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ABSTRACT

This study examines the effects of using a learning game "Equations," student teams, and the game-teams combination on classroom process variables in seventh grade math classes. Using the game created greater student peer tutoring, less perceived difficulty, and greater satisfaction with the class. Using student teams resulted in greater student peer tutoring, and greater perceived mutual concern and competitiveness in the classroom. The games-teams combination resulted in greater peer tutoring than either games or teams alone. The results are interpreted using a structural theory of games and of teams. (Author)

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LEARNING GAMES AND STUDENT TEAMS: THEIR EFFECTS ON CLASSROOM PROCESSES

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INTRODUCTORY STATEMENT

The Center for Social Organization of Schools has two primary objectives: to develop a scientific knowledge of how schools affect their students, and to use this knowledge to develop better school practices and organization.

The Center works through five programs to achieve its objectives. The Academic Games program has developed simulation games for use in the classroom. It is evaluating the effects of games on student learning and studying how games can improve interpersonal relations in the schools. The Social Accounts program is examining how a student's education affects his actual occupational attainment, and how education results in different vocational outcomes for blacks and whites. The Talents and Competencies program is studying the effects of educational experience on a wide range of human talents, competencies, and personal dispositions in order to formulate -- and research -- important educational goals other than traditional academic achievement. The School Organization program is currently concerned with authority-control structures, task structures, reward systems, and peer group processes in schools. The Careers and Curricula program bases its work upon a theory of career development. It has developed a self-administered vocational guidance device and a self-directed career program to promote vocational development and to foster satisfying curricular decisions for high school, college, and adult populations.

This report, prepared by the Social Organization program, is one of a series of reports that investigate the effects of using learning games and student teams in the classroom. This report examines how games and teams, individually and in combination, affect classroom processes.

ABSTRACT

This study examines the effects of using a learning game (Equations), student teams, and the game-teams combination on classroom process variables in seventh grade math classes. Using the game created greater student peer tutoring, less perceived difficulty, and greater satisfaction with the class. Using student teams resulted in greater student peer tutoring, and greater perceived mutual concern and competitiveness in the classroom. The games-teams combination resulted in greater peer tutoring then either games or teams alone. The results are interpreted using a structural theory of games and of teams.

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This study examines the effects of using a learning game (Equations), student teams, and the game-teams combination on classroom process variables in seventh grade math classes. Using the game created greater student peer tutoring, less perceived difficulty, and greater satisfaction with the class. Using student teams resulted in greater student peer tutoring, and greater perceived mutual concern and competitiveness in the classroom. The games-teams combination resulted in greater peer tutoring then either games or teams alone. The results are interpreted using a structural theory of games and of teams.

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INTRODUCTION

Research has recently been completed which supplies strong evidence supporting the classroom use of a combination of learning games and student teams. In a study by Edwards, DeVries, & Snyder (1972), the games-teams combination in seventh grade math classes resulted in a significant increase on several dimensions of mathematics achievement. Edwards, et al., however, did not measure any of the several classroom process variables which have been posited as mediating the effects of either learning games (cf. Boocock & Schild, 1968; Gordon, 1970) or student teams (Hamblin, et al., 1971; Spilerman, 1971) on student achievement. The purpose of the present study is to examine the effects of a learning game, of student teams, and of the games-teams combination on classroom processes. Classroom processes are defined by the following dimensions: relationships between students and their teacher, relationships between students and their assigned tasks, and relationships between students and their classmates. Examining the classroom processes affected by games and teams should suggest why games and teams have the positive impact on student achievement noted by Edwards, et al., (1972).

Learning Games

Learning games are activity structures in which players use a body of knowledge or set of skills as resources in their competition with other players. A familiar example of a classroom learning game is the spelling bee, in which students use their vocabulary skills to win the game.

Although evidence for the effectiveness of learning games as tools for learning is increasing (Boocock & Schild, 1968; Allen, et al., 1970), the means by which the games affect students are relatively unexamined. As Fletcher (1971) has noted, little attention has been paid to the structural classroom features altered by the introduction of learning games. Until these structural features are defined, the theory of learning games will remain at a primitive level. In an attempt to delineate the classroom processes affected by learning games, the present study will examine the academic task and the reinforcement contingencies surrounding the students, both of which are assumed to be altered by learning games, and both of which should affect classroom processes.

Classroom task structures are defined by the manner in which a student approaches the academic materials assigned to him. One dimension of task structure is interdependence. An interdependent task structure is one in which a student must rely on his classmates to help him complete the task. That learning games frequently create an intense (and often enjoyable) interpersonal experience (Inbar, 1968) is clear, and is due in part to the interdependent task structure which requires interaction among the players. An independent task structure characterizes most traditional classes. For students in such classes, using the resources of their classmates is not encouraged -- in fact, it is usually forbidden by the teacher.

A crucial feature of any learning environment is the differential reinforcement of desired student behaviors (Skinner, 1969). The general structure employed by many learning games changes two dimensions of the classroom reward structure: frequency and immediacy of reinforcement.

Learning games increase the frequency of positive reinforcement in a classroom in two ways. The number of classmates a student competes against is reduced from approximately 30 to 2 (assuming the traditional class uses a normative-based grading system with the teacher grading on the curve). Also, in contrast to the traditional class where a student faces other students of varying ability levels, the competing classmates in learning games, such as Equations, are of comparable academic ability. Consequently, when placed in a class using games, a low-ability student never faces the formidable task of outperforming a high-ability classmate.

Using a learning game in the classroom also provides immediacy of reinforcement or feedback to the students. A student in a traditional class may wait several days before his teacher returns his corrected test paper. By this time the student may have lost interest in the particular subject matter and perhaps have forgotten what he did right or wrong on the test. When performing on a learning game, however, a student finds out immediately and frequently whether he has won or lost. The unique challenge structure (in which a player wins by either correctly challenging another player's mistake, or by being incorrectly challenged) forces valuable verbal mediation of the reinforcement contingencies (by telling a player why he is right or wrong). In short, by creating the opportunity for more positive and more immediate reinforcement in the classroom, learning games should result in classroom processes that facilitate the learning experience.

Student Teams

Although using student teams in the classroom has long been advocated by educators (Miel, 1952; Grambs & Iverson, 1952), empirical evidence supporting the use of groups has come to light only recently (cf. Barrish, *et al.*, 1969). The teams treatment traditionally involves assigning grades or other less formal rewards to individual students based on the performance of all (or in some cases a subset) of their team. Students in the team (or group contingency) condition have been observed to outperform those in the traditional classroom in which reinforcement is contingent on each individual student's performance (Wodarski, *et al.*, 1971). A key reason for the facilitative effect of teams has been the high rate of student peer tutoring in the teams condition.

Teams create greater peer-tutoring and, in turn, facilitate academic performance because assigning students to teams appears to create a high level of reward interdependence among teammates. This interdependence is positive because the higher the performance of a given team member, the greater the reinforcement his teammates are likely to receive. For students in a traditional class, either a reward independence or a negative interdependence exists. In the latter case, the higher the academic performance of a given student, the lower the level of reinforcement received by his classmates.

Positive reward interdependence creates strong peer pressures for academic involvement among the team-members (Spilerman, 1971; DeVries, Muse & Wells, 1971). If a team-member is not working at the task, it is in his teammates' own self-interest to encourage him to do better and to actively help him acquire the requisite skills. In contrast, students in a traditional classroom setting have little reason to encourage or assist their classmates.

Although the studies of student teams have shown positive team effects on academic performance, an additional motivational device, the token economy, was also frequently employed. The teams worked for points which could be cashed in for either material rewards or special privileges. Since using such elaborate economies in most classrooms creates untenable burdens on the teacher, an alternative motivational device needs to be used. Coleman (1959), Bronfenbrenner (1970), and others have suggested using inter-team competition. Julian and Perry (1967), in an experimental study, found higher academic achievement by students when their teams competed against each other than when the teams were reinforced independently. Because inter-team competition may act as a strong motivational device, the present study created competition among the student teams in place of an elaborate token economy.

