

Use of Computer Aided Technology in modern Mathematics Education: an experimental Analysis

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Abstract

Today, more than ever before, concerns are being raised as to how the United States will meet new challenges in education while reforming or eliminating instructional processes which are no longer valid or useful (Mathematical Sciences Education Board, 1990). Worries exist over student performances in mathematics and science within all grade levels. Comparisons of test scores between students in the United States with those in Europe and Japan have placed issues of public education at the forefront of the minds for many in the American Public (Bailey & Chambers, 2005). In responding to these concerns, many disciplines within public education are undergoing various levels of reform as educators search for ways to improve education (Strassenburg, 2004). In particular, the increased use of technology especially computer technology, has been incorporated into educational processes as a way to improve educational opportunities, while enhancing student performance.

The 6-week experiment used in this study has shown conclusive results that the use of dedicated technology in the classroom does improve the achievement results of High School Algebra students. The academic achievement analysis yielded the following results: Significance level (p value) = .0022. The alpha value used in the study was ($p=.05$). Since the obtained value was less than the alpha value, it was concluded that significant difference exists within the two methods of instruction. In summary, the results showed an approximate 20% improvement using the computerized method as opposed to the traditional methodology.

Technology, is seen as a way of providing the tools needed to enable the transition, while serving as a catalyst for further change in high school mathematics education (Owens & Waxman, 2005). The availability of computer systems has resulted in an increased use of computers for teaching and learning in education. Computers and peripheral hardware enable educators to incorporate video, sound, and animation into instruction. Authoring software provides another level of computer use by allowing educators to develop and use multimedia instruction and programs designed for specific learning outcomes. New technologies, such as the personal computer as an instructional tool, are providing teachers and learners the opportunity to explore alternative ways to learn.

Background

Use of technology in mathematical education is not a new issue, nor a recent phenomenon. However, technology in the form of computers and specialized software has changed dramatically over the past fifteen years. These technology tools have gotten smaller, more powerful, and, perhaps most importantly, less expensive. In addition to the computational power and symbolic manipulation capabilities of computers, these tools also provide exciting new ways of sharing data, information, and ideas. Through the use of computer and calculator technology, the modern mathematics classroom is no longer necessarily restricted to the chalkboard and the physical walls surrounding the students (Sorensen, 1996).

In order to meet the expectations for high school mathematics education, school divisions must have adequate technology in place. Teachers must possess the knowledge and willingness to use technology in the classroom. Technology must be used in a frequent and consistent fashion within mathematics courses. Given that the focus of this study is on mathematics education, the term technology will be used to represent the tools such as handheld calculators and personal computers. The purpose of this study was to improve the community's understanding of how computer-integration, used in mathematics education, may significantly improve students' achievement levels.

Research Question

For the purpose of this study, only one research question was featured and further discussed in detail:

- Will students learning Mathematics using a variety of computer-based educational tools have significantly higher achievement rates than students taking Math in a traditional, lecture-based format?

Significance of the Study

The findings of this study should aid school divisions in planning purchases, developing training activities that will enable teachers to better implement technology use, and more fully incorporate the use of computers in mathematics courses. At the very least, the results from this study should aid in the determination of the effectiveness of the commitment to put computer technology into public schools. Perhaps as importantly, this study points out potential weaknesses or anomalies that should be useful in planning for future studies of this kind.

Limitations

There are several limitations to this study. One of them is the time factor. Given the time allotted for this study, only the responses of students presently enrolled could be considered. Another potential important limitation in this study is the sample size of students that may be selected. Some schools may not allow large samples of students to be selected for further studies. This factor may have negative results on the measured outcome results (Hicks, 1964).

Even though the results of this study may be generalized to other mathematical disciplines such as Geometry and Calculus, this study was limited to measuring and interpreting the results only for the academic performance of Algebra classes.

Review of Literature

Introduction:

In preparing for this study, literature representing a variety of topics was reviewed. To set the context of technology use in mathematics education, literature concerning reform movements in mathematics education was examined. Issues involving technology use in education, and the role of technology in mathematics reform, were explored through current literature.

Mathematics Reform

One place to begin a study of technology in mathematics education is through examining the reforms and changes, which have taken place over the past 40 years in mathematics education. Many of the courses currently taught at the high school level came about as a result of changes proposed during the 1950s by the Commission on Mathematics of the College Board Examination (Usiskin, 1995).

Although the content of high school mathematics has not changed dramatically, the approach toward teaching mathematics has. As expressed by the National Council of Teachers of Mathematics, and echoed by Glidden, the emphasis has gradually shifted from the mechanics of computation to the understanding processes of the students, with personal computers being used to perform routine computations (Glidden, 1996; NCTM, 1995, Sinclair, 2005). As part of this change, as observed by Kitchens, the roles of the teacher and student are being redefined – teachers are seen as facilitators and co-learners with the students in the education process. This shifting from teacher-centered instruction to a student-centered environment has placed greater importance on the active participation of the students working in a collaborative environment with teachers to promote a deeper level of understanding (Mathematical Sciences Education Board, 1990; Wilcox & Zielinski, 1997).

