Evaluating Classroom Strategies to Enhance Performance: Using a Computer-Assisted Program

Chanda D. Elbert[1]
Texas A&M University
College Station, TX 77843-2116
Sharonda Poma[2]
Life Extension Foundation
Fort Lauderdale, FL 33309
Gary Briers[3]
Texas A&M University
College Station, TX 77843-2116

Abstract

This study examined a cooperative learning strategy to infuse technology into classrooms with economically disadvantaged students defined as individuals who come from a family which the state board identifies as low income on the basis of uniform methods such as at or below the official poverty line. Findings indicated that environmental health science knowledge levels were increased equally among males and females. Student attitudes were improved, but the difference was not statistically significant. No statistically significant difference existed in knowledge by task assignment of driver versus navigator. The term driver was designated to delineate the role requiring physical contact with the mouse at the computer. The term navigator was designated to delineate the role of the individual required to do the paperwork (e.g., daily work sheet).

Introduction

The proliferation of technology during the last 25 years fundamentally has changed society. Access to computers and the Internet is becoming increasingly more important for participation in economic, political, and social life. Communication with healthcare professionals and scientists all over the world now occurs at the press of a button, enabling new discoveries and ideas to improve overall quality of life. In today's technology-driven society, inequities in computer access and literacy can lead to economic as well as educational handicaps. Consequently, having access and exposure to computer technology is increasingly important.

While providing access to computers in schools is important, helping teachers use these technologies is critical. In the past, some schools with educational technology have been criticized for not integrating the technology into the classroom effectively (CEO Forum on Education and Technology, 2000). Among schools that use computer resources in the classroom, a considerable variability exists in how the technology is infused into the curricula (Kozma & Croninger, 1992).

Generally, urban schools, which tend to have a high proportion of minority students, use less effective methodologies when infusing technology into the classroom. In contrast, more affluent schools with non-minority students tend to use more effective technologies, including software, which emphasize critical thinking skills (President's Committee on Science and Technology, 1997). These inconsistencies contribute to an educational divide even among those children with access to computers at school.

Over the past decade, a wealth of research has been conducted testing the effectiveness of the computer as an interactive learning tool in the classroom. Research indicates that technology can improve academic performance; however, the most efficacious infusion strategies to use this technology remain to be determined (Collis & Carleer, 1993; Corston & Colman, 1996). As more schools and classrooms gain access to computers and the Internet, then understanding the dynamics of the learning environments that best produce knowledge gains becomes imperative. Particularly, while incorporating technology, attention needs to be given to groups such as minorities, females, and the poor. Historically, within the school environment, these groups often have had inequitable access to technology (Becker & Sterling, 1987; Educational Testing Services, (ETS), 1997; Milone & Salpeter, 1996; Sutton, 1991). All of these factors led to this study, which was designed to evaluate a cooperative learning strategy to infuse technology into classrooms with economically disadvantaged students in the state of Pennsylvania.

[1]Assistant Professor, College of Agriculture and Life Sciences, Department of Agricultural Education, 223 Scoates Hall
[2]Nutrtition Science Advisor, 1100 West Commercial Blvd
[3]Professor, College of Agriculture and Life Sciences, Department of Agricultural Education, 107 E Scoates Hall

Methods and Objectives

The purpose of this study was to evaluate the effects of classroom strategies involving computer use on the performance of economically disadvantaged students. The following objectives guided the study:

1. Assess the effectiveness of an interactive computer program as an instructional strategy to improve environmental health knowledge.
2. Assess the effectiveness of an interactive computer program as an instructional strategy to improve attitudes toward computers.
3. Determine the relative effectiveness of assigned computer tasks, active (driver) vs. passive (navigator) in a cooperative computer-assisted learning environment.
4. Investigate gender differences in student responses to task assignment (driver vs. navigator) in a cooperative computer-assisted learning environment.

Target Population and Sample

This study involved 311 students recruited from an inner city middle school in Pennsylvania. All students had similar socioeconomic backgrounds. The researchers obtained verbal assent from all subjects, and written permission from their parent/guardian. Participation was voluntary, and students received no compensation for their involvement in the study. Students' ages ranged from 11 to 14 with a median age of 12.7 years. Subjects were African American (74%), Latino/a (7%), Anglo (15%) and unreported or some other designation (4%). The study used a quasi-experimental design described by Campbell and Stanley (1963), with pre-test, intervention, and post-test, after one week. Power analyses were conducted a priori to determine the minimum sample size for a test of a 4 (dyad group) x 2 (task assignment) x 2 (pre-test/post-test) Repeated Measures Analysis of Variance to detect medium effects (d = 0.25; alpha = 0.05). Results from GPOWER© analyses (Erdfelder et al., 1996) suggested a minimum sample size of 240 students. These numbers were increased by 40% to allow for attrition due to normal absenteeism in urban environments.

