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ABSTRACT

Four classes (n=53) of Basic Algebra and five classes (n=50) of Intermediate Algebra in a community college setting were randomly assigned to sections either using or not using computer assisted instruction (CAI) supplemental to classroom instruction. Based on standardized pre- and posttest scores, students using supplemental CAI in Basic Algebra had significantly higher achievement growth than students not using supplemental CAI. In the Intermediate Algebra classes, there were no significant differences in achievement growth. However, it was determined that there were significant differences in pre-test scores between the Intermediate Algebra experimental and control groups. When an analysis of covariance was used to account for these initial significant differences, the results approached significance. Further use and study of different types of CAI in a variety of mathematics courses is encouraged. Contains 10 references. (Author/MKR)

The Effectiveness of Computer Assisted Instruction Supplemental to Classroom Instruction On Achievement Growth in Courses of Basic and Intermediate Algebra

by

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Abstract

Basic and Intermediate Algebra classes in a community college setting were randomly assigned to sections either using or not using computer assisted instruction (CAI) supplemental to classroom instruction. Based on standardized pre- and posttest scores, students using supplemental CAI in Basic Algebra had significantly higher achievement growth than students not using CAI. In the Intermediate Algebra classes, there were no significant differences in achievement growth. However, it was determined that there were significant differences in pretest scores between the Intermediate Algebra experimental and control groups. When an analysis of covariance was used to account for these initial significant differences, the results approached significance. Further use of different types of computer assisted instruction in a variety of mathematics courses should be encouraged and investigated.

(Keywords: Computer assisted instruction, computer assisted instruction in developmental education, developmental education, computer assisted instruction in remedial education, computer assisted instruction in higher education, computer assisted instruction in mathematics education.)

The Effectiveness of Computer Assisted Instruction Supplemental to Classroom Instruction on Achievement Growth in Courses of Basic Algebra and Intermediate Algebra

Developmental educators have long been concerned with improving student achievement. As part of the Title III grant at Bucks County Community College, a computer lab with twelve IBM DESKlab workstations and a laser printer, was established to offer supplemental instruction in Reading, Writing, and Math courses. Also, as part of this grant, research was conducted into the efficacy of supplemental computer assisted instruction, and significant results were found in reading and writing, but not in math (Klicka, 1993). To continue the work begun by the Title III grant, this study was designed to ascertain the effectiveness of supplemental computer assisted instruction in math, specifically courses in Basic and Intermediate Algebra. The research question asked was: Is there a difference in mathematics achievement between college developmental and remedial students who have had supplemental computer assisted instruction and those who have not?

The necessity for developmental courses has increased as greater numbers of underprepared students are entering college. In particular, basic mathematics courses are offered to students to prepare them for the levels of mathematics needed in their programs of study. It is in the interests of both the students and the colleges to increase the level of mathematical achievement in the most efficient way possible. One possible instructional method is the use of computer assisted instruction

(CAI) either in place of, or in addition to, traditional classroom instruction.

Computer assisted instruction has increased in usage and popularity as computers themselves have become more efficient and affordable and as software for specific courses has become more available. Early mathematics software usually involved basic drill and practice methods to increase computational skill. Later, more tutorial and testing programs became available. These programs often were more complex and included more advanced problem solving skills. Currently, technology is available for much broader applications of computer learning, both in and out of schools--such as learning networks and distance education--but the potential has been applied to education only in very limited ways (Krendl & Clark, 1994).

Most studies of CAI effectiveness, which have focused on achievement test scores, have found increased mathematics achievement scores with the use of CAI. Nordstrom (1988), in a review of research, suggested that the best results occur with lower grade levels, with low achievers, or in comparison with traditional instruction, rather than with other nontraditional methods. These findings are supported by a study involving third and fifth graders using supplemental drill and practice for computational skills (Fletcher, Hawley, & Piele, 1990).

However, CAI has also been used successfully at higher levels of education and with more complex material. Georgia State University (Layne & Wells, 1990) has successfully developed a series of courses to prepare graduate students to write CAI

modules for the University's course in research methodology and statistics. Askar and Koksal (1990) reported that a supplemental CAI program used by economics students to learn graphs of calculus functions significantly improved mathematics achievement scores. A study at American University (Akbari-Zarin & Gray, 1990), where faculty designed software to assist students in applying critical thinking skills, concluded that mathematics software should be designed and used for complex problems, not just for drill and practice.