Games and Teams

Inter-team competition has been combined with learning games to form a classroom technique claimed to be even more potent than either games or teams used by themselves (Allen, et al., 1970; Edwards, et al., 1972). As noted earlier, games and teams represent complementary structural variations which, when combined, should result in an even more profound classroom change. In the games-teams combination the students should experience an intense face-to-face competition in the game, combined with encouragement and active helping from teammates. We predict a positive effect of the games-teams combination on classroom process beyond that obtained by either games or teams.

METHOD

Subjects

The subjects were 110 seventh grade students at a large urban junior high school; 43% of the students were blacks, and 47% were males. Individual students were randomly assigned to one of four treatment conditions on a stratified basis; the stratification was based upon three levels of math ability (using the previous quarterly math grade) to insure an equal distribution across the four conditions. There was no significant nonrandom clustering by ability, race, or sex of students across the four treatment conditions.

Design

The experiment was a 2 x 2 x 3 randomized block design; the three factors were (a) Task (game vs. quiz), (b) Reward (team vs. individual), and (c) Ability (low, middle, and high). The experiment was conducted over a four-week period, involving twenty school days. Four mathematics classes were included in the study, with all four classes meeting during the first period of the day.

Two male and two female teachers participated in the study. All were in their first or second year of teaching. At the mid-point of the study the four teachers were rotated; consequently, each treatment was taught by both a female and male teacher.

Independent Variables

Two types of math tasks were used: an instructional game and standard math quizzes. The instructional game was Equations, developed by Allen (1969). The game taps both arithmetic and general logic skills. When playing Equations the objective is to beat the other players by superior use of multiple mathematical solutions to a preassigned numerical "goal." Within a classroom of thirty students, ten Equations games were played simultaneously (three students per game). The players at any given table were grouped homogeneously on math ability. At the end of each game, each individual player was assigned a score, and at the end of the period, his game scores were summed to form a total day score. Depending on whether a student won or lost, he was moved up to a higher ability table or down to a lower ability table. This "bumping" procedure maintained homogeneous game tables while taking into account new learning (as reflected in a student winning or losing).

The second level of the task variable consisted of biweekly teacher-made math quizzes on material covered during the preceding days. For each quiz the students were assigned a percentage score based on the number of problems answered correctly.

The weekly schedule of all treatment groups proceeded as follows: students in the two games classes played Equations for one-half period each Tuesday and for the entire period on Friday. The math quizzes were administered to the two nongame classes for part of the period on each Tuesday, and Friday. For the remainder of the week the students received classroom instruction (two-and-a-half days for game and three days for nongame classes) and practice sessions (total of one day per week for all classes).

Two types of reward structure were used: one administered rewards to four-member teams and the other rewarded individuals. In the two team classes students were assigned to four-member groups with the specific intention of creating maximal intrateam heterogeneity (on race, sex, and ability) while maintaining interteam equality. Teammates were encouraged to help each other during the practice periods. However, each team member performed individually in both the game and quiz classes.

On the day after the game or quiz newsletters were given to the students in all of the treatment groups. In the teams conditions, the newsletter listed the preceding day's scores for each student as well as for his entire team. A cumulative score for each student and each team was also listed. The teams were ranked by both the preceding day's team scores and the cumulative scores (or season record). In the two classes using individual rewards, the newsletter listed only the scores of individual students.

The Dependent Variables

The dependent variables in this study were of three types: observations of student behavior, students' reports of their own relationships with other members of the class, and students' characterizations of the classroom environment. The classroom observations were made by research assistants, who observed fifteen randomly selected students (out of approximately thirty) in each class. Each observer made a series of five-second observations, with each observation followed by a ten-second recording period. The observers recorded each observation by classifying the student's behavior during the five-second interval under one (and only one) of six categories:

1. Peer/Task: Two or more students working together on relevant math tasks.
2. Peer/Nontask: Two or more students interacting on tasks not related to math class.
3. Individual/Task: Behavior of a student directed toward completion of a math-relevant task while working alone.
4. Individual/Nontask: Behavior not contributing to completion of academic tasks, and not interfering with the academic involvement of other students.
5. Teacher/Task: Behavior directed toward the teacher, in either an active or passive way, that assists in the completion of academic tasks.
6. Teacher/Nontask: Any behavior directed toward the teacher, in either an active or passive way, which does not assist in completing academic tasks.

The ratings were taken during twenty-minute practice periods during the latter two weeks of the experiment. The two "game" groups were each observed twice; the two "no-game" groups were each observed three times. When two different pairs of raters were rating the same students, the raters agreed upon between 80 and 85% of the observations. The ratings from the two practice periods were summed for each of the four treatment groups to indicate the frequency of each type of behavior in each treatment group.

In order to assess the level and direction of informal friendship and helping patterns within each treatment, the students were asked to give the names of students in the class (1) who were their friends, (2) who helped them, and (3) whom they helped. Eight blank lines were allotted for each question. These data were collected on the final day of the experiment.

The Learning Environment Inventory (LEI) was used to obtain the students' characterizations of the classroom environment. The LEI is a student self-report device that measures several dimensions of the classroom social climate. It has been used extensively in prior studies of secondary schools, and there exists reasonable evidence concerning its reliability and validity (Walberg & Anderson, 1968, 1972; Anderson, 1970; Anderson, Walberg & Welsh, 1970). Of the original fourteen LEI scales, four were selected as being relevant to either the games or team treatment: "difficulty," "competition," "satisfaction," and "cohesiveness." The first three of these are cited by Anderson (1970) as being positive predictors of student learning, at the classroom level. Each scale consists of six statements; the student expresses his agreement or disagreement with each statement on a four-point Likert-type response scale. The students' response scores for each item (ranging from 1 to 4) were multiplied by the loading of that item on the first principal component of the scale (i.e., the loadings were used as item weights). In addition to the four scales from the LEI, the authors created an additional scale, using the LEI format. This scale was entitled "mutual concern." Table 1 presents sample items for

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Insert Table 1 about here

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each scale, along with the average first-factor loading for all six items on the scale.

RESULTS

The treatment group means for incidence of peer-tutoring, as recorded by the classroom observers, are shown in Figure 1. Both the game task and the team reward increase the amount of peer-tutoring by the students, with the team reward having the larger effect. These effects were tested for significance by Goodman's (1969, 1970) analysis of variance for qualitative data. Both the task and reward effects were significant ($p < .001$). The task-by-reward interaction was also significant ($p < .01$), but this effect was small and was largely a consequence of the logarithmic transformation that forms the basis for Goodman's analysis technique.

Insert Figure 1 About Here

The sociometric choice data were based on items that asked the student to list the other students who were his friends, the students he had helped, and the students who had helped him. In general, the two students were much more likely to agree on whether they were friends than on whether one had helped the other; 61 percent of the friendship choices were mutual, while only 46 percent of the helping choices were corroborated by the other student involved. The students in the classes that played the game seem to have considerable doubt as to what constituted "helping;" only 33 percent of their helping choices were corroborated, compared with 62 percent in the non-game classes.

Insert Table 2 and Figures 2 through 5 About Here

The treatment group means for the sociometric choice data are shown in Figures 2, 3, and 4. Table 2 presents the results of analyses of variance on these variables. There were no significant treatment effects on the friendship variable, but on the two helping variables there were significant main and interaction effects involving the task, reward, and ability factors. Both the game task and the team reward increased the number of helping relationships reported, with the team reward having the greater effect. There is also an interaction between the two treatment factors on the "helped you" variable. On this variable, student ability also interacts with reward condition, as shown in Figure 5; students of low and medium ability in the team-reward classes reported receiving the most help. On the "you helped" variable there is a significant ability effect; as might be expected, high and medium ability students do most of the helping.

Insert Figures 6 through 10 and Table 3 About Here

Figures 6 through 10 present the treatment group means on the five Learning Environment Inventory (LEI) scales. Analyses of variance on these scores are shown in Table 3. On the difficulty scale the main effects for task and ability are significant and fairly large. The students who played the game reported less difficulty than those in the nongame classes (as can be seen in Figure 6). Low-ability students reported the most difficulty, and high ability students the least. On the satisfaction scale (Figure 7), only the task effect was significant, with the students who played the game reporting greater satisfaction than those who did not. On the competition scale (Figure 8) both the task and reward effects are significant, as is their interaction. These effects are all attributable to the no-game, team-reward class, which was clearly the most competitive. On the mutual concern scale (Figure 9), only the reward effect is significant. The students in the team-reward classes indicated more mutual concern than those in the individual-reward classes. On the cohesiveness scale (Figure 10) the only significant effect is the task-by-reward interaction. The game task increased cohesiveness in the individual-reward class but decreased it in the team-reward class.

