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Enhancing student achievement in the middle school mathematics classroom using computer-based instruction

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The importance of this review is to cite specific research and studies to determine the effectiveness of such computer-based applications in the mathematics classroom in relation to student achievement and professional development. The most productive and positive integration of CBI in terms of student achievement and motivation in the classroom was due to the professional development and training of teachers.

Enhancing Student Achievement in the Middle School Mathematics Classroom Using Computer-Based Instruction

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Abstract

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Introduction

Student achievement in the mathematics classroom has been scrutinized in recent years. The demand to produce confident and competent students in the area of mathematics has been a driving force in the curriculum of American schools. The ever competitive global community is pressuring educators to push students into becoming fluent and knowledgeable members with a deep and sophisticated understanding of mathematical concepts.

Standardized test scores in mathematics continue to plateau or worse plummet in the United States (Stillwell, 2002). Therefore, teachers are scrambling for ways to revamp the curriculum in order to actively engage students and efficiently raise the level of achievement. The current curriculum in many mathematics classrooms is not meeting the needs of individuals on a holistic basis. As a result of such practices, students are unable to master mathematical standards and benchmarks set forth by the state or local education systems (J. O'Brien, personal communication, May 12, 2003). One targeted remedy for this problem has been technology. Computer-based instruction (CBI) has provided teachers with an instructional resource tool to enhance the curriculum and a means to meet all students' learning needs. Kulik (1994) stated that students who used CBI learned more, learned faster, had a positive attitude towards computers, and also had a more positive attitude towards instruction. The advantage of CBI over traditional types of instruction is the potential for students to progress through the instruction at their own rate (Eom & Reiser, 2000).

This literature review supports the current plans in many school districts to change the current mathematics curriculum to integrate CBI and/or computer-assisted instruction (CAI) to boost student achievement. There have been several types of CBI that have been available to teachers. CBI, also known as computer-based education (CBE), are the broadest terms used to define instruction with any type of computer use, including drill-and-practice, tutorials, simulations, instructional management, supplementary exercises, programming, database development, writing using word processors, and other applications. Stand-alone or reinforcement activities are ways to integrate CBI as a learning tool. In addition to CBI, the more specific area of computer-assisted instruction (CAI) will be addressed. CAI is defined as drill-and-practice, tutorial, and simulations offered as stand-alone components or as a supplement to concepts taught in traditional teacher-directed instruction (Cotton, 1991). These programs provide an introduction of the applications and practicalities of technology in the mathematics classroom. CBI creates an environment centered on individualized, flexible learning where students can be more self-directed and independent (Bloom & Haynch, 2002).

The importance of this review is to cite specific research and studies conducted across the nation and around the world to determine the effectiveness of such computer-based applications in the classroom. Students are more immersed in technology than ever before and teachers need to embrace the challenge to create an environment with ample technological materials to actively involve and retain student's interests (Miller, Schweingruber, & Brandenburg, 2001). Teachers need to take advantage of the technological tools available to help enhance student achievement.

According to Manoucherhri (1999), teachers need to be adequately trained and sufficiently supported in the educational use of such technologies. Training and support lead to a more positive integration of technology into the curriculum and thus helping teachers change their attitudes towards the use of this tool (Clark, 2000). The most productive and positive integration of CAI in terms of student achievement and motivation in the classroom was due to the professional development and training of teachers.

This review seeks to answer two main questions:

1. What are the needs of teachers to effectively implement CBI into their classroom?
2. What are the effects of CBI on student achievement in the mathematics classroom?

Methodology

The author focused on supporting the hypothesis of enhancing student achievement using computer-based programs by exploring print and on-line sources. These sources included the Rod Library at the University of Northern Iowa; educational laboratories such as the North Central Regional Educational Laboratory (NCREL), the Northwest Regional Educational Laboratory (NWREL), and the Mid-continent Regional Educational Laboratory (MCREL); the National Council of Teachers of Mathematics (NCTM); and the Association of Educational Communications and Technology (AECT).