As studies have included more sophisticated software, they have also investigated how CAI compares with other methods. When the effects of CAI were compared with small group tutoring in an arithmetic skills unit for nursing students, no significant difference in achievement was found (Hofmann, 1993). The author concluded that, if CAI is comparable in results to other types of intervention, it allows instructors greater flexibility in methods, depending upon resources available or individual preferences. CAI can also free an instructor's time to work with students needing additional personal or small group tutoring (Fletcher, Hawley & Piele, 1990). In addition, CAI may be more cost-efficient in raising achievement scores than using additional tutoring, reducing class size, or increasing instructional time (Fletcher, Hawley, & Piele, 1990).

In a study of mathematical achievement by prospective minority teachers preparing for the Education Entrance Examination (Reglin, 1990), all instruction was given by computers, with no teacher intervention. Significantly higher

posttest scores were achieved by students working cooperatively in pairs than those working individually.

Several studies have also suggested that students using computers tend to have more positive attitudes towards themselves, computers, the particular course, and school in general (Krendl & Clark, 1994).

Other studies have investigated additional effects of CAI, as illustrated by two separate studies of college developmental mathematics students. Watkins (1991) reported that the dropout rate for students in supplemental CAI is lower than in courses without CAI. Crumo (1988) found that only students using individualized CAI experienced a significant decrease in mathematics anxiety over the course of a semester.

Many of these findings occur in limited studies, so it is evident that more investigation is needed. It also appears that the potential of CAI is great, its use should be considered in conjunction with other learning methods, and it should be adapted to the particular needs of an institution and its students. The purpose of this study was to investigate the effectiveness of CAI in particular developmental courses.

Hypothesis

H_0 1. There will be no significant difference in growth in achievement between students who are required to use computer assisted instruction (supplemental to classroom instruction) in Basic Algebra courses and those who do not.

H_0 2. There will be no significant difference in growth in achievement between students who are required to use computer

assisted instruction (supplemental to classroom instruction) in Intermediate Algebra courses and those who do not.

Design and Setting

An experimental two group, pretest-posttest design was used. There was a fourteen week interval between testing. The setting was a public county community college in a suburban area. Classes of students were randomly assigned to control (not receiving CAI) and experimental (receiving CAI) groups. All students in these classes were pretested on the computer with The College Board Accuplacer Test, Algebra Subtest, and a raw score was obtained.

All students in both groups were given the same textbook/worksheet assignments. Those in the experimental group were required to use the computers supplemental to classroom instruction and were given a quiz grade for their performance. This supplemental instruction consisted of the networked software package, "Integrated Learning System," by CTB MacMillan/McGraw-Hill. All students in the experimental group received the same modules.

In this managed software, the student is presented with a pretest. If the score is 80% or above, the computer presents the next module. If the score is below 80%, the computer presents tutorials on the topic, more guided practice, and then posttests the student. If the 80% mastery level has been achieved, the computer presents the next topic. If it has not, the student is given the tutorial again and the cycle continues. If the student fails another time, the computer places the module at the end of

the student's strand. Since the professors have access to the students' records, they can see the areas requiring attention and provide human intervention before the student is presented with the same module for the third time. If there has not been any intervention and the student fails a third time, the computer locks the student out of the system with a message, "See your instructor immediately." The instructor would then certainly know the need for human intervention and would also need to reinstate the student on the system. This intervention was provided through tutoring during the professor's office hours or at the college's Learning Center.

At the end of the semester, all students remaining in the course were posttested with the College Board Accuplacer Test, Algebra Subtest. These raw scores were collected as a data base file and pre- and posttest scores were merged and analyzed using the Statistical Program for the Social Sciences (SPSS). Forty-six students who had not posttested because they had withdrawn from the course were dropped from the study. A pre- to posttest score difference was calculated for each of the students, and each was coded according to group and course. A t-test statistic between the means of the experimental and the control group was calculated for the two courses. Further examination using a t-test statistic on the pretest scores between the two groups was also conducted.

