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ABSTRACT

This document presents reports of three studies focused on cooperative pedagogical strategies. The first concerns individualistic and cooperative goal structures in high school mathematics achievement. Two general mathematics classes were taught a unit on percents, one with a cooperative and the other an individualistic goal structure. The cooperatively goal structured classroom demonstrated significantly higher posttest achievement scores than the individualistic group. The second paper is on cooperative learning in ninth grade remedial mathematics classes. One class used a modified team approach, while the other used an individualistic goal structure including class lecture, individual seatwork, and homework. Significant increase in mean post-test scores was obtained, suggesting that cooperative strategies are effective. The third paper is written on cooperative versus competitive reward-structured secondary science classroom achievement. Two biology classes were taught an identical unit, one in an individually competitive structure and one using a cooperative structure called the group-investigation model. No significant differences were found. (MNS)

COOPERATIVE STRATEGIES IN SECONDARY MATHEMATICS AND SCIENCE CLASSES: THREE COMPARATIVE STUDIES.

A SYMPOSIUM PRESENTATION ORGANIZED AND CHAIRED BY:

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"Mathematics and Science - Basic Today, Crucial Tomorrow."

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COOPERATIVE STRATEGIES IN SECONDARY MATHEMATICS AND SCIENCE CLASSES: THREE COMPARATIVE STUDIES.

INTRODUCTION

The three studies being presented in this session represent the efforts of three graduate students who received their Master's degrees from the Department of Teacher Education of Miami University's School of Education and Allied Professions. Graduate training in the School of Education and Allied Professions requires practical experiences, both applied and theoretical, in the area of educational research. These requirements are fulfilled by both course work in educational research as well as the successful completion of an individually selected research project which is usually directed by graduate faculty from the department from which the graduate student is receiving her/his degree. The topics of these research projects are usually obtained from other graduate course work that has specific content as its focus. While I am not a member of the Department of Teacher Education, but rather of the Department of Educational Psychology, all three of these papers were completed under my direction. The explanation for this deviation from normal procedures is that the focus of all three papers, cooperative pedagogical strategies, was obtained from a course in classroom group processes which all three authors took from me. I also am a frequent instructor of our more general educational research course and firmly believe that these research experiences should be important not only in the professional development of our graduate students, but should also be valuable contributions to the education profession in general. Therefore, I believe the dissemenation of research findings (in the form of publications and presentations at professional meetings such as this one) to the general educational community not only lessens the triviality of graduate student research projects, but also enhances the knowledge base of the profession as a whole.

One of the more significant topics of the classroom group processes course which I instruct is the focus on three reward or goal structures described as cooperative, individually competitive and individualistic and their effects upon achievement (classroom learning), affect (self-esteem), and inter-personal relationships (inter-racial relationships and peer affiliations). These contemporary techniques have been developed by social psychologists and are quite well grounded on sound social-psychological theories which are discussed in each of the papers. For the most part, these cooperative strategies have been developed to aid more effective learning in desegregated classroom environments. The notion of "desegregation" would also include "mainstreamed" developmentally handicapped students. Thus, these techniques also assume the use of classrooms which are heterogeneous with regard to academic abilities of students. All three of these papers compare, with regard to achievemnt, some variant of a cooperative with either an individualistic or an individually competitive goal structure. For the most part, the samples represent intact classrooms which the researchers normally teach. Ms. Thomas' study compares a general mathematics classroom unit taught with a cooperative strategy that is contrasted with a similar classroom which utilized an individualistic strategy. Ms. Sosby compares two classrooms of remedial mathematics students who each receive either cooperative or individualistic strategies at one time or another, a repeated measures

design. Both Thomas and Sosby used a cooperative strategy called Student Teams and Achievemnt Divisions which has been developed by the American social psychologist Robert Slavin. Ms. Zimmerman's project focused on two parallel high school biology classrooms, one which received a cooperative and the other an individually competitive stragegy. Ms. Zimmerman's cooperative stategy was based on the Group Investigation model developed by the Israeli social psychologist Shalomo Sharan.

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INDIVIDUALISTIC AND COOPERATIVE GOAL STRUCTURES IN HIGH SCHOOL MATHEMATICS ACHIEVEMENT[1]

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ABSTRACT. Two high school general mathematics classrooms were differentially taught a unit on percents, one with a cooperative and the other an individualistic goal structure. A pre- post-test design with a three-way ANOVA analysis of treatment by time within subjects was used. Neither group was found to be significantly different from each other on the pre-test. Although both groups obtained significant ($p<.05$) gains on their post-test scores as contrasted with their pre-test scores, the cooperatively goal structured classroom demonstrated significantly ($p<.05$) higher achievement post-test scores than the individualistic group. The data strongly support theories concerning the effectiveness and motivation associated with inter-group competition of small cooperating groups.

INTRODUCTION. The objective of the present study was to experimentally replicate past findings regarding the effectiveness with regard to achievement gains of a cooperative as contrasted with an individualistic goal structured unit of instruction. Johnson (1979) has described three classroom pedagogical strategies noted as 1) Competitive, 2) Individualistic and 3) Cooperative. Cooperative group strategies have been defined by Slavin (1982) as "...instructional methods in which students of all levels of performance work together in small groups toward a common goal". He states further that every group member is rewarded on the "...basis of the quality or quantity of the group product according to a fixed set of standards" (p. 150). An individualistic structure is one in which students are given individual goals and by using a criterion-referenced evaluation students are assigned individual rewards. Where as student interdependence is required in the cooperative structure, students behave quite independent of each other in an individualistic structure. "The essence of a competitive goal structure is to give students individual goals and reward them by means of a "normative evaluation" system (Johnson, 1979).

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[1] The development and preparation of this paper was supported by the Dean of the Graduate School and Research and the Dean of the School of Education and Allied Professions. This paper is based in part upon a graduate research project by Ms. Thomas which partially fulfilled the requirements for her Master of Education degree. Ms. Thomas is a presently teaching mathematics in the Ross High School, Ross, Ohio. Requests for reprints should be sent to Lawrence W. Sherman, Department of Educational Psychology, Miami University, Oxford, Ohio 45056.

Slavin (1980; 1983) delineates why certain cooperative learning strategies increase student achievement as contrasted with other cooperative strategies. He distinguishes six major types of cooperative strategies on the interactive basis of two possible "task structures" and three possible "incentive structures." Out of 46 experimental studies contrasting his six types of cooperative structures with either individualistic or competitive goal structures, he found that small group cooperative structures having the elements of group study with group reward for individual learning were the most consistently effective in improving achievement. Two pedagogical strategies which fit this model are Student Teams and Achievement Divisions (STAD) and Teams Games and Tournaments (TGT). Out of eighteen studies examining the effectiveness of small group cooperative structures as compared to individualistic and competitive structures in mathematics instruction, 12 employed STAD and TGT. Eleven of these 12 studies significantly favored the STAD/TGT treatments. Five other cooperative strategies obtained no significant difference and only one study favored an individualistic strategy. None of the 18 studies used a midwestern, predominantly caucasian, middle-class, rural secondary school sample of low achieving students. The present study is an experimental replication of past findings regarding the effectiveness of cooperative as contrasted with individualistic goal structures in two secondary general mathematics classrooms. Based on Slavin's (1983) discussion of six different types of cooperative structures, it was hypothesized that a cooperatively structured group using inter-group competition would achieve greater than an individually structured group.