Technology Use in Education

In reviewing national survey data from 15,000 tenth-grade students on the use of technology, Owens and Waxman (2004) concluded that while technology provides the tools, it might also be acting as a catalyst to bring about additional changes in mathematics education. It has been suggested that it is the availability of this technology that is driving the current reform in mathematics (Keitel, Kotzmann, & Skovsmose, 1993). Others credit the changes in technology as providing a part of the influence for reform, with other equally important components coming from the social and economic needs of the American society, as well as the results of years of research about learning from the field of cognitive psychology (Schifter, 2004).

Based on a nationwide survey of 608 teachers in grades 4 through 12, Sheingold and Hadley found that with the use of personal computers in education, teachers were better equipped to act as facilitator-coach and provide individualized guidance to students, while further promoting the movement away from teacher controlled lecture environment into student controlled learning environments. In a similar nationwide survey of 550 teachers in grades K through 12, Honey and Henriquez (2003) found that students, and teachers, might be provided with opportunities to move beyond the physical confines of the classroom for sharing information with others, without excessive costs or delay. As expressed by Dwyer, Ringstaff, and Sandholtz (1991), based on their studies of the Apple Classrooms of Tomorrow (ACOT) project, expectations of what students are capable of accomplishing may increase, and more material may be covered in a shorter period of time, when using the tools of technology.

Research Methodology

Hypotheses

Based on the review of literature and the research question, the following hypothesis was developed:

Students taking Algebra in a computer-assisted format will have significantly higher achievement rates than students taking Algebra in a traditional, lecture-based only format.

The Experimental School

The study was conducted in the Premier High School. The school has about 1000 students, about 250 of which are taking Algebra I. There are approximately 10 sections of Algebra I that meet on a daily basis, each of which has about 25 students (Terrell, 2004).

Selection of the Population

Subjects for this study will be Algebra I freshman-year students. The selected students will represent a relatively homogeneous group, with similar academic achievement and behavioral characteristics. To achieve better accuracy of the study, each student in the selected group will have to pass a qualifier pre-test/questionnaire.

The study will be conducted for a period of six weeks. Even though it is suggested to use larger subject groups for more accurate statistical test results, only 50 students, comprised of both genders, participated in the study. The students were randomly divided into two groups. The first group (25 students) completed 6 weeks of Algebra training, using traditional lecture only method of instruction. The second group participated in the same class using personal computers equipped with Internet and Multimedia Mathematics software.

The required computer program is available at no charge to the school or the students: <http://www.math.com>. This program enables students to solve most of the algebraic equations in an easy-to-follow user-friendly format. In addition, students were able to see instant graphical representation of the solved equations.

Methodology

Due to the use of one control group (non-manipulated), and one experimental group (manipulated), the design of this research was quantitative quasi-experimental in nature (Gay & Airasian, 2000). For better definition of the proposed methodology of this project, it is important to establish and describe the variables that can later be statistically measured and interpreted.

The independent variable in this project is method of instruction. There are two levels of this variable:

1. Students taking Algebra I using computer-assisted format of instruction (experimental group).
2. Students taking Algebra I using traditional lecture-based format of instruction (control group)

The dependent variable is achievement. This variable consisted of pre-test, grades for homework assignments, and post-test scores. The obtained data was used to establish the validity of the previously stated hypothesis (Gay & Airasian, 2000). These constructs will be measured and the results tested using the following methodology:

Treatment

The students in the control group completed the prescribed study as usual, learning Algebra I in a traditional lecture-based class setting and completing their weekly homework and in-class projects.

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The students in the experimental group learned the same theoretical material in class, but use the Algebra Equation Solver Internet-based computer program to complete their prescribed class work and homework assignments.

Every week, the teachers from both groups supplied the researcher with grades for students' homework assignments. Then, researcher has entered all of the aquired data in the statistical computer program for final analysis.

Post-Test Procedures

At the completion of the experimental period, the following steps were taken:

1. At the end of the duration of the experiment, the teachers in both the experimental and control groups have administered a post-test, developed specifically for this study by the researcher.
2. The group of students, interviewed earlier, were interviewed again by the researcher to assess any changes in their attitudes towards the use of computer technology, and how it affects their understanding of the subject learned.

At the conclusion of the experiment, all of the data obtained throughout the project were entered into the computer program and statistically examined to determine which, if either, treatment produced the higher results.

Results of the study

The 6-week experiment used in this study has shown conclusive results that the use of dedicated technology in the classroom does improve the achievement results of High School Algebra students. The academic achievement analysis yielded the following results: Significance level (p value) = .0022. The alpha value used in the study was ($p=.05$). Since the obtained value was less than the alpha value, it was concluded that significant difference exists within the two methods of instruction. In summary, the results showed an approximate 20% improvement using the computerized method as opposed to the traditional methodology.

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