The Rod library was used to find peer-reviewed periodical material though the electronic resource website provided by the university. Many of the articles were found using the Education Full Text database and the InfoTrac database. The author searched for documents from journals identified as peer-reviewed journals which supported the topic of student achievement with the use of CBI.

NCREL, NWREL, and MCREL were identified as sources where pertinent research had been conducted and documented. The NCTM website and Standards document were used to find curriculum related articles. The AECT website provided on-line research documents from their *Educational Technology Research and Development* journal.

Many of the keywords used for the search of pertinent information had to be refined. The author used a broad to specific topic search to find valuable information. Identifying the topic of CAI in the mathematics classroom, "computer-assisted instruction" and "CAI" were used for the main keyword search. There was an ample amount of articles pertaining to the keywords. To eliminate many articles, the search of "computer-assisted instruction and mathematics" was used. Browsing many articles did not turn up information to support middle school student achievement with CAI. The author continued to search for documents with a middle school focus and included CAI. Many more searches were made with keywords of "CAI and junior high" and "CAI and middle school." Expanding to "CBI and middle school" and "CBI and mathematics" proved to find articles that supported the middle school focus of computer-based programs in mathematics classrooms. Many of the articles used have research that does not address the middle school focus but shows how students above and below this age develop and what curricular steps need to be taken enhance a curriculum with CAI.

To search for technology training and development of teachers the keywords of "training and CAI" and "professional development and CAI" were used but results were not favorable. Therefore, the search was broadened to "CBI and training" where many articles included CAI as the main topic.

When analyzing the sources, the abstract was read to identify valid articles. If the abstract was not available, the author quickly skimmed the article for relevancy to the topic. Articles that focused on the implementation of CAI in the mathematics classroom and articles addressing teacher training were identified and used to support the review.

The criteria to use the literature was based upon those peer-reviewed or juried articles that pertained to the integration of computer-assisted programs that enhanced student learning in a K-12 environment where teacher training had an impact on the successfulness of the implementation.

Analysis and Discussion

To effectively integrate CBI into classrooms, teachers need to have adequate professional training, preparation, and support. Knowing how to use these technologies in the classroom, teachers can more fully understand the impact on curriculum in the content areas and thus be able to effectively integrate this tool. Student achievement relies on the strong content knowledge of the teacher, the insightfulness of the teacher in the methods of teaching, and the dynamic variety of tools to help students to learn. Computer-based instruction provides a catalyst for more individualized instruction and engaged learning which promotes the success and achievement of students in the classroom. To merge technology and the curriculum, teachers must be involved in the integration and be active in "helping students learn with and about technology" (Sheumaker, Slate, & Onwuegbuzie, 2001, p. 2).

Technology can make learning more engaging and individualized to meet the needs of students, provide access at the touch of a button, and encourage students to tap into their creative ability to expand and explore the world around them (Kleinman, 2000).

From the findings of Clark (2000), middle school teachers feel technology plays an important role by which to disseminate information to better meet the needs of students. Computers are potentially useful tools that teachers can use to involve students which promote active, inquiry-based learning (Bloom & Haynch, 2002). When integrating technology into the classroom, the teacher's role changes from the source of information into the information facilitator (Clark, 2000).

Training and professional development courses can change the attitudes of reluctant teachers so they become more confident in integrating technology into the curriculum. Student achievement can therefore be increased with proper knowledge and understanding of not only the content area but also the technology.

Teacher Training

The national student-to-computer ratio has improved from 125-to-1 in 1984 to 4.2-to-1 in 2002 (Technology Counts 2002: E-Defining Education, 2002). The availability of computers to students has encouraged more teachers to integrate computers in the curriculum. However, computers can be used more effectively on a network and Internet connection. Therefore, schools are moving to a creation of networked computers. According to Technology Counts (2002) the ratio of students per networked computers is 5.6-to-1. Access to software and individual information on any school networked computer allows students to utilize technology more efficiently. In addition to a network, schools are expanding computer capability to include the Internet. The ratio of students per Internet-connected computers is 6.8-to-1 respectively (Technology Counts 2002: E-Defining Education, 2002). Internet-connected computers enable students to access web-based programs or information with the touch of a button.