METHOD

SAMPLE AND TREATMENT. Two general mathematics classrooms taught by two different teachers were utilized. The high school was rural, midwestern, predominantly caucasian and middle-class. The freshmen and sophomore students taking this class were primarily low academic achievers. There was an equal distribution of both sexes in both classrooms and the median age was 15 years. Each classroom was differentially taught a 25 day unit of instruction concerned with the computation and interpretation of percentages. The classroom taught by the cooperative structure (n=20) followed the specifications described in Slavin's (1980) Using Student Team Learning handbook for implementing STAD and TGT. The classroom instructed with the individualistic goal structure (n=18) made use of individual drill and homework exercises as well as teacher lectures and textbook assignments. Both classes used criterion-referenced grading systems.

DESIGN AND ANALYSIS. A control group, pre-test, post-test quasi-experimental design was used to contrast the two intact classrooms' achievement scores (Cambell and Stanley, 1966). The same teacher-made pre- and post-test was given to both classes either prior to the 25 days of instruction or at the end of the instructional unit. A three-way within subjects ANOVA (Time x Treatment within subjects) with repeated measures on the time factor was used to analyze the data. Duncan multiple range tests were used in post hoc contrasts of the groups' pre- and post-test mean achievement scores.

RESULTS

Evidence to support the reliability of the achievement test was obtained for the post-test results of both classrooms combined. The KR20 of .86 was considered highly acceptable. A statistically significant ($p < .001$) interaction between treatment and time was obtained ($F(1,36)=18.62$). As can be seen in Tables 1 and 2 whereas neither group was significantly different from each other on the pre-test, the cooperative group obtained significantly ($p<.05$) higher achievement on the post-test than the individualistic group. It should be noted that both groups demonstrated significant ($p<.05$) gains from pre- to post-test.

Table 1
Mean pre- and post-test achievement scores for cooperative and individualistic classrooms.

Classroom type	pre-test mean	pre-test sd	post-test mean	post-test sd
Cooperative (n=18)	3.10	2.75	19.85	5.77
Individualistic (n=20)	3.33	3.68	12.89	5.96

Table 2
Three-way within subjects ANOVA of classroom type (cooperative vs individualistic treatment) by time (pre- vs post-test).

Source	df	MSe	F	p<
Treatment	1	241.40	6.79	.01
Subj. within treatment	36	31.56		
Time (pre- vs post-test)	1	3283.43	249.32	.0001
Treatment by Time	1	245.18	18.62	.0001
Sub. by Time within Treatment	36	13.17		

DISCUSSION

As predicted, the primary research hypothesis was confirmed. The data strongly support Slavin's (1980; 1983; 1984) position regarding the effectiveness of the incentive and task structure associated with STAD/TGT, both requiring group study and group reward for individual learning. Deutsch's (1949) theories regarding cooperation and competition are the basis for Slavin's (1982) STAD/TGT models. Both models require cooperation within competing groups (inter-group competition). This element of inter-group competition provides the peer pressure as well as incentive structure which has been hypothesized as the primary motivating force behind the effectiveness of the STAD/TGT

model. The results agree with 11 out of 12 previous studies dealing with similar mathematics instruction comparisons which Slavin (1983; 1984) has reported.

In conclusion, two high school general mathematics classrooms were differentially taught a unit on percents with two pedagogical strategies: 1) a cooperative and 2) an individualistic goal structure. While neither group significantly differed from each other on a pre-test, the cooperative group demonstrated significantly higher achievement on the post-test than the individualistic group. Both groups obtained significantly higher post-test achievement scores as contrasted with their pre-test scores. The data strongly support Deutsch's (1949) theories concerning the effectiveness and motivating qualities associated with inter-group competition among small cooperating classroom groups. The ease with which STAD/TGT techniques can be developed by classroom teachers (Slavin, 1982), as well as their effectiveness (Johnson, et al, 1976) would lead one to conclude that teachers of general mathematics and other disciplines should give this approach serious and favorable consideration.

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COOPERATIVE LEARNING IN NINTH GRADE REMEDIAL MATHEMATICS CLASSES.[1]

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ABSTRACT. The purpose of this study was to test the general hypothesis that a cooperative learning method of teaching has positive effect upon academic achievement in 9th grade remedial mathematics students with learning disabilities. The study used a rotational experimental research design in two intact classroom groups, n=11 and n=7 respectively. The Stanford Diagnostic Mathematics Test (SDMT) was given as a pre- and post-test at the beginning and end of the 26 week study. The experimental conditions made use of a modified Student Teams and Achievement Divisions (STAD) approach (Slavin, 1978) and were contrasted with conditions which utilized an individualistic goal structure including class lecture, individual seatwork and homework. Criterion referenced evaluation was used in both classrooms. The null hypothesis was tested at the alpha<.05 level of significance using a two-way within subjects analysis of covariance, Mann-Whitney U and Wilcoxon Signed Rank tests. Statistically significant contrasts were obtained between the two groups' SDMT pre- and post-tests which supported a hypothesis suggesting that cooperative strategies are effective. Statistical significance was obtained within groups when their pre- and post-test scores were contrasted with each other for each of the four units of instruction indicating that effective learning had taken place. These results are discussed with regard to the small sample sizes of these two classes and the particular backgrounds, disabilities, and motivation associated with the students who were included in this study.

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[1] The development and preparation of this paper was supported by the Dean of the School of Education and Allied Professions. This paper is based in part upon a graduate research project by Ms. Susan Sosby which partially fulfilled the requirements for her Master of Education degree. Ms. Sosby is presently teaching high school mathematics in the Fairfield City Schools, Fairfield Ohio. Requests for reprints should be sent to Lawrence W. Sherman, Department of Educational Psychology, Miami University, Oxford, Ohio 45056.

