consideration. Thus, all participants used the program at same level.

Thus, the data that were analyzed for this study included the pretest and posttest scores for all students.

A. Analysis among both groups

C. Statistical Tests and Instruments

To test for the first Hypothesis: **Computer-Assisted Instruction (CAI) employed as a supplement to traditional mathematics instruction increases mathematics performance scores in elementary school pupils relative to students who do not use CAI.**

A comparison of pretest and posttest gains was made between the two groups of students a t-test was conducted on the gain scores between the Pretest and Posttest scores between the CAI and TAI methods. Thus program type was the independent variable and gain scores for the students was the dependent variable.

The t-test showed a significant difference between mean gain scores and between the program type (CAI and TAI). $t(df=46), p = 0.000$. These results come in line with the hypothesized relationship. Students in CAI group overall scored significantly higher on the posttest than the pretest. While there was no significant change in the means among the TAI group. (See Table 4.5)

Table 4.5 - Difference in scores (post-test - pre-test)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2087.783	1	2087.783	34.511	.000
Within Groups	2661.844	44	60.496		
Total	4749.627	45			

Part 2 – Change in Attitude

A. Analysis among both groups

As for the attitude hypothesis: Computer-Assisted Instruction (CAI) employed as a supplement to traditional mathematics instruction contributes to a positive attitude of elementary school pupils towards mathematics in relative to students who do not use CAI.

This hypothesis was test by a 2 by 2 analysis of variance, 2(CAI, TAI) X 2(M,F), in order to test the differences between CAI and TAI . The results showed that there is a main effect of the instruction method on student’s attitude regardless of the gender.

B. Analysis of attitude among the CAI group alone

The data reveals that students exhibited a change of attitude towards the learning of mathematics through a CAI program. When the students answered the question: **I enjoy doing my math lessons on the computer more than in the book.** The Cross tabulation analysis showed both males and females enjoyed studying mathematics on the computer more than the traditional method. A total of the 23 students who

answered the questionnaire “agreed or strongly agree” that they enjoyed the math CAI program. (See table 4.6)

Table 4.6 – Gender Crosstab (a)

		Gender			
			male	female	Total
I enjoy doing my math lessons on the computer more than in the book	Agree	Count	6	3	9
		% within Achievement Level	37.5%	42.9%	39.1%
		% of Total	26.1%	57.1%	39.1%
	Strongly Agree	Count	10	4	14
		% within Achievement Level	62.5%	57.1%	60.9%
		% of Total	43.5%	17.4%	60.9%
Total		Count	16	7	23
		% within Achievement Level	100.0%	100.0%	100.0%
		% of Total	69.6%	30.4%	100.0%

a Instructional Method = CAI

Furthermore, a 3 by 2 analysis of variance 3 (high, middle, low achievers) X 2 (CAI, TAI) showed that all subjects within the groups had equally positive attitude towards CAI program.

While the answers to the question: **I can learn math more from books than from computers**, revealed that 60.8 % males (n=16) and 26 % females (n=7) of the CAI group reported that learning and solving mathematics on computers is more beneficial. (See table 4.7)

Table 4.7 – Gender Crosstab

			Gender		Total
			male	female	
I can learn math more from books than from computers	Strongly Disagree	Count	11	1	12
		% within Gender	68.8%	14.3%	52.2%
		% of Total	47.8%	4.3%	52.2%
	Disagree	Count	3	5	8
		% within Gender	18.8%	71.4%	34.8%
		% of Total	13.0%	21.7%	34.8%
	Agree	Count	2	1	3
		% within Gender	12.5%	14.3%	13.0%
		% of Total	8.7%	4.3%	13.0%
Total	Count	16	7	23	
	% within Gender	100.0%	100.0%	100.0%	
	% of Total	69.6%	30.4%	100.0%	

The overall are in line with previous research findings. When it comes to Computer-assisted instruction in mathematics, the CAI program contributed positively to the performance of students in mathematics. In addition the attitude of students towards the subject matter changed after using CAI program.

