2003

Using computer-based instruction to strengthen student achievement in the middle school mathematics classroom

Anne Nedved
University of Northern Iowa

Using computer-based instruction to strengthen student achievement in the middle school mathematics classroom

Abstract

According to the National Research Council (2001), students in mathematics should be able to understand mathematics, compute fluently, apply concepts in a problem-solving manner, reason logically, and engage with mathematics in a sensible, doable, and useful manner.

The goal of this project is to develop a curriculum guide for the implementation of the Computer Assisted Instruction program PLATO into the current curriculum of the Council Bluffs Community School District. 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.

USING COMPUTER-BASED INSTRUCTION TO STRENGTHEN STUDENT ACHIEVEMENT IN THE MIDDLE SCHOOL MATHEMATICS CLASSROOM

A Graduate Review

Submitted to the

Division of Educational Technology

Department of Curriculum and Instruction

In Partial Fulfillment

Of the Requirements for the Degree

Master of Arts

UNIVERSITY OF NORTHERN IOWA

by

Anne Nedved

August 2003

This Review by: Anne Nedved

Titled: Using Computer-Based Instruction to Strengthen Student Achievement in the Middle School Mathematics Classroom

has been approved as meeting the research requirement for the Degree of Master of Arts.

9/4/03
Date Approved

Terri McDonald
Graduate Faculty Reader

Sept. 4, 2003
Date Approved

J. Ana Donaldson
Graduate Faculty Reader

9/4/03
Date Approved

Rick Traw
Head, Department of Curriculum and Instruction

Table of Contents

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 project supports the current plans in Council Bluffs School District 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), is the broadest term 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 project is to develop a curriculum guide for the implementation of the CAI program PLATO into the current curriculum of the Council Bluffs Community School District. 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.

The rationale for the current project stems from a CAI program being used in the mathematics classroom. PLATO was implemented in the 2002-2003 school year from a grant awarded to the district. The grant sought to determine the effectiveness of the CAI in rural and urban eighth graders as measured by the Iowa Test of Basic Skills.

Due to the lack of training and support in the implementation of the program, the participating teachers were overwhelmed with the amount of information and curriculum selection of CAI offered. PLATO offered several curriculum avenues for the teachers to utilize. However, being able to find the most meaningful tasks for students proved to be difficult due to the non-linear curriculum. In addition to the difficulties of finding the most meaningful tasks, the program was not exempting students from material they already knew. Mastery tests would also disconnect from the host which locked the test and made the students redo the practice and application before the test would unlock for them to complete. Therefore, students had to repeat modules and waste time going through the motions of pushing buttons instead of learning mathematics concepts. Students did not show the increase in achievement as the administration would have wanted. Therefore, the program is in jeopardy of being cut from the current tools being used by the mathematics department.

As a new means of improving student achievement, the mathematics department is implementing an initiative from the Iowa Department of Education in cooperation with the University of Northern Iowa entitled "Every Student Counts." In this initiative, teachers are to integrate a series of small programs designed to improve understanding of mathematical concepts by students. The programs are centered on a theme that is identified as being an area in which students are in need of improvement.

The curriculum guide developed by this author may serve as a means to identify material to best fit with the needs of students. It may be used as a reference guide, a curriculum, guide, or a material guide. The purpose of this guide, essentially, is for teachers to have a printed source of pertinent information and material offered by PLATO dealing with the topic chosen by the mathematics department. Ideally, the guide may serve as a road map to seamlessly connect with all other curriculum tools being used.

According to the National Research Council (2001), students in mathematics should be able to understand mathematics, compute fluently, apply concepts in a problem-solving manner, reason logically, and engage with mathematics in a sensible, doable, and useful manner. Within this project, teachers will be able to match PLATO lessons to the curriculum to meet the National Research Council requirements and therefore meet the needs of students and the new initiative using a CAI.

Methodology

Research Method

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.

