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ABSTRACT

This study, conducted with college developmental studies students, explored possible relationships between individualized computer-assisted instruction (CAI) in basic mathematics skills and each of two variables; mathematics knowledge and anxiety toward mathematics. Both experimental (N=5) and control (N=12) groups made significant gains in computational and problem-solving skills during the treatment period of one semester; however, only the experimental group (using individualized CAI) evidenced a significant decrease in mathematics anxiety. These results suggest that using CAI may be an appropriate non-threatening means of addressing the needs of developmental studies students who possess math anxiety and mathematics computational and problem-solving skills needs. Includes 17 references. (Author/MVL)

CAI Use
by Developmental Studies Students

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Abstract

This study conducted with college developmental studies students explored possible relationships between individualized computer assisted instruction (CAI) in basic mathematics skills and each of two variables: mathematics knowledge and anxiety toward mathematics. Both experimental and control groups made significant gains in computational and problem-solving skills during the treatment period of one semester; however, only the experimental group (using individualized CAI) evidenced a significant decrease in mathematics anxiety. These results suggest that using CAI may be an appropriate non-threatening means of addressing the needs of developmental studies students who possess math anxiety and mathematics computational and problem-solving skills needs.

CAI Use

by Developmental Studies Students

Background

The search for an efficient and cost-effective means of meeting the needs of developmental studies students for basic mathematics skills has been an important concern of the Western Kentucky University developmental studies program since its inception. During this study, the delivery of instruction in Math 054: Basic Mathematics at Western Kentucky University was provided by two senior-level teacher education students, one with a major in mathematics and the other with a mathematics minor. Their instruction was supervised and coordinated by a professor of mathematics education in the College of Education. The purposes of this course were: (a) to help students attain mastery of basic mathematics concepts and computational skills involving whole numbers, fractions, decimals, percents, and elementary geometry; and (b) to reduce the mathematics anxiety of the developmental studies student through individualized computer assisted instruction. Classes met on Tuesdays, Thursdays, and alternate Fridays during the semester, for a total of 40 hours of instruction.

There is some evidence that such remediation can be effectively provided using computer assisted instruction

(CAI). A study conducted by Educational Testing Service indicated that computer assisted instruction may diminish in effectiveness for students beyond the elementary school levels (Ragostra, 1981). However, some school districts have found the use of CAI effective in remediation of math skills among older students (Spiller, 1985).

Two major concerns in math remediation programs are attitudes about math and self-concept regarding math (M. B. Snyder, personal communication, March 10, 1986). Gourgey (1985) reported that there are several misconceptions about the development of attitudes about mathematics as related to the nature of mathematics and self-concept. Gourgey's study involved university students ranging from ages 18-59. Older students who returned to school after a number of years were found to have the most negative attitudes toward mathematics. Those with higher math anxiety tended to have the lowest self-concept regarding mathematics and to have misconceptions about mathematics in general.

A study of math anxiety among 197 college students was conducted by Alexander and Cobb (1985). In this study, math anxiety was assessed using a self-reporting instrument, the Mathematics Anxiety Rating Scale (Suinn, 1972). Subjects reported more anxiety stimulated by mathematics test items and numeral task items than by any of the other factors studied. High school course work and grades showed a significant inverse relationship to math anxiety. Students who had not taken Algebra II in high school reported significantly higher math anxiety than did students who had taken the subject at that level. Those who achieved _A_s and _B_s in high school algebra or geometry reported significally less math anxiety than students with poorer grades. Alexander and Cobb recommended examination of the high school mathematics performance of entering college students and the implementation of early intervention strategies for those whose school performance fall below the levels indicated.

Resnick, Viehe, and Segal (1982) found low levels of math anxiety among 1045 college freshmen, with no significant differences between male and female subjects studied. Conversely, DeBronac-Meade and Brown (1982) compiled a profile that described the typical math-anxious student as female with less encouragement from her parents to study mathematics and whose mother had less formal education than other students in the study population.

Low self-concept, low overall level of maturity, low personal adjustment, and an early traumatic learning experience related to math were believed by elementary teachers to be causal factors of math anxiety among students, grades 1-6, according to Minix (1982). Interruptions in students' sequential learning of mathematics by moving and by extended absences from school were also believed to be contributing factors to development of math anxiety.

