DOCUMENT RESUME

ED 387 341 SE 056 781

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TITLE	The Effects of Cooperative Learning on Student Achievement and Motivation in a High School Geometry Class.
PUB DATE	Apr 95
NOTE	48p.; Paper presented at the Annual Meeting of the American Educational Research Association (San Francisco, CA, April 18-22, 1995).
PUB TYPE	Speeches/Conference Papers (150) -- Reports - Research/Technical (143)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Beliefs; *Cooperative Learning; *Geometry; Grade 10; High Schools; *High School Students; *Mathematics Achievement; Mathematics Instruction; Questionnaires; *Student Attitudes

ABSTRACT

In this study, the effects of a form of cooperative group instruction (Student Teams Achievement Divisions) on student motivation and achievement in a high school geometry class were examined. Ninety (mostly 10th-grade) students were randomly assigned to either a control group receiving traditional instruction or one of two treatment groups receiving cooperative learning instruction. Geometry achievement was assessed using scores from the IOWA Test of Basic Skills and teacher-made exams. An 83-item questionnaire was used as a pretest, posttest, and post-posttest assessment of efficacy, intrinsic valuing, goal orientation, and cognitive processing. Students in the cooperative treatment groups exhibited significantly greater gains than the control group in geometry achievement, efficacy, intrinsic valuing of geometry, learning goal orientation, and reported uses of deep processing strategies. The implications for cooperative group structures and motivation theory are discussed. Contains 30 references. (Author/MKR)

The Effects of Cooperative Learning on Student Achievement and Motivation in a High School Geometry Class

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Submitted: 1-25-95

Running Head: COOPERATIVE LEARNING

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An earlier version of this article was presented at the 1995 conference of the American Educational Research Association, San Francisco. I wish to thank Raymond B. Miller, University of Oklahoma and Lowell Madden, Indiana/Purdue University at Ft. Wayne for their comments on drafts of this article.

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Abstract

In this study, the effects of a form of cooperative group instruction (Student Teams Achievement Divisions) on student motivation and achievement in a high school geometry class were examined. Ninety students were randomly assigned to either a control group receiving traditional instruction or one of two treatment groups receiving cooperative learning instruction. Geometry achievement was assessed using scores from the IOWA Test of Basic Skills and teacher-made exams. An eighty-three item questionnaire was used as a pretest, posttest, and post-posttest assessment of efficacy, intrinsic valuing, goal orientation and cognitive processing. Students in the cooperative treatment groups exhibited significantly greater gains than the control group in geometry achievement, efficacy, intrinsic valuing of geometry, learning goal orientation and reported uses of deep processing strategies. The implications for cooperative group structures and motivation theory are discussed.

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When used properly, cooperative group learning has been shown to be effective in increasing academic achievement (Johnson & Johnson,1989; Slavin,1990; Nichols & Miller,1994). The purpose of the present study was to examine the impact of one type of cooperative group environment on several motivational variables which may underlie these achievement gains previously noted.

Slavin (1984) has argued that a possible factor responsible for the success of cooperative group instruction is the positive motivational impact of peer support for learning. Small groups of students are provided the opportunity to provide tutorial support to each other while working jointly to accomplish learning objectives. Graves (1991) also suggests that the social rewards of cooperative group interaction may in fact enhance students' intrinsic valuing of the learning task. By reducing the competitive nature of the typical classroom, cooperative groups may direct students toward improving their knowledge in their pursuit of the team goal of demonstrating achievement.

If this is the case, cooperative learning may also be altering the goal orientations of students (Dweck & Leggett,1988; Nicholls,1989). Individuals with learning goals seek reasonable challenges and persist under adversity, while those with performance goals avoid challenging tasks and display low persistence when difficulties arise. Students with strong learning goal orientations are interested in increasing their competency on a task and their primary goal is to obtain knowledge and improve their skills. Nichols (Nichols & Miller,1994) has shown that cooperative learning can have a positive impact on student learning goal orientations.

Bandura (1986) argues that an individual's efficacy beliefs influence motivation in several ways. Individuals will tend to avoid activities they believe are beyond their capabilities so they selectively choose easier tasks where the chances for success are greater. The amount of effort an individual invests in an activity and the level of persistence at difficult tasks are also linked to efficacy. The greater our self-efficacy the greater our effort and persistence should be thus leading to improved achievement. Ames (1984) and Nichols (Nichols & Miller,1994) have found that students' self-perceptions of ability (self-efficacy) increase following group success in cooperative group activities. Additionally, Bandura (1986) has argued that an individual's self-efficacy for a task is positively related to experiencing the intrinsic rewards of the activity.

Csikszentmihalyi and Nakamura (1984) define intrinsic motivation as a desire to do something because of the reward gained from doing an activity itself while extrinsic motivation occurs when the activity is engaged in because a separate reward is likely to occur. Several studies (Ames & Archer,1988; Meece,Blumenfeld & Hoyle,1988; Miller, Behrens, Greene &

Newman,1993; Nichols & Miller,1994) have indicated a positive relationship between students' learning goal scores and their intrinsic valuing of the subject matter they are studying. Positive relationships have also been observed between student's self-efficacy and their perceptions of the intrinsic value of the task (Meece et al.,1988; Miller et al.,1993; Pintrich & Degroot,1990; Pokay & Blumenfeld,1990; Nichols & Miller,1994). Nichols (Nichols & Miller,1994) has also shown cooperative learning activities can have a positive effect on goal orientation and self-efficacy while also encouraging students to display greater intrinsic valuing of the subject matter.

Students with learning goals are also more likely to report engaging in self regulatory activities such as the use of monitoring, planning and cognitive strategies (Ames & Archer,1988; Meece et al.,1988). Pintrich (Pintrich & DeGroot,1990) showed that self-efficacy and intrinsic valuing were positively related to cognitive engagement and performance. Particulary, intrinsic valuing of the learning task was strongly related to self-regulation and cognitive strategy use. Because of the impact that cooperative group learning has on achievement and the motivational variables previously discussed, it is hypothesized that it may also have an impact on student use of cognitive processing strategies.

Cooperative learning has been show to be effective in increasing student acvhievement when used properly and preliminary results of the impact on student motivation is also promising. Students learning in cooperative groups experience increased achievement and positive attitudes toward the learning task (Johnson & Johnson,1989; Sharan,1980; Slavin,1990) and also expressed an increased enjoyment of mathematics and an increase in self-efficacy toward mathematics (Slavin & Karweit,1985; Slavin, Leavey & Madden, 1984; Slavin, Madden & Leavey,1984; Oishi et al.,1983). Nichols (Nichols & Miller,1994) has also shown a form of cooperative learning to be effective in increasing student achievement while also showing increases in students' self-efficacy, learning goal orientation, and intrinsic valuing of the learning task

The present study seeks to improve upon several design constraints that were present in an earlier study (Nichols & Miller, 1994) which are the result of factors often associated with the field setting. In the initial study, the school district allowed a one semester trial of the cooperative learning treatment in one class. The current study compared three classes with one serving as a control and the remaining two receiving cooperative group instruction at two different time spans in the school year. This allowed an examination of a "return to baseline" for the treatment groups when compared to the control and assured that changes in performance would strengthen the arguments of causal influences of the treatment.

Subjects in the present study were enrolled in high school Geometry rather than Algebra II which was the case in the earlier study. The previous use of Algebra II classes may have been a confounding factor when measuring achievement because of its similarity in content area to a prerequisite course in Algebra I.