Having an ample number of computers in schools has prompted the administration to support initiating professional development training for teachers to help them integrate technology into the curriculum. According to Bruner (as cited in Tomei, 1997), developing effective methods of instruction for students depends on the teacher's ability to match instruction to the student's learning style. Manoucherhri (1999) stated that reform efforts may not have any effects on the classroom curriculum unless teachers are provided with opportunities and training to infuse technology into their teaching environment.

Teachers' attitudes toward technology can greatly impact students' attitudes toward technology (Clark, 2000). Many teachers are neither convinced of the role computer-based instruction has in the classroom nor do they see the potential of this technology to enhance curriculum. Consequently, before technology can be implemented, teachers need to be adequately trained and sufficiently supported in the educational use of such technologies (Manoucherhri, 1999). When the classroom focus shifts from teacher-directed to student-centered, teachers need effective skills and strategies to improve student learning (Kimble, 1999). Learning to teach with new instructional tools demands that teachers have hands-on experience, practice with the tools, and continued support from colleagues and others professionals in the field (Manoucherhri, 1999). The 1999 CEO Forum (as cited in Kimble, 1999) report stated:

> Professional development for teachers is an on-going, long term commitment that begins with the decision to pursue a career in education and continues, through a combination of formal and informal learning opportunities, for the duration of the career. (Research Supporting Technology Use, para. 4)

Using technology in the classroom requires the learning environment and instructional practices to become intertwined with the goal of providing students with real learning results (Kimble, 1999). The success or failure of computers relies on the human component as to the extent of the amount of training received on integrating the technology. Ryan (as cited in Valdez et al., n.d.) examined 40 studies and found that technology training of teachers was significantly related to the achievement of students. When training of teachers exceeded ten hours, the achievement level of students outperformed those students whose teachers had five or fewer training hours.

Staff development needs to encompass four aspects in order to be deemed successful. When efforts include "presentation of theory and information, demonstration, practice with feedback, and coaching and follow-up over time" (Bradshaw, 2002, p.134), the transfer of practices to the classroom and instructional improvement are increased. Teachers need to have on-going support and sufficient time for use of the equipment and programs, and assistance should be available when hardware or software problems are encountered (Bradshaw, 2002).

Shuemaker, Slate, and Onwuegbuzie (2001) stated that teachers who had computer training used more presentation software and showed an increase of student technology use than those teachers who did not have this type of training. This study also suggested that technology training was beneficial in promoting an integration of technology into the curriculum. Wenglinsky (1998) found teachers who received any amount of computer-related professional development in the past five years used computers in more effective ways than those teachers who did not receive any training. In the same study, 76 percent of eighth graders had math teachers who received such computer-related professional development training within the past five years. Math students in the eighth grade scored .35 of a grade level higher than their counterparts when the teachers received training on computers (Wenglinsky, 1998). Soloway (as cited in Archer, 1998) stated "The teacher has always been the key to determining the impact of innovation" (para 59).

Clark (2000) pointed out that teachers want access to programs other than just word processing. Teachers want relevant technologies that can be used for various educational purposes and settings to improve student achievement. An Educational Testing Service study (as cited in Clark, 2000) found teachers who were provided with technology training to use computers to teach higher-order concepts had students who showed increased gains in mathematics achievement. Through encouragement and support of teachers implementing technology into the curriculum, students may have an increased level of achievement in the mathematics classroom (Clark, 2000).