Using the Math Anxiety Rating Scale to determine level of anxiety among elementary education majors, Kelly and Tomhave (1985) found that a high proportion of the female students were indeed mathematically anxious. The authors proposed that this anxiety could eventually be transmitted to students in the elementary schools through their teachers.

Monroe, Minix, and Crumb (1986) concluded that researchers tend to agree upon the nature and prevalence of mathematics anxiety, although the incidence of the factor as related to gender is not consistently reported. These authors also found that computer assisted instruction as an intervention strategy produced a significant reduction in math anxiety among a group of preservice elementary education majors. They reported that, even though the use of CAI did not produce greater gains in math skills when compared with the traditional approach, the reduction in math anxiety was believed to be a significant contribution to the members of the study population, all preparing to enter the teaching profession.

Wright and Miller (1981) studied several groups of individuals, including students and teachers, in regard to math anxiety. Their findings indicated that subjects with high anxiety believed their skills in mathematics were lower than their skills in other areas. Further, many of the teachers reported that they neither liked mathematics nor enjoyed teaching it. Motivation and frequent successful experiences with mathematics (a) had high degrees of correlation with lowered anxiety toward mathematics and (b) greatly impacted the successful completion of mathematical tasks.

DeBronac-Meade and Brown (1982) studied negative self-statments and relaxation treatment in male and female high school and college students. Students who were in the treatment groups showed a significant decrease in mathematics anxiety. Even though the findings indicated a higher level of math-anxious behavior among female subjects, the authors recommended that treatment programs be designed to deal with both male and female students.

Various methods for treating math anxiety were summarized by Mathison (1978). The three most common methods were (a) remediation of math skills, (b) content manipulation, and (c) an integrated approach involving both math coursework and psychological intervention. Mathison recommended that institutional resources, including faculty members, should be considered when making intervention choices. Faculty characteristics were considered highly important because of the positive effects on student attitude derived from respect for students, clear explanations, and clear but flexible goals.

Frequently, recommendations made by researchers studying math anxiety among college students involve remediation strategies which are nonjudgmental, provide immediate reinforcement, are individualized, and focus upon develoment of concepts and skills (DeBronac-Meade & Brown, 1982; Mathison, 1978; Wright & Miller, 1981). Therefore, it appears reasonable to explore available strategies which may possess these characteristics.

Because of the sensitivity of older learners about elementary school level mathematics skills which they do not possess, computer assisted instruction has been used to provide anonymity during tutorial and drill and practice sessions. Several studies involving the uses of computer assisted instruction programs developed by the Computer Curriculum Corporation indicate a high degree of success with remediation of mathematics skills (Crumb, 1987).

Purpose

The purpose of this study was to explore possible relationships between individualized computer assisted instruction in basic mathematics skills for college developmental studies students and each of two variables: mathematical knowledge and anxiety toward matnematics. Mathematical knowledge was operationally defined as

(a) computational and problem solving skills and (b) knowledge of vocabulary deemed necessary for learning mathematics. _Mathematics anxiety_ was operationally defined in terms of self-reported frustration levels and feelings of inability to understand or "do" mathematics. This exploratory investigation endeavored to determine for a group of college students enrolled in developmental studies whether or not a relationship existed between individualized computer assisted instruction and scores on (a) a test of computational and problem solving skills, (b) a test of mathematics vocabulary knowledge, and (c) a measure of levels of anxiety toward mathematics.

Method

The sample consisted of 17 students constituting the total enrollment in Math 054. Each subject had a score of 10 or below on the mathematics subtest of the American College Test (ACT).

Five of the 17 students encountered scheduling difficulty and constituted a separate group for instructional activities. Both groups followed the same course outline with instruction proceeding in a linear fashion through the mathematics content. Both groups were assigned to computer assisted instruction based upon a paper-and-pencil diagnostic pretest battery. Students in the smaller (experimental) group were enrolled in the Computer Curriculum Corporation _Math Skills_ (CCC-MK) course, and students in the larger (control) group made use of selected commercial software packages for microcomputers available from the Minnesota Educational Computing Consortium (MECC) or locally developed programmed software.