Geometry is a uniquely different domain and may encourage greater interaction among cooperative group members due to the nature of the analysis of geometrical figures and logic proofs. Using the subject area of Geometry it was also anticipated that students would report using deeper processing strtegies as opposed to shallow processing stategies. In addition by using the STAD (Slavin,1990) program the effects of individual pacing and retesting could not be considered a causal factor in observed achievement or motivation gains that were recognized in the previous study.

In the present study the effects of a form of cooperative group instruction (Student Teams Achievement Division) on motivation and achievement in a high school Geometry class were examined. When compared to students receiving traditional instruction, do students in a cooperative learning condition (1) display higher levels of Geometry achievement, (2) report being more learning goal oriented, (3) have greater positive self-efficacy beliefs regarding their abilities in Geometry, (4) display greater intrinsic valuing of Geometry, and (5) report the use of deeper cognitive processing strategies.

METHOD

Subjects

The sample consisted of students (majority tenth grade) enrolled in three sections of the first semester of Geometry at a suburban high school in the Midwest. All students had completed a traditional Algebra I class prior to enrollment in Geometry.

Students were enrolled by computer in Treatment Group I, Treatment Group II or the Control Group from a pool of approximately 400 students. Due to the nature of the enrollment process there is no reason to believe that groups would differ systematically. Although some students from the original pool may have not had the opportunity to be enrolled in one of these sections due to scheduling conflicts (e.g. enrollment in band first hour), there is no reason to believe that significant differences existed between groups initially. At the time of enrollment, counselors and students had no knowledge that some classes would be lecture format classes while others would be cooperative group format (Total n=approximately 90 students, 30 in each group).

The school population was approximately 90% Caucasian with students of various ethnic backgrounds accounting for the remainder of the student body. Enrollment was open and unrestricted as long as students had successfully completed a course in Algebra I. Initial variation between groups was assumed to be negligible. Each Geometry class met daily (Monday through Friday) for an 18 week period for a 55 minute class session.

Instruments

Five dependent variables were measured: geometry achievement, goal orientation, self-efficacy, intrinsic motivation toward geometry, and cognitive strategy use. A discussion of the instruments follows.

An 83-item questionnaire has been developed to assess various aspects of student motivation. Variations of this questionnaire have been used by Miller (Miller et al.,1993; Nichols & Miller,1994; Montalvo, Miller, Greene & Nichols,1994; Miller, Greene, Nichols & Montalvo,1994.) on related research projects.

The items were Likert-type questions which were intended to measure student learning and performance goal orientation (twelve items); perceived intrinsic and extrinsic valuing of a task (four each subscale); cognitive strategy use (nine deep strategy and nine shallow strategy items) and self-efficacy (eight items). Although the instrument includes items involving other motivational variables, only those mentioned above were analyzed for this project. Selected items from each subscale are included in Table 1. The items were randomly ordered using a five-point scale with "strongly agree" and "strongly disagree" at the extremes. The questionnaire was distributed during the first week of school in August, at the end of the first nine week grading period and again at the end of the second nine week grading period. Students completed the questionnaire at each phase of the project in approximately twenty minutes.

Mathematical achievement was measured to determine initial differences in achievement using national percentile scores from from the IOWA Achievement Test of Basic Skills from the 1992 school year. In addition, two teacher-made comprehensive tests reflecting the state mandated curriculum as well as the local school district curriculum standards were also used to measure achievement. These tests or variations of them have been used in previous years. The first was a 40 question multiple choice test with items derived specifically from the objectives students worked on in both the treatment and control groups. This test was administered at the end of the first 9 week grading period and their score counted as 20% of their nine week grade. The second teacher-made test was similar in nature again impacting the semester grade, and was administered following the second 9 week grading period. At each testing period, students had one hour to complete the exam.

Treatments

The goal for both styles of instruction (traditional lecture and STAD) was to have students gain an equal balance of conceptual and computational understanding of plane geometry. A standard curriculum was followed with the cooperative group students covering the same course objectives as the lecture group.

Cooperative Learning Treatment

The cooperative learning treatment was based on the previous work reported by Slavin (Slavin,1990) on Student Teams Achievement Divisions (STAD). Students receiving STAD instruction were placed by the instructor, in heterogenous groups consisting of four to five students. Previous achievement in Algebra 1 classes was used to place students in these groups. Ideally, each group consisted of a prior low-achieving student (grade of D), a low-medium achievement student (grade of C), a high-medium achievement student (grade of B) and a high achievement student (grade of A). At the end of each two week period, students were placed into new heterogenous groups so that one team would not dominate another.

Cooperative group students received brief whole class instruction at the beginning of each class after which students moved to their respecive groups and worked on assignments receiving tutoring from their fellow group members. Using STAD, the instructor was minimally involved in routine management and checking while spending much of his time teaching to small groups.

Students in cooperative groups received individual grades on their assignments, however, the individual performances of team members were combined at the end of each week for a team score. The team with the best score for the previous week (determined by team members individual improvement) was acknowledged at the beginning of each week.

Traditional Lecture Treatment

Subjects in the traditional lecture group received more detailed instruction from the teacher on the assignment for the day. These students covered the same material and in-class assignments were equivalent to those given in the cooperative group treatment. Students in the traditional class worked independntly on assignemtns rather than in teams and also received individual grades.

Procedure

Permission to incorporate this project into the high school in the fall was obtained from the building principal. In addition, letters explaining the project and method of instruction were sent home with students the first week of school so that a parental signature for participation could be filed for later reference. Each Geometry class met daily Monday through Friday for an 18 week period with each class session totaling 55 minutes. The students completed the motivation survey on the same day at the end of August during the first week of school, at the end of the first nine weeks and again at the end of the second nine week period. At the end of each nine week period, students also completed the teacher-made exam reflecting objectives for that instructional period. During the first week of school, percentile scores from the math portion of the IOWA achievement test were also obtained from student records for use in establishing initial differences in achievement between the groups.

Students or parents who did not wish their son or daughter to participate had the option to transfer into another Geometry class the first week of school or had the option of remaining in class and not participating in the cooperative group format, choosing instead to work independently. All students in this project chose to participate. Treatment group 1 received STAD instruction for the first nine weeks of school and beginning the second nine weeks period, received traditional lecture format instruction. Treatment group 2 received traditional lecture format instruction for the first nine weeks of the course and received STAD instruction the second nine weeks of the project. The Control group received traditional lecture instruction throughout the 18 weeks of the project. The same instructor was used for all three sections of Geometry to minimize any teacher variability.

Results

Realibility Analysis

Items which were intended to measure goal orientation for the geometry class, intrinsic and extrinsic valuing of geometry, self-efficacy regarding performance, and the use of shallow and deep processing strategies were analyzed to determine subscale reliabilities. Coefficient alpha was used for this purpose. All of the reliabilites were reasonably high on the pretest, posttest, and post-posttest questionnaire ranging from r=.41 to r=.93. Reliablity values are included with selected subscale items in Table 1.

Insert Table 1 about here

Initial achievement was obtained from student files and recorded from the national percentile rank of math achievement from the IOWA Test of Basic Skills, 1992. The total math achievement score consists of subcategories of math concepts, math reasoning, and math computations. The reliability values for the IOWA from the 1992 national norms were .90, .89, and .88 for sophmores, juniors, and seniors respectively. Reliabilities for each of the two teacher-made nine week exams were calculated using the Kuder-Richardson 20 and were found to be .85 and.88 respectively.