Of the 311 students recruited, 269 appeared in the analyses requiring both pre-test and post-test data; thus, 42 students were excluded. The analyses were conducted using data from students who completed the intervention and submitted both pre-test and post-test.

Instrumentation and Analysis

The researchers developed pre-test and post-test intervention questions to measure the variables in the study. The measure of knowledge consisted of 25 multiple-choice items which assessed environmental health science content. Students' scores ranged from 0-25, indicating the number of questions answered correctly. The attitude instrument component consisted of 10 Likert -scale items which were designed to assess attitudes related to the classroom intervention. The 41-item pre-test was designed to collect information on (1) student demographics, (2) computer access and attitudes, (3) confidence (perceived self-efficacy) in computer usage, and (4) knowledge of environmental health science. The 49-item post-test was designed to collect post-intervention data pertaining to (1) students' attitude toward task assignment and computers, (2) students' attitudes toward computers, (3) confidence (perceived self-efficacy) in computers, and (4) knowledge of environmental health science.

The format and design of some of the questions were developed using Dillman's (1978) Total Design Method. A panel of experts consisting of The Pennsylvania State University science-curriculum and instruction professors, science educators, and environmental health and public health professionals reviewed the instruments to establish content validity. Based on the results of the evaluation by science educators, the researchers modified some of the questions. A convenience sample of middle school students pilot tested the instruments to determine face validity. The pilot test took approximately 30 minutes to complete.

The alpha coefficient was calculated as an estimate of reliability. The Cronbach's Alpha value for the internal consistency for the knowledge questions was calculated as alpha = 0.75 for the pilot and 0.73 for the actual study. Individual items were used to measure attitudes and did not fit into a scale. The pilot study was conducted at another school of a middle to high income socio-economic background.

Results and Discussion

Following the one-week classroom computer intervention in which students were assigned a specific computer task, researchers conducted a paired sample t-test and found a statistically significant difference existed in terms of improvement in student knowledge of environmental health science from pre-test to post-test ($\propto = 0.01$). The improvement in subjects' environmental health science knowledge likely occurred as a result of the program and the cooperative learning strategy used with this group.

In this study, participants were instructed to work together cooperatively. However, they all were held individually accountable for their mastery of the material, as illustrated by their individual pre-test and post-test scores and their designated assigned roles throughout the intervention. Cooperative learning has proven to be quite effective for enhancing student knowledge, motivation, and productivity when utilized correctly in the classroom (Johnson & Johnson, 1989; Sharan, 1980; Slavin, 1990). Researchers found this to be one of the most effective ways of introducing computer-based technology into the classroom. The results of the present study added to the growing body of literature on computer-assisted cooperative learning.

Ten individual items were used to determine students' attitudes toward the computer, both pre- and post-intervention. A series of paired sample t-tests in which each individual's pre-test attitude data were compared with post-test attitude data were conducted on the 10 individual items used to assess the attitudes of participants. Due to the number of comparisons, the alpha value was adjusted to 0.005 using the Bonferroni adjustment equation to control for experiment wide error. Overall, student attitudes toward computers did not change (See Table 1).

Table 1 Changes in Computer Attitudes
(n=269)

Questions (1-10)	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	T Value	P Value
1. I like using computers	4.32	.81	4.20	1.10	1.67	0.099
2. I would like to use a computer as part of a classroom lesson	4.24	1.00	4.00	1.20	3.122	0.002*
3. I'm not the type to do well with computers	2.19	1.20	1.85	1.07	4.437	0.000*
4. I hate working in pairs at the computer	2.58	1.41	2.65	1.43	-.698	0.486
5. I like to be in charge of the mouse when I work in pairs at the computer	3.29	1.40	3.53	1.28	-2.377	0.018
6. I like to be the leader of a group all the time	3.05	1.35	2.95	1.31	1.147	0.253
7. Boys make better partners at the computer than girls	2.50	1.31	2.51	1.23	-.080	0.936
8. Girls know more about computers than boys	2.57	1.25	2.76	1.18	-2.301	0.022
9. Girls make better partners at the computer than boys	2.90	1.32	2.98	1.27	-.874	0.383
10. I feel more confident at the computer when I work alone	3.30	1.39	3.26	1.36	.439	0.661

A series of paired sample t-tests (Strongly disagree 1-Strongly agree 5) on a 5-point scale
Bonferroni Adjusted Alpha
*p value < 0.005

The researchers conducted a three-way mixed model RM-ANOVA in which task assignment (driver vs. navigator) and gender comparison were treated as the grouping variables, and knowledge was treated as repeated measures (pre-test and post-test) to discern whether statistically significant differences existed in knowledge increase by task assignment. Even though drivers and navigators improved in environmental health knowledge, the differences were not statistically significant (See Table 2).