The author used a broad-to-specific topic search to find valuable information. Many of the keywords used for the search of pertinent information had to be refined. 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 number of articles returned using the keywords. To narrow the selection of articles, the keyword combination of "computer-assisted instruction and mathematics" was used. Browsing many articles did not turn up information to support middle school student achievement with CAI. Refining the search 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 show how students in other age groups develop their understanding of mathematics and what curricular steps need to be taken to enhance a curriculum with CAI.

Reviewing articles pertinent to the development of the project was key to identifying what should be included in the actual curriculum guide. Due to the immense amount of support material provided by PLATO and the lack of actual curriculum guides pinpointing topic areas, the curriculum guide was developed out of a necessity to map available resources of the CAI.

Literature Review

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). 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. 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).

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).

Student learning can be facilitated with the integration of CBI. Providing resources and a variety of ways for students to learn may lead to a successful integration of a CAI program.

The Project

The initial training session in 2002 for teachers included several documents on the scope and sequence of the curriculum, how to create classes within PLATO and PLATO LINK, and other administrative tasks. The documents were difficult to follow due to the multitude of information presented and the poor quality of training received. The training included three sessions consisting of two-hours listening to the trainers. The sessions did not provide teachers with enough time to investigate the program in depth with support from the trainers. During training, the author felt the information was not user-friendly nor was it convenient to find needed information.

The integration of PLATO into our school's curriculum was riddled with equipment failure, program failures, troubleshooting those failures, and the inability of teachers to find useful and meaningful content for students. When the middle school students began using the program, they spent more time pushing buttons than learning new concepts because of the lack of training and support the classroom teachers received.

The conception of this project derived from the author's belief that information provided by PLATO needed to be gathered in an organized manner according to how the previous grant teachers integrated the CBI. PLATO user guides included printed pages as well as many documents that needed to be downloaded and read. It was difficult to find and organize the electronic resources. A hard copy was needed. Creating an organized printed notebook of essential resources would enable those teachers using PLATO to integrate the program more effectively by providing a quick reference guide of the most frequently asked questions of teachers using the program to support the "Every Student Counts" initiative.

When developing this curriculum guide, the author identified the key topic of fractions, decimals, percents, ratios, and proportions to coincide with "Every Student Counts." Knowing there were several different courses, modules, and programs to use, the author aligned the identified topics with the Scope and Sequence guide provided by PLATO.

Participating grant teachers used an on-line program entitled "Fastrack" to allow learners to progress through a predetermined set of concepts. Each of the levels was printed as a guide for which concepts were included. Teachers could then look through the level and determine if the content is appropriate for the needs of the students. The hard copies can be used to show parents, administration, and other teachers how the students are meeting standards and benchmarks.

Math Expeditions and Problem Solving were the next section to be added. The teacher's guide was printed off again as a reference. The resources were located in a downloaded user's guide. During the previous year, the grant teachers could not find this information needed to help students when they worked on the lesson. Providing hard copies of the documents may save teachers time in locating the resources. Teachers may be able to walk around the room with the documents in hand and help students when there are problems. The Expeditions levels E – I and Problem Solving guides were made into a hard copy so teachers can examine the type of learning that should be taking place during each lesson.

The sections Math Fundamentals, Pre-Algebra, and Beginning Algebra included modules dealing with the topic of fractions, decimals, percents, ratios, and proportions. Each of scope and sequence was printed to enable the teacher to see how much time each activity may take and in which course the applicable module may be. The objectives for each module were printed as a guide for those who may not have Internet access outside school and for those individuals outside the mathematics department that do not have access to the programs. Individuals can see the objectives of each course and determine how they fit in to the standards and benchmarks. Since teachers need to report the mastery of each benchmark, this is a means to show how each module is aligned.