Correlational Analysis

A complete correlational analysis is shown for the pretest (Table 2), posttest (Table 3), and post-posttests (Table 4).

Insert Tables 2, 3 and 4 about here

The consistency of these correlations with theoretical predictions and findings provide support for the construct validity of the subscales. Most noteworthy are the significant correlations throughout the project between learning goals and intrinsic valuing (.57, .72, .64), learning goals and self-efficacy (.49, .69, .59), and learning goals and deep processing (.38, .66, .60). Intrinsic valuing and self-efficacy were also significantly correlated throughout the project (.70, .77, .66), while deep processing and self-efficacy also showed this same significant trend (.42, .69, .58).

Data Analysis

The means and standard deviations for the pretest, posttest and post-posttest motivation and achievement scores are reported in Table 5.

Insert Table 5 about here

Figures 1-8 are provided as a visual representation to allow for a quick comparison of each variable of interest for the three groups throughout the project.

Insert Figures 1-8 about here

Using the corresponding pretest measure of achievement as a covariate, ANCOVA revealed a significant (all significant differences at the $p<.05$ level) overall difference among the three groups on the achievement variable at the second $F(2,76)=28.12$, $MS_e=35.12$, and third $F(2,76)=15.58$, $MS_e=38.74$ phases of the project. Planned comparisons revealed that achievement scores for the treatment 1 group were significantly greater than the control $t(27)=2.56$, and treatment 2 $t(27)=2.67$, groups at the end of the first nine weeks of the project. At the end of the second phase of the project treatment 2 showed no significant increase over the control group on achievement, . however treatment 1 continued to exhibit a significant edge over the control group even after the cooperative groups had ended for them at the first nine week period $t(27)=3.56$.

To analyze the motivation questionnaire results, repeated measures analysis and planned comparisons tests were used. Results for the learning goal variable showed a significant group main effect $F(2,77)=3.11$, $MS_e=1.09$ a significant effect for time $F(2,154)=37.66$, $MS_e=.12$, and a significant group by time interaction $F(4,154)=37.76$, $MS_e=.12$. Planned comparisons at time 2 revealed these findings (treat1>control) $t(27)=6.55$, (treat1>treat2) $t(27)=5.68$ at the second phase of the project, and at the third phase of the project, (treat2>control) $t(27)=3.54$. Performance goals also showed a significant main effect for group $F(2,77)=4.83$, $MS_e=1.45$, for time $F(2,154)=21.51$, $MS_e=.11$, and showed a group by time interaction $F(4,154)=22.95$, $MS_e=.11$. Planned comparisons revealed these findings at time 2, (treat1<control) $t(27)=5.56$, (treat1<treat2) $t(27)=5.17$ and at time three, (treat1<control) $t(27)=2.80$ on the performance goal variable. Results for self-efficacy revealed significant group main effects $F(2,74)=3.12$, $MS_e=.90$, significant effects for time $F(2,148)=56.05$, $MS_e=.10$, and a significant group by time interaction $F(4,148)=38.57$, $MS_e=.12$. At time 2, planned comparisons showed these significant differences (treat 1>control) $t(27)=5.26$, (treat1>treat2) $t(27)=6.21$ and at time 3 these differences were observed (treat1>control) $t(27)=4.56$, (treat2>control) $t(27)=4.39$.

Intrinsic valuing of the learning task showed a significant group main effect $F(2,75)=3.35$, $MS_e=2.64$, a significant effect for time $F(2,150)=70.80$, $MS_e=.15$, and a significant group by time interaction $F(4,150)=47.09$, $MS_e.15$. Planned comparisons revealed these results at time 2 (treat1>control) $t(27)=4.21$, (treat1>treat2) $t(27)=5.71$ and at time 3, (treat1>control) $t(27)=2.91$, (treat2>control). $t(27)=2.89$. Repeated measures results of deep processing strategies revealed a significant group main effect $F(2,76)=9.82$, $MS_e=.50$, a significant effect for time $F(2,152)=58.42$, $MS_e=.10$, and a significant group by time interaction $F(4,152)=61.46$, $MS_e=.10$. Planned comparisons at time 2, revealed these results, (treat1>control) $t(27)=11.19$, (treat1>treat2) $t(27)=9.63$ and at time 3, (treat1>control) $t(27)=4.90$, and (treat2>control) $t(27)=4.90$.

Discussion

The results of this investigation into the motivational factors influencing achievement in cooperative learning groups were clear. Achievement gains in both treatment classes were observed and these findings are consistent with numerous researchers who have found similar achievement gains using cooperative group instruction (Oshi,1983; Slavin,1983; Slavin & Karweit,1985; Nichols & Miller,1994). Treatment Group 1 experienced a slight decrease in achievement scores after they converted to a lecture format but continued to maintain a significant advantage over the control group who also experienced small decreases in achievement scores during the second nine week period. Nichols (Nichols & Miller,1994) observed this same trend after the removal of cooperative groups which is indicative of the treatment effects that cooperative learning may produce. These students had the opportunity to interact and work as a team for nine weeks to achieve specific course objectives. Achievement scores increased during this time but when they lost this group support and interaction during the second nine weeks, their achievement scores declined. One explanation for this decline could be that typically students will experience a decline in achievement during the second nine week period after the newness of the school year begins to abate. Additionally, in a typical high school geometry class, students are heavily into geometric proofs during the second nine weeks and often struggle with some of the difficult concepts. Although these explanations are both warranted, this same decrease in achievement scores was not seen in the second treatment group or the control group during the second nine weeks which indicates that these scores were more probably linked to the removal or implementation of cooperative groups.

Reflecting earlier findings (Nichols & Miller, 1994), Students in cooperative groups also showed significant increases on the learning goal variable while again showing a slight decline after conversion to a lecture format. Both groups remained significantly higher that the control group at the end of the project. Support has been established for the positive relationship between learning goals and persistence toward achievement on a task (Ames & Archer,1988; Nolen,1988; Miller et al.,1993) therefore, the rise in learning goals along with achievement gains was not unexpected. Cooperative learning establishes a support group for learning objectives in a non-competitive environment. Students are more concerned with learning the material rather than comparing their abilities to their peers. With a focus toward learning objectives, and the peer support gained from cooperative groups, students become more learning goal oriented which appears to result in increased achievement.

Performance goal results showed a dramatic difference in cooperative and traditional learning groups particularly in the early stages of the project. These findings provide support for earlier findings (Nichols & Miller, 1994). The drop in performance goals in the treatment groups are important to note, particulary for the first cooperative group class and are indicative of the powerful impact of cooperative groups on the perceived goals that students assume in the classroom. Deci (Deci, Schwartz, Sheinman & Ryan,1981) has also suggested that after eight weeks of school, student perceptions are relatively fixed or stable for the year and this could explain Treatment 2's failure to decrease in performance goals when cooperative groups were implemented. Once students form these goals, they are difficult to change. It is important to note that after cooperative groups were removed from Treatment 1 their performance goals followed an inverse trend even after 18 weeks of school. This indicates cooperative groups could be a factor in changing student perceptions even after cooperative learning no longer occurs.

Intrinsic valuing of the learning task also tended to show the same trends as the earlier variables in that cooperative group students showed significant increases over the control group and exhibited the same characteristic drop off after cooperative learning was removed, again supporting earlier findings (Nichols & Miller,1994). With the control group remaining stable on the intrinsic variable throughout the project, it again suggests the impact of the treatment on intrinsic motivation.