INTRODUCTION. Johnson (1979) and Johnson and Johnson (1975) have described three possible management or goal structures by which classroom instruction may be accomplished. They include the 1) Cooperative, 2) Competitive and 3) Individualistic models of classroom goal structures. Recent literature contributed by Kohn (1986a &1986b) has been seriously critical of the role of competition in the classroom, and he has offered an alternative which is cooperation. A number of other researchers have also presented a great deal of evidence supporting the positive effects of cooperative models of instruction (Bondi, 1982; Chandler, 1980; Johnson & Johnson, 1975; Johnson et al., 1984; Pepitone, 1980; Sharan, 1980; Slavin, 1982, 1983; Slavin, et al., 1985). These views favoring the positive effects of cooperation are not new and most are based on the earlier theoretical rationale of Deutsch's (1949) seminal paper, "A Theory of Cooperation and Competition." In the last 10 years there has been a proliferation of techniques by which cooperative models have been applied to the classroom in a variety of different curriculum content areas including mathematics and the sciences (eg., Slavin & Karwit, 1984; Okebukola, 1985; Johnson et al., 1984; Sherman & Zimmerman, 1986).

The idea behind a competitive goal structure is that students are given individual goals and rewarded by means of a classroom-based normative evaluation system. In a competitive structure a person can attain his or her goal if and only if the other participants cannot attain their goals: outcomes are personally beneficial but detrimental to others. A cooperative incentive structure has been described as one where two or more individuals are in a situation in which the task-related efforts of any individual helps others to be rewarded. In a cooperative structure every group member is rewarded on the basis of the quality or quantity of the group product according to a fixed set of standards (criterion-referenced or master evaluation). Slavin (1983) has pointed out that the element of inter-group competition can be applied to the cooperative goal structures (his Teams Games and tournaments technique is one example). An individualistic structure is one where students are given individual goals and by using a criterion-referenced or mastery based evaluation system the students are assigned individual rewards.

While some studies (e.g., Slavin & Karwit 1984; Sherman & Thomas, 1986) have comparatively examined the effects of cooperative, competitive and individualistic goal structures on mathematics achievement specifically, none have worked with secondary learning disabled students experiencing severe difficiencies in basic mathematics skills. One of the authors (Sherman, 1986) has previously made a comparative examination of these goal structures in an undergraduate university setting. The primary purpose of the present study was to examine the comparative effectiveness of a cooperative versus an individualistic goal structure on mathematics achievement in two high school freshman classrooms in which students were experiencing severe deficits in basic mathematics skills. From the literature on cooperative goal structures a general hypothesis favoring the positive effectiveness of cooperative as contrasted with individualistic goal structures was formulated.

METHODOLOGY

SAMPLE. This study made use of two intact remedial general mathematics classrooms in the Fairfield Freshman School, Fairfield, Ohio. Both groups used the same Basic Mathematics Skills textbook (Treff & Jacobs, 1982). This school district utilizes a quarter system consisting of three 12 week quarters in the academic school year. The study took place during the first two quarters of the year over a duration of 24 weeks of instruction. Group A (n=11) originally contained four girls and seven boys. Subject mortality in Group A consisted of one boy who left the school after the study began. Group B (n=7) contained five girls and two boys. Eight of the 17 subjects were officially diagnosed as Learning Disabled and were receiving special help from Learning Disability tutors outside of the classroom (5 in Group A and 3 in Group B).

A general impression of most of the students in both groups was that they had a quite negative attitude towards school. This was reflected by absenteeism which was quite often attributed to truancy. For the most part, the students could be divided into two categories, those who were immature and somewhat quiet students, and those who were quite "hard" and "street-wise". Group A, which contained 7 officially diagnosed learning disabled students, was the most difficult to work with. Three boys and one girl in Group A had records with the local Juvenile Court system for drug offenses, truancy, and armed robbery. They were seeing parole officers on a regular basis. One of the drug offending boys was actually admitted to a drug rehabilitation program the following quarter after this study was completed. Group B, while not containing any students who were experiencing legal difficulties, did have three members who were officially diagnosed as learning disabled.

DEPENDENT VARIABLES. Both Groups took the Stanford Diagnostic Mathematics Test (SDMT) (Beatty, et al., 1976) before they received 24 weeks of instruction consisting of four units: Unit 1 focused on general computational skills including addition, subtraction, multiplication and division; Unit 2 dealt with number theory; Unit 3 focused on fractions; and Unit 4 concentrated on addition, subtraction, multiplication and division of fractions. The SDMT pre-test scores (Form A) were used as a basis upon which to structure the small cooperative groups. Form B of the SDMT was used as a post-test. Before each unit was started a pre-test was administered for the unit. An alternate form of the unit exam was used as a post-test. All 25-item unit pre- and post-tests were commercially provided by the publisher of the textbook (Treff & Jacobs, 1982). Grading on unit exams for either Group A or B was accomplished with the use of criterion-referenced evaluation with mastery standards used to determine grades. Thus, in either condition neither group was experiencing competition.

TREATMENTS. Two types of goal-structures were used including a Cooperative and an individualistic goal structure. Student Teams and Achievement Divisions (STAD) (Slavin, 1978a; 1980; 1982) was the cooperative group structure utilized in this study. It is a cooperative reward-structure making use of peer tutoring in academically heterogeneous small classroom groups. Children's SDMT scores were

ranked separately in each classroom so that students could be heterogeneously assigned to their peer tutoring groups. Children of relatively high, middle and low abilities (based on their SDMT scores) were included in each of the small groups. In Group A where there were 10 children, two groups of three and one group of four were used. In Group B where there were only seven students, two groups, one group of four and one of three students, were used. After the teacher introduced (lectured) the content of a particular unit of instruction, group members studied together and drilled each other throughout the unit of instruction. These assignments would be similar to the textbook, seatwork and homework which were used in the contrasting individualistic condition, with the exception that these activities were carried out in small cooperative groups in the classroom. Weekly quizes were given each Friday throughout each unit of the study. Quiz scores were contrasted with previous performances and points were given for improvement over past scores. Groups and their individual members who obtained the most improvement points on these quizes were posted in the classroom on the bulletin board each week. At the end of a unit of study the unit post-test was administered and the criterion-referenced mastery grading scale determined. Thus, children were not competing with other individuals, but with their past performances. While Slavin's (1980) procedures include inter-group competition between classroom groups in which groups are rewarded on the basis of their cumulative improvement points which outscore other groups, the present study did not utilize this element of inter-group competition.

The contrasting treatment, an individualistic goal structure, also utilized presentations by the teacher in a lecture format. Textbook assignments, individual seatwork sheets and homework were assigned. Weekly quizes were also used throughout each of the units of study. When the individualistic goal structure was in operation, the children had to carry out the assignments by themselves. Some would describe this as the "traditional" manner of classroom instruction. At the end of a unit of instruction the students took the criterion-referenced mastery graded test and received a grade for the unit.

PROCEDURES. An attempt was made to counterbalance the treatments in the two groups. Each group received each treatment (both cooperative or individualistic) twice. During the first unit Group A received the Cooperative treatment while Group B received the individualistic treatment. During the second unit the treatments were reversed so that Group B received the cooperative and Group A received the individualistic treatment. Both groups received the individualistic treatment for the third unit and the Cooperative treatment for the fourth unit of instruction.