Members of the control group were required to log 10 hours of computer time. No management or control was available to determine the specific lessons or programs used. Data regarding actual time-on-task for each student and achievement gain resulting from use of these packages by the control group members were not available because of limitations of the management system for the software. For the experimental group (using CCC-MK), extensive weekly documentation was provided including: number of sessions, number of attempts, attempts correct, percentage of attempts correct, achievement gain after initial placement, and achivement gain in the most recent two-week period. In addition, a course report provided the proctor/teacher diagnostic-prescriptive information to support teaching of concepts.

CAI for the experimental group was totally individualized and computer-managed by the CCC-MK curriculum software. Access to lessons was provided by a terminal connected to a supermicrocomputer. The instruction was branching, not linear. Because the presentations by the proctor/teacher were linear, they were not designed to conform time-wise to student need for concept instruction as identified by the diagnostic-prescriptive system available from the CCC-MK software and support packages.

For the control group members, extra-class tutorial sessions were held to meet individual needs. For experimental group members, individual tutoring and assistance with concepts were confined primarily to the regular period assigned for instruction. In some cases, that time was also used for CAI access. A goal of the experimental group was to have 20 minutes of CAI time-on-task each day of the semester.

A nonequivalent control group design was used in the study (Gage, 1963).

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As indicated above, neither pair matching nor random assignment to group was employed. According to Siegel (1956), "A nonparametric statistical test is a test whose model does not specify conditions about the parameters of the population from which the sample was drawn" (p. 31). Such tests were employed in the study.

Hypotheses tested were:

1. No signficant difference exists between the experimental and control groups in performance prediction measured by (a) the composite ACT scores and (b) the scores on the mathematics subtest of the ACT.

2. No significant difference exists within groups in mathematics skills and knowledge measured by the

Hooper-Wolff Diagnostic Test--Revised (HWDT-R) as a result of the treatment.

3. No significant difference exists between the experimental and control groups in mathematics skills and knowledge measured by the HWDT-R as a result of the treatment.

4. No significant difference exists within groups in mathematics vocabulary measured by the Essential Mathematics Vocabulary Test (EMVT) as a result of the treatment.

5. No significant difference exists between the experimental and control groups in mathematics vocabulary measured by the EMVT as a result of the treatment.

6. No signficant difference exists within groups in mathematics anxiety measured by the Mathematics Anxiety Rating Scale (MARS) as a result of the treatment.

7. No significant difference exists between the experimental and control groups in mathematics anxiety measured by the MARS as a result of the treatment.

The .05 level was selected as the required level of confidence for hypothesis testing u[illegible] Mann-Whitney *U* test (Siegel, 1956).

Instrumentation

For purposes of comparing the performance of the two groups in this project, the following measures were used: ACT (composite and mathematics subtest); Hooper-Wolff Diagnostic Test-Revised (HWDT-R), an 86-item pre-post measure of mathematics skills and knowledge (Hooper, Wolff, and Monroe, 1983); Essential Mathematics Vocabulary Test (EMVT), a 60-item pre-post test of basic mathematics vocabulary designed by Monroe and Redfield (1983), and Mathematics Anxiety Rating Scale (MARS), a 98-item pre-post self-report of level of anxiety in mathematical situations (Suinn, 1972).

Data Analysis

All data were analyzed for within-group and between-group differences using the Mann-Whitney $\underline{U}$ test, $\underline{p}<.05$. The Mann-Whitney $\underline{U}$ is a nonparametric statistic appropriate for use when the population has not been randomly selected, when the sizes of the samples are small or uneven, and when the data from the population are at least ordinal. Although not a measure of central tendency or a comparison of means, the Mann-Whitney $\underline{U}$ is a measure of whether two independent samples are drawn from the same population. The $\underline{U}$ predicts the probability that the "bulk" of one set of samples differs from the other set of samples. This statistic is a powerful nonparametric statistic, and has power nearly equivalent to the parametric $\underline{t}$ test (Siegel, 1956).

As indicated in Table 1, significant differences were not found at the .05 level in ACT scores of the two groups. The ACT scores of the control group were lower but not significantly lower than those of the experimental group. Thus, Hypothesis 1 was confirmed.