Sample

Four classes of Basic Algebra (n=53) and five classes of Intermediate Algebra (n=50) were randomly assigned to

experimental and control groups. Five classes were assigned to the experimental group (n=57) and four (n=46) to the control. Because of the random assignment by class, by chance one faculty member had only experimental classes, while the other had both.

Instruments

Validity was established by a review of the content by professors of mathematics and basic studies. The College Board reports test-retest correlations for the algebra subtest as .96, which indicates that the Accuplacer is highly reliable and can be used for in-course progress testing or end course evaluation without concern that substantial practice effects will affect the interpretation of the results (College Board Examination Board and Educational Testing Service, 1991).

Results

There was a significant difference ($p<.05$) in the growth scores between the experimental group and the control group in Basic Algebra. The mean growth score of the control group was 20.1, while the computer assisted group had a mean growth score of 28.4. The t value was -2.13, df 51. The results reject Hypothesis 1.

There was no significant difference in achievement growth between those students in Intermediate Algebra who had received supplemental computer assisted instruction and those who had not. The mean growth score of the control group was 22.8, while the mean growth score of the supplemental computer assisted group was 20.8. The t value was .36, df 48. Hypothesis 2 was not rejected. (See Table 1)

Discussion

Although the groups were assigned randomly, the experimental and control groups in Intermediate Algebra were different from the beginning. There was a significant difference ($p<.05$) between the pretest scores of the experimental and control groups in Intermediate Algebra. This was not the case for Basic Algebra. There was no significant difference on the pretest scores between the experimental and control groups in Basic Algebra. (See Table 2)

Using an analysis of covariance to account for this, the results for Intermediate Algebra approached significance ($p<.18$). However, the adaptive scoring procedure in the posttest created a ceiling effect. The experimental group whose pretest mean was significantly higher than the control group's, did not have as many raw score points to gain. Thus, the experimental group's posttest mean may underestimate their actual achievement.

Because fewer modules were available in Intermediate Algebra, students in this experimental group were assigned fewer modules than those in the Basic Algebra experimental group. The students in this group may not have received sufficient computer assisted instruction to significantly improve their growth in achievement. This factor needs to be acknowledged and investigated.

While classes were randomly assigned and, in this way controlled, there was no control for random assignment of students within classes because of the nature of the institution. Students had the option of selecting the class and had the option

of withdrawing. There was no measurement in this experiment to determine the rate of learning, IQ, or any other variables which could influence the data. While both professors taught the same material in class at about the same pace, there was no control for difference in teaching styles. Course tests were different for both professors and the subsequent grading could have affected the withdrawal rate, which further could have affected the results.

In spite of these factors, students who were required to use computer assisted instruction in the Basic Algebra course showed significantly higher levels of growth in achievement than those not required. It is recommended that college remedial and developmental programs include computer assisted instruction, supplemental to classroom instruction, in courses of Basic or Beginning Algebra. Additional software should be made available for supplemental instruction. Math faculty should be trained and encouraged to require the managed computer assisted tutorials supplemental to classroom instruction in these courses. Further studies need to be designed to determine the effectiveness of CAI in other courses of mathematics and long term research should be continued to further validate the findings made in this study.

Table 1

Condition	*n*	*M*	*SD*
Basic Algebra			
Experimental	3[illegible]	28.4	15.4
Control	22	20.1	11.8
Intermediate Algebra			
Experimental	26	20.8	20.0
Control	24	22.8	18.4

Table 2

Condition	*n*	*M*	*SD*
	Pretest Scores		
Basic Algebra			
Experimental	31	40.8	11.4
Control	22	40.4	11.1
Intermediate Algebra			
Experimental	26	70.1	15.3
Control	24	56.1	16.1
	Posttest Scores		
Basic Algebra			
Experimental	31	69.2	16.2
Control	22	60.4	12.0
Intermediate Algebra			
Experimental	26	90.9	17.1
Control	24	78.8	17.6

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Barbara A. Ford, M. A., is an adjunct instructor in the Developmental Education unit of Bucks County Community College, Newtown, PA. She has been teaching courses in Basic Algebra, Intermediate Algebra, and Principles of Arithmetic for seven years. Prior to this, she was a junior high school mathematics teacher.

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