DESIGN AND ANALYSIS. Both a between subjects and a within subjects quasi-experimental mixed design was utilized in this study. The Stanford Diagnostic Mathematics Test was administered to both groups before and after the 26 week period of instruction. Anticipating initial differences on pre-test SDMT scores between the two groups, analysis of co-variance was a contingent statistical alternative since these two small samples did meet the restrictions of homogeneity of variance. In addition, a pre- and post-test was administered before and after each of the four units of instruction. Since the sample sizes of the two groups were so small and we could not meet the assumptions of

homogeneity of variance on the unit pre and post-tests, two non-parametric statistics were relied upon. Several Mann-Whitney U tests were used to test significant differences between the two groups (a between subjects design) on the dependent variables SDMT and each of the unit's pre- as well as post-test scores. Several Wilcoxon Signed Rank tests were used to test significant differences within groups contrasting their pre- and post-test results (a repeated measures design). Null Hypotheses were rejected at the alpha < .05 level of significance. The Null and Alternative Hypotheses were as follows:

Ho: No significant differences would be obtained between the two groups' pre-test SDMT or any of the unit pre-test scores.

H1: The same as the above null-hypothesis.

EXPLANATION: By accepting the null hypothesis we could at least establish that the two groups started the study or each unit at the same level of knowledge.

Ho: No significant differences would be obtained between the two groups post-test SDMT scores.

H2: The same as the above null-hypotheses.

EXPLANATION: Since both groups received both cooperative and individualistic goal structures for the same number of units (two each), neither group would be expected to be at an advantage on the SDMT post-test.

Ho: When the two groups are treated differentially, no significant differences would be obtained on mean post-test unit scores between the group receiving the Cooperative treatment and the one receiving the individualistic one.

H3: The group receiving the cooperative treatment would have at least equal or higher post-test unit scores than the group receiving the individualistic treatment regardless of which group was receiving either treatment (i.e., unit 1 or unit 2 where the two groups are differentially treated.

EXPLANATION: If Slavin's (1983) theories are correct, the cooperative group will be expected to do as well or better than the individualistic group. The cooperative goal-structure should demonstrate this effectiveness in either group. The cooperative goal structure is not any worse than the individualistic structure.

Ho: No significant difference between mean pre- as contrasted with post-test SDMT scores would be obtained in either group.

H4: Both groups would demonstrate significantly higher SDMT mean post-test scores as contrasted with their mean pre-test scores.

EXPLANATION: Rejection of the Null-hypothesis and confirmation of the Research Hypothesis (H4) would suggest that cognitive learning had taken place.

Ho: When both groups are given the same treatment for a unit of study, no significant differences should be obtained between their mean post-test unit scores (i.e., in unit 3 where both groups receive the individualistic treatment and unit 4 where both groups receive the Cooperative treatment).

H5: The same as the above null-hypothesis.

EXPLANATION: If the groups are not different from each other as should be established in H1 above, then when they equally receive the same treatment (i.e., as in unit 3 where both receive the individualistic goal-structure, and in unit 4 where they both receive the Cooperative goal-structure), their mean post-test scores should be expected to be equal.

Ho: No significant differences between any of the four unit mean pre- as contrasted with post-test scores would be obtained in either group, regardless of treatment condition.

H6: All four unit mean post-test scores would be significantly higher than the mean pre-test scores for both groups.

EXPLANATION: Rejection of this Null-Hypothesis and confirmation of the Research Hypothesis (H6) would suggest that cognitive learning had taken place within each of the four units of instruction for both groups.

RESULTS

The major results of this study are contained in TABLE 1 and 2 where the SDMT pre- and post-test scores for the two groups are displayed. Since both groups' pre-test SDMT scores were significantly ($p>.05$) different from each other (disconfirming Research Hypothesis 1), analysis of covariance was utilized to examine examine the two groups' post-test scores. The two groups did maintain their significant difference between each other on the post-test thus, accepting Research Hypothesis 2. When each groups' SDMT pre-test scores were controlled for, both groups obtained significantly ($p<.05$) higher post-test scores, thus demonstrating that learning did take place (accepting research hypothesis 4).

Upon examination of TABLE 3 one can observe the pre- and post-test unit scores for each group under each treatment. For unit 1 the two groups do not significantly differ from each other on the pre-test, however they do differ on their post-test, but not in the direction which hypothesis 3 predicted. The cooperative treatment group was significantly lower than the individualistic treatment on the post-test for unit 1. Both groups however did demonstrate significantly higher post-test scores as contrasted with their pre-test scores. For unit 2 the two groups also significantly differ on their unit pre-test (partially failing to accept Research Hypothesis 1) with Group B obtaining a significantly lower pre-test score. No significant difference was obtained between the two groups on their unit 2 post-test scores. This might be interpreted as positive evidence for the success of the cooperative STAD technique in that while Group B starts the unit

at a statistically distinct disadvantage, at the end of this second unit of instruction, Group B is performing at the same level as Group A. Unit 2 post-test scores were significantly higher than pre-test scores for both groups, once again confirming Research Hypothesis 6. Neither group obtained significantly different pre- or post-test scores in Unit 3 or unit 4, as was predicted by research hypothesis 5. Both groups did demonstrate significantly higher post-test scores on units 3 and 4, as in units 1 and 2, thus fully confirming Research Hypothesis 6.

TABLE 1
Mean Pre- and Post-Test SDMT Mean Raw Scores for Two Groups.

	Pre-Test	Post-Test
Group A (n=10)		
Mean	33.90	37.90
SD	10.53	9.42
Group B (n=7)		
Mean	47.14	54.14
SD	14.74	8.41

TABLE 2
Two-Way Within Subjects ANCOVA of Mean SDMT Scores by Group by Time with Pre-test Score Differences Controlled for Through Covariance.

Source	df	MSe	F	p
Groups	1	129.28	6.58	.02
error	14	19.65		
Time	1	249.12	7.21	.02
Group x Time	1	18.53	.54	ns
error	15	34.533		

TABLE 3
Mann-Whitney U Tests for Pre- and Post-Test Mean Achievement Scores in 4 Units of Mathematics Instruction.