Students who did not receive cooperative groups increased early in the project on the extrinsic valuing variable while Treatment 2 showed a decline when cooperative groups were implemented. It is important to note that Treatment 1 receiving cooperative group learning early in the project, showed no fluctuation and their extrinsic valuing of mathematics remained at a significantly lower level. Important to also note is the increase of Treatment group 2 along with the control group on the extrinsic variable, and their subsequent decrease on this same variable to a point almost equal with Treatment group 1 after cooperative learning was in place for them the second nine weeks. This indicates that cooperative groups can have the desired effect of increasing students intrinsic valuing of the learning task, while decreasing extrinsic valuing that is so often promoted in the typical classroom. Extrinsic valuing is a part of our societal make-up and these increases were expected, but it was also interesting to note that students receiving cooperative group instruction experienced stability or a decrease in extrinsic valuing as was seen with Treatment 2. Cooperative group instruction worked to foster an increase in intrinsic valuing while encouraging a decrease in extrinsic valuing of the learning task.

Based on Nichols' (Nichols & Miller,1994) study in which self-efficacy was shown to increase after the introduction of a form of cooperative learning, it might be predicted that the efficacy variable would follow the same trend and this was in fact the case. Cooperative group students increased in their self-efficacy judgements, while Treatment 1 showed as before, a slight decreases upon conversion to the lecture format class. This supports Ames' notion that cooperative learning can enhance student self-efficacy (Ames,1984) by improving achievement.

Students participating in cooperative groups showed significant increases over the control group in the reported use of deep processing strategies. Although only moderate increases in shallow processing strategies were seen in cooperative groups, these results were a surprise providing a possible link between shallow processing and learning goals that has not been previously observed. The collaborative work undertaken in the cooperative groups is an indication that students are encouraged to reflect and elaborate on the knowledge they have with their peers. This interaction among students encouraged them to reflect and elaborate on the knowledge they have with their peers. This interaction encourages them to actively consider the processing they use in solving problems.

Previous research has indicated that students who are learning goal oriented report greater use of deep processing strategies (Ames & Archer,1988; Meece, Blumenfeld & Hoyle,1988; Nolen,1988; Pintrich & Garcia,1991; Miller et al,1993). In addition, this project also supports Pintrich's and Miller's findings (Pintrich & Degroot, 1990; Miller et al.,1993) that students were more cognitively engaged in a process showed greater self-efficacy and intrinsic valuing of the task, and this cognitive engagement ultimately supports greater achievement or performance. In a subject like geometry, students analyze diagrams and geometric proofs and cooperative learning can provide a stage for student interaction and discussion that impacts the use of meaningful (deep) processing strategies. This in turn, can result in greater achievement which can serve to increase student self-efficacy and their intrinsic motivation to learn a task.

These results help to support the link already found between the use of cognitive processes, effort, and achievement (Krutetskii,1976; Schoenfeld,1979; Ames & Archer,1988; Baron,1988). Students who tend to emphasize learning goals report greater use of more effective processing strategies and are more persistent believing that effort is the key to one's success or achievement. This increase in deep processing strategies within the treatment groups receiving cooperative group learning is an important finding and may lead to further work in the analysis of social and group interactions and their impact on cognitive processing development.

In summary, these results indicate that cooperative group learning can result in increased achievement and motivation to learn. The adoption of learning goals, intrinsic valuing of the learning task, increased self-efficacy, and increased use of deep processing strategies are all clear indications of the impact cooperative learning can have on student motivation. Additional research needs to be conducted which examines the social interactions that occur in a cooperative group environment while also considering the possible impact that cooperative group instruction can have on teacher attitudes concerning the traditional classroom structure format.

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TABLE 1

Selected Items From The Motivational Survey With Corresponding Subscale Reliabilities

Leaning Goals (r=.65 -.77)

1. I do the work assigned in this class because I like to understand really complicated ideas.
2. I do the work assigned in this class because I like to understand the material I study.
3. I do the work assigned in this class because I like learning interesting things.

Performance Goals (r= .80 -.86)

1. I do the work assigned in this class because I don't want to be embarrassed about not being able to do the work.
2. I do the work assigned in this class because I like to do better than other students.
3. I do the work assigned in this class because I don't want to look foolish or stupid to my friends, family or teachers.

Self Efficacy (.83 -.89)

1. I am confident about my ability to do the work in this class.
2. I am certain I can understand the math presented in this class.
3. I am confident I can perform as well or better than others in this class.

Intrinsic Motivation (.83 -.93)

1. I think working with mathematics is personally satisfying.
2. I find learning mathematics interesting.
3. I enjoy the challenge of mathematics.

Extrinsic Motivation (.51 -.76)

1. I will need to know mathematics for my future work.
2. Being knowledge about mathematics will be of value to me in the future.
3. Mathematics has little to do with my future work.

Shallow Processing (.41 -.80)

1. When I study for tests, I use solved problems in my notes or in the book to help me memorize the steps.
2. When I work problems in class, I check my neighbors answers to see how I'm doing.
3. I try to memorize the steps for solving problems presented in the text or in class.

Deep Processing (r=.52 -.81)

1. When studying, I try to combine different pieces of information from course material in new ways.
2. I draw pictures or diagrams to help me solve problems.
3. When working a problem, I sometimes look at the correct answer first, when it is available, then I try to work backwards to solve the problem.

Note: Reliabilities reflect the range of indexes on the pre, post, and post-posttest scores on the motivation survey.

TABLE 2

Correlations Among Pretest Scores

Variables	1	2	3	4	5	6	7	8
1. Achievement	-							
2. Learning goal	.12	-						
3. Perform goal	.04	.17	-					
4. Intrinsic	.01	.57**	.28*	-				
5. Extrinsic	-.15	.09	.05	.12	-			
6. Efficacy	.12	.49**	.19	.70**	.17	-		
7. Shallow	.17	-.03	.10	-.02	.06	-.05	-	
8. Deep	.09	.38**	.12	.37**	.18	.42**	.13	-

*p<.01, **p<.001.

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TABLE 3

Correlations Among Posttest Scores

Variables	1	2	3	4	5	6	7	8
1. Achievement	-							
2. Learn goal	.34*	-						
3. Perform goal	-.23	.27*	-					
4. Intrinsic	.20	.72**	-.06	-				
5. Extrinsic	-.05	-.06	.16	-.07	-			
6. Efficacy	.27*	.69**	-.21	.77**	-.02	-		
7. Shallow	.12	.03	.10	-.02	-.02	-.08	-	
8. Deep	.29*	.66**	.38**	.65**	.24	.69**	.06	-

*p<.01, **p<.001.

TABLE 4

Correlations Among Post-Posttest Scores

Variables	1	2	3	4	5	6	7	8
1. Achievement	-							
2. Learning goal	.29*	-						
3. Perform goal	.02	.02	-					
4. Intrinsic	.20	.64**	.05	-				
5. Extrinsic	.26	.02	.10	-.09	-			
6. Efficacy	.10	.59**	-.19	.66**	.01	-		
7. Shallow	.09	.31*	.07	.20	-.23	.18	-	
8. Deep	.20	.60**	-.16	.57**	-.16	.58**	.31*	-

*p<.01, **p<.001.