Figure 11 summarizes the effects of the experimental treatments on the sociometric-choice and LEI variables, in the form of a profile for each of the four treatment groups. In order to graph the variables

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Insert Figure 11 About Here
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using comparable scales, the cell means for each variable were transformed using the following formula: $Z = \frac{\text{cell mean - grand mean}}{\text{S. D. of cell mean}}$. The figure reveals similar effects of the two team reward conditions on the sociometric variables, and divergent effects on the LEI variables. The game, individual-reward and the no game, team-reward conditions have the most divergent profiles, particularly for the LEI scales.

DISCUSSION

The present study assessed the effects of games, teams and the games-teams combination on classroom processes. The games treatment resulted in greater peer tutoring and created a classroom that students perceived as satisfying, less difficult, and less competitive. The teams treatment also resulted in significantly more student peer tutoring. With respect to the class climate, teams created more competition, as well as mutual concern, but did not make the class more enjoyable or less difficult. Significant effects of the games-teams combination, as measured by either the concomitant main effects for games and for teams or their interaction, were observed for the peer tutoring as well as for two of the classroom climate dimensions. A detailed discussion of the results for games, teams and the games-teams combination is given below.

Games Effects

The data reveal a positive games effect on peer-tutoring from the class observations, and mixed effects from the sociometric helping items. The mixed results from the sociometric data may reflect confusion among the game students as to what constituted helping. The task was foreign to the students, and may not have been viewed by some students as a legitimate academic task. The mixed results may then be due to the instability of the sociometric measure of peer-tutoring.

The main effect of games on classroom processes as measured by the LEI scales is more consistent. The decrease in perceived difficulty and increase in satisfaction are probably due to the task interdependence created by the game, which allowed the students to work (and play) together. They may also be due to the changed reinforcement structure, which increased significantly the chance of a student winning in his classroom. A student's perception of the difficulty of the class may not only be a function of the subject matter, but, perhaps more importantly, of the chance he has for receiving some positive reinforcement in the classroom. The administering of immediate reinforcement during the game playing may also be a factor in creating a less difficult and more satisfying class.

The slight decrease in the level of competition in the games class and the lack of Task effects on the level of cohesiveness and mutual concern are surprising. A central feature of Equations is the face-to-face competition, with the announcing of a winner and a loser at the end of each game. One would expect the game students to experience intense competition. This competition, in turn, should reduce cohesiveness and mutual concern. Why then did playing Equations not increase the level of competition? First, it is possible that playing Equations was not perceived as a legitimate academic task because of the game-like character of the competition. Consequently, the students may have minimized the game competition in making their estimates. A second plausible hypothesis is that level of perceived competition (and difficulty) is primarily a function of the scarcity of the reinforcement. In a traditional classroom there is typically a fixed, limited amount of positive reinforcement to be distributed among the students, particularly when teachers grade on the "curve." Consequently, the competition for the scarce reinforcements is intense. For a classroom employing Equations, however, the probability of receiving some positive reinforcement is much higher and, more importantly, constant across all students. Consequently, the relatively high probability of winning for all students makes a face-to-face competition task appear no more competitive than a traditional classroom in which the competition is indirect and more private.

Additional data collected on the posttest questionnaire also suggest that the game created a more satisfying classroom experience for the students. The students were asked to indicate whether they liked playing Equations. Almost all students (94%) indicated "Yes." When asked why they liked it, 65% of the students said it was fun, while a small number indicated it helped them to "learn math."

Effects of Student Teams

Placing students on teams and administering group contingencies increased the amount of student peer-tutoring. The data are consistent with several other recent studies of student teams (Wodarski, et al., 1971; Hamblin, et al., 1971; Witte, 1972).

The peer-tutoring appeared to focus on the low, and to a small degree, middle ability students. It appears that if a student group is given feedback on the performance of all of its members, the students will concentrate on the subset of members who need the most help. If the lower ability students are to receive help it should ideally come from the middle and high ability students, and these students appear to accept this responsibility.

The nonsignificant Reward effect on number of friends suggests that the teams were primarily task-oriented. Although there was considerable interaction among team members, the interaction was focused on the classroom material. A recent study of student teams by DeVries, Muse,and Wells (1971) obtained similar results. It is also possible that the teams did not function long enough for friendships among teammates to develop.

The effects of teams on classroom process, as measured by the LEI, are mixed. In the absence of the game, the teams created a more competitive classroom, with greater class cohesiveness. Teams also created classes with greater mutual concern. Characterizing a class as being high on competition as well as cohesiveness and mutual concern would be contradictory if the competition were at the individual level, but not necessarily when the competition is among teams of students. The increased cohesion and mutual concern probably characterize the individual teams, rather than the entire classroom. Because the LEI measured only classroom-wide processes, no direct test of this hypothesis is possible with the existing data. In general, the results support the findings of earlier small group studies (cf. Deutsch, 1949; Grossack, 1954) which found that individuals expressed concern for each other when they were placed in small groups.

Although the teams created more mutual concern in the classroom, the students might have expressed their concern in a hostile fashion by placing strong sanctions on the low ability students. However, when asked if they liked being on teams, 79% of the students indicated they did. When asked why they liked being on teams, 54% said it allowed them to be helped by their fellow students. Of the students who disliked being on teams, 67% were high ability students. That is, the few students who did not like the teams were the ones who could benefit the least from them. There is no evidence that the low ability students were subjected to undue pressures. If there was any disaffection with the teams, it was on the part of the high ability students.

Effects of Games and Teams

Since instructional games and student teams were viewed as complementary classroom structures, the question of their combined impact is of particular interest. In assessing whether or not the combined treatment had an impact beyond that attained by each of the two components, two patterns in the analyses were considered to indicate such additional effects: significant main effects for Task and Reward, and a significant Task-by-Reward interaction.

The games-teams combination increased significantly the level of peer tutoring beyond that obtained in either the games-only or teams-only classes. This may be due in part to the novelty of the games task, which likely created greater student interest in the academic material on which the teams were being rated. Perhaps such student interest in the task at hand is an important facilitator of group processes.

The effects of the games-teams combination on the number of students selected as helpmates and friends is minimal. The significant games-by-teams interactions for the univariate test of the "helped you" variable indicates the combination of the two treatments resulted in only a marginally larger number of students who helped the respondents. Such an interaction may be due to a ceiling effect. The students in the games-teams condition reported an average of 2.0 students helping them. Since the students were placed on four-member teams, and the peer-tutoring was likely to occur almost exclusively within the teams, the maximum number of students available to help them was three. In addition, a student is likely to be helped only by students of comparable or higher ability at math, so the number of possible helpmates becomes even less than three. Consequently, the mean of 2.0 for the games-teams combination may represent the maximal number of helping relationships actually possible.

The treatment group profiles in Figure 11 for the LEI suggest the combined treatment created an effect highly similar to that created by the games-individual reward treatment on such dimensions as difficulty, satisfaction, competition, and cohesion. As noted earlier, the combined treatment was more pervasive than the no game-team reward treatment in that it restructured the classrooms on more dimensions. The use of games created a more interdependent and social task structure, and changed the reinforcement or reward structure by increasing the frequency and immediacy of the reinforcement. The teams treatment, in contrast, was a less major alteration of the classroom in that it only created a more interdependent reward structure. When the two treatments were combined, the classroom processes appeared to be shaped primarily by the playing of the game Equations.

The results suggest that both games and teams represent useful techniques for restructuring classroom processes. Their effects are complementary in that they create very different classroom experiences for the students. Incorporating an instructional game such as Equations into a course curriculum may cause the students to translate their increased interpersonal interaction (due to the game structure) into increased informal peer tutoring on the subject material at hand. They are also likely to view their class in a much more positive light. The addition of teams to a traditional classroom meets a rather different set of objectives. Attending the class and encountering the subject matter is not made more fun. The students still face the traditional classroom tasks, of which they may not be particularly enamored. But they do work together on the tasks to a much greater degree. This working together results in an increased level of mutual concern among the students. The two techniques appear effective for meeting different sets of teacher objectives. Because the two techniques affect different classroom processes, by combining the two techniques an even more powerful effect on the learning environment is created.