Included in PLATO is another component called PLATO LINK. This is a separate program that functions on its own but sends information to the PLATO server on learner progress. PLATO LINK simulates the Iowa Test of Basic Skills assessments for students to practice. PLATO LINK has a skill bank that tells the students and the teacher where PLATO resources are on the web and in the program to link with each of the skill objectives. This allows the students to return to PLATO and work on the skills identified in the PLATO pretest. This section in the guide allows the teacher to get wide view of where PLATO skill resources are in the program. The chapters in LINK were printed for the teacher to know where in the PLATO courseware each of the skills is located. In addition to LINK skill builders, there are also teacher tips. These tips are additional hands-on activities that can be used as a supplement to classroom or PLATO lessons. The activities seek for students to gain a deeper understand of the concept. Included in the guide are print outs of the lessons to help build student understanding. These may be handy if there is ever any technological problem in the lab. Many of the tips are quick lessons that do not take much time or preparation to implement.

For the teacher document, the author separated the material into a Fraction and Decimal PLATO Skills section along with a Ratio, Proportion, and Percent PLATO

Skills section. The separation of these sections may allow teachers to find lessons that supplement classroom material or the need to support individuals in their learning.

The Test Taking Strategies provided by PLATO LINK were printed to allow teachers an additional resource when preparing students for classroom tests or the Iowa Test of Basic Skills. Students need test taking strategies in order to do well on standardized tests.

The section entitled Student Reports was printed to help with record keeping. This may be a nice addition for helping teachers and students monitor daily progress. These forms can be used for parent-teacher conferences to show parents exactly what their child is learning using PLATO.

When the author was reviewing many of the links and resources available, there were also some additional Internet resources provided by PLATO that seemed engaging for students and would help with their understanding. The lessons included a variety of Internet, hands-on, and problem solving based activities. These lessons may serve as a preview, review, or supplement to the lesson being taught in the classroom. The lessons may also serve as alternative activity if the Internet is down and students are unable to work on PLATO during that period.

Lastly, PLATO LINK provides teachers the chance to create on-line and paper tests that simulate the ITBS. The concepts, number of questions, and actual questions are chosen by the teacher. The teacher can align the test to either the National Council of Teachers of Mathematics (NCTM) standards or the Iowa Test of Basic Skills (ITBS) standards. The author used the LINK tool to create several tests that were aligned with both the NCTM standards and the ITBS standards. These tests may help provide the practice on computation that students need.

The guide was created as a way for teachers to have all the needed information in one place. This may alleviate frustration felt by many teachers. This project may also serve as the backbone for the integration of PLATO into the curriculum.

The materials included can be used in various ways for students. The Expeditions and Problem Solving units can be used as cooperative learning projects as a means for student understanding of concepts. The LINK skill builders can be done individually to build the skills for each student.

Each teacher will be able to use the guide as they see fit for their students. The best possible way to find the methods that increase student achievement will be to collaborate and document implementation procedure.

Conclusions and Recommendations

As a result of this project, the author feels more comfortable in being able to implement PLATO this year because the documentation is organized and matched to our new initiative of "Every Student Counts" along with the district standards and benchmarks. Those teachers who did not use PLATO during the 2002-2003 school year should be able to spend less time locating material. Therefore, they should be able to focus on implementing PLATO to meet students' needs. Other resource material used until this point was in a variety of places. This project includes all the needed curriculum resources in one place. Finding a section can now be done with less hassle and frustration. Print sources will reduce the time to find materials and then print them off. The project can serve as another textbook resource to be utilized.

The project may have taken some time to do: finding material, sorting out topics that fit into the new initiative, reviewing material, and creating print sources. However, it should be useful when materials for the needs of the mathematics department are in one place.

The project in no way is a linear guide to implementing PLATO. This guide was designed to support the needs of the mathematics department in coordination with the "Every Student Counts" initiative. Each section included meets the initiative and also meets the standards of the district.

Future projects should include to creating other guides suited to meet the needs of department by outlining other major concepts the students need to work on individually. Taking each of the mathematics standards and finding which areas and topics in PLATO align with the district goals needs to be done.

Creating a plan of action of the possibilities for the integration of PLATO should ease much of the frustration felt by many of the teachers over the past year. This guide creates a concrete plan of how teachers may be able to teach the concepts of fractions, decimals, percents, ratios, and proportions using CBI.

