Operative Computer Learning with Cooperative Task and Reward Structures

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Introduction

America is in a recession that is strangling budgets and challenging educational administrators to stretch existing resources. Compounding this challenge is the ever changing field of computer technology and the dire need to educate a technically competent work force. Currently, the United States is falling behind technological leaders such as Japan and Britain in our attempts to educate a technological work force. Although the reasons for this lack of success in teaching technology are diverse, the most common barriers are financial. These financial barriers are most noticeable in the regional inequities between suburban and rural schools and are manifested in the lack of computer equipment in schools, or outdated equipment not being replaced. (Mruk, 1987) Therefore, the teaching of computer technology is faced with a distinct educational problem: how can we educate more students using limited computer resources without sacrificing student aptitude or enjoyment of the learning event? Cooperative learning provides a plausible solution.

Cooperative learning is a teaching strategy that encourages student success by alleviating overt competitiveness and substituting group encouragement. In cooperative learning, individuals work with their peers to achieve a common goal rather than competing against their peers or working separately from them. Research on the benefits of cooperative learning has shown an increase in academic achievement, positive attitudes towards learning and increased student satisfaction.

Review of the Related Literature

Effects of Cooperative Learning on Student Achievement

The effect of cooperative learning on academic achievement has been well documented and research suggests that cooperative learning produces greater student achievement than traditional learning methodologies. In fact, a review completed by Slavin in 1984, found that 63% of all cooperative learning studies

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analyzed showed increases in academic achievement. Slavin's review isolated the prominent characteristics responsible for increased achievement scores and discovered that cooperative task structures and cooperative reward structures were the two determining factors in the success of cooperative learning. This data is supported again in Slavin's 1990 meta-analysis when he concludes that methods emphasizing group goals and individual accountability are consistently more effective in increasing student achievement than other forms of co-operative learning. Although this holds true for the majority of research, a study completed by Okebukola (1985) included individual accountability and group goals and showed no significant positive effects on achievement. In addition, research conducted by Rich, Amir, and Slavin (1986) incorporated individual accountability and group goals but showed negative effects on achievement.

Cooperative Learning Effects Other Than Achievement

Cooperative learning models have shown effects other than academic achievement that contribute to the overall satisfaction of course participants (Salend & Sonnenschein, 1989). A wide variety of social benefits have been documented. Such benefits include: promotion of positive attitudes toward schooling (Johnson & Johnson, 1978), promotion of group socialization and cohesiveness (Slavin, 1990), decreased prejudicial attitudes (Johnson & Johnson, 1978; Slavin, 1990), encouragement of risk taking (Johnson & Johnson, 1975), fostering of self esteem (Slavin, 1990) and increased ability to see another's perspective (Slavin, 1990).

Cooperative Learning and the Computer

In almost all schools the number of students far exceeds the number of computers, however, individualistic education has dominated the use of computers (Dickson & Vereen, 1983). One student per computer is the tradition and few have challenged this in the research arena, although understanding the effects of cooperation at the computer could have economic as well as academic benefits. One untapped resource for education of computers is peer tutoring. Peer tutoring is the cooperation between two or more students in which one student actively takes on the teaching role. It has been an effective cooperative behavior in fostering intellectual and social growth (Hill & Helburn, 1981). In a recent study by Teer, Teer & McKnight (1988), students using peer tutoring gained greater computer and relational skills than students working independently. Mehan (1985) suggests a natural tendency for students to collaborate at the computer regardless of adult supervision. Mehan states that when students are placed at a computer and “left to their own devices....(they) work out the details of task completion themselves, resulting in voluntary instead of compulsory forms of instructional activity". This tendency for students to rely on each other to work out problems is at the heart of cooperative learning.

Research directly relating cooperative learning with computers is limited, but some excellent studies have been completed by Webb (1984) and Oh (1988). Webb's study evaluated group effectiveness in the teaching of computer programming to 30 students ranging in age from 11 to 14. The study dealt extensively with group planning and processing involved in the breakdown and dissemination of knowledge. Webb also looked at the relationship of cooperative groups to increased academic achievement and found that cooperative group learning was positively related to academic performance for students learning BASIC (a computer programming language).

A study conducted at Illinois State University by doctoral student Hyun-an Oh (1988), looked at the effects of both cooperative and individualistic incentive and task structures on achievement in computer programming. His study ran for seven weeks during which he compared the performance of 114 university students enrolled in a introductory microcomputer course under three treatments. The treatments were variations of cooperative task, cooperative incentive, individualistic task and individualistic incentive. Oh's findings indicated that there were no differences in achievement between cooperative learning with computers and individualistic learning with computers. He also concluded that incentive made no difference in student achievement for either cooperative structures or individualistic structures. This conclusion was drawn from the fact that students who had no incentive performed as well as students with incentive in both cooperative and individualistic treatments.