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Table 1

Learning Environment Inventory (LEI) Scales

Scale	Sample Item	Average Factor Loading
1. DIFFICULTY	Students in this class tend to find the work hard.	.56
2. COMPETITION	Students in this class compete to see who can do the best work.	.52
3. SATISFACTION	Almost all students like the class.	.57
4. COHESIVENESS	Each student knows the other members of the class by their first names.	.55
5. MUTUAL CONCERN	If a student does well in this class, his classmates congratulate him.	.59

Table 2

Analyses of Variance for the Sociometric Choice Data

	MULTIVARIATE		UNIVARIATE			
SOURCE	df	F	df	.		Friends
TASK (A)	3/96	1.85	1	3.97* $(\eta^2=.03)$	1.14	1
REWARD (B)	3/96	7.46***	1	9.85** $(\eta^2=.08)$	18.57***	1.63
ABILITY (C)	6/192	2.48*	2	2.66	3.14* $(\eta^2=.0\ )$	1.49
A x B	3/96	1.97	1	3.83* $(\eta^2=.03)$	<1	<1
A x C	6/192	<1	2	<1	<1	<1
B x C	6/192	1.46	2	3.06* $(\eta^2=.05)$	<1	<1
A x B x C	6/192	<1	2	<1	<1	<1
ERROR			98			

*$p < .05$
**$p < .01$
***$p < .001$

Note: η^2 (eta square) is the porportion of the total variance accounted for by a given source of variation.

Table 3

Analyses of Variance for the Learning Environment Inventory

MULTIVARIATE			UNIVARIATE					
Source	df	F	df	Mutual Concern	Cohesiveness	Competition	Difficulty	Satisfaction
TASK (A)	5/94	7.14***	1	3.25	<1	6.03* (η^2=.05)	14.92*** (η^2=.11)	13.00*** (η^2=.11)
REWARD (B)	5/94	4.86**	1	12.74*** (η^2=.11)	3.37	6.61* (η^2=.05	1.19	1.34
ABILITY (C)	10/188	1.76	2	<1	<1	<1	6.00** (η^2=.09)	1.31
A x B	5/94	2.81*	1	<1	6.24* (η^2=.05)	3.98* (η^2=.03)	<1	<1
A x C	10/188	<1	2	<1	1.31	<1	1.81	<1
B x C	10/188	1.26	2	1.30	1.32	2.06	2.10	<1
A x B x C	10/188	<1	2 98	<1	<1	<1	<1	<1

*p $<$ .05
**p $<$ .01
***p $<$ .001

Note: η^2 (eta square) is the proportion of the total variance accounted for by a given source of variation.

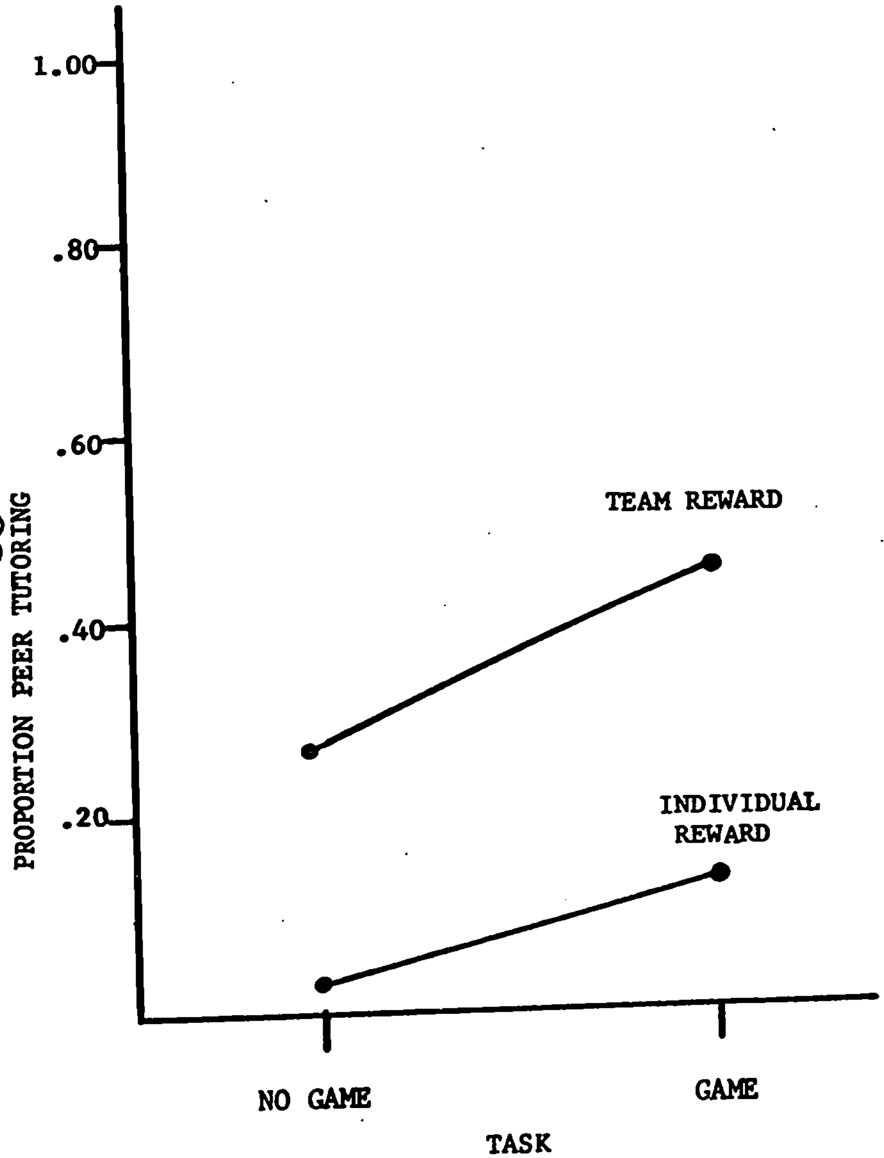

Fig. 1 - Proportion of observed behaviors classified as "Peer-Tutoring"