Becker (as cited in Sheumaker, Slate, & Onwuegbuzie, 2001) stated that through increased formal staff development, teachers began to increase their usage of computers and also discuss teaching practices and project ideas informally more than they had in the past. In a Georgia staff development program entitled Integrating Technology in the Student-Centered Classroom (InTech), middle school teachers who were trained in this program showed an increase of students technology use in the classroom and implementation of presentation software by teachers (Sheumaker, Slate, & Onwuegbuzie, 2001). The findings of this study suggested that the InTech training was indeed beneficial to promote the integration of technology into the classroom by teachers. The training enabled teachers to integrate technology into their middle school curriculum with instruction and a foundation to support methods in the classroom (Sheumaker, Slate, & Onwuegbuzie, 2001).

To address the need for computer training for pre-service teachers, two schools in Texas implemented a plan to utilize technology as part of the teacher education program. The basis for the plan was that the natural classroom setting would be used in order to make the training effective. The pre-service teachers would meet with a technology specialist once a week for two hours of training on word processing, graphics, databases, spreadsheets, multimedia, and authoring presentations. Through the training, the pre-service teachers gained confidence in using technology for personal productivity and to enhance instruction (Curtin et al., 1994).

Staff development has provided teachers with a means to create a solid foundation for integration technology into the curriculum. Wenglinsky (1998) stated that any amount of professional development transferred to the classroom in the form of achievement gains in students. More elaborate hands-on training where teachers use the actual software and hardware may pose greater gains in the learning of students. As Lookatch (as cited in Sheumaker, Slate, & Onwuegbuzie, 2001) stated, “It is not the machine that motivates. Rather it is content and instructional strategies that motivate the learner” (p. 9).

When the curriculum and technology complement each other seamlessly, the instruction is more meaningful and therefore more effective than if both are separate entities (Wenglinsky, 1998). Thus, implementation can only effectively occur when training and support are given to staff on the most effective ways to use the programs

(Bradshaw, 2002; Manoucherhri, 1999; Shuemaker, Slate, and Onwuegbuzie, 2001; Wenglinsky, 1998).

Student Achievement

Middle school is a time of change for many students, emotionally, physically, and intellectually. In this developmental age, students are usually now placed for the first time according to achievement which will often follow them to high school. The success of failure of students at this level is dependent upon their developmental needs being met. The wide-range of ability can pose a problem for middle school teachers who are trying to accommodate every student in the ways each learns best (Jarrett, 1998).

Students of this age begin to emerge in their ability to think abstractly. These students have a "growing capacity for conceptualization, for considering more than a single idea at a time, and for planning steps to carry out their own learning" (National Middle School Association, 1995, p. 6). Yet concrete learning still needs to be incorporated while students develop their abstract thinking abilities.

Teachers may be hesitant to use any form of technology in the mathematics classroom because they are burdened with the fact they are to prepare students to be better thinkers and problem-solvers. The pressure mounting to cover the topics in the textbook and spend less time on technology-based mathematical activities is prevalent due to the need to increase student achievement on standardized tests. However there is evidence that integrating technology into the curriculum can improve "student's computation and writing skills, problem-solving and inquiry strategies, as well as cooperative learning, motivation, and self-esteem" (Jarrett, 1998, p. 6).

The educational process has changed with the integration of CBI. Teachers are being asked to accommodate each individual student by meeting their needs, interests, prior knowledge, and learning styles (Kulik, 1994). "Developing life-long learners who are intrinsically motivated, display intellectual curiosity, find learning enjoyable, and continue seeking knowledge after their formal instruction has always been a major goal of education" (Small, 1997, para 10). Technology is the new tool in education to motivate students and raise levels of achievement in the classroom. Using CBI as an individualized plan includes demonstrating simulations of mathematical concepts, providing skill work in needed areas, or providing assistance in computation (Wenglinsky, 1998).

Technology improved student scores when consideration of context, content, resources, and learning issues were taken into account. When the relationship between education and the use of educational technology is identified and acted upon in a precise and intentional manner, optimum potential for the enhancement of student learning and achievement can be obtained (Valdez, 2001).