The project will take time for individuals to feel comfortable using. Trying new teaching methods and delivery when using the guide to implement lessons should be documented to enable other teachers to identify the best practices in integrating CBI.

As with any project, the guide will need to be revamped, realigned, and modified to identify the best parts of PLATO to use with the students being taught. The project can be considered a developing work-in-progress.

References

Bloom, M.V. & Hanych, D.A. (2002). Skeptics and true believers hash it out [Electronic version]. *Community College Week*, *14*, 17.

Clark, K.D. (2000). Urban middle school teachers' use of instructional technology [Electronic version]. *Journal of Research on Computing in Education*, *33*(2), 178-195.

Cotton, K. (1991). Computer-assisted instruction. *School Improvement Research Series.* Retrieved May 10, 2003 from http://www.nwrel.org/scpd/sirs /5/cu10.html

Cohen, V.L. (2001) Learning styles and technology in a ninth-grade high school population. *Journal of Research on Technology in Education*, *33*(4), 355-367.

Eom, W., & Rieser, R.A. (2000). The effects of self-regulation and instructional control on performance
and motivation in computer-based instruction [Electronic version]. *International Journal of Instructional Media*, *27*(3), 247-261.

Hopson, M.H., Simms, R.L., & Knezek, G.A. (2001) Using a technology-enriched environment to improve higher-order thinking skills. *Journal of Research on Technology in Education*, *34*(2), 109-120.

Jarrett, D. (1998). Integrating technology into middle school mathematics: It is just good teaching. Northwest Regional Educational Laboratory Mathematics and Science Education Center. Retrieved June 1, 2003 from http://www.nwrel.org/msec/book6.pdf

Kulik, J.A. (1994) Meta-analytic studies of findings on computer-based instruction. In E.L. Baker and H.F. O'Neil, Jr. (Eds.). *Technology assessment in education and training.* Hillsdale, NJ: Lawrence Erlbaum.

Miller, L.M., Schweingruber, H., & Brandenburg, C.L. (2001). Middle school students' technology practices and preferences: Re-examining gender differences [Electronic version]. *Journal of Educational Multimedia and Hypermedia*, *10*(2), 125-140.

National Research Council. (2001). *Adding it up.* Washington D.C.: National Academic Press.

Pa. middle school implements computer-assisted math lab [Electronic version]. (1997) *T.H.E. Journal*, *24*(8), 48.

Riordan, J.E. & Noyce, P.E. (2001). The impact of two standards-based mathematics curricula on student achievement in Massachusetts. *Journal for Research in Mathematics Education*, *32*(4), 368-398.

Shuemaker, F., Slate, J.R., & Onwuegbuzie, A.J. (2001) The role of InTech training in the integration of technology into instructional practices among Georgia middle school teachers. *Journal of Research on Technology in Education*, *33*(5), 1-12. Retrieved September 30, 2002 from http://206.58.233.20/jrte/3/5/shuemaker.html

Stillwell, T. (2002). Condition of education report: 2003. Iowa Department of Education. Retrieved May 30, 2003 from http://www.state.ia.us/educate/fis/pre/coer/doc/coer02.pdf

Small, R.V. (1997) Motivation and instructional design. (Report No. RR93002009). Syracuse, NY: Center for Science and Technology. (ERIC Document Reproduction Service No. ED409895)

Valdez, G. (2001). Technology: A major catalyst for educational improvement. Retrieved May 5, 2003, from http://www.mff.org/edtech/article.taf?function=detail&Content_uid1=108

Wenglinsky, H. (1998). Does it compute? The relationship between educational technology and student achievement in mathematics. Educational Testing Service Policy Information Center: Newark, NJ.

Xin, J.F. (1999). Computer-assisted cooperative learning in integrated classrooms for students with and without disabilities [Electronic version]. *Information Technology in Childhood Education Annual, 1999*(1999), 61-78.