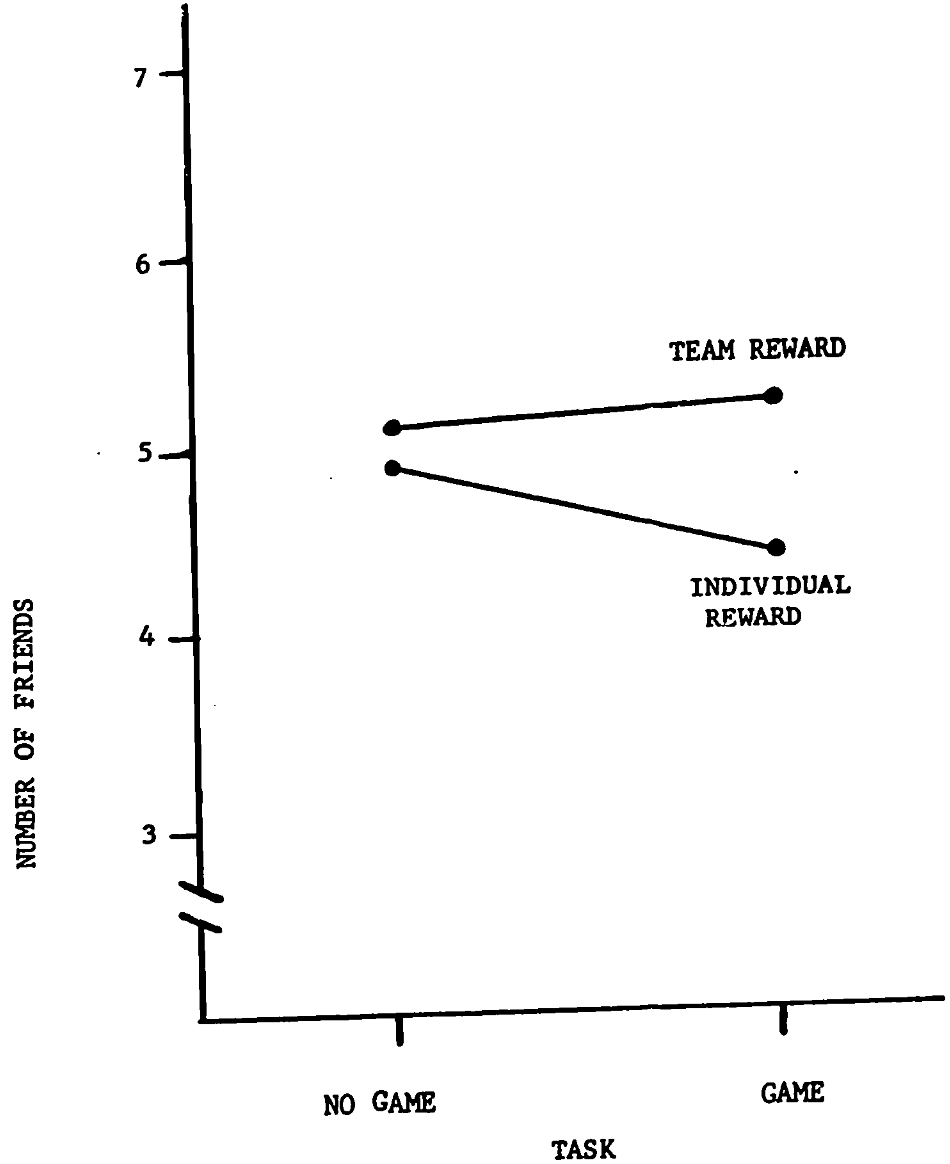

Fig. 2 - Mean number of classmates who are friends

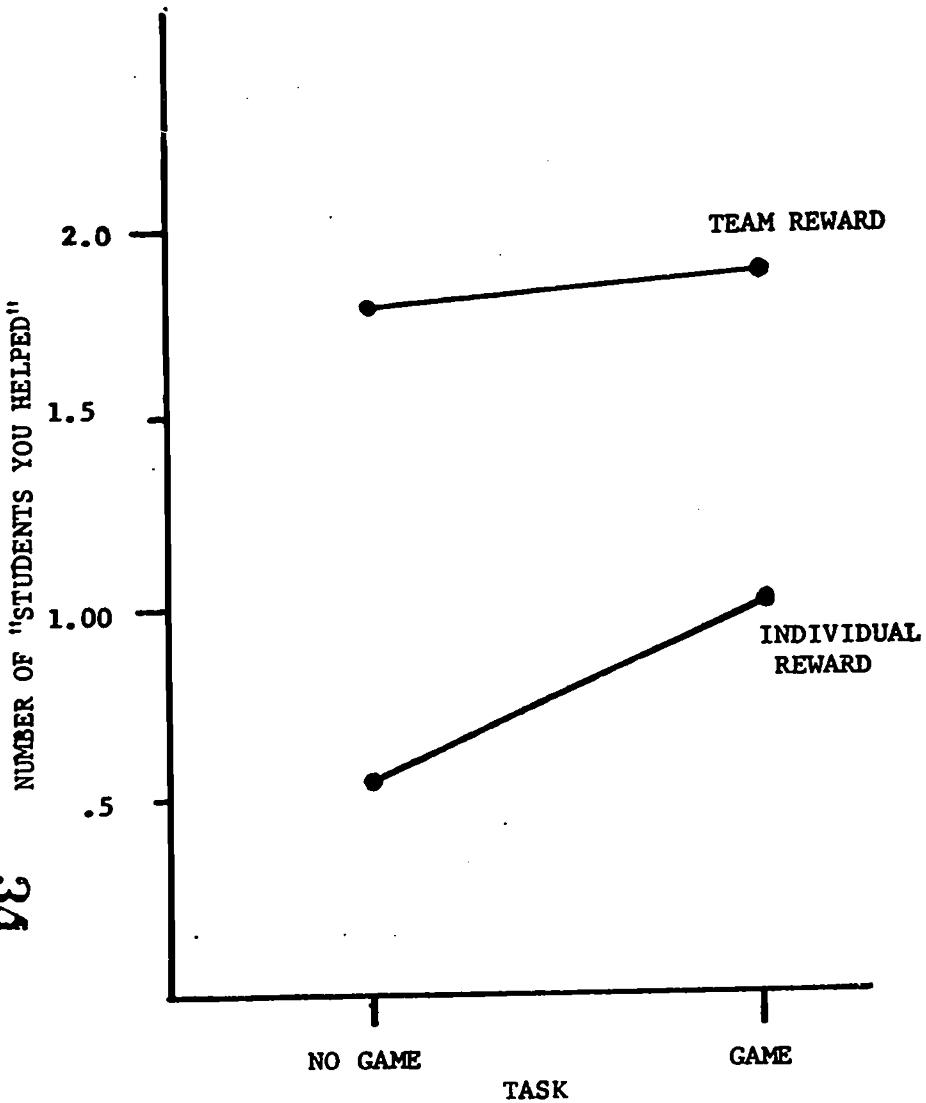

Fig. 3 - Mean number of "students you helped"

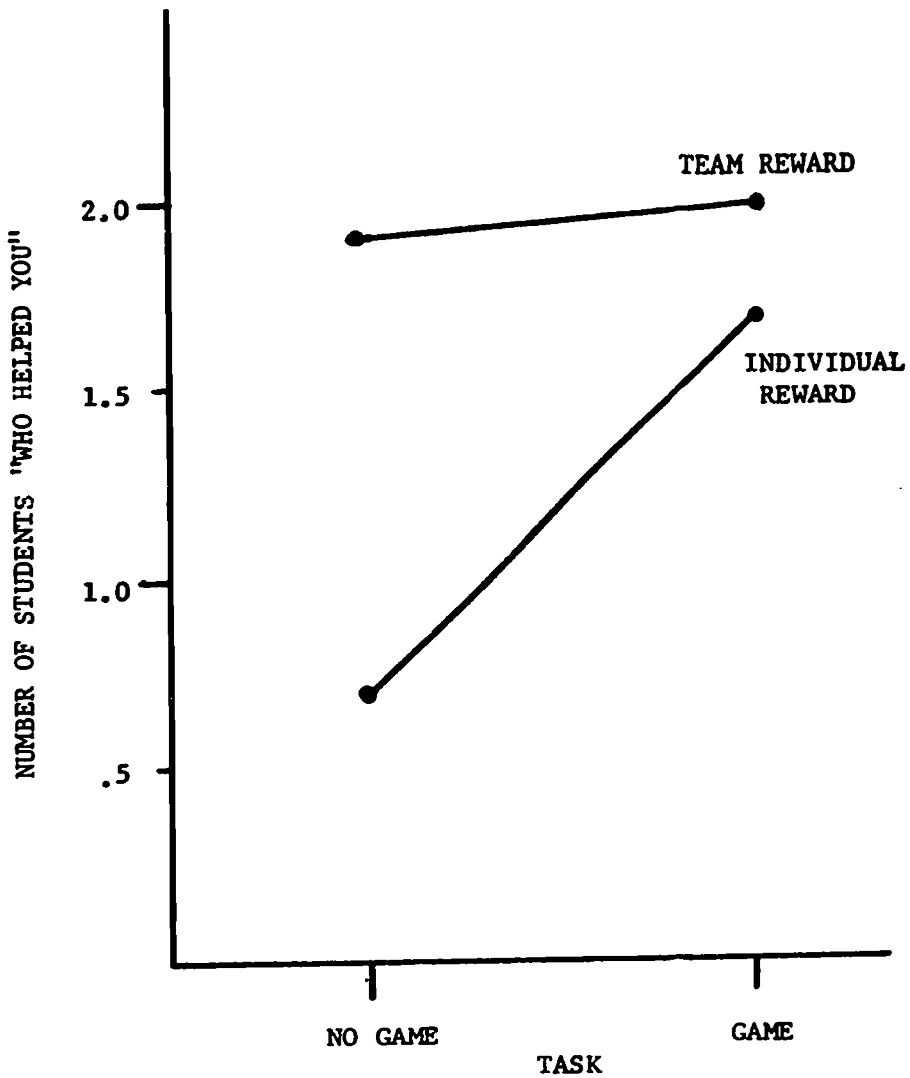

Fig. 4 - Mean number of "students who helped you"