TABLE 5

Motivation Subscale And Achievement Means And Standard Deviations For Treatment And Control Groups

Variables	Pretest		Posttest		Post-Posttest	
	M	SD	M	SD	M	SD
Achievement						
Treatment 1	66.96	16.40	89.67	11.20	84.22	10.58
Treatment 2	62.78	17.94	74.15	14.36	82.19	10.66
Control	63.81	20.09	79.26	18.03	79.03	16.48
Learning Goal						
Treatment 1	3.09	.73	4.25	.58	3.56	.62
Treatment 2	3.17	.69	3.23	.73	3.89	.68
Control	3.10	.65	3.17	.63	3.25	.65
Perform Goal						
Treatment 1	3.00	.76	1.94	.58	2.56	.67
Treatment 2	2.86	.77	2.90	.77	2.99	.75
Control	3.05	.84	3.06	.87	3.09	.72
Intrinsic						
Treatment 1	2.56	0.98	4.12	0.68	3.64	.78
Treatment 2	2.65	1.16	2.69	1.12	3.68	.97
Control	3.09	1.07	3.10	1.06	3.13	.86
Extrinsic						
Treatment 1	3.01	.35	3.08	.72	3.07	.49
Treatment 2	3.15	.52	3.85	.79	3.21	.84
Control	3.14	.52	3.67	.75	3.51	.63
Efficacy						
Treatment 1	3.10	.61	4.38	.41	3.82	.53
Treatment 2	3.27	.72	3.38	.73	3.85	.67
Control	3.44	.50	3.55	.71	3.48	.59
Shallow						
Treatment 1	3.11	.36	3.23	.63	3.46	.60
Treatment 2	3.29	.48	3.37	.47	3.89	.62
Control	3.12	.52	3.23	.48	3.25	.36
Deep						
Treatment 1	3.05	.46	4.36	.31	3.24	.36
Treatment 2	3.27	.48	3.19	.55	3.90	.60
Control	3.29	.41	3.27	.40	3.24	.36

Note: Pretest achievement scores are national percentile ranks on the IOWA Test of Basic Skills while posttest and post-posttest achievement scores reflect percentage scores on the nine weeks teacher-made tests.

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FIGURE 1
ACHIEVEMENT BY TIME