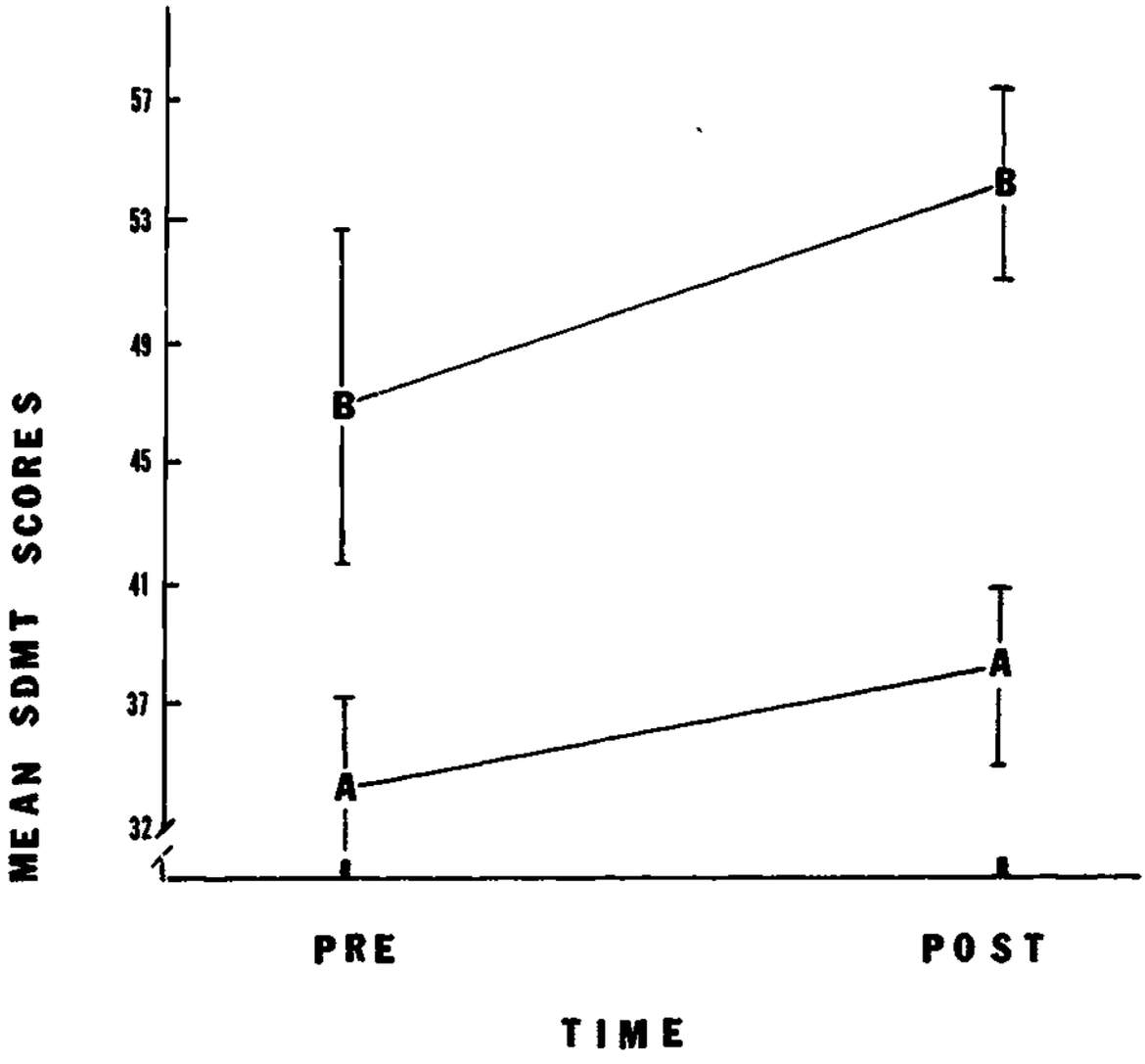
	UNIT 1		UNIT 2		UNIT 3		UNIT 4	
	PRE	POST	PRE	POST	PRE	POST	PRE	POST
Group A								
Mean	10.90	15.73	1.22	13.44	2.10	13.20	0.30	12.50
SD	5.90	3.84	.63	5.23	1.97	5.38	0.46	4.20
n	11	11	9	9	10	10	10	10
U	54	62	12*	32	41	47.5	47.5	34.50
Treatment	COOP		INDIV		INDIV		COOP	
Wilcoxon signed-Ranks	Z=2.04*		Z=2.67*		Z=2.80*		Z=2.80*	
Group B								
Mean	14.00	19.43	0.43	14.43	2.86	16.72	1.17	12.29
SD	2.98	2.06	0.49	2.25	2.42	5.97	2.12	4.86
n	7	7	7	7	7	7	7	7
U	23	15*	51	31	29	22.50	15.50	35.50
Treatment	INDIV		COOP		INDIV		COOP	
Wilcoxon signed-Signed Ranks	Z=2.37*		Z=2.37*		Z=2.37*		Z=2.20*	

* $p<.05$

CONCLUSIONS

In summary, the purpose of this study was to test the general hypothesis that a cooperative learning strategy has positive effect upon academic achievement in ninth grade remedial mathematics students with learning disabilities. The study used a counterbalanced design contrasting cooperative with individualistic reward structures in two intact classroom groups. Mean Stanford Diagnostic Mathematics Test scores, administered as pre- and post-tests, revealed that both groups obtained significant ($p<.05$) learning after 26 weeks of instruction, confirming Hypothesis 4. This significant increase in mean post-test scores was obtained even though the two groups did significantly differ from each other, both at the beginning of the study as well as at the end.

The primary experimental condition under study here, Student Teams and Achievement Divisions (STAD) has been hypothesized to be more effective, or at least as effective as other pedagogical strategies (Slavin, 1978). We believe that Slavin's (1983) hypothesis has been supported in our study. With the exception of findings contrary to this hypothesis which were obtained during the first unit of instruction where the individualistic treatment group received significantly higher