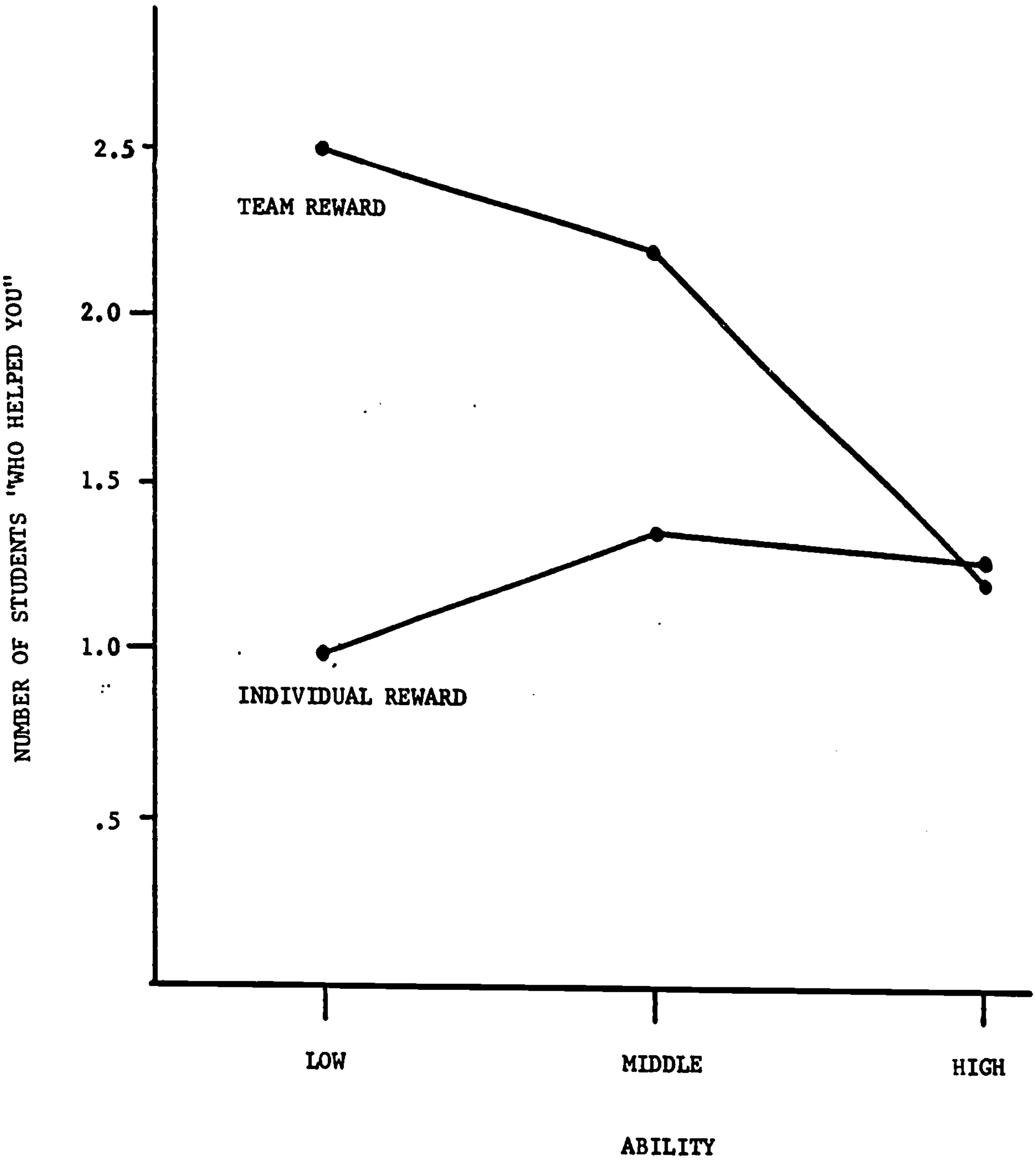

Fig. 5 - Mean number of "students who helped you" by reward and ability

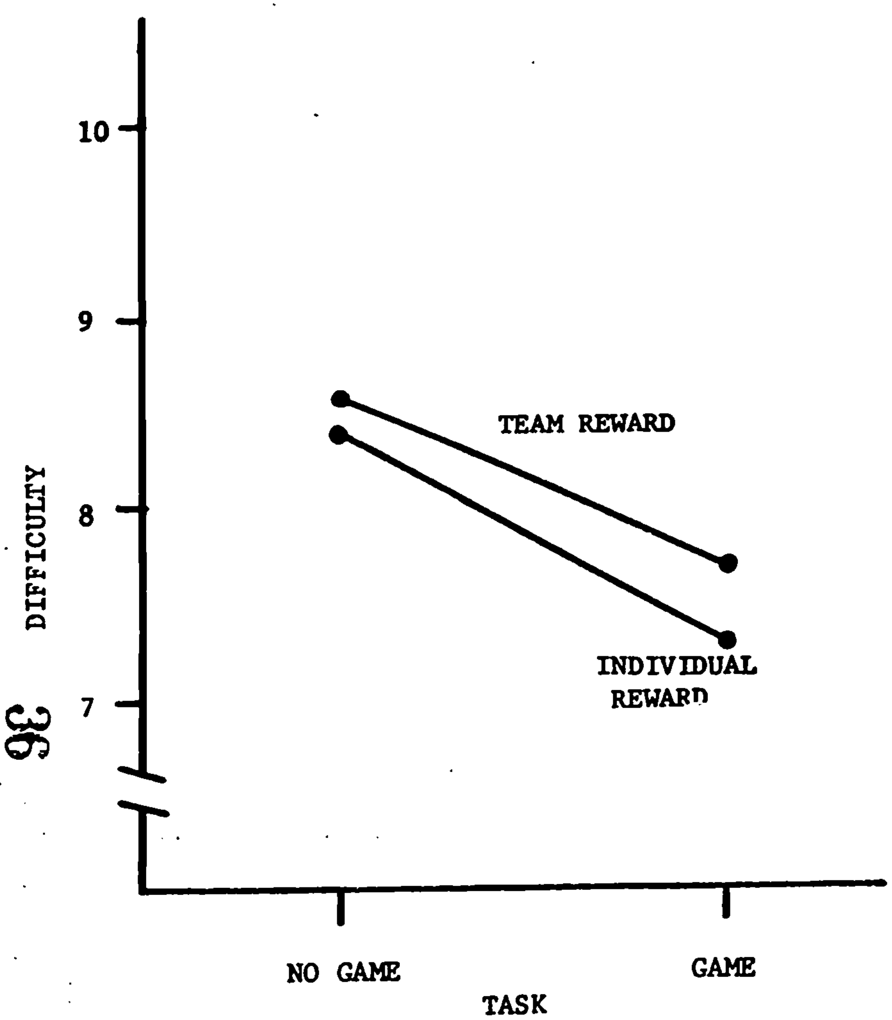

Fig. 6 - Difficulty (LEI): treatment group means

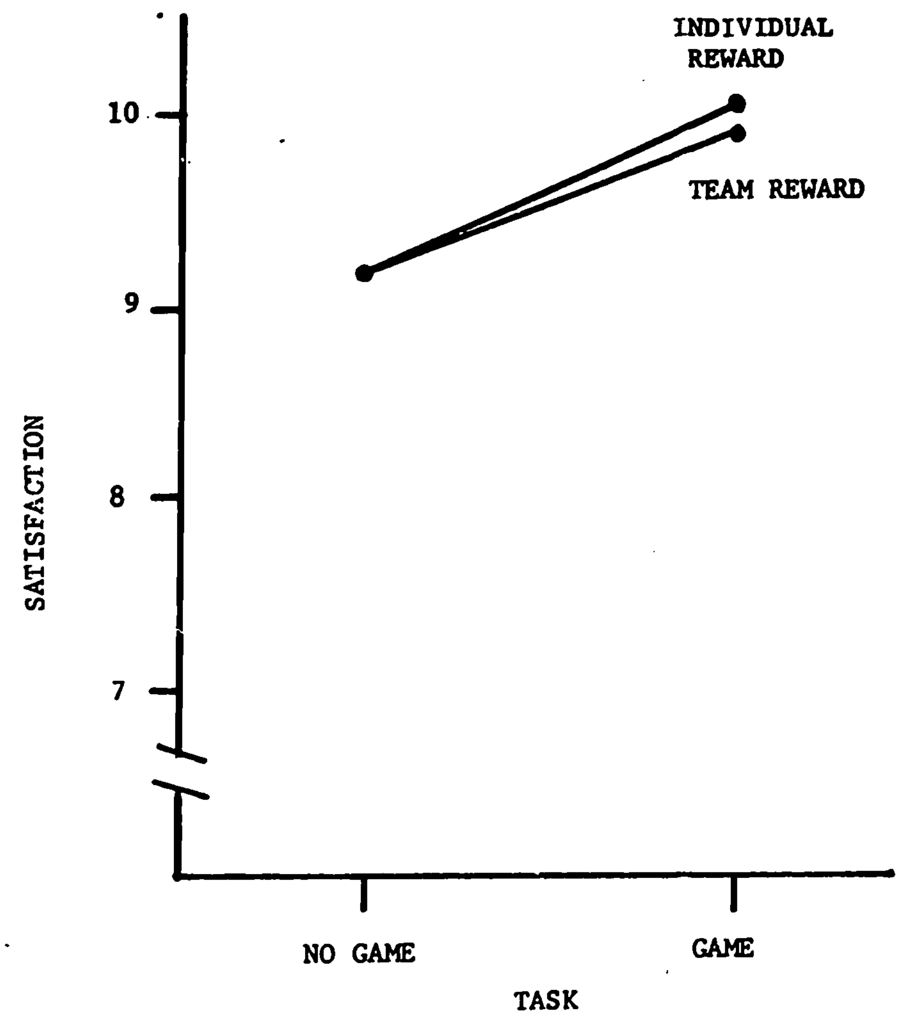