Hopson, Simms, and Knezek (2001) reported teachers who enriched curriculum with technology had a more cooperative learning environment where students focused on applying knowledge than acquiring knowledge. The learning in this environment was centered on student learning and not on a teacher-centered or textbook driven classroom. When the curriculum presented to students is standards-based, students tend to achieve higher than their counterparts. Riordan and Noyce (2001) thought that standard-based curriculum has a positive longitudinal effect on student gains achievement.

In Cotton (1991), the effect of supplementary CAI and traditional classroom instruction produced achievement levels higher than that of just traditional classroom instruction. This has been noticed in an Iowa school district with the implementation of PLATO, a web-based computer-assisted program that is aligned with NCTM Standards. The effects have been more positive when teachers supplement instruction and identify specific learning needs through PLATO than if the program is used for the primary source of instruction. Students who have not been successful in previous mathematics courses are now beginning to understand concepts which were never mastered. Each student worked on concepts which are prescribed from an assessment within the program. Achievement scores on the Iowa Test of Basic Skills showed that a number of students are being pulled from the bottom percentile levels into the middle percentile. The same was found for students in the middle percentile moving up to the top percentile. Student perception of the program indicated a ratio of 3:1 in favor of the program to traditional classroom instruction. The positive attitudes may also be attributed to the way the program is integrated with the numerous courseware offered to better fit the needs of the student. Students can work on skills, simulations, and applications in various forms and formats. The results have been positive for the program, teacher use of the program, and student learning and achievement in the mathematics classroom (R. Hardiman, personal communication, May 4, 2003).

Xin (1999) found that integrating technology into the classroom may create ways to include an academically diverse population of students and aid teachers in meeting the needs of those students with different learning abilities. The results of a study by Cohen (2001) suggested school environment can change a student's learning style. This research reported that those classrooms centered on collaborative, project-based learning through the integration of technology had a positive effect on student motivation. The students in this study found education more relevant to their everyday lives because of the use of technology. According to Means and Olsen (as cited in Jarrett, 1998), the enhancement of the curriculum with technology can increase student motivation. Quiet and reserved students can become leaders in the classroom through their knowledge of technology. Students are more willing to work on needed skills in mathematical areas through the integration of computers. The feeling of accomplishment and power among students increases and they value the immediate feedback given by computers. When students have multiple ways to communicate their understanding, the demonstration of knowledge is done more effectively (Jarrett, 1998).

Crooks, Klien, Savenye, and Leader (1998) suggested that when students are allowed the opportunity to bypass certain instruction, they tended to view more optional material than they would have if they would not have been given that control. Students who worked collaboratively spent more time on practice than did those students who worked individually. These students also selected more elaborative feedback than their counterparts did. This finding was due to the fact that collaborative students had time to help each other, discuss material, and then subsequently search out more information needed to answer the questions. K. Shirley (personal communication, May 1, 2003) stated that students in the classroom are more engaged using CBI and confident in mathematics than in the traditional classroom. They are more willing to collaboratively work together so the lesson can be completed. Students have covered more material and filled in gaps which may not have happened without the program. They have control over choosing which part of the module they would like to work on. If a concept is a review of prior knowledge, then the student can complete the mastery test and move on to more complicated material. Continuing the program will hopefully give students the needed edge to succeed in upper level mathematics classes which may have not been an option for them without this program.

Corno and Snow (cited in Xin, 1999) stated that CAI provides (a) students with individual learning instructions that allow them to monitor their speed and progress, (b) immediate feedback where the accuracy of responses can be monitored, and (c) immediate reinforcement to motivate students to continue working on the program. Klein and Keller (as cited in Crooks, Klein, Sayenye, & Leaders, 1998) stated students also can have options to control several variables of the program such as pace, sequence, feedback, practice, difficulty on the practice items, the specific objectives studied, and the content covered. Students tend to work more productively when the material is done independently because they are not being judged by their peers (Jarrett, 1998). Yet students can also work in cooperatively and still effectively learn ("Pa. Middle School," 1997). In a study by NCREL (as cited in Valdez, 2001), using CAI can be effective to monitor individual needs; increase parent involvement; align curriculum, instruction, and assessment; and improve student motivation and attendance.