Purpose of the Study

In keeping with the concept of optimizing computer resources by pairing students at one computer, it is necessary to know if cooperative learning structures affect the academic achievement and satisfaction of students learning about computers. Therefore, the purpose of this study was to analyze the difference in achievement and satisfaction between three groups of post secondary students learning computer aided drafting under three different learning treatments: cooperative task and reward, individualistic task and reward and a combination of cooperative and individualistic tasks and rewards. By manipulating the independent variables (cooperative task, cooperative reward, individualistic task and individualistic reward) significant differences in two dependent variables (student achievement and student satisfaction) were tested.

Research Hypotheses

The following hypotheses were proposed for this study of cooperative learning structures on post secondary, computer aided design students:

1. There is no significant difference in achievement levels between cooperative learning structures and individualistic structures.
2. There is no significant difference in student satisfaction levels between cooperative learning structures and individualistic structures.
3. There is no significant difference in achievement levels between cooperative learning structures combined with individualistic structures and individualistic structures alone.
4. There is no significant difference in satisfaction levels between cooperative learning structures combined with individualistic structures and individualistic structures alone.

The scope of this study was limited in that it encompassed 57 students enrolled in an Introduction to Computer Graphics course at Colorado State University. It was assumed that the time allotted for this study (15 weeks) was appropriate in determining the effects of cooperative learning on student achievement and satisfaction, and that students completed evaluative instruments honestly.

Methodology

The cooperative model studied was based on Slavin's Student Teams-Achievement Divisions (Slavin 1986, 1990). This method of cooperative learning clusters students in four-member learning teams that are mixed in performance level. Performance levels of students were determined by pretest scores and grade point averages, and then students were randomly assigned to a group.

Three sections of an Introduction to Computer Aided Drafting course, consisting of 14, 21, and 22 students, were involved in the study and each group participated in three treatments (cooperative task and reward, individualistic task and reward and a combination of cooperative and individualistic task and reward). The course was divided into nine progressive units designed to introduce new concepts, practice application, and test understanding. A post test, an attitude survey, three quizzes and three drawing assignments were used to determine the level of achievement for each treatment. The post test was a comprehensive test covering information presented during each five week session and which students took at the end of each session. The same attitude survey was used for each of the treatments and was given to students at the end of each five week session. Students were also responsible for completing nine drawings and taking nine quizzes during the course of the semester (three per treatment). All instruments were consistent across teams and course sections.

The population for this study was post secondary students enrolled in an introductory course in computer aided drafting. The research was conducted on a purposive sample which was established through the Colorado State University enrollment system.

Procedures

At the beginning of each unit the instructor presented new material by talking the students through new commands while they worked at the computer. The same presentation was given to all three treatments, but during the combined and cooperative treatments, students were paired while working through the software's commands. Students in the individualistic treatment worked alone at the computer during the presentation of new commands.

Upon completion of the lecture, drawing assignments were given and students in the cooperative and combined treatments were assigned a partner. Drawing partners were rotated each week to give students the opportunity to work with each member of their team during each treatment. In addition, members within a team were responsible for 1 of 4 drawings. This insured that team members would complete their own drawings rather than submit a team member's drawing as their own.

During lab time, students in the cooperative and combined treatments took turns at the computer to complete their drawings. Obviously, while one student was busy working at the computer, the other was passive. However, because this student had a vested interest in the success of their partner (the grades of the teammates were averaged) the drawing became a cooperative task experienced by both members. In other words, while one student was working at the drawing, the other student acted as a coach, making sure the drawing was being done correctly and helping out if mistakes were made. This behavior was encouraged and monitored by the instructor during the cooperative and combined treatments. When students were in the individualistic treatment, they completed their drawings on their own, sitting and working by themselves at the computer. This behavior was also encouraged and monitored by the instructor.

A quiz was given at the end of each unit which covered information presented in lecture, outlined in the reading and practiced in the drawing exercises. Prior to each quiz, students were given ten minutes to review their notes. Students in the cooperative section were encouraged to use this time to study with their team mates to ensure that their team mates were prepared, because the quiz grade awarded would be the average of their team members' grades. The individualistic and combined treatments did not average quiz grades so they were given ten minutes to prepare for the quiz but were not allowed to study together (see Figure 1).