Fig. 7 - Satisfaction (LEI): treatment group means

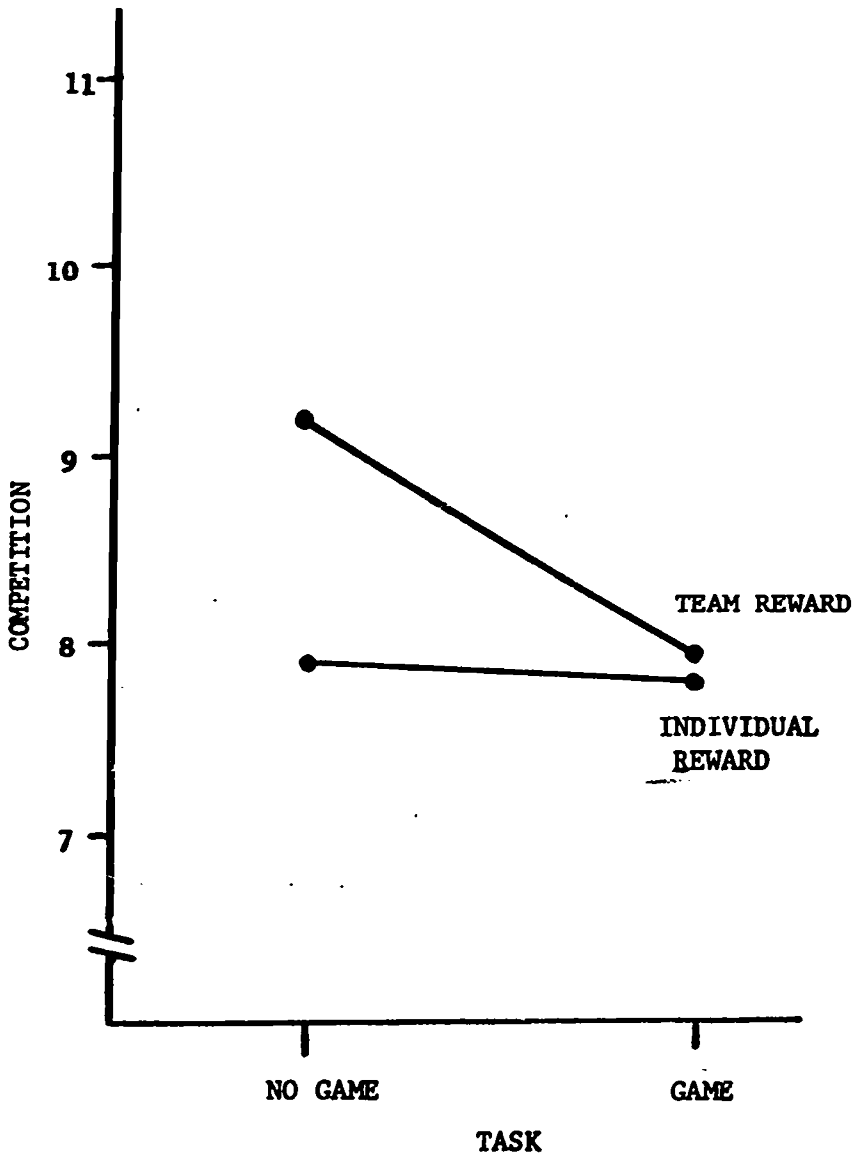

Fig. 8 - Competition (LEI): treatment group means

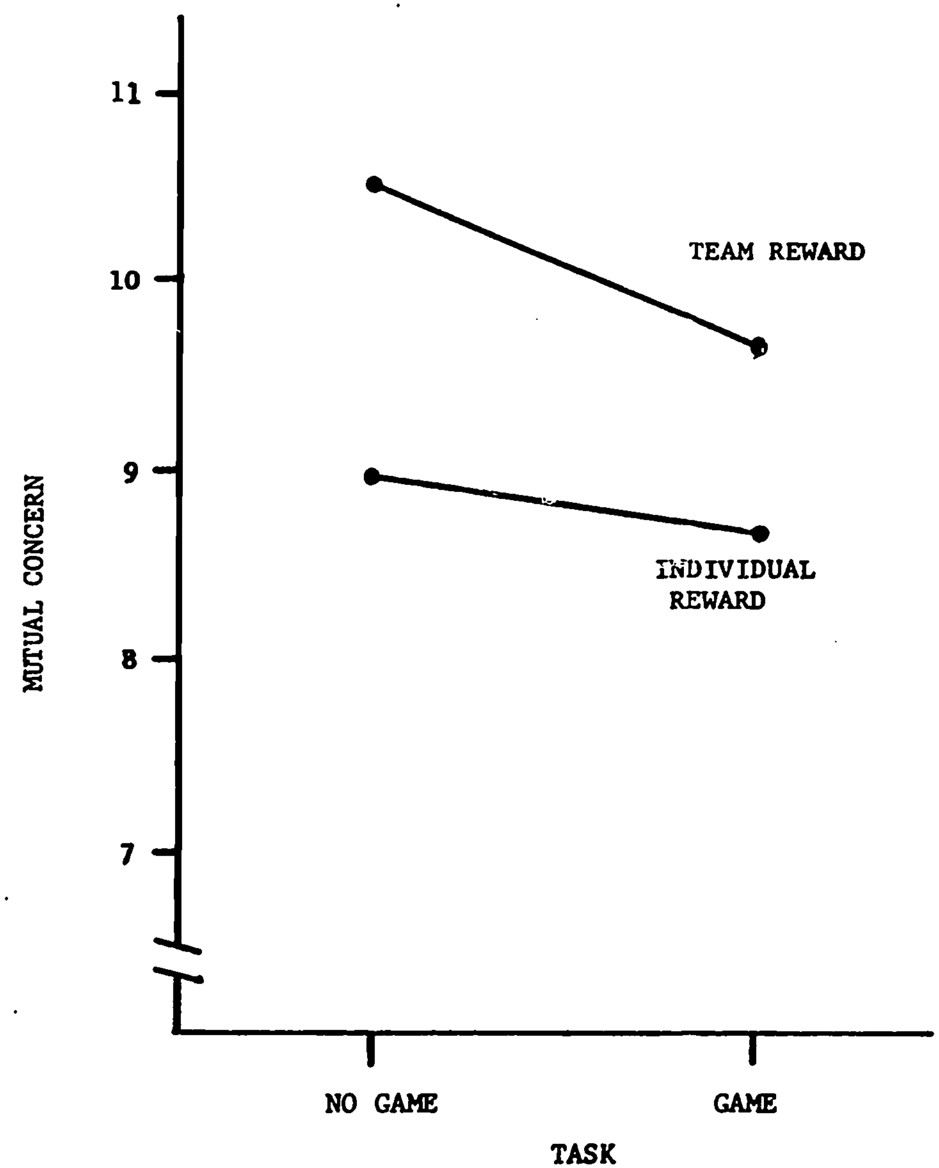

Fig. 9 - Mutual concern (LEI): treatment group means

