Using Microcomputers in Education: Assessment of Three Teaching Strategies

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Much has been written in recent years about the introduction of microcomputers in education. Some teachers have experimented with microcomputers in their classrooms; others have resisted adopting microcomputers and viewed the new technology as a fad that will pass with time. Beginning teachers are being prepared with computer literacy skills which will enable them to utilize microcomputers in their classrooms (U.S. Department of Education, 1986). However, such preparation has not focused on instructional methods which have proven to be effective classroom teaching strategies.

Lockheed and Mandinach (1986) reported that the trend in secondary schools has shifted from computer programming courses toward an emphasis on applications-based courses. They further suggested that "Future research should provide systematic cognitive analyses of computer-based learning activities and explore the instructional implications of their adoption into school curricula" (p. 25).

The need for empirical research in the area of microcomputer-assisted instruction was described by Hawley, Fletcher, and Piele (1986) when they noted, "The future of computing in schools is most probably tied to the microcomputer" (p. 1). Thus research is needed to determine whether microcomputer-based instruction can be educationally effective under typical conditions of use. Henderson (1985) also noted that further research was necessary regarding the use of microcomputers for instructional purposes. She suggested; "Research studies, which go beyond the collection of descriptive data, should be conducted to determine the relationship between microcomputer use and educational outcomes. Little empirical evidence exists on the role and value of microcomputers in educational settings" (p. 10).

Purpose and Objectives

The purpose of this study was to assess the effects of three teaching strategies which incorporated a microcomputer component. The three teaching strategies examined in this study were tutorial, drill-and-practice, and simulation. Each teaching strategy was compared with one another and a traditional lecture/discussion teaching strategy. The lecture/discussion teaching strategy was designated as the comparison treatment group.

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This study was designed to fulfill the following objectives.

1. To assess differences in the level of student achievement among the four treatment groups after controlling for pre-experiment achievement differences.
2. To assess differences in student attitudes toward the subject matter among the four treatment groups after controlling for pre-experiment attitude differences.
3. To assess differences in the strength of the relationship between student achievement and selected student characteristics among treatment groups.
4. To assess the extent to which each treatment or selected student characteristic accounted for a significant proportion of the variance associated with posttest achievement scores.

The following null hypotheses were tested:

Ho_1: There is no significant difference in the mean achievement scores among the four treatment groups after controlling for pre-experiment differences.

Ho_2: There is no significant difference in the mean attitude scores among the four treatment groups after controlling for pre-experiment differences.

Ho_3: There is no significant difference in the strength of the relationship between student achievement scores and selected student characteristics among the four treatment groups.

Ho_4: There is no treatment or student characteristic which can be used to explain a significant proportion of the variance associated with the posttest achievement scores.

Procedures

A pretest-posttest experimental design was used to assess the effect of utilizing microcomputer-enhanced strategies in teaching secondary agriculture classes. The population consisted of 5,784 eleventh and twelfth grade students who were enrolled in an agriculture course. Using the Krejcie and Morgan (1970) formula for determining sample size, and assuming an average of 10 students enrolled per class, it was determined that the experiment should be conducted in 36 classes. Thirty-six secondary agriculture programs were randomly selected and each respective instructor was asked to designate the class in which lessons on soil erosion could most appropriately be taught. Students in each selected class were randomly assigned to one of four treatment groups in approximately equal numbers to control for anticipated differences in the effectiveness of individual teachers.

Three microcomputer programs were designed for use in this study which reflected the microcomputer teaching strategies to be assessed. The microcomputer programs were written by a graduate student in Agricultural Education at the University of Missouri-Columbia. The content and construct validity of the programs were examined and approved by two panels of experts consisting of faculty members in the College of Education and the College of Agriculture. Only Apple II and Apple IIe microcomputers were used in this study. Schools which did not have access to those models were provided computers for use during the experiment.

Two objective tests were developed to assess the achievement level of students. The tests were prepared in a multiple-choice format and contained questions and problems relating to the study questions in each of the two lessons in the study. The instruments were reviewed by a panel of experts for content validity and modified as per their recommendations.

Student attitudes were assessed using data collected on an adaptation of the "Attitude Toward Any School Subject" instrument which was developed by Remmers, (Purdue Research Foundation, 1986). Twenty questions from the original instrument were selected and the words <u>subject matter</u> were replaced with the words <u>soil management</u>.

A field test of the experimental procedures used in the study was conducted in an agriculture class which was not included in the sample. As a result of the field test, minor changes in the research procedures and data collection instruments were made.

The study required five consecutive class periods in each selected classroom. Students in each treatment group were simultaneously taught an initial lesson focusing on soil erosion by local teachers using lesson plans supplied by the researchers during the first two class periods. At the conclusion of the first lesson, students completed pretest achievement and attitude instruments. The second lesson was also taught by the local teacher during the third and fourth class periods. Again, treatment groups were taught simultaneously throughout the two-day lesson. However, each microcomputer treatment group was removed from the regular classroom for 20 minutes on a rotating basis. Students in each group were allowed to individually interact with the tutorial, drill-and-practice, or simulation microcomputer program. A member of the research team monitored students as they individually operated the respective programs. However, the monitor was not allowed to provide instruction concerning the subject matter being presented. Local teachers remained in the classroom and instructed students according to the lesson plan provided. This activity comprised the experimental treatment for the study. Each of the microcomputer programs were designed to reflect the experiences of students in the classroom setting (see Figure 1).