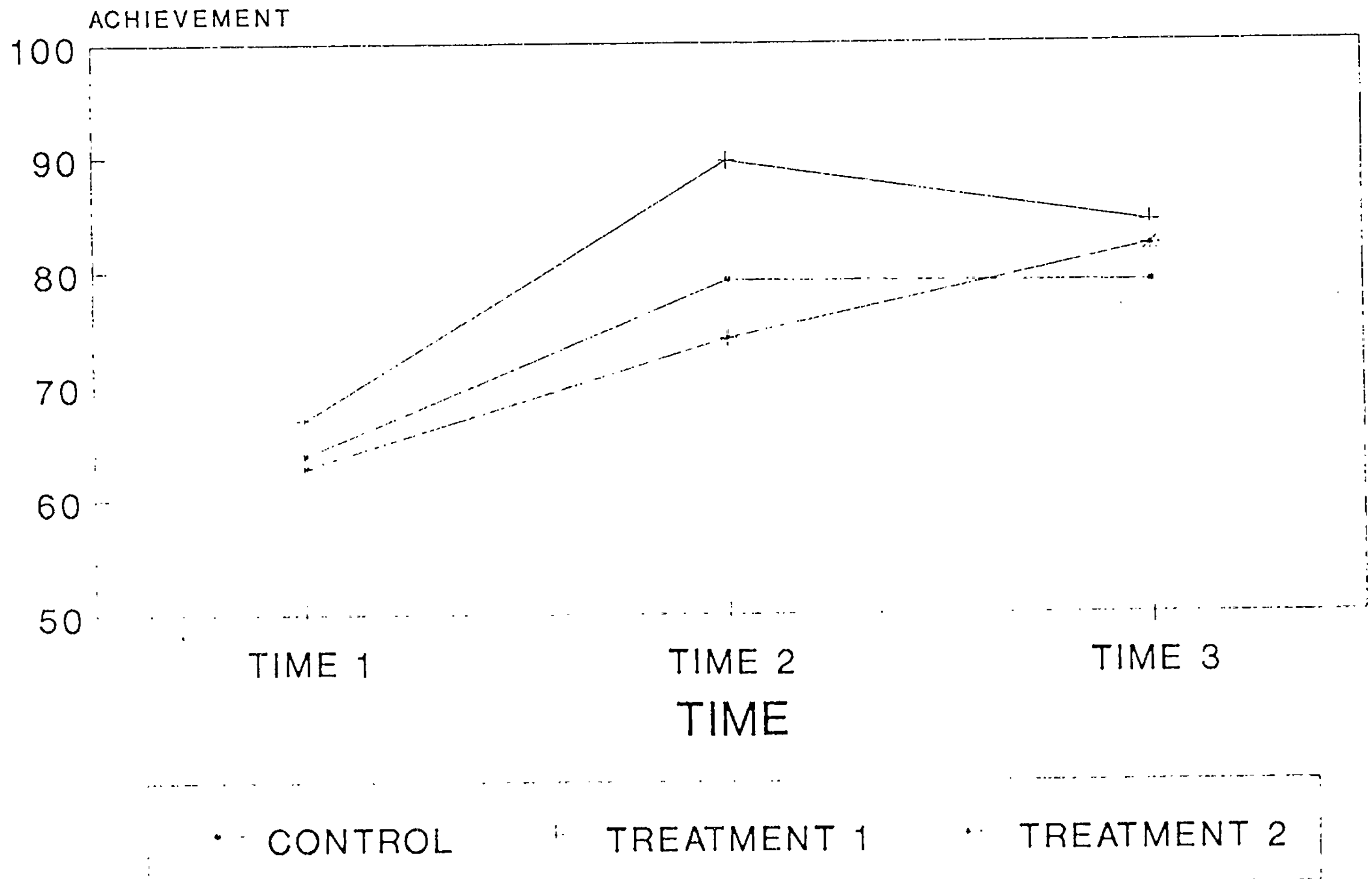

FIGURE 2
LEARNING GOALS BY TIME

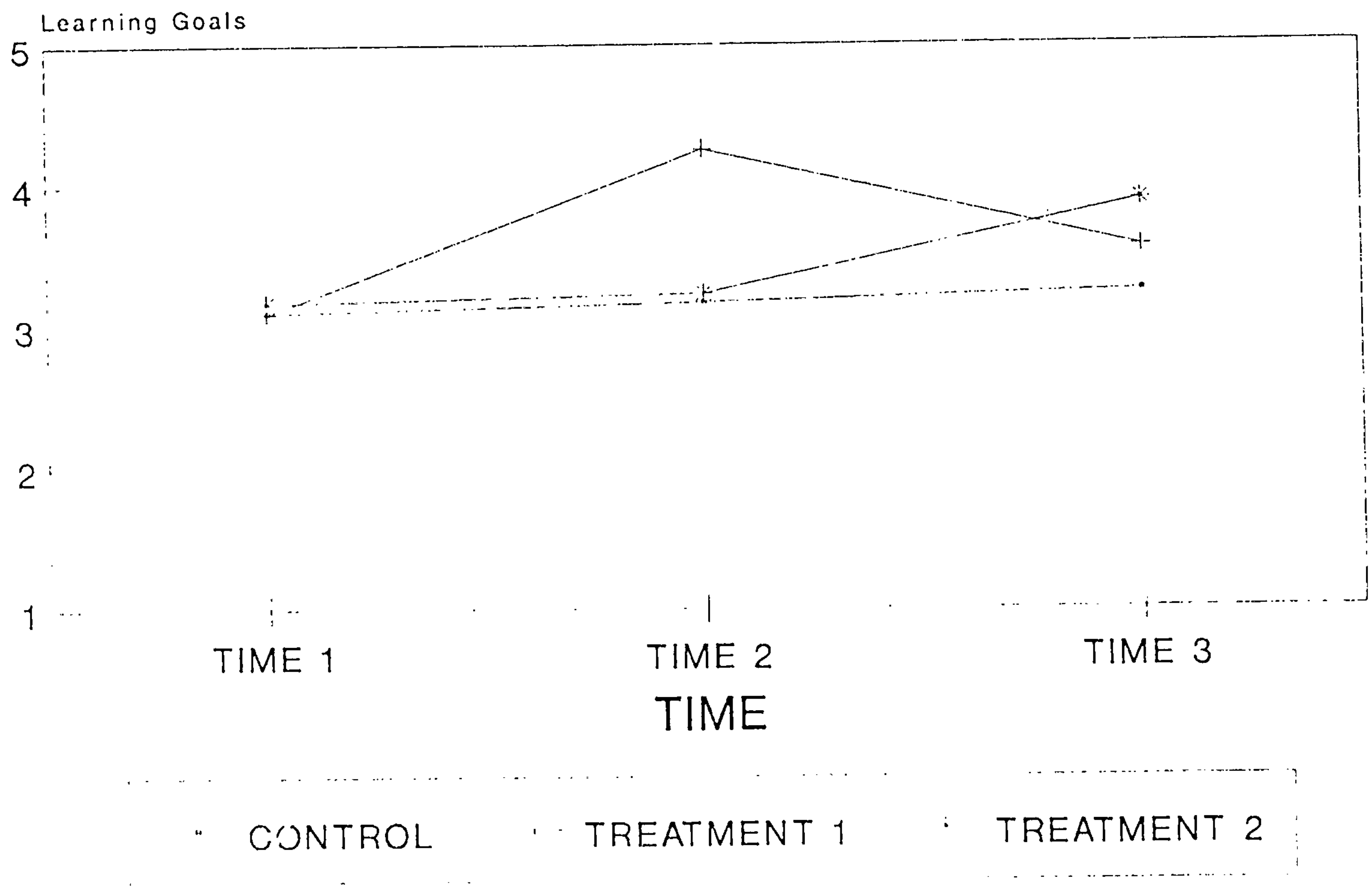

FIGURE 3
PERFORMANCE GOALS BY TIME

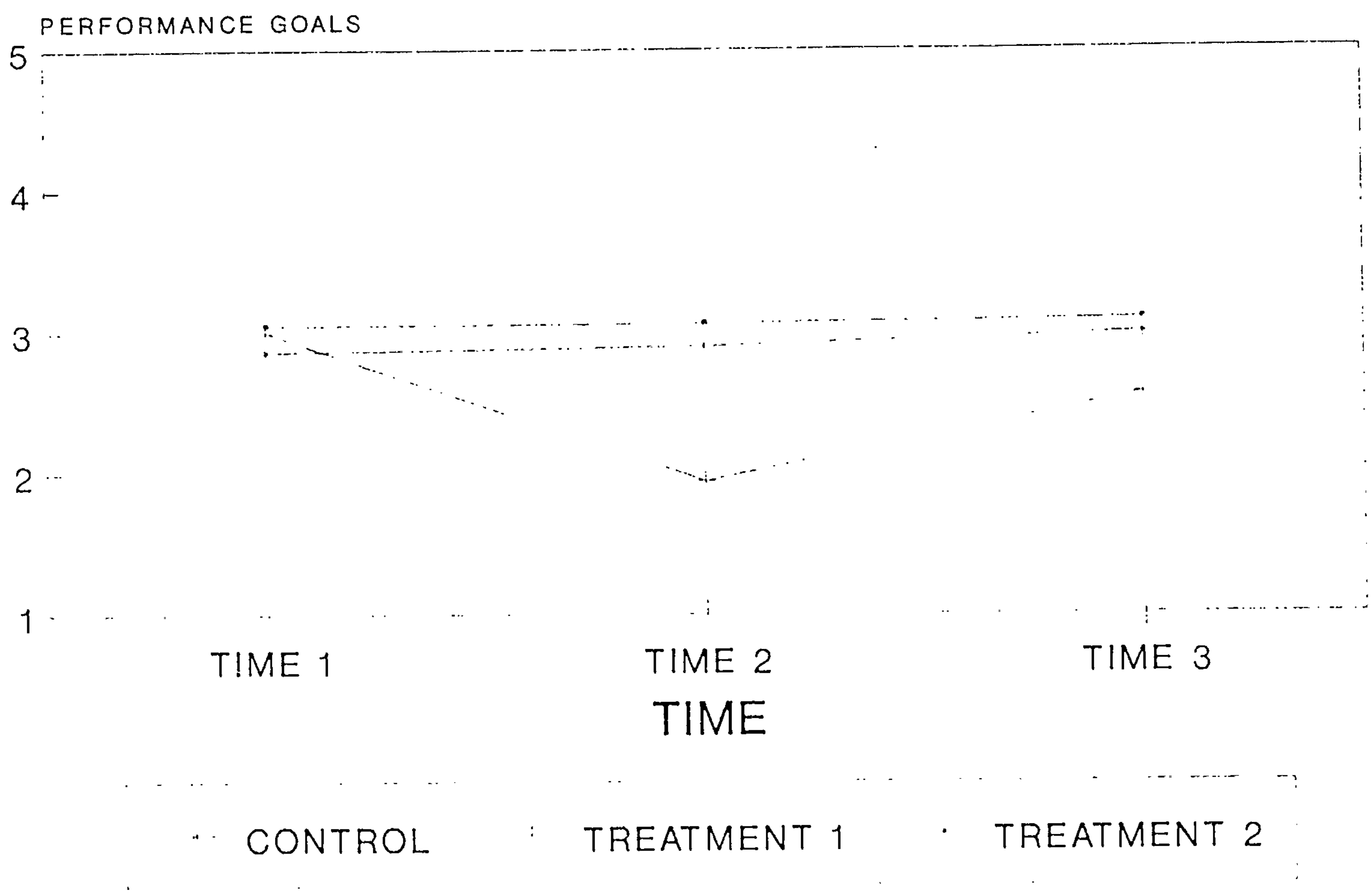

