Cooperative Learning in a CEGEP Science Class

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August 28, 1992

Final Report submitted to Programme d'Aide sur l'enseignement et l'apprentissage (PAREA), Government of Quebec, Ministry of Education

ACKNOWLEDGEMENTS

This research was supported by grants to the authors from the Ministry of Education, Province of Quebec, Programme d'aide sur l'enseignement et l'apprentissage (PAREA).

The authors wish to express their appreciation to the teachers and students who participated in this study. We also wish to thank all the Vanier personnel (in the book store, the print shop, audio-visual, etc.) who facilitated this research. Special thanks are due to Krishore Kumar and Francis Federbush, the Vanier Biology technicians who helped make this project possible.

We wish to thank the members of the Centre for the Study of Classroom Processes for their invaluable discussion and help during all stages of this research. Further thanks are due to Christine Kouros, Kiki Kastelorizios, Diane Wagner and Scott MacKay for their invaluable assistance in carrying out this project.

Finally, we would like to thank Nancy Brown and Maurry Epstein, of the Insitutional Planning, Research and Professional Development Office for their help and encouragement.

ABSTRACT

Cooperative learning is a set of instructional strategies in which students work in small, usually heterogeneous, groups to accomplish shared academic goals. Teams-Games Tournaments (TGT) is a cooperative learning strategy which uses group rewards based on the individual performance of all group members to create positive interdependence. Although research has indicated that this reward contingency enhances student achievement, some researchers question the effect of extrinsic rewards on other learning goals and the advantage of heterogeneous grouping, over homogeneous grouping.

The data reported in this paper demonstrate that TGT enhanced achievement for all students and perceived learning for low- and medium-ability students. However, TGT was detrimental to the academic self-concept of medium-ability students.

Rewarding students on the basis of group performance enhanced achievement, but decreased future expectations of success, academic self-concept and feelings of group cohesiveness compared to rewarding students independently of performance. There were significant interactions between reward type and grouping such that when students in homogeneous teams were rewarded independently of performance, they felt less negative, more positive about learning biology, and more competent than did students in heterogeneous teams. Gender, status, and prior performance moderated the behaviours of students in small groups and subsequent learning.

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GENERAL INTRODUCTION

Theoretical Framework

There are several objectives in effective instruction: first, students should learn and what they learn should remain with them and ultimately expands their cognitive skills. Second, students should develop positive attitudes toward learning, schools, teachers, and classmates. Third, students should acquire the desire to learn and a belief that they can learn. Finally, students should acquire these abilities and dispositions in the social, interpersonal context that they will experience both inside and outside of the classroom and school. Cooperative learning methods attempt to satisfy these objectives better than alternative methods of instruction.

At last count there were at least twenty cooperative learning methods in use in schools (e.g., Aronson, 1978; Slavin, 1987, Johnson & Johnson, 1987; Sharan & Sharan, 1976; and Kagan, 1985). Thus, it is not possible to provide a single definition of cooperative learning which encompasses this diversity. One characteristic which distinguishes cooperative learning from other methods is the goal or reward structure employed. There are three classroom reward structures: competitive, individualistic and cooperative. In a cooperative structure, student rewards or goals are positively linked. In a competitive structure, student rewards or goals are negatively linked, while in an individualistic structure, student rewards or goals are not linked. Robert Slavin and his colleagues at Johns Hopkins

University have developed a number of student team learning strategies based on the belief that students are not always intrinsically motivated to learn academic material and that, in traditional educational settings, students do not have equal opportunities to succeed. One of these strategies, Teams-Games-Tournaments (TGT), has been used extensively at many grade levels and across a diversity of content areas. Although it has often been used for content-acquisition, there is no inherent reason it could not be used with more complex learning tasks. Cooperative learning is a set of instructional strategies where students work together in small, usually heterogeneous, learning teams to accomplish shared academic goals. Cooperative learning strategies differ from traditional group work in that the former explicitly include ways of encouraging students to work together.

The large and diverse literature on cooperative learning has been extensively reviewed (Johnson, Maruyama, Johnson, Nelson & Skon, 1981; Johnson & Johnson, 1989; Slavin, 1989a; Sherman, 1986). Most reviewers have found that cooperative learning enhances both achievement and attitudes towards learning. However, Slavin (1983b, 1989a) has reported that not all cooperative learning strategies are equally effective. In general, cooperative learning methods that employ both group rewards and individual accountability were superior. Both the learning efforts of every member of the group must be necessary for group success, and the performance of each group member must be clear to the other group members.

Still other, reviews of classroom reward structures (e.g. Elliot & Turco, 1986; Hayes, 1976; Michaels, 1977; Sharan, 1980; Slavin, 1977; Slavin, 1980; Webb, 1985) deviate from the conclusions of Johnson *et al*. (1981). For example, Michael (1977) concluded that individual competition was consistently superior to cooperative learning. These inconsistent conclusions are due to several factors. First, the reviewers differed in the dimensions of cooperative learning they chose to contrast. Second, different collections of primary studies were included in the reviews. Third, the reviewed cooperative learning strategies reflect different theoretical perspectives about underlying mechanisms; instructional innovations are often introduced rendering the cooperative learning strategies ineffective.

Although the benefits of cooperative learning relative to traditional instruction have been frequently investigated, less is known about the mechanisms which underlie cooperative learning. These proposed mechanisms reflect different theoretical perspectives (Abrami *et al*., 1990; Slavin, 1989b). Three of the perspectives that have informed this research are the behavioral, humanistic, and developmental perspectives.

Behavioral perspectives Behavioral theories of learning, notably B.F. Skinner's theory of operant conditioning, emphasize the relationship between student learning behaviours and the reinforcing or punitive consequences of those behaviours. A learning behaviour is increased when it is followed by a reward; nonrewarded or punished behaviours will be decreased. To a behaviourist, it is important both to specify the content to be learned (i.e., the student behaviour to be emitted) and to identify ways and methods to reward correct student learning.

Another motivational mechanism which may result in learning gains is the tendency to use more and larger terminal and intermittent rewards in cooperative learning than in traditional instruction. For example, in Johnson, Johnson, and Stanne (1985, 1986) the cooperative groups achieved a far greater number of intermittent rewards than either the competitive or individualistic groups. Slavin and his colleagues at Johns Hopkins University have developed a number of cooperative learning strategies (such as TGT) based on the beliefs that students are not always intrinsically motivated to learn academic material and that in traditional classes not all students have equal opportunity to earn rewards for learning gains (Slavin, 1987). These strategies employ a group contingency, in which group rewards are based on the individual contribution of all team members. Reviews of the literature on cooperative learning (Slavin, 1989a) have indicated that, with few exceptions, only those strategies that employ both group rewards and individual accountability enhance learning. Some advocates of cooperative learning downplay the use of tangible rewards to control team behaviour (e.g., Johnson & Johnson, 1987). To them, extrinsic rewards interfere with the intrinsic interest generated by the learning task and the positive group environment. Research on intrinsic motivation has explored the effects of tangible rewards on student interest (Lepper, 1983). Subsequent interest can be reduced by rewards if initial interest is high and the reward is seen as an attempt to control behaviour. Under such circumstances, students have two competing explanations for learning--interest and the reward--and their behaviour is overjustified, causing them to deny their interest. However, if initial task interest is low or rewards are perceived as informational (e.g., give feedback about performance), then subsequent task interest is not affected adversely.

Other motivational theorists emphasize the role of student attributions about success (Weiner, 1986). Ames (1984) suggested that different motivational systems are associated with each classroom reward structure. An egotistical motivational system underlies competitive rewards. Students are motivated by the desire to win in order to enhance their self-perceptions and consequently, learning outcomes are attributed to ability. A morality-based motivational system underlies cooperative rewards. Students are motivated by the desire to help others in order to increase the probability of a positive group outcome and consequently, learning outcomes are attributed to effort. A mastery-oriented motivational system underlies individualistic rewards. Students are motivated by the desire to achieve some standard of excellence. Consequently, when social comparison does not occur, learning outcomes are attributed to effort. However, when social comparison occurs, learning outcomes are attributed to ability. Chambers and Abrami (1991) argued that classroom research is needed to explore these motivational systems when other factors (e.g., ego involvement, partner familiarity, task importance, duration of treatment, etc.) impinge on students.