Findings

Regarding Hypothesis One, the results indicate that the computer-assisted instruction program, Achieve Math and Science Grade 3 - 5 (The Learning Company), increased overall student learning, as measured by pretest and posttest gains for the three types of students in the study: High Achievers, Middle Achievers, Low Achievers. Also, the results show

Chapter Five

Conclusions, Implications and Significance

The purpose of this study was to determine the effect of Computer Assisted Instruction of the achievement and attitude of students in grade 5 and 6. The students were divided into 2 groups, one was subject for mathematics instruction in a Computer – Assisted Instruction and the other group was subject to Traditional – Assisted Instruction. The Hypotheses of the research were:

H1: Computer-Assisted Instruction (CAI) employed as a supplement to traditional mathematics instruction increases mathematics performance scores in elementary school pupils relative to students who do not use CAI.

H2: Computer-Assisted Instruction (CAI) employed as a supplement to traditional mathematics instruction contributes to a positive attitude of elementary school pupils towards mathematics in relative to students who do not use CAI.

Findings

Regarding Hypothesis One, the results indicate that the computer - assisted -instruction program, Achieve Math and Science Grade 3 - 6 (The learning Company), increased overall student learning, as measured by pretest and posttest gains for the three types of students in the study: High Achievers, Middle Achievers, Low Achievers. Also, the results show

there was a significant difference in the means of the pretest and posttest gains of Middle and Low Achievers students.

Even though only 3 mechanisms (providing practice activities that incorporate challenges and curiosity, providing a fantasy context and providing the learner with choice over his/her own learning) of the five mechanisms (see page 24). Were used in this study, a significant improvement in performance scores were obtained. Such results are in consistent with previous literature.

As for hypothesis two, students who followed the CAI developed a positive attitude towards the subject, the obtained data tended to support the hypothesis. The study indicated that this was due to the fact that students did not need to spend longer time on solving mathematics home works and preparation at home.

Direction for Future Research and Practice

The results indicate that the computer - assisted -instruction program increased overall student learning. Since the program incorporated only three of the five identified mechanisms of computer programs that have been shown to increase student learning: (1) providing practice activities that incorporate challenges and curiosity, (2) providing a fantasy context and (3) providing the learner with choice over his/her own learning. It could be reasonably assumed that better results could be obtained among the various types of students using a computer - assisted -instruction program that incorporates the remaining two

mechanisms, (1) personalizing information, and (2) animating objects on the screen.

As mentioned above, the overall increased learning found in this study is consistent with current research. Therefore, the program used in this study, Achieve Math and Science Grade 3 - 6 (The learning Company), or programs that incorporate the components of computer programs that have been shown to increase student learning, should be considered by educators whose goal is to increase student mastery of specific objectives.

Recommendations

Computer - assisted instruction has a positive influence on student's motivation, interest, and learning. This research project validates the effect that computer - assisted instruction has on fifth and sixth graders development during a crucial time when they are learning to develop their mathematical skills. To improve upon this study, the following idea can be considered:

1. A concentrated effort should be made to determine the developmental math knowledge level of each student. Students could then receive more individualized instruction at their appropriate level as well as receiving group instruction in general. Additionally, teachers/researchers need to move students from dependent direct instruction to more independent learning. A natural follow-up to this study could be to see if this move to more

1. independent learning is facilitated by differing uses of technology in the classroom.
2. A further research could be conducted on teacher's attitude towards the use of computer as an instructional tool. Because it has been found in research that teacher's attitude towards the use of technology in instruction, especially teachers who are in their forties and fifties, is not receptive to new ideas especially the integration of computer in the instruction process. According to Bralove (1983) resistance to implementation of technological change may be due to underlying perceptions. These perceptions include sensing or anticipate loss of control; insecurity; work overload resulting from learning a new order; altered status; learning unwanted new skills; financial loss; a challenge to self-organization; or that the new order imposes forced changes in behavior, beliefs, or values.
3. This study could also be tried on different subject matters to see if same effects exist with respect to these concentrations. It is highly observed that mathematics is a subject matter that most students dread. If this study can be implemented on subject matter like English and Science or even Arabic language, it could contribute to validate these findings even more.
4. This study could be expanded to include other variables. The sample can be chosen based on the information if students own a computer at home or not. Consequently this could contribute to their achievement in certain areas.