FIGURE 4
INTRINSIC VALUING BY TIME

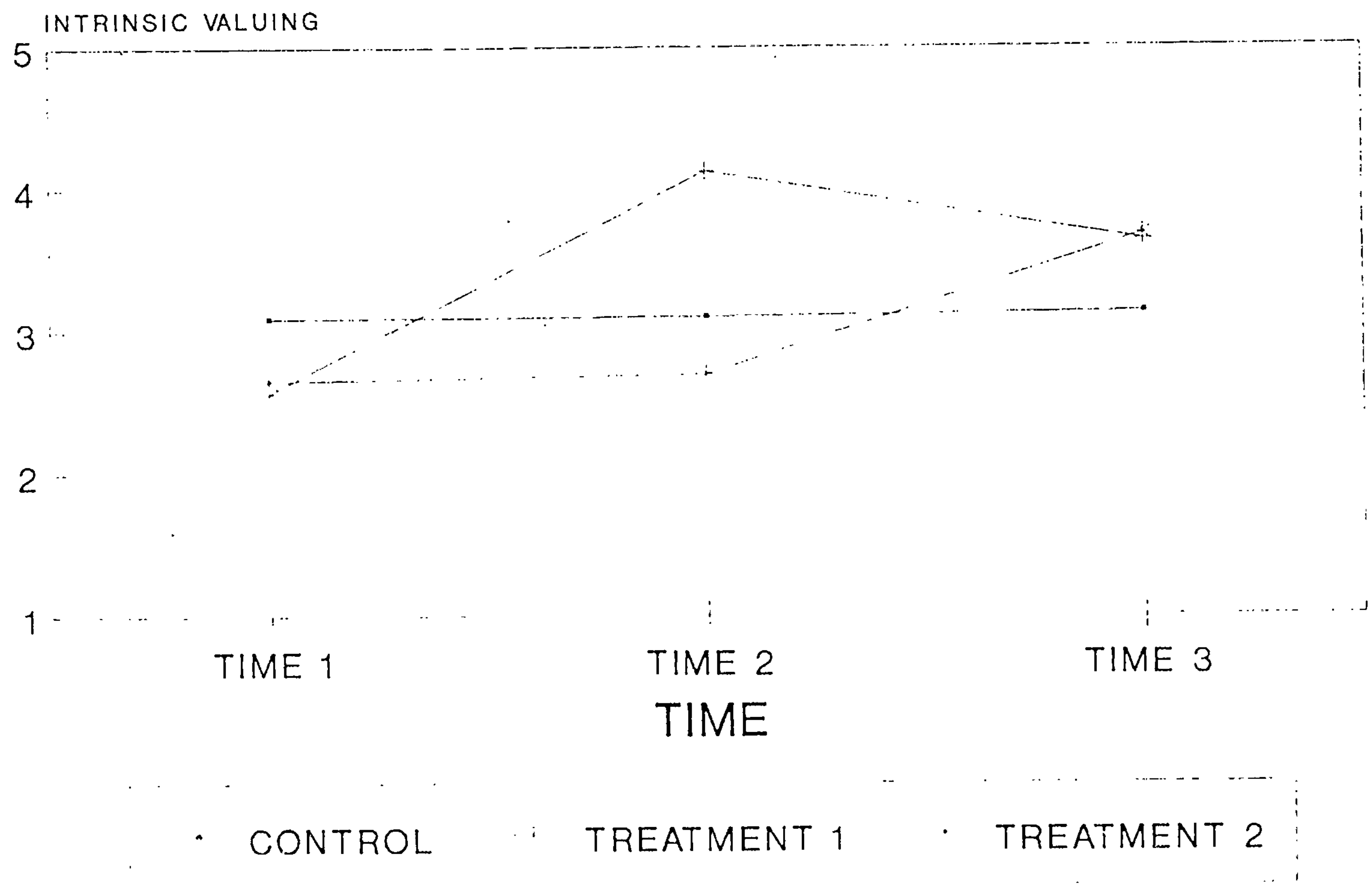

FIGURE 5
EXTRINSIC VALUING BY TIME

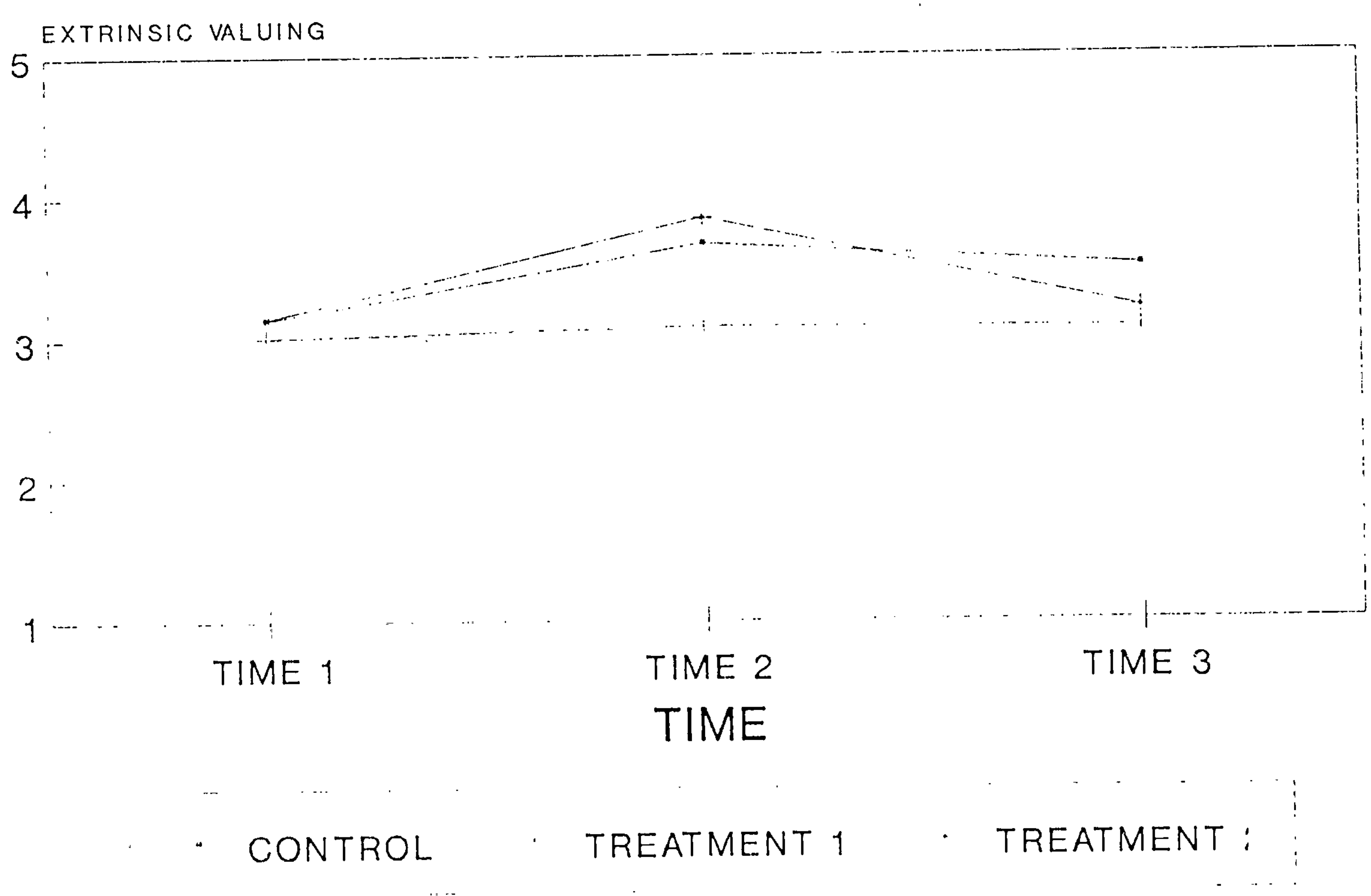

FIGURE 6