Cooperative Learning often changes the probability of success for team members in a way that enhances achievement. For example, high ability students may learn that doing well is more difficult in a group, while the opposite occurs for low ability students. According to Atkinson's (1966) expectancy-value theory of achievement motivation, changing the subjective probability of task outcome toward a moderate likelihood of success increases a student's motivation to succeed. Thus in a group learning situation both high and low ability students may be more motivated to work at learning.

Humanistic perspectives Humanistic approaches to learning are especially concerned with the individual's feelings and self-perceptions and with developing human potential. Some humanists argue that their approaches enhance cognitive performance and mastery of school subjects. Other humanists argue that they do not care if humanistic teaching relates to academic achievement because personal development is an important objective of schooling in its own right. Recent school applications of humanistic theories include open education and values clarification activities. Humanistic principles of education assume that students have a natural potential for learning and that their learning is enhanced when students are actively involved in a nonthreatening environment that fosters independence, creativity and self reliance. This is accomplished when students find the subject matter interesting and relevant to their own purposes; when students' learning is self-initiated and they are totally involved in the process.

Many educators consider that social comparison of academic achievement results in students forming self concepts of academic ability which in turn may affect subsequent learning. These may be debilitating to poorer students. Based on the positive reports from the major proponents of cooperative learning (Johnson, *et al.*, 1981; Johnson, Johnson, & Maruyama, 1983; Slavin, 1983b) one expects that cooperative learning students will have positive academic self concepts. However it is equally likely that with prolonged exposure to learning in heterogeneous teams the reduced academic recognition and possibility of lower grades for high achievers results in a diminished self concept.

Virtually all cooperative learning methods promote the development of student affective and social skills. But they do not place equal emphasis either on affective development as a learning goal or on allowing students control over what is to be learned and how it is to be learned.

<u>Developmental perspectives</u> An alternative view to Slavin and other motivational theorists is offered by developmental theorists. Both Piaget and Vygotsky recognized the importance of peer interaction in enhancing cognitive development. It was Vygotsky's view that the internalization of social interaction

leads to learning. Children who have attained a particular level of achievement may be capable of grasping concepts beyond their current level with cooperation or instruction from others (Vygotsky, 1978). Interaction with another provides feedback to the individual about one's behaviour, which enables one to reflect upon this and modify future behaviour (Johnson & Fortman, 1988). Peer interactions among students create cognitive conflicts and stimulate higher level thought processes. Egocentrism is overcome by the restructuring of mental structures to accommodate new information; thus, exposure to verbal interaction with peers would initiate this restructuring.

Johnson and Johnson (1987) believe that taking another's point of view is increased primarily through the use of controversy. Controversies arise when two people have ideas or opinions that are incompatible with each other. If students learn how to resolve constructively differences of opinion that they encounter in their work with other students, their cognitive development is enhanced. Some cooperative classroom techniques provide many opportunities for students to engage in discussions which can increase student achievement (Johnson & Johnson, 1981).

Learning through Interpersonal Interaction. Although researchers usually take one perspective, the causal mechanisms underlying cooperative learning need not be mutually exclusive. Abrami *et al.* (1990) presented a framework useful for integrating the disparate approaches to Cooperative Learning. A revised version is represented in Figure 1.

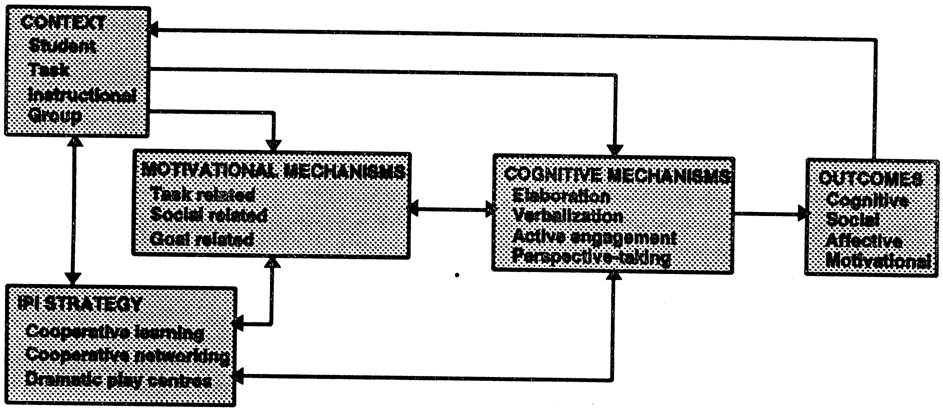

Figure 1. A General Model of Learning Through Interpersonal Interaction.

<u>Context</u> A model of Cooperative Learning must take into account the larger context within which instruction occurs and its impact on the effectiveness of the strategy employed. For example, consideration must be given to the individual student's skills and qualities brought to the learning situation (e.g., prior knowledge, verbal ability, gender, status), and to the group dynamic which develops when these individual characteristics are combined. In addition, consideration must be given to instructional characteristics (e.g., teacher style, class and school climate), and the nature of the learning task (e.g., reproductive *versus* constructive).

<u>Motivational and Cognitive Mechanisms</u> There are two basic mechanisms--motivational and cognitive--which are responsible for effective Cooperative learning and which operate differently depending on context and strategy. By motivational mechanism we

mean any structure or event which affects effort, involvement, or persistence at a learning task. By cognitive mechanism we mean any structure or event which affects the processing, storage, or retrieval of information. The Cooperative Learning strategies differentially activate the motivational mechanisms which control learning. Students may be motivated by tangible group rewards to assist their teammates (behavioral perspective; Slavin, 1989), because they care about the group and its accomplishments (social interdependence perspective; Johnson & Johnson, 1989), because they believe personal effort affects learning (attribution perspective; Chambers & Abrami, 1991), or because expectations for success are enhanced (achievement need perspective; Abrami *et al.*, 1992). In the humanistic perspective (Clarke, in press), learning is enhanced when students are actively involved in a nonthreatening environment that fosters independence, creativity and self reliance. The Cooperative Learning strategies also differentially activate the cognitive mechanisms. In the developmental perspective (Damon, 1984), interaction among children around appropriate tasks affects their understanding. In the cognitive elaboration perspective (Dansereau, in press; Webb, 1989), learning occurs as the student elaborates on or restructures the material to be learned. Finally, in the practice perspective (Rosenshine & Stevens, 1986), learning occurs as the student rehearses with teammates.

Cooperative Learning Strategy All Cooperative Learning methods involve students working actively in small groups that are structured to foster positive student interdependence. However, Cooperative Learning strategies take many forms and may vary on a number of dimensions including: the nature and degree of individual accountability, group composition, how positive interdependence is structured, the roles teachers and students take, how the task is structured, how learning is evaluated, and the degree to which students reflect on and assess their interactions (Abrami *et al.*, 1990).

Slavin's (1990) Student Team Learning techniques (e.g., Teams-Games-Tournaments) exemplify the behavioral perspective because the learning task is divided into small segments and success is recognized and rewarded. Learning Together (Johnson & Johnson, 1987) exemplifies the social interdependence perspective because students are encouraged through team building and group processing activities to develop both interpersonal skills and positive classroom climate and social support. Aspects of Group Investigation (Sharan & Hertz-Lazarowitz, 1980) and Co-op Co-op (Kagan, 1990) exemplify the humanistic perspective because students are given extraordinary control for planning, executing, and reporting on their learning activities and/or because an objective of group work is building self-esteem and responsibility. Peer tutoring techniques (Damon, 1984) exemplify the developmental perspective because more capable peers help other students progress further in their zone of proximal development (Vygotsky, 1978). Cooperative Networking, a cooperative learning strategy being developed for science text comprehension (d'Apollonia *et al.*, 1992) exemplifies the cognitive elaboration perspective because students work in small groups to develop concept maps to facilitate text comprehension.