Owen and Waxman (1994) indicated that using computer-assisted instruction was more effective for learning mathematical concepts. Students in this study had higher geometry scores than those students in the traditional classroom. Approximately one-third of eighth grade students had math teachers who used computers for drill and practice. Teachers used simulations for instruction 29 percent of the time along with applications 27 percent of the time (Valdez et al., n.d.). Students immersed in a technologically rich environment had higher standardized test scores (Page, 2003).

In a study by Taylor (1998) on the effects of a program called *Learning Expeditions*, the results showed that those students who spent more time on the program improved on the end-of-year mathematics tests. The study also showed that roughly for every ten hours spent using CAI, the students improved approximately 0.5 of a level concluding that this instruction had a positive effect on student's performance in mathematics. Eighth grade students who use simulation and higher order thinking software showed gains of 15 weeks above grade level in math scores (Wenglinsky, 1998).

Discovery learning over the past few years has been a practice incorporated into many classrooms. Interactive courseware including those through the Internet may lead to discovery learning where students are provided with support, feedback, and stimulating graphics, sounds, and animations that engage students. Jih (2001) reported:

> Learners are more likely to construct meaning out of their interactive experiences, to interpret the verbal as well as visual information, construct their mental frameworks, and understand the natural facts as they work directly with virtual phenomena in the learning context. (p. 368)

This interactive courseware allows students to be actively involved which encouraged a meaningful incorporation of information that triggers their prior knowledge. Discovering the connections between prior knowledge and new information helps students in the transfer of knowledge (Jih, 2001).

In a study by Schenone-Stevens (1999), students favorably viewed CAI as a tool used in the learning process. Visualization of statistical calculations was made easier and the learning experience deemed more positive through the use of the program. Students remarked they would be more willing to take another similar mathematics course if CAI was involved. Perceptions from the students indicated that the teacher plays a major role in the learning process. Encouragement and direction from the teacher was wanted and needed in addition to the feedback given by the computer.

In a middle school in Philadelphia ("Pa. Middle School", 1997), students were involved in the Computer and Team-Assisted Mathematics Acceleration (CATAMA) program. Students were pulled from an elective class temporarily for ten weeks. Placement tests were given to assess what each student knew. Students were given a partner and placed next to each other in the computer lab to form a cooperative learning team. The lessons consisted of comparison, prediction, and estimation concepts. On a standardized math test the CATAMA eighth grade students outperformed counterparts in six comparison sites. Only two-percent of the students stated they would have rather stayed in their electives ("Pa. Middle School", 1997). Xin (1999) pointed out that students enjoy using the computer more for mathematics because of their success in learning mathematics concepts.

Computer-assisted instruction can be effective for work on mathematical concepts (Knapp & Glenn, as cited in Jarrett, 1998). Students would prefer to work independently and at their own rate as so not to be judged by their peers for mistakes that may be made. The computer also offers immediate, non-judgmental feedback. The main drawback of CBI and CAI is when used in isolation from the rest of the core curriculum, students tend to be unable to apply the skills to real world applications (Jarrett, 1998). Therefore, the technology and the curriculum need to be a component of seamless instruction between technological and non-technological instruction (Wenglinsky, 1998).

Computer-assisted instruction has the potential to enhance and facilitate learning in a classroom. Students may become better self-directed learners and motivated to learn the essential concepts with technology which in turn promotes achievement in the classroom (Xin, 1999).

More substantial research needs to be conducted to convince stakeholders that technology is beneficial for student use. "If this were a new drug, you'd have a fairly hefty percentage of the costs spent on research and development. But that has not happened with educational technology" stated William L. Rukeyser, chief coordinator of Learning in the Real World (cited in Symonds, 2000, p.118). Many of the CBI studies conducted have been with elementary, high school, and college level students. Research is starting to be conducted on the effect of technology and student achievement in regards to middle school students. More emphasis and research needs to target the middle school population to find the best methods to integrate technology into the curriculum which promotes the highest level of achievement in students.