SELF-EFFICACY BY TIME

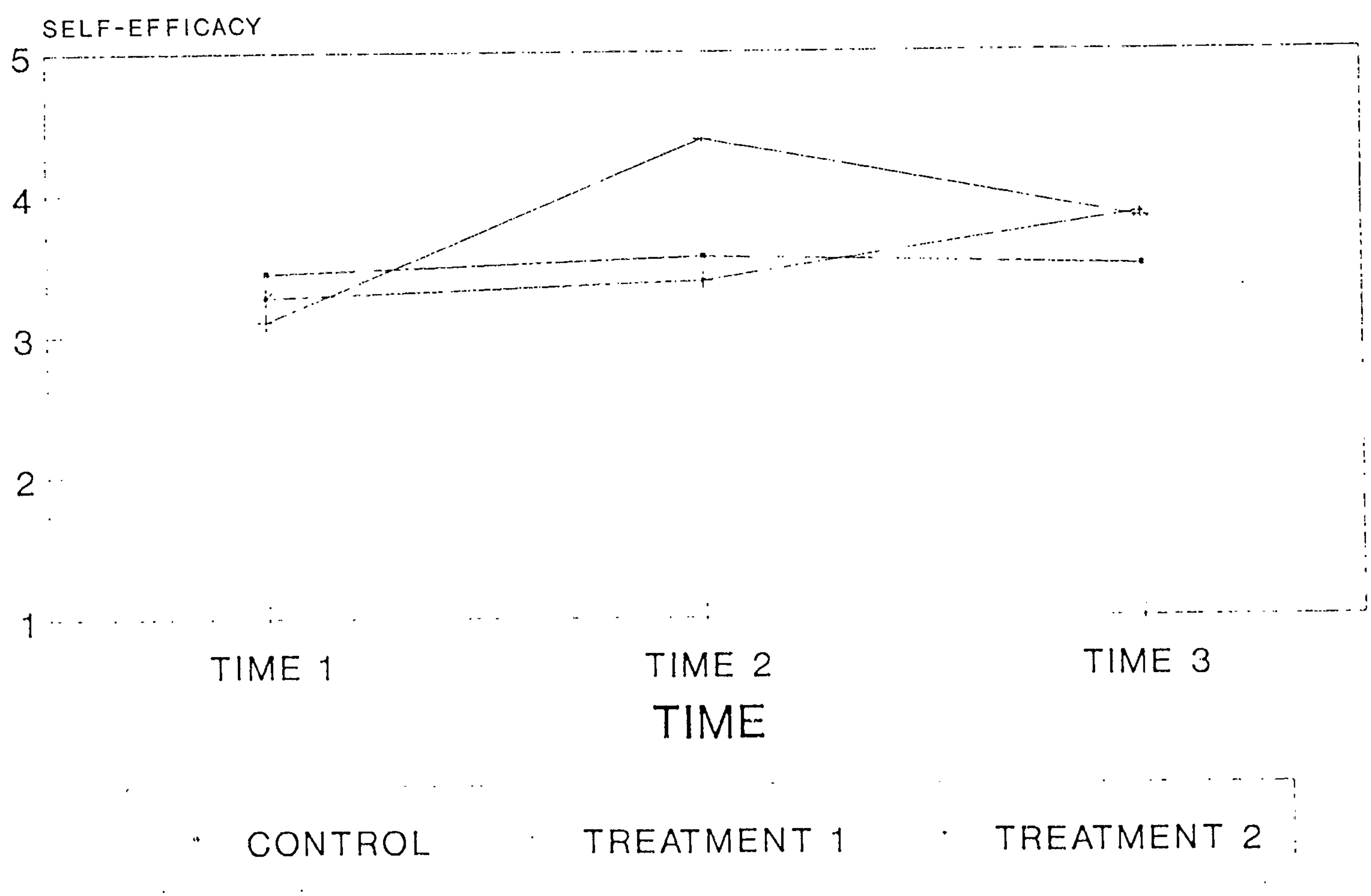

FIGURE 7
SHALLOW PROCESSING BY TIME

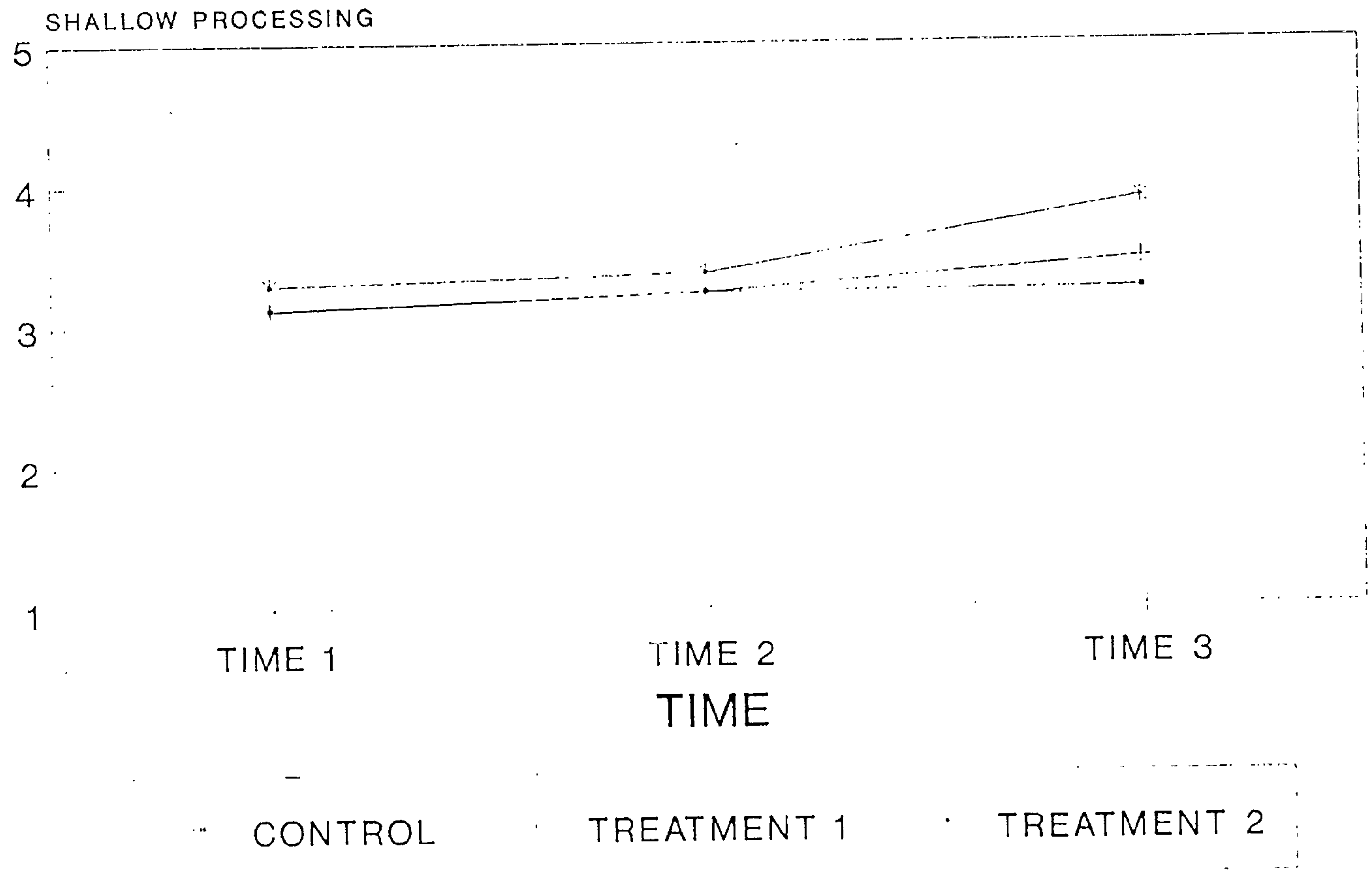

FIGURE 8
DEEP PROCESSING BY TIME