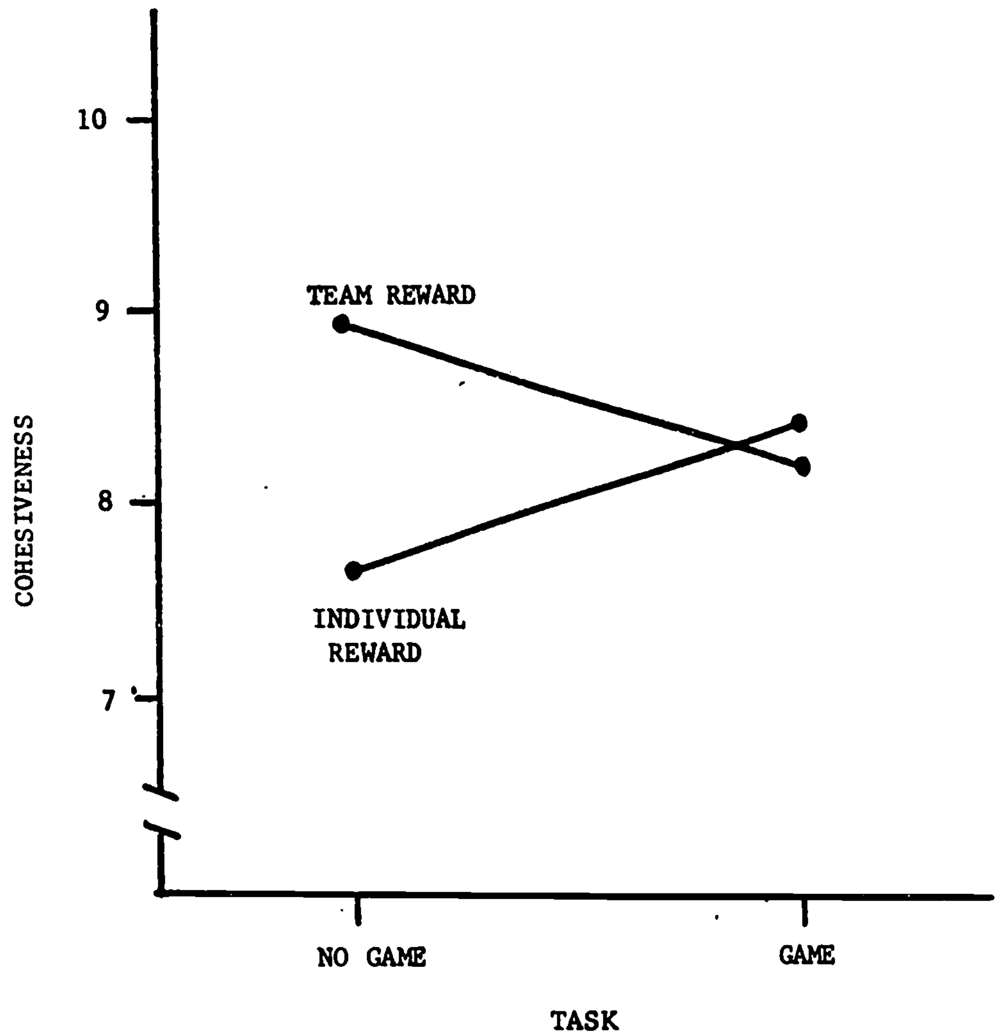

Fig. 10 - Cohesiveness (LEI): treatment group means

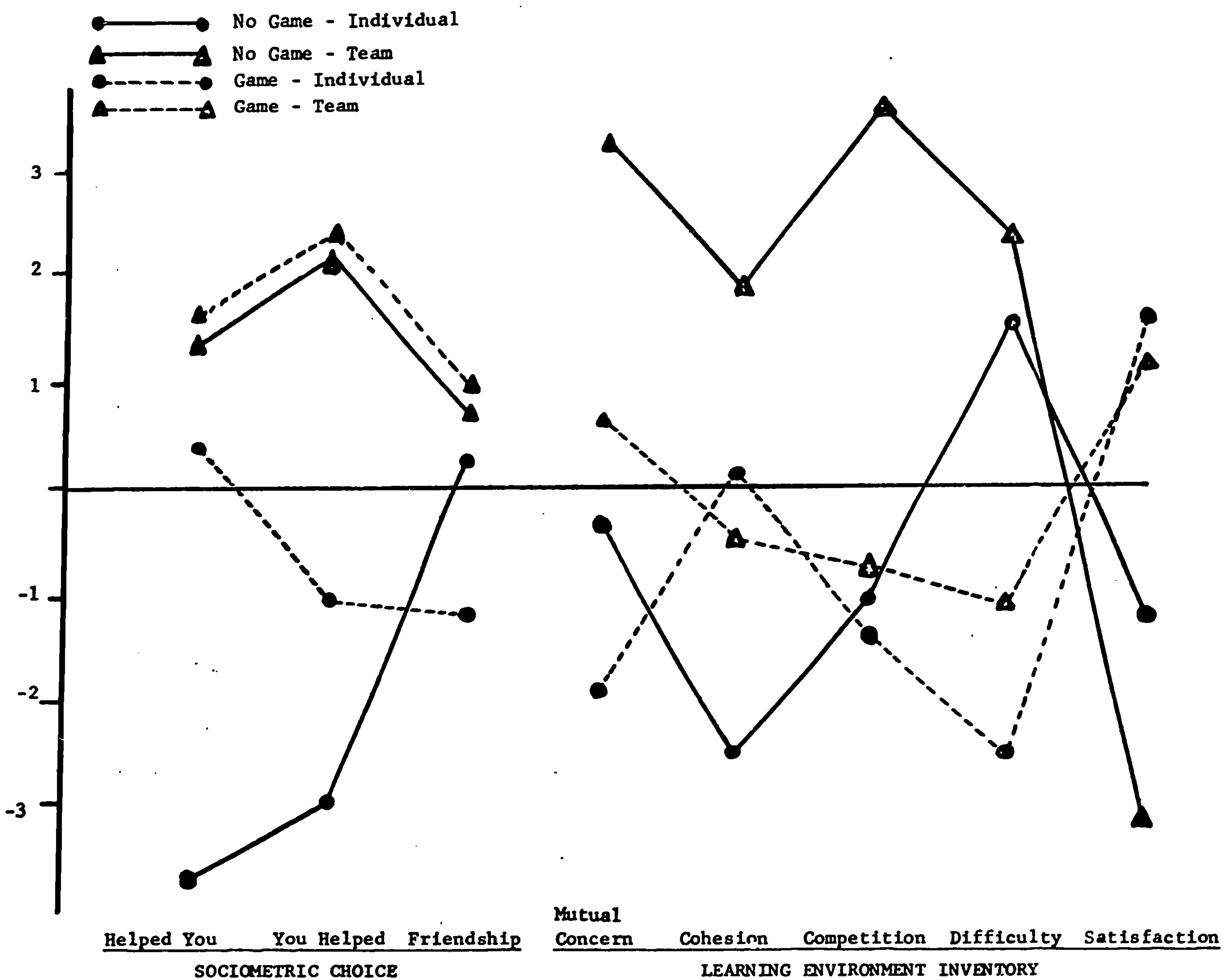

Fig. 11 - LEI profiles for the four treatment groups

$$^{1}z = \frac{\text{cell mean - grand mean}}{\text{S. D. of cell mean}}$$