In order to enhance learning, Cooperative Learning strategies manage specific aspects of the context (e.g., arrange group composition). Thus, one issue that often arises is how to assign students to groups. Most cooperative learning strategies recommend assigning students to heterogeneous groups to improve classroom management and social integration, and to reduce possible negative effects of labelling on low ability students' self-concept. However, in a review of within-class ability grouping (not using cooperative learning), Slavin (1987) stated that in the few studies that have been conducted (all in mathematics classes) homogeneous grouping has been more favourable than heterogeneous grouping. However, he cautions readers that more research on the effects of homogeneous grouping is needed. Other researchers (Abraham, 1976, Webb, 1985) have also cautioned that heterogeneous grouping is not beneficial for some students (e.g., medium ability students, introverted students).

Other educators consider that social comparison of academic achievement results in students forming self concepts of academic ability which in turn may affect subsequent learning. This may be especially detrimental to low ability students in heterogeneous groups. Educational sociologists have pointed out that using characteristics such as race, gender, and ability to distribute students "equitably", confirms the saliency of such status characteristics. Although between-group status problems may be decreased, within-group status problems may be increased (Cohen, 1986).

Outcomes The results of learning through Cooperative Learning are classifiable into four domains: intellectual, social, affective, and motivational. These outcomes affect one another (e.g., a student's academic learning promotes feelings of self-worth). They also affect, in a cyclical fashion, the context characteristics (e.g., by affecting group harmony or changing student beliefs about the learning task). An underlying assumption for the benefits of Cooperative Learning is that they are mediated via positive verbal and non-verbal interactions among the group members. However, there have been few studies which have collected observational data of these student interactions (Webb, 1989; Hertz-Lazarowitz & Davidson, 1990; Battistich, Solomon, & Delucchi, 1990; Deering & Meloth, 1990). Thus, student behaviours during Cooperative Learning are important outcome variables that should be observed.

Relevance to CEGEP System

Most of the research that has been described has been carried out in elementary and secondary school settings. There have been very few field studies of cooperative learning conducted in postsecondary institutions, even though multisection college courses offer a unique opportunity to study the factors which influence team learning. Cooperative learning techniques have been used in biology courses (Owie, 1983), health related courses (Frierson, 1987), and psychology courses (Cooper, 1973; Sherman, 1986; Carrol, 1986). In general, cooperative learning strategies improved academic performance especially when test-taking instruction was given (Frierson, 1987). Results also suggested that the peer interaction and exposure to different learning strategies rather than the reward structure was responsible for the effectiveness of cooperative learning (Hagman & Hayes, 1986).

Short-term laboratory studies have also shown that cooperative learning strategies are not always superior to traditional instruction. Moderator variables such as gender (Michaels, 1974), student preference for competitive versus cooperative learning situations (Cohen, 1984), heterogeneity of learning styles within group (Bodine, 1977; Hall *et al.*, 1988; McDonald *et al.*, 1985; Larson *et al.*, 1984) and task type (O'Donnell *et al.*, 1985) could affect learning such that cooperative learning methods were inferior. These studies have also indicated that intergroup processes (Michaels, 1974; Cohen, 1984; Worchell & Norvell, 1980) and the verbalization of metacognitive activities (Tjosvold & Fabrey, 1980) rather than the reward structure itself are responsible for the effectiveness of the cooperative learning method in post-secondary classes. Thus, an additional goal of this study is to explore the effectiveness of Cooperative Learning in post-secondary education.

Objectives for this Research Project

The objectives of this study are threefold: First, we will determine the effectiveness of cooperative learning (TGT in this case) in CEGEP science class on achievement, affect and motivational learning outcomes. Second, we will manipulate reward type and grouping and investigate the effects of these variables on the above learning outcomes and on obserbed students verbal interactions. Third, we will investigate whether individual differences (such as gender, verbal ability, within-group status and prior performance) and group differences (such as degree of team heterogeneity) moderate the effectiveness of cooperative learning. The following questions will be addressed:

1. Does cooperative learning (TGT in this study) enhance achievement, motivation, and affect compared to traditional biology laboratory instruction?
2. What are the effects of reward contingency and grouping on the above outcomes and on students' interactive behaviours?
3. Do individual differences, such as ability, gender, status, and prior performance moderate the effectiveness of cooperative learning?

METHODOLOGY

Subjects.

Students (N=346) enrolled in the multi-section introductory biology course from a Montreal CEGEP and five instructors participated in three studies during the 1989-1990 and 1990-1991 academic year.

Instructional Strategy and Research Design

Since, both researchers teach introductory biology at a Montreal CEGEP, and are therefore most familiar with the biology curriculum, we decided to implement the research project in the CEGEP General Biology Course (Biology 301). Students often complain about the section on diversity and appear to find this section of the course difficult. Since TGT was designed to resolve problems associated with poor student motivation, discriminatory learning opportunities, and tasks demanding factual recall, we decided to implement TGT in the last four weeks of the semester when students are studying diversity in prokaryote, protista, fungi, plants and animals. In general, TGT[1] consists of a cycle of activities which includes whole-class lectures by the teacher, structured-team learning sessions, academic tournaments and team recognition. The three latter activities are intended to enhance motivation, give every student an equal opportunity to learn, and to make learning facts "enjoyable".

This section of the biology course consists of 9 hours of laboratory instruction in addition to the time spent in class. The content used for this study was adapted by the principal investigator from the regular biology laboratory curriculum for use with TGT (group laboratory activities, group worksheets, tournament questions). A common laboratory exam (worth 15 marks)

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[1] A more complete description of TGT, from *Using Cooperative Learning* is given in Appendix 1.

was prepared in consultation with the instructors normally teaching the course. Examples of the curricular materials can be obtained from the first author of this report.

In Study 1[2] (carried out in the winter 1990 semester) two instructors each taught one laboratory section using TGT and one section using traditional methods. There were 73 students enrolled in the four laboratory sections. The researchers categorized students in the experimental classes into three ability groups (low, medium, and high) on the basis of their performance on a verbal ability test and randomly assigned students within ability groups to 3-member heterogeneous or homogeneous teams (see Appendix 1 for details). The instructor introduced the laboratory exercises (approximately 30 minutes) and then instructed the students to worked in their teams (approximately two hours). Students then participated (approximately 15 minutes) in either a tournament (experimental classes) or a class quiz (control classes). At each tournament, students of similar ability representing different learning teams competed to answer questions on the laboratory material and gained points for their learning team. After each tournament, the researchers calculated the team scores, publicized the results of the tournaments, and reassigned students to new competition levels (bumping) for the next tournament. Students in the experimental sections were given their team cumulative

[2] Because more students take biology in the fall semester, and since we required a larger sample size for the second study, Study 1 followed Study 2 temporally.

tournament score as their lab grade for the three labs (3% of their final grade). Since the 73 students were not randomly assigned to experimental and control classes, this study used a nonequivalent control group pretest-posttest with student ability (ranking in the group) as a within-group factor.

In study 2 (carried out in the fall 1989 semester) four instructors volunteered to teach eight laboratory sections using TGT, but with three reward conditions (see below). The researchers divided the 156 students into three ability groups (low, medium, and high) based on their performance on a verbal-ability test and then randomly assigned students within each ability group to either 3-member heterogeneous or homogeneous teams. The principle investigator introduced the laboratory exercises (approximately 30 minutes) and then instructed the students to work in their teams (approximately two hours). Students then participated in a tournament (approximately 15 minutes). After each tournament, the researchers calculated the team scores, publicized the results of the tournaments, and reassigned students to new competition levels (bumping) for the next tournament. The eight laboratory sections were randomly assigned to one of three reward contingencies (performance-independent, individual-performance, group-performance). In the performance-independent contingency (PIC) condition, 3 students were selected at random to "win" pairs of cinema passes; in the individual-performance contingency (IPC) condition the three individuals who received the highest scores in each lab, each received a pair of cinema passes; in the group-performance (GPC) condition, the team that obtained the highest cumulative score received six cinema passes. Thus, the core design for study 2 was a 2x3x3 factorial (grouping by reward by ability).