Table 2 Pre- and Post-test Knowledge Difference by Task

Variable	Pre-test Mean	Pre-test S.D.	Post-test Mean	Post-test S.D.	Diff	F Value	P Value
Drivers (n=136)	9.16	3.16	10.57	4.00	1.41	1.60	0.21
Navigators (n=133)	9.33	2.91	11.39	4.23	2.06		

The sample size varies due to missing data. Three-way mixed model Repeated Measure ANOVA

Students who were assigned the task of driver were required to take control of the mouse at the computer in every session throughout a one-week computer-based classroom intervention. Students were directed not to relinquish control of the mouse at any time during the sessions. Students who were assigned the task of navigator were instructed to help guide the drivers through each of the five sections of the CD-ROM and to work together to solve the real life case-base problem presented to them in the CD-ROM. Navigators were instructed to type in the solution on the keyboard and to complete the daily worksheets directly related to the information being presented in the CD-ROM. Both students were directed to decide jointly on the correct responses; and both students were given credit for completion of the worksheet and the assignments embedded in the CD-ROM program. However, drivers were the only ones allowed to control the mouse, hence, physically to control the program.

To determine whether changes in environmental health knowledge differed by gender, the researchers conducted a two-way mixed model Repeated Measure ANOVA in which gender comparison was treated as the grouping variable and knowledge was treated as the repeated measures (pre-test and post-test). Researchers found no statistically significant differences regarding gender (See Table 3).

No interaction between gender and task assignment for knowledge was found. Both males and females improved in knowledge at the same rate. This finding likely may be attributed to the fact that the intervention achieved its underlying goal of creating gender equality in the classroom by assigning tasks. This finding also may be attributed to the nature of the program design. A Drop of Water, was designed with sensitivity to gender issues. The main character in the program is female, and she acts as the leader of her group of friends (both boys and girls) as they discover a water pollution problem and then begin a scientific exploration.

Table 3 Pre- and Post-test Knowledge Difference by Gender

	Pre-test		Post-test			F	P
Variable	Mean	S.D.	Mean	S.D.	Diff	Value	Value
Male (n=127)	9.10	3.22	10.85	4.27	1.75	0.76	0.38
Female (n=139)	9.40	2.87	11.19	3.98	1.79		

Additional tests were run to determine whether differences existed by dyad groupings in knowledge from pre-test to post-test. Each treatment group worked cooperatively in dyads and varied by gender composition (mixed gender pairing or single gender pairing). Four dyad groups were compared in these analyses. A two-way mixed model Repeated Measures ANOVA in which dyad groups were treated as the grouping variable was performed to determine if any treatment group differences existed for knowledge. Results indicated that no statistically significant differences existed by dyad group. All dyads improved in knowledge at the same rate. Moreover, analyses revealed no difference for single-gender vs. mixed gender dyads. (Table 4).

These findings also were surprising because based on previous studies, one would expect differences in knowledge gain by gender and by dyad grouping (Johnson, et al., 1986; Barbieri & Light, 1992; Mevarech, 1991, 1993; Underwood et al., 1990; Underwood et al., 1994; Pryor, 1995). These studies reported learning disadvantages for mixed gender dyads and, in some cases, single gender male dyads. In mixed gender dyad arrangements, males tended to dominate the mouse and isolate the females in the dyad. In single gender male dyads, conflict, competition, and less knowledge gain have been observed. Conversely, in same gender female dyads, the partners shared responsibilities and control of the mouse by "taking turns" being in control of the mouse (Barbieri & Light, 1992).

Table 4 Pre- and Post-test Knowledge Difference by Dyad Group

	Pre-test		Post-test			F	P
Variable	Mean	S.D.	Mean	S.D.	Diff	Value	Value
Boy(D)-Boy(N) (n=56)	8.66	3.08	10.17	4.49	1.52	0.04	0.99
Girl(D)-Girl(N) (n-65)	9.27	2.93	11.0	4.17	1.73		
Boy(D)-Girl(N) (n=76)	9.53	2.58	11.21	3.88	0.68		
Girl(D)-Boy(N) (n=69)	9.49	3.42	11.27	4.14	1.79		

The sample size varies due to missing data.
Two-way mixed model Repeated Measure ANOVA

Conclusions

This research investigated classroom strategies to enhance gender and economically disadvantaged students' performance in computer-assisted classrooms. Researchers sought to determine the effect of gender and task assignment (driver vs. navigator) on students' knowledge and attitudes using a computer-assisted instruction (CAI) program. A goal of this research was to determine the most efficacious strategy to enhance the achievement of economically disadvantaged youths in (CAI) classroom environments.

Based on the findings in this study, one can conclude that neither the pairing of dyads by gender nor the assignment of roles (driver versus navigator) impacts knowledge skills. This suggests that grouping students by gender and the assignment to specific roles in cooperative learning situations do not affect differences in attainment of knowledge.

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