Conclusions and Recommendations

Computer-based instruction has the potential to reform mathematics classrooms. This classroom transformation can lead to a more student-centered environment where there is a high level of motivation, engagement, and activity through the successful integration of computer-based technologies.

To implement technology into teachers' repertoire of instructional techniques, there needs to be intense training in the usefulness and application of such tools. Without training, teachers may be reluctant to use such a tool. Teachers should have a shift in attitude from reluctance to acceptance through subsequent training.

Training should be reinforced with hands-on experiences and practice with the technology. Teachers may integrate technology more into their curriculum through a constructivist method of teaching. Preparation and implementation of computer-based technologies in the classroom should be enhanced not only by training but also via support from colleagues and other professionals in the field.

CBI and CAI can meet the needs of a diverse population of academic learners. Learner-controlled programs give students options to progress through the instruction. Feedback, pace of the program, reinforcement, content covered, sequence, and practice create an actively engaged environment where the students could create meaning through the interactive computer-assisted instruction.

Discovery learning through the use of the Internet also helps create an engaging environment where students can activate prior knowledge and construct knowledge about the world around them. When responsibility for learning is placed upon the student through the discovery method, connections can be made which are meaningful.

Students can work successfully with CBI and CAI independently or cooperatively. The component that makes learning successful is not whether the program is used for independent or cooperative activities but instead how integration into the curriculum occurs.

The author recommends using CBI and CAI in the mathematics classroom to enhance student achievement through intense teacher training. Teacher training is the most important factor in successfully integrating CBI and CAI. Teachers need to be aware of how to use the tool in the most efficient and effective way to benefit students and create an environment where learning and achievement are the top priorities. When more teacher training occurs, the outcome of student achievement seems to be positively related. Therefore, schools need to invest not only in technology for the students, but also for training of those using the tool to enhance student achievement.

When students use CBI and CAI in a curriculum where technology and content are a seamless component of instruction, they may become better self-directed learners and have the possibility to engage in more learning than in the traditional classroom setting. CBI and CAI create an individualized, controlled pace for the student where the immediate feedback, correction, and progression of learning may promote higher achievement in the classroom. However, the potential for students to utilize a tool that promotes achievement is only as great as the training for teachers implementing the program.

Technology that has been implemented and researched has shown signs to positively effective student achievement and motivation in the mathematics classroom. Yet, in the constant ever-changing world of technology, implementation will not only take billions of dollars in equipment, but also the training of those teachers. The surface has just barely been scratched to see the major capabilities of student achievement and motivation through the use of technology.

The author believes that technology is a catalyst to student achievement in the mathematics classroom. For successful integration of technology in the classroom, teachers should have rigorous training and support. The training and support serves as a springboard towards the integration of technology. Teachers can create an active and engaging environment for students through their positive attitudes toward technology integration.

Computer-based instruction research has been conducted in the elementary, high school, and college populations more than in middle schools. Identifying best practices and methods for teaching middle school students may help support the integration of technology in the curriculum. In order middle school teachers to accept the technological changes that have been occurring there needs to be more extensive research in the best practices to achieve the greatest student gains with the integration of CBI.

There has been a push for students to become more mathematically competent. CBI provides teachers with individualized instruction where students can learn at their own rate and therefore make mathematics less frustrating. Creating an environment that meets the needs of all students can create a great burden for teachers. Yet, with CBI teachers can move to a more student-centered environment where there may be more options for students to succeed.

As standardized tests become the norm for teacher and student accountability, CBI may be used supplement curriculum and may lead to higher student achievement. Teachers when trained properly can identify material on the CBI or CAI that may benefit student needs and enable the greatest gains to be achieved.

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