In study 3 (carried out in the fall 1990 semester) two instructors taught six sections of the course. The researchers categorized the 117 students into three ability groups (low, medium, and high) based on their performance on a prior laboratory test and randomly assigned students within their ability group into either 3-member heterogeneous or homogeneous teams. The principle investigator introduced the laboratory (15 minutes) and instructed the students to get into their teams and review the information necessary to complete the laboratory exercise (approximately 30 minutes). Students then participated in a tournament on the laboratory material (approximately 15 minutes). The instructor then instructed the students to complete the laboratory exercises as a team and hand in a team lab report (approximately two hours). After each tournament, the researchers calculated the team scores, publicized the results of the tournaments, and reassigned students to new competition levels (bumping) for the next tournament. Students were given their team cumulative tournament score as their lab grade for the three labs (3% of their final grade). Thus, the core design for study 3 was a 2x3 factorial (grouping by ability).

These design features and the independent, dependent and moderator variables used in each study are summarized in Table 1.

Table 1. Investigated variables and study features.

Study 1. Winter 1990.

Subjects:
2 instructors
4 lab sections
73 students

Independent Variables:
Instructional Strategy (TGT vs Traditional)

Moderator Variables:
Verbal ability rank within group (low, medium, and high)

Dependent Variables:

Achievement: common final lab test, individual tournament or quiz scores, team tournament scores, perceived learning.

Affect: academic self-concept, future expectations of learning, feelings of group cohesiveness, cooperative, individualistic, and competitive classroom climate.

Motivation: attributions to effort, ability, difficulty, and luck, external, stable and controllable causal dimensions, orientation to mastery, ego, affiliative and work-avoidance goals.

Study 2. Autumn 1989.

Subjects:
4 instructors
8 lab sections
156 students

Independent Variables:
Reward Contingency (Group-performance contingency, individual-performance contingency and performance-independent contingency)
Grouping (homogeneous vs. heterogeneous)

Moderator Variables:
Verbal ability rank within group (low, medium, and high)

Dependent Variables:

Achievement: common final lab test, individual tournament or quiz scores, team tournament scores, perceived learning.

Table 1 cont. Investigated variables and study features.

Study 2. Autumn 1989.

Dependent Variables:

Affect:	academic self-concept, future expectations of learning, feelings of group cohesiveness, cooperative, individualistic, and competitive classroom climate, positive feelings, negative feelings and feelings of competence about learning biology.
Motivation:	attributions to effort, ability, difficulty, and luck, external, stable and controllable causal dimensions, orientation to mastery, ego, affiliative and work-avoidance goals.
Observations:	group behaviours.

Study 3. Autumn 1990.

Subjects:
3 instructors
6 lab sections
117 students

Independent Variables:
Grouping (homogeneous vs heterogeneous)

Moderator Variables:
Prior performance rank within group (low, medium, and high)
Gender
Status
Degree of group heterogeneity

Dependent Variables:

Achievement:	common final lab test, individual tournament or quiz scores, team tournament scores, perceived learning.
Affect:	future expectations of learning, feelings of group cohesiveness, positive feelings, negative feelings and feelings of competence about learning biology.
Motivation:	attributions to effort, ability, difficulty, help from others, and luck, orientation to mastery, ego, affiliative and work-avoidance goals, active engagement and superficial learning.
Observations:	individual behaviours.

Measures.

Scores from the verbal component of the Canadian Cognitive Abilities Test (CAT) (Thorndike & Hagen, 1988) were used to categorize students as either low medium or high ability. These CAT scores were also used to assign students to groups. Scores from teacher-constructed laboratory test administered four weeks prior to the start of the study were used to control for pre-existing achievement differences amongst students. At the conclusion of the study, all students took a common laboratory achievement test. In addition, all students completed a questionnaire two weeks prior to the start of the study and again at the end of the study. A sample questionnaire is presented in Appendix 2; The complete set of questionnaires and tests can be obtained from the first author. Thus, the following three types of outcomes[3] were assessed:

Achievement. There were five measures of achievement:

a) Achievement was assessed using the common final laboratory test (20 questions) prepared by the principle investigator in consultation with the instructors.

b) Team performance was assessed using the average of team scores on the three weekly tournaments.

c) Individual performance on the tournaments was assessed using the individual student's average score on the three tournaments.

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[3] The outcomes are categorized in this manner to simplify reporting and discussing the results and not because the authors necessarily believe in this categorization schema.

d) Perceived learning was assessed by one item on the questionnaire (How well have you learned biology in the past?).

e) Prior knowledge was assessed using a laboratory test which was prepared by the instructors and co-ordinated by the department.

Affective. There were five measures of affective outcomes:

a) Expectations of future success were assessed by one item on the questionnaire (How well do you expect to learn biology in the future?).

b) Academic self concept was obtained using the Self Descriptive Questionnaire II (Marsh, 1988).

c) Group cohesiveness was obtained using the Gross Cohesiveness Scale (Johnson & Fortman, 1988).

d) Classroom climate was obtained using the items from the Cooperative, Independent and Competitive Scales of the Classroom Life Instrument (Johnson, Johnson, & Anderson, 1983).

e) Feelings about learning were assessed by an instrument developed by the Centre for the Study of Classroom Processes. This instrument measures positive feelings about learning biology, negative feelings about learning biology and feelings of competence about learning biology.

Motivation. There were three measures of motivational outcomes.

a) Causal beliefs were assessed using Beliefs About Learning (Ames, 1984) which assesses the extent to which students attribute learning to ability, effort, luck, course difficulty and help from teammates.

b) Attributional dimensions were assessed using the Causal Dimension Scale (Russell, 1982) which assesses the extent to which students make external, stable and controllable attributions.

c) The students learning goals were assessed with the Science Activity Survey (Meece, Blumenfeld, & Hoyle, 1988) which assesses the degree to which students are motivated by mastery, ego, social and work-avoidance goals. This scale also measures the degree to which students are actively and superficially engaged in learning activities.

Observation Schema for Study 2:

The Lab Station Observation Scheme consists of six major categories: time, group, students' functional interactions and behaviours; student's non-functional interactions and behaviours; seeking helping; and students' reactions to both rewards and group work (Poulsen, *et al.*, 1992). For a more detailed description of this observation schema contact the first author.

The first and second categories, time and group, were used to identify the groups and to determine the length of time that each group was observed at the lab station.

The third category, functional interactions, and its three sub-categories, task-related, working-relationships, and non-verbal were used to observe the positive and constructive interactions and behaviours among group members. More specifically, the task-related sub-category was included in order to observe the students' cognitive interactions and behaviours. For example, the types of questions that students asked, their responses to these questions, and spontaneous comments that occurred during the group's interactions. The working-relationships sub-category was used to assess the social interactions and behaviours that occurred in students' groups. The non-verbal sub-category was used to tap the cognitive and social behaviours that occurred in students' groups.

The fourth category, non-functional behaviours, consisted of verbal and non-verbal sub-categories which were used to observe the students' negative and counter-productive interactions and behaviours.

The fifth category, seeking help, was used to observe the source of students' help, namely the instructor or students from other groups.

The last category, was designed to tap students' reactions to rewards as well as their reactions to group work.

The biology labs were set up with four large tables at which six or seven students were seated. In addition, six lab stations were set up with various displays. Students and their group members came to these lab stations to work on the displays. Observers conducted observations at one of these lab stations using the Lab Station Observation Scheme. To facilitate observing, the groups were instructed by the instructor to work at the target lab station one at the time.

During the observations, observers: a) sat close enough to the group to hear the interaction but not so close as to interfere with the groups' functioning; b) noted the time at which they began and finished observing each group; c) noted the group's identification label; d) noted the number of team members that were present; e) recorded the activity; and f) recorded the frequencies of the groups' interactions and behaviours according to the items on the scheme. If a groups' interactions were complex such that they required the observers to code more than one item on the observation scheme, multiple coding was permitted. For example, if a corrective statement became an elaboration of information, then two tally marks were entered under the corrective category and under the elaboration of information category. If a groups' interaction could not be classified using the scheme, that interaction was described.

Observation Schema for Study 3.

The Lab Station Observation Scheme used in Study 3 (Fall of 1990) was a modification of the scheme used during Study 2 (Fall of 1989). This revised scheme consisted of 12 major categories which observers would use to categorize students' behaviours and interactions. The observation scheme captured a predetermined set of behaviours: giving directions (DI), asking for help or for the answer (HE), giving information (with no elaboration) (IN), providing an explanation or elaboration (EL), checking one's own answers and/or understanding (CH), supporting peers (SP), belittling peers (BP), listening in (LI), on-task work (non-interactive) (ON), off-task behaviours (OF), reading text aloud

(RE), and departing from group (DE) (Kouros, *et al.*, 1992). A complete description of these variables and of the observation scheme can be obtained from the first author.