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Review
motivation &       Supervised     Discussion     Conclusion
assignment         study

Group
  A-----------------------------------------------------------------------
  B--------------------X1-------------------------------------------------
  C---------------------------------X2------------------------------------
  D-----------------------------------------------X3----------------------
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Figure 1. Schedule of Experiment Treatments During the Second Lesson

Note. A = Comparison group, B = Tutorial group
C = Drill and practice group, D = Simulation group

At the end of each treatment groups' 20 minute period of interaction with the microcomputer, students in each treatment group returned to the classroom to complete the remainder of the lesson. As illustrated in Figure 1, the tutorial treatment group was the first to utilize the computer which substituted for the supervised study portion of the lesson. Students using the tutorial program read computer-generated text similar to an extension publication distributed to students in the classroom. The drill-and-practice treatment group utilized the computer during the discussion segment of the lesson which involved the calculation of localized Universal Soil Loss Equation (USLE) problems. Students using the drill-and-practice program reviewed sample USLE problems similar to those presented by the instructor in the classroom. The simulation treatment group utilized the microcomputer during the latter portion of the discussion segment of the lesson. Students using the simulation program manipulated variables in the USLE to observe the impact on the expected level of soil erosion.

At the end of the second lesson all students completed achievement, attitude, and personal data instruments. Data regarding individual student class rank and grade point average (GPA) were collected from guidance counselors in each participating school.

Data were collected and analyzed to address each objective of the study. The first two objectives were analyzed using analysis of covariance in which the pretest achievement score was used as the covariate. Correlation coefficients were computed to address the third objective. A $\underline{Z}$ transformation procedure was employed to identify differences in the strength of the relationship between selected variables among the four treatment groups. The fourth objective was analyzed using a stepwise regression procedure. All statistical tests were conducted at the .05 alpha level.

Results

A total of 312 students from 31 randomly selected agriculture classes in Missouri secondary schools provided data used for analysis. Student absences prevented five classes from providing usable data for this study. It was not feasible to repeat the experiment in the selected classes in an attempt to collect data from non-respondents.

Reliability coefficients were calculated for the two achievement and attitude instruments which were used for data collection. The achievement test instruments produced reliability coefficients of .73 for the pre-experiment test and .76 for the posttest. Coefficient alphas of .98 and .99 were computed for the attitude instrument for the pretest and posttest administrations, respectively.

Table 1 presents results of the analysis of covariance procedure for objective 1. The test revealed that the pretest achievement score was a significant covariate variable, and when equalized among treatment groups, no differences in group posttest achievement mean scores were identified. Therefore, Ho_1 was not rejected.

Table 1
Analysis of Covariance of Posttest Achievment Scores by Treatment Groups

Source	df	SS	F	p
Covariate (pre-experiment achievment score)	1	1279.31	184.05	.001
Treatment	3	24.93	1.20	.312
Error	306	2127.01		
Total	310	3431.25		

Table 2 presents results of the analysis of covariance procedure for objective 2. The test revealed that the covariate variable (pretest attitude score) was significant, and when equalized among treatment groups, no differences in group posttest attitude mean scores were identified. Therefore, Ho_2 was not rejected.

Table 2
Analysis of Covariance of Posttest Subject Matter Attitude Scores by Treatment Group

Source	df	SS	F	p
Covariate (pre-experiment score attitude)	1	54381.09	359.73	.001
Treatment	3	984.46	2.17	.092
Error	268	40514.15		
Total	272	95879.71		

Correlation coefficients computed to fulfill objective 3 are reported in Table 3. Academic rank was found to be moderately associated with the posttest achievement scores of students in the comparison, tutorial, and drill-and-practice treatment groups. Conversely, academic rank was not found to be significantly related to the posttest achievement scores of students in the simulation treatment group. The *Z* transformation procedure did not identify significant differences in the strength of the relationship between academic rank and achievement test scores among any of the treatment groups.

The pretest achievement scores of students in each of the four treatment groups was found to be positively related to their posttest achievement test scores. Correlation coefficients calculated for the four treatment groups ranged from .53 to .66 and were each significant at the .01 level. Grade level and student gender were not found to be significantly related to the posttest achievement test scores of students in any of the four treatment groups.

Table 3
Correlations Between Selected Student Characteristics and Achievement Scores by Treatment Group

Characteristic	Treatment Group A[1] (n = 91)	B (n = 69)	C (n = 73)	D (n = 78)	Groups (Z transform.)
Academic rank	.385**	.327**	.308**	.199	
Pre-experiment achieve. test score	.657**	.528**	.642**	.607**	
Grade level	.018	.147	.066	-.037	
Microcomputer experience	.270**	.273*	.142	-.007	A vs D B vs D
Farm experience	-.165	.372**	.061	.009	
Soil management experience	-.060	.284*	.314**	.243*	A vs C
Gender	-.194	-.016	-.032	-.156	

Note. [1]A = Comparison group; B = Tutorial group; C = Drill & practice group; D = Simulation group
* $p < .05$, **$p < .01$.