5. On a wider scale the educational authorities should consider introducing a special assistantship program for low and middle achieving students to help them improve their performance. And this can be achieved by providing students with the facilities to own a computer and the appropriate software with reduced prices.

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Appendices

Appendix A

Computer Attitude Questionnaire for CAI group

Please answer the following questions by circling the appropriate answer according to the following scales:

	1. Strongly Disagree	2. Disagree	3. Agree	4. Strongly agree
1. I enjoy doing my math lessons on the computer more than in the book.	1	2	3	4
2. I am tired of using a computer.	1	2	3	4
3. I will be able to get a good job if I learn how to use a computer.	1	2	3	4
4. I am comfortable using a computer when I use one.	1	2	3	4
5. I enjoy math lessons on the computer.	1	2	3	4
6. I would work harder if I could use computers more often.	1	2	3	4
7. I know that computers give me opportunities to learn many new things.	1	2	3	4
8. I can learn many things when I use computers.	1	2	3	4
9. I enjoy math lessons on the computer.	1	2	3	4
10. I believe that the more often teachers use computers, the more I will enjoy school.	1	2	3	4
11. I believe that it is very important for me to learn how to use a computer.	1	2	3	4
12. I feel comfortable learning math with a computer.	1	2	3	4
13. I get a sinking feeling when I think of trying to use a computer.	1	2	3	4
14. I think that it takes a long time to finish when I use a computer.	1	2	3	4
15. Computers do not scare me at all.	1	2	3	4
16. Working with a computer makes me nervous.	1	2	3	4
17. Using a computer is very frustrating.	1	2	3	4
18. I will do as little work with computers as possible.	1	2	3	4
19. I can learn math more from text books.	1	2	3	4

Appendix A

Computer Attitude Questionnaire for CAI group

Please answer the following questions by circling the appropriate answer according to the following scale:

	1. Strongly Disagree	2. Disagree	3. Agree	4. Strongly agree	
1	I enjoy doing my math lessons on the computer more than in the book	1	2	3	4
2	I am tired of using a computer	1	2	3	4
3	I will be able to get a good job if I learn how to use a computer	1	2	3	4
4	I concentrate on a computer when I use one	1	2	3	4
5	I enjoy computer games very much	1	2	3	4
6	I would work harder if I could use computers more often	1	2	3	4
7	I know that computers give me opportunities to learn many new things	1	2	3	4
8	I can learn many things when i use computers	1	2	3	4
9	I enjoy math lessons on the computer	1	2	3	4
10	I believe that the more often teachers use computers, the	1	2	3	4
11	more I will enjoy school	1	2	3	4
12	I believe that it is very important for me to learn how to use a computer	1	2	3	4
13	I feel comfortable learning math with a computer	1	2	3	4
14	I get a sinking feeling when I think of trying to use a computer	1	2	3	4
15	I think that it takes a long time to finish when I use a computer	1	2	3	4
16	Computers do not scare me at all	1	2	3	4
17	Working with a computer makes me nervous	1	2	3	4
18	Using a computer is very frustrating	1	2	3	4
19	I will do as little work with computers as possible	1	2	3	4
20	I can learn math more from text books	1	2	3	4

Please answer the following questions by circling the appropriate answer according to the following scale:

- | | 1. Strongly Disagree | 2. Disagree | 3. Agree | 4. Strongly agree |
|--|----------------------|-------------|----------|-------------------|
| 1. It takes me much effort to learn my math lesson | 1 | 2 | 3 | 4 |
| 2. I need to study much at home to finish my math homework | 1 | 2 | 3 | 4 |
| 3. It is not easy to learn math from the text book | 1 | 2 | 3 | 4 |

Appendix B

Computer Attitude Questionnaire for both groups

Please answer the following questions by circling the appropriate answer according to the following scale:

- | | 1. Strongly Disagree | 2. Disagree | 3. Agree | 4. Strongly agree |
|---|---|--------------------|-----------------|--------------------------|
| 1 | It takes me much effort to learn my math lesson | | | 1 2 3 4 |
| 2 | I need to study much at home to finish my math homework | | | 1 2 3 4 |
| 3 | It is not easy to learn math from the text book | | | 1 2 3 4 |