MEAN SDMT SCORES
57
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B
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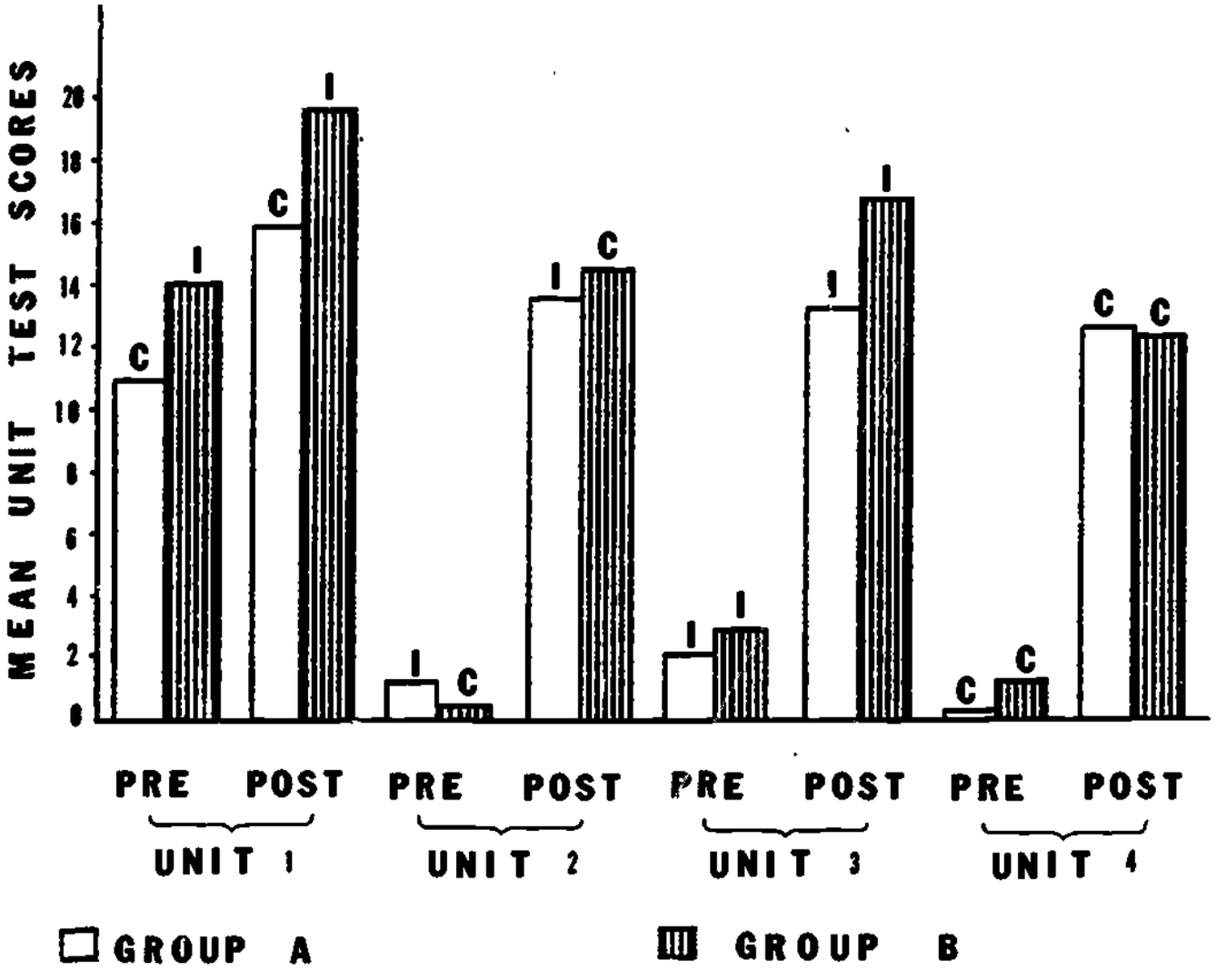
A
PRE
POST
TIME


MEAN UNIT TEST SCORES
0
2
4
6
8
10
12
14
16
18
20
C
I
PRE
POST
UNIT 1
UNIT 2
UNIT 3
UNIT 4
GROUP A
GROUP B

post-test scores than the cooperative group, the majority of findings in this study support our six research hypotheses which were based on Slavin's predictions. In general the results indicate that learning did take place and that these students demonstrate as positive a response to the cooperative strategy as the individualistic one. In this respect, these findings are similar to Sherman and Zimmerman (1986) and Sherman (1986). Slavin et al. (1984) has presented evidence that another variety of cooperative strategy, Team Assisted Individualization, has been moderately effective with regard to mathematics achievement in samples of children who were academically handicapped or nonhandicapped.

It should be noted that this was not an ordinary sample of high school students. In fact, they were a quite difficult group of students to work with, both because of their learning disabilities, as well as their general attitudes with regard to schooling. While the increases in post- over pre-test scores was significant, these four units of instruction elevated the students approximately eight months in norm-based (SDMT) grade-level equivalent scores from 4.5 and 5.6 to 5.2 and 6.9 in groups A and B respectively. In other words, both groups were indeed in need of remedial instruction from which they benefited. While the two samples were indeed quite small, which should normally be a caution with regard to generalization of these findings, the fact that statistical significance was obtained in the analysis of covariance is even more important: the likelyhood of obtaining statistical significance is usually doomed with such a small sample, thus making our findings even more important! Nevertheless, because of the unique backgrounds of the students in this study, it may not be safe to generalize the findings to so-called "normal" high school students who generally respond to the cooperative strategies more favorably as can be seen in the paper by Sherman and Thomas (1986). Further studies with other populations similar to our sample are needed.

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COOPERATIVE VERSUS COMPETITIVE REWARD-STRUCTURED SECONDARY SCIENCE CLASSROOM ACHIEVEMENT.

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Abstract. Academic achievement in an individually competitive and a cooperatively reward-structured environment was examined in two high school sophomore level biology classes of equal academic ability. Each was pre-tested and taught an identical unit of study, one in an individually competitive structure and one using a cooperative structure called the Group-Investigation model. At the end of 7-weeks both classes were post-tested. A two-way repeated measures ANOVA was used to determine significant differences in pre- and post-test scores within subjects and between the two treatment groups. The analysis indicated that the two groups were not significantly different from each other on the pre-test. Although both cooperative and competitive techniques obtained significantly ($p<.05$) higher post-test scores than their pre-test scores, neither strategy was superior over the other in producing academic achievement. Results are discussed and compared to previous studies which have examined differences among cooperatively, competitively and individually structured classroom environments.

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INTRODUCTION. The term "reward-structure" has been used to describe the means by which a teacher motivates students to perform school tasks. In his discussion of reward structures Johnson (1979) mentions three pedagogical structures noted as individualistic, competitive, and cooperative. Classroom structures have usually been somewhat competitive and sometimes individualistic in the past. In an individualistic structure, students are given individual goals, and a criterion-referenced evaluation system is used to assign rewards. In a competitive system, students are also given individual goals, but are rewarded by means of a norm-referenced evaluation system. Theoretically in a competitive system students discourage the performance of their peers, since one student must fail if another is to succeed (Slavin, 1978b). Success is available to only a few, and many students who could potentially achieve at a high level turn their attention away from academics to peer-supported activities such as sports and social functions (Coleman, 1961). Several studies have discussed the potentially negative effects of a competitive reward system on learning (Holt, 1967; Johnson & Johnson, 1975) and self-concept (Kirschenbaum et al., 1971). Kohn (1986) has recently presented an important case against competition both in and out of school settings. Competitive instruction has been observed to stress the acquisition of low level information rather than high level ideas (Sullivan, 1980), stimulate competition and social comparison rather than cooperation (Johnson & Johnson, 1975; Pepitone, 1980), and produce negative intergroup perceptions and attitudes (Cohen, 1980). Michaels (1977), on the other hand, has hypothesized that individually competitive goal structures should produce superior achievement behaviors as contrasted with the individual and cooperative structures.