	Individualistic Task	Indivualistic Reward	Cooperative Task	Cooperative Reward
Indivualistic Treatment (3 units)	Quiz Preparation Drawing Com-pletion	Quiz Grade Drawing Grade		
Combined Treatment (3 units)	Quiz Preparation	Quiz Grade	Drawing Com-pletion	Drawing Grade*
Cooperative Treatment (3 units)			Quiz Preparation Drawing Com-pletion	Quiz Grade* Drawing Grade*

*grades are based on the average of the teams' grades

Figure 1. Task and reward structures used in each treatment.

Results

The statistical design chosen for this study was a counterbalanced design. This design is ideal for eliminating threats to internal validity when random assignment of subjects is not possible. Each group receives each treatment, thus eliminating the possibility that non randomized groups might not be equivalent and differences construed as an effect of the independent variable. The counter balance design diminishes potential differences by exposing all groups to the variations of the independent variable, while at the same time ruling out order-of-presentation effects (Isaac & Michael, 1990).

In the counterbalanced design, each group of students was exposed to each variation of the independent variable at different times during the experiment (see Figure 2). After each treatment, the column mean for each variation of the independent variable was computed. These mean scores were then compared using an ANOVA to check for initial differences and sequencing differences in the dependent variables: student achievement and student satisfaction.

Analysis of Student Achievement

Three dependent measures were evaluated to determine levels of significance between and among treatment groups: post test scores, drawing scores, and quiz scores. The maximum score for the post test is 30 and the maximum for both the drawing and quiz scores is 10. Table 1 shows the statistical means of the treatment groups for each of the dependent measures.

Treatment Variation				
	Weeks 1-5	Weeks 5-10	Weeks 10-15	
Section 1	A	B	C	A = Individualistic Treatment
Section 2	B	C	A	B = Combined Treatment
Section 3	C	A	B	C = Cooperative Treatment

Figure 2. Counter balanced design as utilized in the treatment schedule.

Table 1
Mean of Dependent Variables by Treatment Group

	Post Test Scores		Drawing Scores		Quiz Scores	
Treatment	Mean	SD	Mean	SD	Mean	SD
Individualistic	22.7588	3.5613	9.7661	.3147	8.1520	.8798
Combined	21.5263	4.9623	9.8012	.2263	7.8889	1.2477
Cooperative	22.4649	3.8352	9.8538	.2978	8.2378	.5592

The statistical means show little difference in achievement between the treatment groups. For both the quiz and drawing means there is a slightly higher score for the cooperative groups than the individualistic and combined groups. However, the scores for post tests indicate higher achievement in the individualistic groups than in either the cooperative or combined groups. Comparing combined scores to the individualistic and cooperative scores, we find that for both the post test and quiz scores, the combined scores were the lowest. Only in the drawing scores did the combined treatment show slightly higher achievement scores than the individualistic group.

The statistical means of achievement scores show little or no difference between the treatment groups in promoting achievement. However, it is helpful to analyze the standard deviations for each dependent measure to determine the spread of the scores. One-way ANOVAs were run on each of the achievement measures to determine variance between scores for each treatment. This analysis is depicted in Table 2.

The analyses of variance for both the post test scores and the drawing scores show an F ratio less than 1.96 and an F probability higher than 5 percent. It is therefore concluded that neither of these show significant differences within or between the treatment groups.

Due to the lack of significant difference in achievement scores between cooperative, combined and individualistic treatments, the following hypotheses are accepted for this study of cooperative learning structures on post secondary, computer aided design students:

1. There is no significant difference in achievement levels between cooperative learning structures and individualistic structures.
2. There is no significant difference in achievement levels between cooperative learning structures combined with individualistic structures and individualistic structures alone.

Table 2
Analysis of Variance for Achievement Scores by Treatment

Analysis of Variance of Post Test by Treatment

Source	*df*	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	47.2390	23.6195	1.3623	.2589
Within Groups	168	2912.8860	17.3386		
Total	170	2960.1250			

Analysis of Variance of Drawing Scores by Treatment

Source	*df*	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	.2222	.1111	1.3950	.2507
Within Groups	168	13.3816	.0797		
Total	170	13.6038			

Analysis of Variance of Quiz Scores by Treatment

Source	*df*	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	3.8012	1.9006	2.1568	.1189
Within Groups	168	148.0443	.8812		
Total	170	151.845			

Analysis of Student Attitude

Student attitude was tested at the end of each treatment. The attitude survey consisted of twelve questions used to determine the level of student understanding and enjoyment of the course.

In order to determine differences between treatment groups in their responses to the attitude survey, student responses were converted to an attitude score. The scores were based on positive responses to course enjoyment and student understanding. If students responded strongly positive (either with a strongly agree or strongly disagree – they received four points. Positive responses (either agree or disagree) received three points. Two points and one point were rewarded for negative and strongly negative responses respectively. Once the scores were determined, statistical means were calculated for each group (Table 3) and an Analysis of Variance was performed (Table 4) to determine if there was significance between group satisfaction.