In addition to recording the 12 behaviours outlined above, the Source and Target for each behaviour were recorded in order to identify who was initiating the behaviour and who was the recipient of the behaviour (e.g., when a group member asked for help observers noted whether the observed student gave (source) or received (target) the help). Student and Time categories were used to identify the students within a group and to keep track of the ten second intervals. Finally, global ratings were assigned for: a) the level of cooperation within each group; and b) the relative dominance status of each group member.

As with the previous Lab Station Observation Scheme, this revised scheme also captured the academic and social behaviours of group members, however, there were a smaller number of such variables than found in the first scheme. The reasons for this reduction in the number of variables were because observers in Study 2 found it difficult to keep track of all the variables on the scheme and because some of the variables in Study 2 occurred infrequently.

As in the first study, biology labs were set up with large tables at which six or seven students were seated. In addition, six or seven lab stations and an additional observational lab station were set up with various displays. During the three-hour lab, students were instructed to complete their work at the lab stations with their group members. To facilitate observing, each group member was asked to wear their name tags which had been previously prepared and each group was asked to reserve 15 minutes to work at the observational lab station.

In order to observe student behaviours as they worked together in a group, two observers and a video camera were stationed at the observational lab station. Observers conducted observations at this specified station using the Revised Lab Station Observation Scheme. In order to assess inter-rater reliability two observers were used. At the beginning of each observation, observers entered the Date, LAB period, Observer, and the Name of the Student on the Lab Station Observation Scheme. Every ten seconds the observers focused on a different group member and recorded the behaviours that occurred during the 10-second interval. A walkman with two sets of earphones was used to inform the observers when the ten second intervals had elapsed and when to focus on the next group member. For each team member that was observed, observers coded the appropriate category. For example, if the team member was giving directions to another team member, observers entered a "DI (S)" onto the scheme. However, if the observed student received these direction, then the observers recorded this information as "DI (T)". Multiple codes for a given behaviour or interaction were not permitted.

Approximately, four minutes after the initial observation, and again at the end of the observation session, the observers rated the level of cooperation of the group and the status of each member. To rate the cooperation of the group, a slash mark was placed on a scale representing group cooperation. The length of the line, so depicted, indicated the degree of cooperation exhibited by group members. High ratings of cooperation were given when each and every member of the group actively participated and contributed to the work at the lab station. Whereas, one global rating for cooperation was assigned to each team, status ratings were assigned for each individual student in the group. To rate the status of each student within the group, observers placed a slash mark on a scale representing status. The length of the line, so depicted, indicated each students status within the group. Status was determined on factors other than ability;*e.g.*, posture, dominance, voice, and territoriality.

Data Analysis.

Changes during the course of instruction were analyzed using repeated measures techniques. Since there were pretest differences for some of the measures, analysis of covariance (ANCOVA) was used to adjust posttest means for initial non-equivalence. The covariate in all cases was the appropriate pretest measure. In addition, hierarchical multiple regression techniques were used to test for aptitude by treatment interactions with degree of heterogeneity in the third study. The appropriate pretest measure was entered during the first step, performance-rank (within the group) was entered second, the degree of heterogeneity was entered third, and the interaction between performance and grouping was entered on the fourth step. Post-hoc comparisons were made using Duncan's procedure (Kirk, 1982).

RESULTS [4]

Study 1. The questions addressed in this study were 'Does cooperative learning (TGT) enhance achievement, affect, and motivation?' and 'Do student differences such as ability moderate the effectiveness of cooperative learning?' The pretest and posttest scores for all achievement, affect and motivation measures used in this study are presented in Tables 2 to 7. The significant differences between the pretests and the posttests, as affected by the different instructional treatments, are reported below.

Achievement Measures. There were four measures of achievement used in this study: scores on a summative lab test, individual scores on the tournaments or quizzes, team scores on the tournaments, and perceived learning. Students performed significantly less well on the lab posttest than they did on the lab pretest, $F(1, 65) = 53.14$, $p < .001$. The average scores on the lab pretest and posttest were 12.2 and 9.7, respectively. However, this decrease in achievement was significantly reduced by cooperative learning, F (1, 65), $p = .05$. Students who were taught biology using TGT performed significantly better (adjusted $M = 10.65$) than did students taught by a traditional method (adjusted $M = 9.45$). In addition, there was a significant

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[4] The results of these studies have been reported in d'Apollonia *et al.* (1992).

TABLE 2

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR ACHIEVEMENT MEASURES FOR PRETESTS AND POSTTESTS (STUDY 1)

	CONTROL CONDITION								
MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
LAB	11.57	2.62	12	12.29	2.21	11	12.79	3.91	10
LAB	8.51	3.22	12	9.09	3.56	11	12.95	3.49	10
PASTEX	3.64	.92	11	3.82	.87	11	3.60	.84	10
PASTEX	3.25	.62	12	3.00	.45	11	3.60	1.07	10
TEAMTOT	-	-	-	-	-	-	-	-	-
INDTOT	16.38	5.51	12	15.45	4.25	11	17.63	2.52	10

Measures in **bold** are posttest measures. LAB is the teacher-constructed lab test. PASTEX is perceived learning. TEAMTOT is the mean team score on the tournaments. INDTOT is the mean individual score on the tournaments.

TABLE 3

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR ACHIEVEMENT MEASURES FOR PRETESTS AND POSTTESTS (STUDY 1)

	COOPERATIVE CONDITION								
MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
LAB	11.75	3.07	12	12.35	3.12	12	12.41	2.77	14
LAB	10.04	3.14	13	10.55	2.64	12	11.05	2.48	14
PASTEX	3.08	1.32	13	3.58	.67	12	3.23	1.30	13
PASTEX	3.58	.90	12	3.58	.79	12	3.14	.77	14
TEAMTOT	12.41	1.43	13	12.08	1.46	12	11.71	1.51	14
INDTOT	11.77	2.31	13	12.33	2.90	12	11.61	2.87	14

Measures in **bold** are posttest measures. LAB is the teacher-constructed lab test. PASTEX is perceived learning. TEAMTOT is the mean team score on the tournaments. INDTOT is the mean individual score on the tournaments.

TABLE 4

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR AFFECT MEASURES FOR PRETESTS AND POSTTESTS (STUDY 1)

	CONTROL CONDITION								
MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
SELF	2.85	.65	11	2.83	.56	11	2.59	.32	10
SELF	2.59	.43	12	2.83	.45	11	2.72	.65	10
COHESIV.	3.46	.66	11	3.35	.36	11	3.50	.80	10
COHESIV.	3.46	.57	12	2.89	.73	11	3.40	.63	10
EXPECT.	3.55	1.04	11	3.91	1.14	11	3.10	.74	10
EXPECT.	3.33	.78	12	3.27	.65	11	3.00	1.32	9
COOP.	3.53	.84	11	3.48	.49	11	3.85	.68	10
COOP.	3.51	.41	12	3.25	.62	11	3.66	.68	10
INDIV.	3.02	.63	11	3.38	.65	11	3.00	.54	10
INDIV.	2.82	.65	12	3.36	.61	11	3.06	.60	10
COMPET.	2.92	.77	11	2.80	.41	11	2.85	.67	10
COMPET.	2.86	.73	12	2.54	.63	11	2.56	.89	10

Measures in **bold** are posttest measures. SELF is self concept. COHESIV. is feelings of group cohesiveness. EXPECT. is future expectations. COOP. is perceptions of a cooperative classroom climate. INDIV. is perceptions of an individualistic classroom climate. COMPET. is perceptions of a competitive classroom climate.