Three characteristics examined revealed differing relationships among the four treatment groups; Ho_3 was rejected. Previous microcomputer experience was found to be positively, significantly related to the posttest achievement scores of students in the comparison and tutorial treatment groups but not the drill-and-practice or simulation treatment groups. Students in the tutorial treatment group who reported having previous farm experience produced higher posttest achievement scores: however, the farm experience variable was not found to be related to student posttest achievement scores in the three remaining treatment groups. Students who reported having previous soil management experience in the tutorial, drill-and-practice, and simulation treatment groups produced higher scores on the posttest achievement test. The soil management experience variable was not found to be related to the student achievement measure for comparison group students.

Treatment groups which produced significantly different correlation coefficients were identified as a result of the Z transformation procedure and are noted in Table 3. Three comparisons were found to differ significantly. The relationship between the microcomputer experience variable and the student posttest achievement measure differed significantly between comparison and tutorial treatment groups and the simulation treatment group. Student performance on the achievement posttest was not related to previous experience with microcomputers for students in the simulation treatment group, whereas, a significant relationship was found between those variables in the comparison and tutorial treatment groups.

There was also a difference in the strength of the relationship between the soil management experience variable and student posttest achievement scores between the comparison and drill-and-practice treatment groups. Soil management experience was found to be moderately and positively related to the posttest achievement scores of students in the drill-and-practice treatment group. However, there was no relationship between those two variables for students in the comparison group.

Table 4 presents results of the stepwise regression procedure to fulfill the fourth objective of this study. The first variable to enter the prediction equation was the pretest achievement score variable which accounted for 35.8 % of the variance associated with posttest achievement test scores. The second variable to enter the prediction equation was academic rank. This variable, although statistically significant, accounted for less than 2 percent of the variance associated with posttest achievement test scores. Dummy variables for each of the microcomputer treatment effects were included in the pool of potential predictor variables but did not enter the final regression equation. However, Ho_4 was rejected as two significant predictor variables were identified.

Table 4
Stepwise Regression Analysis of Posttest Achievement Scores

Characteristic	Step	B	Part. R^2	F	p
Pre-experiment achievement score	1	0.535	.358	142.14	.001
Academic rank	2	0.019	.019	7.77	.066
Intercept = 4.132			Model R^2 = .377		

Conclusions and Recommendations

Conclusions and recommendations resulting from this study may be generalized to the population of all eleventh and twelfth grade agriculture students in Missouri from which the sample was drawn. These conclusions and recommendations are limited to the specific microcomputer programs and teaching strategies which were assessed in this study, but, they may have implications in other situations.

Conclusions

Student achievement is essentially equal when taught using any of the three microcomputer-enhanced teaching strategies or a traditional lecture/discussion strategy.

Student attitudes toward the subject matter are not affected when students are taught using any of the three microcomputer-enhanced teaching strategies or a traditional lecture/discussion strategy.

Previous achievement scores and academic rank are the best predictors of student achievement.

Student achievement was not found to be significantly affected when microcomputers were used to enhance instruction. Each of the three microcomputer-assisted instructional strategies assessed in this study produced achievement results which were equivalent to the achievement levels of students taught via a traditional lecture/discussion strategy.

Each of the three teaching strategies also appeared to be equally effective with one another. However, student achievement in the simulation group was found to be unrelated to academic rank, which was not the case with the three remaining treatment groups. This observation presented a question regarding the underlying reason for the inconsistency with the microcomputer simulation strategy. Do higher ability students tend to score somewhat lower as a result of using a microcomputer simulation? Do lower ability students tend to score higher? Or is there some other explanation? The answers to these questions were beyond the scope of this study, however future researchers should examine how microcomputer-assisted instruction affects students with differing levels of academic ability.

Student attitudes toward the subject matter were not affected during the course of this study. Five class periods may not have been sufficient time to influence student attitudes concerning the subject of soil erosion. Also, the attitude instrument may have lacked the precision necessary to detect relatively minute changes in student attitudes.

Recommendations

Microcomputer-enhanced teaching strategies may be used to supplement or replace a portion of traditional classroom instruction, thus enabling teachers to spend more time attending to the individual needs of students.

Microcomputer-assisted instruction may be effectively utilized in agriculture using tutorial, drill-and-practice, and simulation teaching strategies.

Further studies should be conducted to assess the effect of microcomputer-assisted instruction on student achievement over an extended period of time.

Additional studies should be conducted to determine if there is a differential effect on student achievement among students of varying academic ability levels when using a microcomputer simulation teaching strategy.

Microcomputers may be used to replace portions of traditional instruction for secondary agriculture students. Teachers who utilize this new technology should strive to identify opportunities and situations in which microcomputer-assisted instruction produces superior gains in student achievement. Until that time, educators may be content with an approximately equal trade-off between teacher-directed and microcomputer-enhanced instructional strategies.

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