In Johnson's (1979) cooperative or team structure students' rewards depend on the performance of a group. Group members, therefore, encourage each other to do well and to help each other meet their goals. Studies have shown that the use of a cooperative reward structure has had positive effects as compared to a competitive structure on academic achievement (Lucker et al., 1976; Slavin, 1978a; DeVries & Slavin, 1978), mutual concern (Aronson et al., 1975; DeVries & Slavin, 1978), self-esteem (Aronson et al., 1975; Blaney et al., 1977; Slavin, 1978a), and increased interpersonal relationships (DeVries et al., 1978; Slavin, 1978b). Theoretically, this occurs because groups improve performance due to an increase in peer norms favoring performance and because they provide opportunities and motivation for students to help one another. They increase mutual attraction because assignment to groups and peer tutoring increase contact between students and propinquity may be associated with students' liking of one another. In addition, group learning can aid students in becoming less dependent on teacher instruction and become more responsible for their own learning (Bingman & Koutnik, 1970).

Several techniques for cooperative learning have been developed in recent years. For example, several student-team learning techniques have been created by DeVries et al. (1978) (Teams-Games-Tournaments, Student Team Achievement Divisions) and Aronson et al. (1975) (Jigsaw) which combine the use of team competition and academic games in the classroom as a cooperative

learning strategy. The success of these student-team learning techniques with regard to academic achievement, increased self-esteem, improved interpersonal relationships, and mainstreaming has been summarized by Slavin (1980). In addition, numerous modifications of these three basic techniques have been developed in recent years to meet special purposes or needs in the classroom.

Group Investigation (GI) is another cooperative learning technique that was developed by Sharan & Sharan (1976) and Sharan & Hertz-Lazarowitz (1980). According to this method, a class is divided into groups of 5-6 students for the study of a particular topic. Groups plan their strategy of study so that each student is involved in the formulation and completion of the project. Each student in the group selects a subtopic for which she or he is responsible. They contribute their research topic to the group and the group prepares and presents the material to the entire class. A group engaging in a GI project will proceed through six phases: topic selection, cooperative planning, implementation, analysis and synthesis, presentation of the final project, and evaluation. A description of these phases can be found in Sharan and Hertz-Lazarowitz (1980).

Slavin (1983) distinguished six types of cooperative structures on the interactive basis of two possible task structures and three possible incentive structures. He reviewed 46 experimental studies contrasting these cooperative structures with either individual or competitive goals. He found that cooperative learning methods that used task specialization and group rewards, of which GI would be an example, increased student achievement more than control methods. Methods that used task specialization and individual rewards, however, did not have this effect. He suggested that because the number of task specialization studies are few, more research is needed before conclusions can be drawn.

In one study (Sharan et al., 1980) GI structure was reported to be more effective than a competitive structure in promoting learning on a high level of cognitive functioning. In a more recent study, Sharan (1984) compared GI instruction, Student Team Achievement Divisions (STAD), and whole-class (individually competitive) teaching strategies with regard to academic achievement, cooperative behavior, and social attitudes in the classroom. Results of his study indicated that the GI and STAD (cooperative) methods were similar in terms of their effect on academic achievement: both of these methods were more effective than individually competitive whole-class instruction; and, the GI method was more effective than both STAD and whole-class instruction in terms of producing more positive social interactive behaviors and attitudes among students. Okebukola (1985) and Okebukola and Ogunniyi (in press) have examined 8th grade Nigerian science classes contrasting Johnson's GI technique, Aronson's Jigsaw and Slavin's TGT and STAD techniques with an individually competitive structure and determined that the most academically favorable structures were the cooperative ones, especially TGT and STAD. Okebukola's studies did not include Sharan's GI goal structure model.

The objective of the present study was to provide further comparison concerning the effectiveness of a cooperative (i.e., Sharan's GI model) versus an individually competitive classroom

structure with regard to achievement gains in two high school Biology classes. This was determined by teaching an identical unit of study to two different classes of approximately equal academic abilities, and comparing the achievement of students in the individually competitive structured class with student achievement in the class utilizing a cooperative group investigation model. Differences between the two classes and relative gains in achievement within each class were evaluated. It was hypothesized that while no significant difference between the two groups was expected on their pre-tests, both groups were expected to obtain significantly higher post-test scores. Furthermore, based on the results of previous studies, the class using the cooperative GI approach was expected to make significantly higher gains on their post-test scores as contrasted with the competitive classroom.

METHOD

SAMPLE. This project was conducted during Spring, 1985 in a midwestern, predominantly white, middle class rural high school. The subjects were from two sophomore level Biology classes of approximately equal academic abilities. Biology is an elective at the high school, and a majority of the students taking this course rank in the top one-third of their class. Class A (n=21) used the cooperative GI strategy; Class B (n=25) received the individually competitive treatment. The unit of instruction examined in this study concerned ecology and environmental science. A significant portion (25%) of the students' 4th-term grades consisted of a research project concerning major biomes of the world. Both classes were exposed to the same study content, labs, in-class activities, homework, reading materials and the same instructor for seven weeks. They differed only in the classroom structure that was utilized.

PROCEDURES. Class A students learned by the GI cooperative technique. All in-class activities, labs, and projects were conducted in pre-assigned groups which consisted of 4-5 members who were equally diverse in terms of academic ability based on previous academic performance in the class, gender, and race. Grades were based on a criterion-referenced evaluation system. Each student within a group was required to contribute to the overall completion of the project. A major biome (tundra, coniferous forest, deciduous forest, grassland, desert, or tropics) was randomly assigned to each group. For each group, 5 major sub-topics concerning their particular biome was required to be addressed in the final report. Students decided amongst themselves who would be responsible for each topic. Final evaluation of the project was based on a) one written report per group with a contribution by each member, and b) a class presentation by each group with participation by each member. Each member of a group received the same final grade for the overall completion of the biome project. This project was designed after the group-investigation method as described by Sharan and Sharan (1976) and Sharan and Hertz-Lazarowitz (1980).

Class B students worked individually on all class activities throughout the 7-week unit. Grades were based on a norm-referenced evaluation scale. Each student in the class had the opportunity to choose the biome they wished to report on. Five major sub-topics

concerning the biome were required to be addressed as with Class A.

Both Classes A and B were given three weeks to complete this assignment. Students in both classes were given two class periods during these three weeks to work on their projects. All other activities related to this assignment were conducted out-of-class. In addition to this major project, students performance on worksheets, laboratory experiences, reading assignments and outdoor experiences were evaluated in both classes. Class A students conducted these activities in their pre-assigned groups; Class B students conducted them individually.

DEPENDENT VARIABLE. The same teacher-made 40 item pre- and post-test was given to both classes at the beginning and end of the ecology unit. To asssess reliability for this test a KR-21 coefficent was computed to be .71 on the post-test, which was considered to be an acceptable measure of internal consistency.