TABLE 5

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR AFFECT MEASURES FOR PRETESTS AND POSTTESTS (STUDY 1)

	COOPERATIVE CONDITION								
MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
SELF	2.85	.80	13	2.93	.30	12	2.73	.57	14
SELF	2.78	.63	13	2.48	.65	12	2.48	.65	14
COHESIV.	3.65	.61	13	3.59	.58	12	3.43	.70	14
COHESIV.	3.25	.85	13	3.33	.77	12	3.32	.79	13
EXPECT.	3.83	1.11	12	3.25	1.14	12	3.31	1.55	13
EXPECT.	3.23	1.24	13	2.82	1.40	11	3.07	1.33	14
CLCOOP	3.66	.63	13	3.86	.31	12	3.90	.59	14
CLCOOP	3.27	.82	13	3.59	.51	12	3.50	.65	14
INDIV.	3.29	.58	13	3.01	.47	12	3.20	.84	14
INDIV.	3.38	.59	13	3.25	.59	12	3.23	.59	14
COMPET.	2.88	1.33	13	3.27	.82	12	2.97	.97	14
COMPET.	2.73	1.18	13	3.24	.82	12	2.80	.87	14

Measures in **bold** are posttest measures. SELF is self concept. COHESIV. is feelings of group cohesiveness. EXPECT. is future expectations. COOP. is perceptions of a cooperative classroom climate. INDIV. is perceptions of an individualistic classroom climate. COMPET. is perceptions of a competitive classroom climate.

TABLE 6

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR MOTIVATION MEASURES FOR PRETESTS AND POSTTESTS (STUDY 1)

	CONTROL CONDITION								
MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
LUCK	1.86	.71	11	1.95	1.06	11	2.75	1.01	10
LUCK	2.71	.84	12	2.27	1.01	11	3.15	1.23	10
EFFORT	3.91	.92	11	3.86	1.10	11	3.90	1.35	10
EFFORT	3.67	.78	12	3.77	.65	11	4.15	.94	10
ABILITY	3.77	.56	11	3.68	.64	11	4.10	.74	10
ABILITY	3.42	.51	12	3.55	.57	11	4.20	.92	10
DIFF.	3.14	.84	11	3.09	.94	11	4.15	.71	10
DIFF.	3.46	.50	12	3.64	.45	11	3.75	.49	10
EXTERNAL	2.46	.72	12	2.27	.52	11	2.05	.93	10
EXTERNAL	2.50	.81	11	2.05	.91	11	2.10	.66	10
STABLE	2.92	.73	12	2.64	.79	11	2.55	1.07	10
STABLE	2.67	.70	12	2.67	.68	11	2.67	.54	10
CONTROL	3.33	1.03	12	3.59	1.00	11	3.35	.82	10
CONTROL	3.17	.78	12	3.32	1.06	11	3.00	1.08	10
MASTERY	17.09	4.16	11	17.36	1.96	11	16.20	4.24	10
MASTERY	16.79	4.29	12	17.47	2.81	11	16.80	4.47	10
EGO	8.73	2.45	11	8.64	1.80	11	8.60	2.32	10
EGO	7.75	1.96	12	7.64	1.86	11	7.00	2.05	10
AFFILIAT.	7.36	2.06	11	8.91	2.12	11	8.10	1.52	10
AFFILIAT.	7.92	2.43	12	7.73	1.95	11	8.90	1.85	10
WORK-AV.	6.55	2.02	11	6.91	1.81	11	9.00	1.89	10
WORK-AV	7.83	1.75	12	6.82	2.60	11	8.20	1.99	10

Measures in **bold** are posttest measures. LUCK, EFFORT, ABILITY, and DIFF. are attributions to luck, effort, ability, and task difficulty. EXTERNAL, STABLE, and CONTROL are the locus of causality, stability, and controllable attributional dimensions. MASTERY, EGO, AFFILIAT., and WORK-AV. are mastery, ego, affiliative and work-avoidance goals respectively.

TABLE 7

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR MOTIVATION MEASURES FOR PRETESTS AND POSTTESTS (STUDY 1)

	COOPERATIVE CONDITION								
MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
LUCK	2.62	1.18	13	1.96	.86	12	1.96	1.10	14
LUCK	2.77	.90	13	2.75	.94	12	2.75	1.12	14
EFFORT	4.04	.90	13	3.88	.96	12	4.11	.88	14
EFFORT	3.92	.95	13	3.67	.75	12	3.93	1.27	14
ABILITY	3.42	.93	13	3.79	.72	12	3.86	.50	14
ABILITY	3.73	.99	13	3.21	.62	12	3.57	.98	14
DIFF.	3.77	.70	13	3.42	.79	12	3.36	1.46	14
DIFF.	3.77	.56	13	3.54	.58	12	3.82	.97	14
EXTERNAL	2.96	1.08	12	2.50	.80	12	1.89	.84	14
EXTERNAL	2.12	1.00	13	2.29	.81	12	2.11	.76	14
STABLE	3.01	.87	13	3.03	.87	12	2.88	1.00	14
STABLE	2.64	.55	13	2.64	.58	12	2.95	.68	14
CONTROL	3.08	1.10	12	3.17	.58	12	3.14	.99	14
CONTROL	3.27	1.01	13	3.08	.47	12	2.68	.70	14
MASTERY	19.77	4.21	13	19.00	2.59	12	17.54	4.21	14
MASTERY	18.60	5.06	13	17.83	2.98	12	15.79	4.46	14
EGO	8.15	2.82	13	8.92	3.06	12	8.36	2.56	14
EGO	7.85	3.46	13	7.92	2.68	12	7.71	1.94	14
AFFILIAT.	8.00	1.68	13	8.33	1.72	12	8.00	2.54	14
AFFILIAT.	7.46	1.81	13	8.42	1.44	12	6.93	2.56	14
WORK-AV.	6.15	2.12	13	7.46	2.59	12	7.71	2.95	14
WORK-AV.	6.62	1.98	13	7.04	1.89	12	6.50	2.98	14

Measures in **bold** are posttest measures. LUCK, EFFORT, ABILITY, and DIFF. are attributions to luck, effort, ability, and task difficulty. EXTERNAL, STABLE, and CONTROL are the locus of causality, stability, and controllable attributional dimensions. MASTERY, EGO, AFFILIAT., and WORK-AV. are mastery, ego, affiliative and work-avoidance goals respectively.

interaction between the students' perceptions of having learned biology well and the instructional strategy, $\underline{F}(1, 68) = 5.82$, $\underline{p} = .02$. When the students were taught using traditional instruction there was a significant decrease in their perceptions of having learned biology well (from an $\underline{M}$ of 3.7 to 3.3); however, when students were instructed using TGT there were no changes in perceptions of having learned biology well. There was also a significant interaction between ability and instructional strategy $\underline{F}(1, 68) = 4.90$, $\underline{p}=.03$. Low ability and medium ability students in the cooperative learning treatment reported that they had learned significantly more than did low ability and medium ability students in traditional classrooms. However, there were no significant differences in perceived learning for high ability students in the two instructional treatments (see Figure 2). Therefore, not only did students learn more when a cooperative learning strategy was used, but low and medium ability students also thought they had learned more.

Affective Measures. There were five measures of affective outcomes in this study: academic self-concept, future expectations of learning, feelings of group cohesiveness, and cooperative, individualistic, and competitive classroom climate. There were significant decreases in students' expectation of future success, $\underline{F},(1,61) = 6.09$, $\underline{p} = .02$, feelings of cohesiveness, $\underline{F}(1,64) = 7.5$, $\underline{p} = .01$, cooperative classroom climate, $\underline{F}(1, 65) = 13.78$, $\underline{p} = .001$, and competitive classroom climate, $\underline{F}(1, 65) = 4.32$, $\underline{p} = .04$, over the instructional period.