Table 3
Means of Attitude Scores by Treatment

	Mean	SD	Cases
Individualistic	40.4035	3.5095	57
Combined	40.4561	3.8502	57
Cooperative	40.1228	3.8641	57

Table 4
Analysis of Variance of Attitude Scores by Treatment

Source	*df*	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	3.6608	1.8304	.1305	.8777
Within Groups	168	2356.0000	14.0238		
Total	170	2359.6608			

Due to the low F ratio and extremely high F probability, it is concluded from this analysis that there is no significant differences in attitude score between the treatment groups. Therefore the following hypotheses are accepted for this study of cooperative learning structures on post secondary, computer aided design students:

1. There is no significant difference in student satisfaction levels between cooperative learning structures and those individualistic structures.
2. There is no significant difference in satisfaction levels between cooperative learning structures combined with individualistic structures and individualistic structures alone.

Observations and Recommendations

One of the immediate benefits of cooperative learning structures over individualistic learning structures in the teaching of computer applications, is that students work two to a computer. This allows twice the number of students to use equipment. Such an obvious benefit would allow lab and course coordinators to enroll twice as many students into microcomputer classes. Observation showed no detriment to students working together at the computer. In fact, those students allowed to complete drawings independently would often leave class early and finish drawings during open laboratory hours. Students working independently also experienced more absences and asked more questions directly of the instructor than did their collaborative counterparts.

Cooperative learning sparked camaraderie throughout the semester and it appeared that most students enjoyed working together. There were many times during individualistic sessions that the instructor had to ask students to stop working together. They seemed hesitant to work at the computer alone and preferred working with a partner. However, the reverse was true as well. Some students balked at working with their team members during the combined and cooperative sessions. There seemed to be a pattern indicating that if students worked together at the first of the semester, as was the case in the combined and cooperative sessions, they wanted to continue working together. Those students who started the semester independently, struggled to get acquainted with their partners once the semester was underway.

With the indication that students liked to work together, the question arises “Why didn't the cooperative and combined treatments produce higher achievement and student satisfaction?”. Obviously there may be a number of confounding variables not controlled for by this study, but observations were made which may effect research design considerations of future studies. Most of the students participating in this study seemed to be extremely grade motivated. Regardless of the treatment in which they participated, they appeared more concerned with quiz grades than with understanding how the computer or software worked. It may be suggested that any student highly motivated by grades will consistently perform for the sake of maintaining a grade point average. Conversely, students who appeared apathetic early in the semester regardless of the treatment did not appear motivated to work within their groups. Group members who were good students no doubt felt stress over a team mate not performing well, but those disinclined students seemed unmoved by the fact that they were pulling their teammates down. In fact, a few such students did not show up during quizzes in which their team mates were dependent on group participation.

The counterbalanced design was used for this study because it eliminated most threats to internal validity. However, one aspect of this design may have negatively effected the outcome of the study. One of the assumptions for this research was that five weeks was enough time to test the effectiveness of the treatments, but treatment overlap was not considered during the planning stages of this investigation. Because each student went from one treatment directly into another, most participants experienced a period of confusion and readjustment. Students were perplexed as to how they were being graded and whether or not they should be working with someone else. This added to the already difficult task of getting students to work together who chose to be independent and getting students to work alone who relied too heavily on their partners.

Because of the unique motivations that apply to college and university students, it would be interesting to look at similar research conducted with populations that may be differently motivated. An example of this would be to use cooperative models in a job retraining program for adults over age 30 who are learning a CAD system. Because this population is motivated by getting or keeping a job rather than grades, cooperative learning might affect them differently than those motivated by grades. Another motivation that should be considered is intrinsic motivation. For example, do individuals studying a subject strictly for pleasure and self improvement benefit from cooperative education?

Although statistics in this study show no positive correlation between cooperative learning and increased satisfaction of the learning event, it is possible that students may have enjoyed the cooperative sessions more than the individualistic session. More extensive research which analyzes student's feelings about working together could be helpful in determining the effectiveness of cooperative learning in a university microcomputer class. Qualitative analysis could be helpful in exploring student feelings because it would allow the researcher to focus on the dynamics of the instructional setting rather than achievement scores. Because this area of analysis is virtually unexplored at the post secondary and adult levels, any information gained in the area of student comfort with a computer or opinions about sharing equipment could greatly benefit the field of technology education. As technology continues to grow exponentially, it is essential that research uncovers effective methods to disseminate technological information. Cooperative learning should be extolled as one of these effective methods.

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