DESIGN AND ANALYSIS. A pre-test, post-test quasi-experimental design for two intact classroom groups (Cambell & Stanley, 1966) was used in this study and allowed two types of evaluation: 1) comparison of pre- and post-test scores within each class, and 2) comparison of changes between pre- and post-test scores between the two classes. Thus, a two-way within subjects repeated measures ANOVA of mean achievement scores between groups (competitive vs. GI cooperative) across time (pre- and post-test repeated measures) within subjects was utilized.

RESULTS

Mean pre- and post-test scores for Classes A and B are presented in Table 1. Results of the ANOVA for the stated hypotheses are illustrated in Table 2. Results from the two-way repeated measures ANOVA indicated a significant difference ($p<.0001$) in pre- and post-test scores. Post-test scores were significantly greater than pre-test scores for students in both treatment groups. The interaction F statistic (i.e., the treatment by time score) was used to determine differences between treatments with regard to academic achievement. No significant difference ($p>.05$) in pre-test or post-test scores between treatment groups was found. These data indicate that although both cooperative and competitive techniques were effective learning strategies, neither strategy was superior over the other in producing achievement gains. While random assignment to each of the five GI cooperating groups was used, an additional check for differences among the five groups on their post-test results was examined. As would expected, no significant difference amoung these five groups was obtained ($p>.05$).

Table 1
Mean pre- and post-test scores in cooperative and competitive classrooms.

Group	Time	
	Pre-test	Post-test
Cooperative (n = 21)		
mean	18.33	25.19
sd	3.58	5.01
competitive (n = 25)		
mean	19.60	27.28
sd	6.04	5.64

Table 2
Two-way within subjects ANOVA of Achievement Scores by Treatment (Cooperative vs. Competitive) by time (pre- vs. post-test).

Source	df	MSe	F	p<
Treatment	1	64.28	1.47	.229
Subject within treatment	44	43.33		
Time (pre vs post)	1	1205.95	110.77	.001
Treatment by time	1	3.86	.35	ns
Subject by time within treatment	44	10.89		

CONCLUSIONS

Previous studies have reported greater academic achievement in cooperative versus competitive classroom reward structures (e.g., Holt, 1967; Johnson & Johnson, 1975; DeVries & Slavin, 1978; Slavin, 1978b; Sharan, 1984). Most of these previous studies, however, utilized a cooperative system with an incentive structure based on group reward for individual learning with no task specialization, as described by Slavin (1983) (e.g., TGT, STAD). Slavin (1983) found this type of cooperative structure to be the most consistently effective in improving academic achievement. Only a few studies, however, have dealt with a cooperative system that has an incentive structure based on group reward for group performance with task specialization, as exemplified by the GI method. Two studies that did use GI reported greater academic achievement in GI versus competitively-structured classrooms (Sharan et al., 1980; Sharan, 1984). Results of the present study do not support these past observations: there was no significant difference in achievement between students learning in a cooperative (GI) environment and those learning in an individually competitive class. Both approaches equally and effectively produced significant learning. It is believed that this is an important finding. Slavin's (1983) theories would predict that the cooperative group would be at least as effective if not more effective than the competitive group. From his point of view, the fact that the cooperative group was equivalent to the competitive group could be interpreted as positive results supporting his theoritical position. At least there is no significant academic disadvantage to using the cooperatve GI strategy. Other theorists, such as Michaels (1977) would

have predicted that the competitive strategy would be more effective than the cooperative one. Although our competive group demonstrated slightly higher post-test scores than the cooperative group, this was not a statistically significant differnce.

Differences between the results of the present study and those found in other reports may be due to the timing and the duration of this project which was accomplished during the final 10 weeks of the high school year. Students at that point in the year may have already established friendship "circles." As a result they may have been more resistant to a change in classroom structure than they would have been if cooperative learning had been established as a classroom norm at the beginning of the year. Sharan (1980) hypothesized that cooperative learning attempted at the beginning of the school year with newly composed classrooms may be more effective than when done after a class has already established a collective history, however he does not report any empirical evidence to support this speculation.

A 35-day unit of study (5 days per week for 7 weeks) may not have been sufficient time to effectively implement and evaluate a cooperative teaching strategy. According to Gibb's (1964) individual-group maturation model of group development, achievement of individual and group goals is not possible unless feelings of adequacy, self-esteem, and trust are felt by all members of the group. Personal observation suggests that this first stage of group development was not completely achieved by some of the group members in the cooperative classroom. As previously discussed, some students were resistant to change in classroom norms because of loyalties to already established friendship circles. One boy, for example often refused to participate in activities with his group and preferred to work alone. However, in the end even he made his contribution to his group. Nevertheless, most of the students gave the impression that the cooperative strategy was a positive experience even though this particular GI method was unfamiliar to them. While this study did not obtain data on affective reactions to the GI strategy, other studies have reported positive attitudes towards cooperative goal-structures (Johnson, et al., 1984; Sherman, 1986).

GI is a method that involves relatively complex cognitive learning tasks (Sharan, 1980), such as the selection and interpretation of data, problem-solving, and the collective synthesis of ideas. Sharan, et al. (1979) suggest that the utilization of GI requires a greater investment in teacher training and educational change than do other cooperative techniques such as peer tutoring. Sharan's (1984) study comparing STAD, GI, and a competitive technique, for example, involved intensive teacher training and the sample size in terms of number of classses used (9-14 per teaching method) was greater, thus allowing for more accurate statistical analyses. It is believed that the GI strategy was properly and effectively implimented in the cooperatve group since all class members made their individual contributions to both the written and oral reports, and, their post-test scores were significantly higher than their pre-test scores: learning did take place. While no empirical evidence was gathered concerning personal interaction patterns, it is assumed that the individual members effectively interacted with each other and were productive in completing their group projects. It is believed that by using the same instructor for both classes, individual differences due to teaching style would be reduced as a source of bias,

a major criticism in an earlier study (Sherman & Thomas, 1986).

To summarize, the results showed no significant difference in academic achievement between students learning in a GI cooperative versus an individually competitive classroom environment. Both groups, however, obtained significantly higher post-test than pre-test scores, indicating that both pedagogical strategies have positive effects on academic achievement. A factor not examined in this study, but which may be an important effect of a cooperative structure over a competitive one deals with the impact of cooperative learning on social values and racial attitudes. Cooperative learning methods have been found to have positive effects on self-esteem, race relations, and the acceptance of mainstreamed academically handicapped students (Slavin 1983). In addition, a cooperative environment may produce more positive attitudes towards learning and teachers than a competitive structure (Johnson et al., 1984; Sherman, 1986). Future studies examining the effects of the GI cooperative learning model on academic achievement and attitudes towards learning are warranted.

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