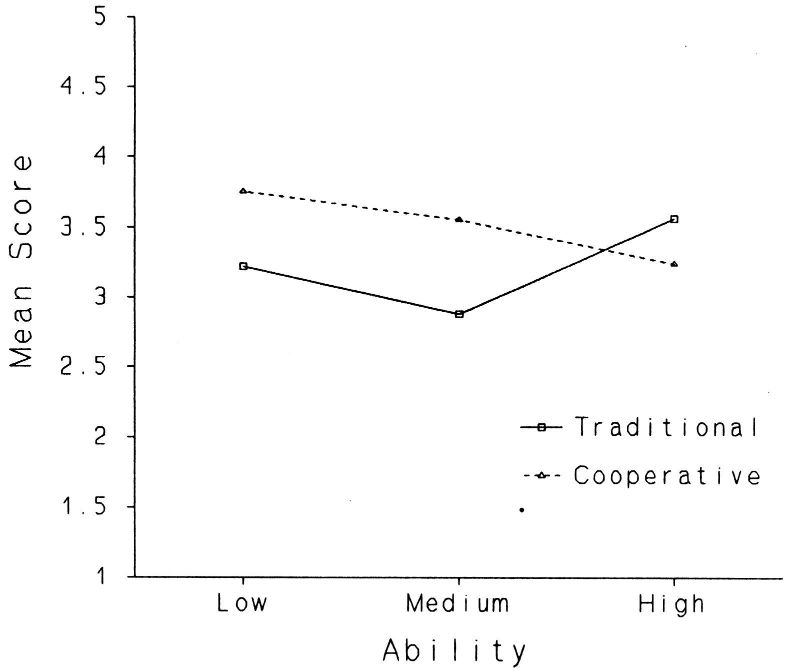


Figure 2. **The interaction between instructional strategy (cooperative learning, traditional instruction) and student ability (low, medium, high) on perceived learning of biology.**

In addition, there was a significant interaction between student ability and instructional strategy on academic self-concept, F(1, 64) = 3.28, p = .04. Low ability students' self-concept was higher under cooperative learning conditions, while medium and high ability students' self-concept was higher under traditional instruction (see Figure 3).

Thus, the laboratory exercises had a negative impact on students' affective outcomes; however, cooperative learning alleviated this effect for low ability students (*i.e.* enhanced their self-concept.)

Motivational Measures. There were eleven measures of motivational outcomes in this study: attributions to effort,

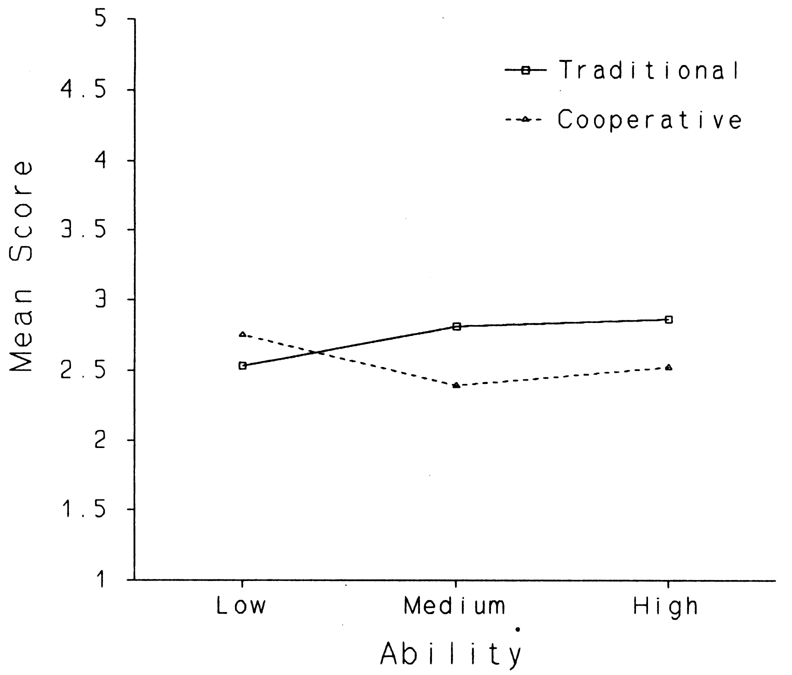


Figure 3. The interaction between instructional strategy (cooperative learning, traditional instruction) and student ability (low, medium, high) on academic self-concept.

ability, difficulty, and luck, external, stable and controllable causal dimensions, and orientation to mastery, ego, affiliative and work-avoidance goals. There were significant decreases in students' ego goals, $\underline{F}(1, 65) = 10.19$, $\underline{p} = .002$, over the instructional period. Moreover, there was a significant interaction between student ability and students' work-avoidance goals, $\underline{F}(1, 65)$ $\underline{p} = .05$. Work-avoidance goals increased for low ability students, remained the same for medium ability students, and decreased for high ability students over the instructional period (see Figure 4).

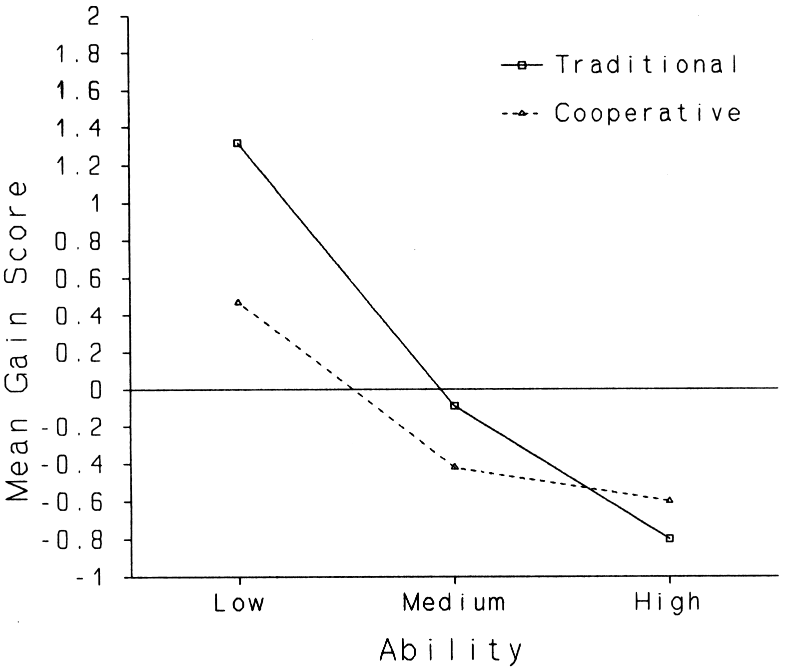


Figure 4. The influence of student ability (low, medium, high) on changes in work-avoidance goals during instruction.

There was also a significant interaction between students' affiliative goals and instructional strategy $\underline{F}(1, 64) = 31.24$, $\underline{p} < .001$. High ability students in traditional classes had more affiliative goals than did high ability students in cooperative classes (see Figure 5).

There was a significant increase in students' attributions of learning biology to luck, $\underline{F}(1, 65) = 19.11$, $\underline{p} < .001$ over the instructional period. In addition, there was a significant interaction between ability and instructional strategy on students'

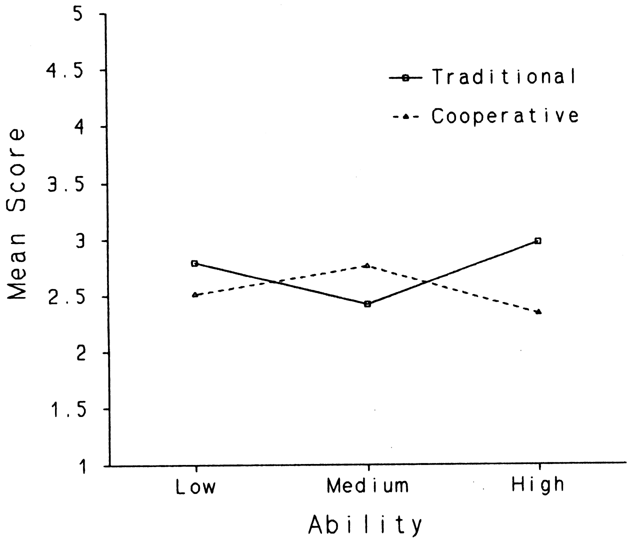


Figure 5. **The interaction between instructional strategy (cooperative learning, traditional instruction) and student ability (low, medium, high) on affiliative goals.**

attributions to ability, F(2, 64) = 3.64, p = .02. Medium ability and high ability students made more attributions to ability in traditional classes; however, low ability students made more attributions to ability in cooperative learning classes (see Figure 6).

Thus, the laboratory exercises had a negative impact on some of the students' motivational outcomes (a reduction in learning to achieve ego goals, and increased attributions to luck). However, these were moderated by student ability. Only low ability students acquired more work-avoidance goals. Cooperative learning affected some of these motivational outcomes for some students: it increased low ability students' causal attributions to ability and decreased high ability students' affiliative goals.