(Insert Table 1 about here)

Both groups made significant gains in mathematics skills as measured by the Hooper-Wolff Diagnostic Test-Revised (see Table 2). The pretest scores on the Hooper-Wolff Diagnostic Test-Revised for the experimental and control groups were not found to be significantly different; the posttest scores were also found not to be significantly different. (See Table 3). These results considered with those cited for within-group test scores on the HWDT-R indicated that both groups made significant gains in achievement and that their beginning and ending levels were not statistically different. Hypothesis 2, therefore, was rejected and Hypothesis 3 confirmed.

(Insert tables 2 and 3 about here)

Neither the experimental nor the control group made significant mathematics vocabulary gains as a result of the treatment as measured by the EMVT pre and posttests (Table 4). The treatment apparently did not affect vocabulary development as measured by the EMVT; therefore, Hypothesis 4 was confirmed.

(Insert Table 4 about here)

Pretest scores for the two groups on the EMVT were not significantly different at the .05 level of confidence. A similar finding resulted when posttest scores were compared (see Table 5). Thus, Hypothesis 5 was confirmed.

(Insert Table 5 about here)

A significant difference between pretest and posttest scores on the Mathematics Anxiety Rating Scale (MARS) was found for the experimental group, $p<.05$ (see Table 6), with posttest scores indicating a lower mathematics anxiety; thus, Hypothesis 6 was rejected for the experimental group. Differences between pretest and posttest scores for the control group were not found to be significant at the .05 level. Between-group pre and post scores were not found to be signficiantly different (Table 7), thereby confirming Hypothesis 7.

(Insert tables 6 and 7 about here)

Summary and Conclusions

Both the experimental and control groups made significant gains in computational and problem-solving skills as measured by the HWDT-R over the treatment period; however, only the experimental group had a significant decrease in mathematics anxiety as measured by the MARS. Neither the experimental nor the control group made significant gains in mathematics vocabulary as measured by the EMVT over the same period. No significant between-group differences were evidenced on either the pretests or the posttests for the HWDT-R, the EMVT, or the MARS. Further, between-group differences on the ACT mathematics subtest and composite scores were not found to be significant. Based upon these findings, it seems appropriate to conclude that both the experimental and control treatments were successful in developing computational and problem-solving skills as measured by the HWDT-R but that only the experimental treatment was effective in reducing math anxiety as measured by the MARS. This finding is consistent with the author's previous research using cmputer assisted instruction which yielded a significant reduction in math anxiety for preservice elementary education majors (Monroe, Minix, & Crumb, 1986).

This analysis suggests that using CAI may be an appropriate means of addressing the needs of developmental studies students who possess math anxiety and mathematics computational and problem-solving skill deficiencies. The achievement gains made by the group using the CCC-MK program were equivalent to the gains made by students exposed to the conventional approaches. The data analysis also suggests that an added benefit may result from the experimental approach in that mathematics anxiety seems to be reduced by use of the CCC-MK courseware.

The size of the study population and aspects of the treatment which did not make the most effective use of the diagnostic- prescriptive management system of the CCC-MK courseware are considered to be factors compromising the conclusions of this study. Further study with a revised instructional strategy and larger groups appears to be warranted.

References

Alexander, L., & Cobb, R. (1985). Identification of the dimensions and predictors of math anxiety among college students. (ERIC Document Reproduction Service No. ED 251 320)

Crumb, G. H. (1987, April). CAI basic skills achievement gains versus time-on-task and cost. Address at the annual meeting of the Association for Supervision and Curriculum Development, New Orleans.

DeBronac-Meade, M. L., & Brown, R. (1982). Reduction of mathematics anxiety: A cognitive behavior modification approach. (ERIC Document Reproduction Service No. ED 218 553)

Gage, N. L. (1963). Handbook of research on teaching. Chicago:Rand McNally.

Gourgey, A. F. (1985). The relationship of misconceptions about math and mathematical self-concept to math anxiety and statistics performances. (ERIC Document Reporduction Service No. ED 254 417)

Hooper, P., Wolff, C., & Monroe, E. E. (1983). The Hooper-Wolff Diagnostic Test-Revised. (Available from E. E. Monroe, Department of Teacher Education, Western Kentucky University, Bowling Green, KY 42101)

Kelly, W. P., & Tomhave, W. K. (1985). A study of math anxiety/math avoidance in preservice elementary teachers. Arithmetic Teacher, 31(5), 51-53.

Mathison, M. A. (1978). Curricular interventions and programming innovations for the reduction of mathematics anxiety. (ERIC Document Reproduction Service No. ED 154 330)

Minix, N. A. (1982). An exploratory study of mathematics anxiety in elementary school children and its implications for program and staff development (Doctoral dissertation, George Peabody College for Teachers of Vanderbilt University, 1981). Dissertation Abstracts International, 42, 4279A.

Monroe. E. E., Minix, N. A., and Crumb, G. H. (1986). A preliminary study of the impact of computer assisted instruction on math anxiety among preservice elementary teachers. In A. Zollman, W. Speer, and J. Meyer (Eds.), The Fifth Mathematics Methods Conference Papers (pp. 179-189). Bowling Green, OH: Bowling Green State University.

Monroe, E. E., & Redfield, D. L. (1983). Essential Mathematics Vocabulary Test. (Available from E. E. Monroe, Department of Teacher Education, Western Kentucky University, Bowling Green, KY 42101)

Ragostra, M. (1981). A longitudinal study of computer assisted instruction (Final Report to NIE by the Los Angeles Unified School District). Princeton: Educational Testing Service.

Resnick, H., Viehe, J., & Segal, S. (1982). Is math anxiety a local phenomenon? A study of prevalence and dimensionality. Journal of Counseling Psychology, 29(1), 39-47.

Siegel, S. (1956). Nonparametric methods for the behavioral sciences. New York: McGraw-Hill.

Spiller, R. (1985). The contribution of training technologies to productivity. T.H.E. Journal, 13(1), 64-66.

Suinn, R. M. (1972). Mathematics Anxiety Rating Scale (MARS). Fort Collins, CO: RMBSI, Inc.

Wright, D. E., & Miller, L. D. (1981). Math anxiety: A research report. (ERIC Document Reproduction Service No. ED 212 465)

Table 1

Results of a Comparison of ACT Scores for Experimental and Control Groups

Measure	Group mean scores: Experimental	Control	U
Mathematics subtest	7.0	5.4	n.s.
Composite	9.5	9.3	n.s.

Table 2

Results of a Comparison of Pre and Post Hooper-Wolff Diagnostic Test-Revised Scores Within Experimental and Control Groups

		Mean score		
Group	*N*	Pre	Post	*U*
Experimental	5	21.4	38.8	$p < .03$
Control	12	29.9	44.8	$p < .05$

Table 3

Results of a Comparison of Pre and Post Hooper-Wolff Diagnostic Test-Revised Scores Between Experimental and Control Groups

	Mean score		
Test	Experimental	Control	_U_
Pre	21.4	29.9	n.s.
Post	38.8	44.8	n.s.

Table 4

Results of a Comparison of Pre and Post Essential Mathematics Vocabulary Test Scores Within Experimental and Control Groups

		Mean score		
Group	*N*	Pre	Post	*U*
Experimental	5	28.4	36.2	n.s.
Control	12	31.8	35.9	n.s.

Table 5

Results of a Comparison of Pre and Post Essential Mathematics Vocabulary Test Scores Between Experimental and Control Groups

	Mean score		
Test	Experimental	Control	U
Pre	28.4	31.8	n.s.
Post	36.2	35.9	n.s.

Table 6

Results of a Comparison of Pre and Post Mathematics Anxiety Rating Scale Scores Within Experimental and Control Groups

		Mean score		
Group	*N*	Pre	Post	*U*
Experimental	5	255.0	198.0	$p < .05$
Control	12	236.9	192.7	n.s.

Note: Higher score indicates higher level of mathematics anxiety.

Table 7

<u>Results of a Comparison of Pre and Post Mathematics Anxiety Rating Scale Scores Between Experimental and Control Groups</u>

	Mean score		
Test	Experimental	Control	*U*
Pre	255.0	236.9	n.s.
Post	198.0	192.7	n.s.

Note: Higher score indicates higher level of mathematics anxiety.