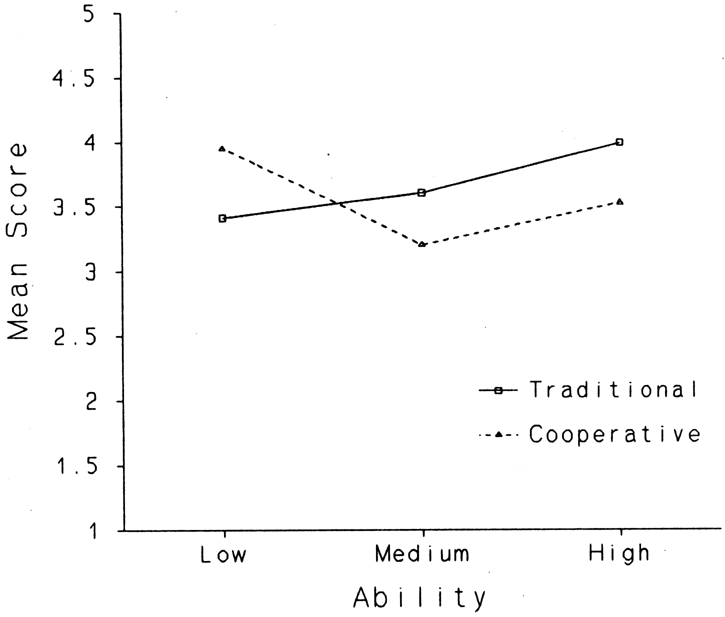


Figure 6. The interaction between instructional strategy (cooperative learning, traditional instruction) and student ability (low, medium, high) on attributions to ability as causes of learning biology.

Discussion. These results confirm anecdotal evidence that suggests that students neither enjoy this section of the biology course, nor are motivated to learn it, nor perform well. Students' feelings of class cohesiveness, cooperative and competitive classroom climate, and expectations of future success decreased. Students' motivation to do well, relative to their classmates decreased while their attributions to luck for their success increased. They neither performed as well on the lab test nor believed they had learned biology well. There are a number of possible reasons for these decreases: the material is more difficult, students are not as intrinsically interested in plant and animal diversity as they are in mammalian anatomy, and this topic is scheduled at the end of the semester when students are under many stresses.

Given that neither the curriculum nor the schedule will change, cooperative learning offers one method of enhancing learning. Students in the cooperative learning treatment learned more than did students in traditional classes. Moreover, cooperative learning was beneficial for low ability students (who are most at risk); enhancing both their perceptions of having learned well and their academic self-concept. It is interesting to note that high ability students had a higher academic self-concept and more affiliative goals in traditional classrooms. High ability students normally do well under traditional instruction where they tend to interact and work with students of similar abilities. Cooperative learning requires them to take on a more active role in helping their less-able peers learn. This new challenge may give rise to some of the negative comments made by the high ability students. Despite these two possible "negative" effects of cooperative learning for high ability students, cooperative learning enhances the performance of <u>all</u> students.

Study 2. Two questions addressed in this study were 'What are the effects of grouping and of reward type on achievement, affect, motivation and on students' interactions?' and 'Are these effects moderated by student ability?'. The pretest and posttest scores for all achievement, affect and motivation measures are presented in Tables 8 to 25.

TABLE 8

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR ACHIEVEMENT MEASURES FOR TESTS AND POSTTESTS (STUDY 2)

PERFORMANCE-INDEPENDENT CONTINGENCY

HETEROGENEOUS GROUPING

MEASURE	LOW			MEDIUM			HIGH		
	M	SD	N	M	SD	N	M	SD	N
LAB	9.99	1.93	7	10.65	1.52	6	10.65	2.75	6
LAB	6.73	2.75	7	7.53	2.33	5	7.80	2.04	6
PASTEX	2.86	1.35	7	3.33	.58	3	4.50	.58	4
PASTEX	3.43	1.27	7	3.00	1.00	5	3.40	1.52	5
TEAMTOT	11.82	1.85	7	12.14	1.96	6	12.13	1.96	6
INDTOT	12.00	2.94	7	12.25	4.73	6	11.67	2.42	6

Measures in **bold** are posttest measures. LAB is the teacher-constructed lab test. PASTEX is perceived learning. TEAMTOT is the mean team score on the tournaments. INDTOT is the mean individual score on the tournaments.

TABLE 9

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR ACHIEVEMENT MEASURES FOR TESTS AND POSTTESTS (STUDY 2)

INDIVIDUAL-PERFORMANCE CONTINGENCY

HETEROGENEOUS GROUPING

MEASURE	LOW			MEDIUM			HIGH		
	M	SD	N	M	SD	N	M	SD	N
LAB	10.89	1.80	10	10.49	2.14	10	11.49	1.60	9
LAB	8.12	2.43	10	7.20	3.22	10	7.47	2.84	9
PASTEX	3.40	1.07	10	3.63	.92	8	3.56	1.24	9
PASTEX	3.20	1.32	10	3.63	1.69	8	4.43	.53	7
TEAMTOT	12.29	1.48	10	12.32	1.48	10	12.19	1.52	9
INDTOT	12.50	4.01	10	11.30	3.50	10	12.67	1.66	9

Measures in **bold** are posttest measures. LAB is the teacher-constructed lab test. PASTEX is perceived learning. TEAMTOT is the mean team score on the tournaments. INDTOT is the mean individual score on the tournaments.

TABLE 10

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR ACHIEVEMENT MEASURES FOR TESTS AND POSTTESTS (STUDY 2)

	GROUP-PERFORMANCE CONTINGENCY								
	HETEROGENEOUS GROUPING								
MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
LAB	9.34	1.88	9	10.87	2.48	9	11.68	1.53	11
LAB	6.67	2.39	9	7.68	3.32	9	10.35	2.00	9
PASTEX	3.55	1.31	8	3.22	1.30	9	3.45	1.21	11
PASTEX	3.33	1.41	9	3.56	.88	9	3.44	.73	9
TEAMTOT	11.55	1.95	9	11.40	2.02	9	11.68	1.79	11
INDTOT	12.61	2.47	9	10.33	3.20	9	12.10	2.29	10

Measures in **bold** are posttest measures. LAB is the teacher-constructed lab test. PASTEX is perceived learning. TEAMTOT is the mean team score on the tournaments. INDTOT is the mean individual score on the tournaments.

TABLE 11

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR ACHIEVEMENT MEASURES FOR TESTS AND POSTTESTS (STUDY 2)

	PERFORMANCE-INDEPENDENT CONTINGENCY								
	HOMOGENEOUS GROUPING								
MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
LAB	9.21	1.56	6	10.34	2.36	6	12.48	.78	6
LAB	6.49	2.58	6	8.57	.71	6	10.15	1.51	6
PASTEX	4.00	1.00	5	4.00	.89	6	4.00	.63	6
PASTEX	4.20	.84	5	4.00	.89	6	3.80	.84	5
TEAMTOT	9.09	.64	6	11.66	1.10	6	12.11	2.33	6
INDTOT	9.33	1.75	6	11.67	4.27	6	12.00	3.52	6

Measures in **bold** are posttest measures. LAB is the teacher-constructed lab test. PASTEX is perceived learning. TEAMTOT is the mean team score on the tournaments. INDTOT is the mean individual score on the tournaments.

TABLE 12

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR ACHIEVEMENT MEASURES FOR TESTS AND POSTTESTS (STUDY 2)

INDIVIDUAL-PERFORMANCE CONTINGENCY

HOMOGENEOUS GROUPING

MEASURE	LOW			MEDIUM			HIGH		
	M	SD	N	M	SD	N	M	SD	N
LAB	9.83	2.24	8	10.68	1.75	9	10.45	3.02	7
LAB	6.74	3.03	8	7.14	2.27	9	8.52	2.58	6
PASTEX	3.71	1.11	7	3.78	.83	9	4.00	.63	6
PASTEX	2.60	1.14	5	3.25	1.04	8	3.67	.58	3
TEAMTOT	11.42	1.18	8	11.68	.53	9	11.83	.29	7
INDTOT	11.50	2.45	8	11.56	2.79	9	12.29	1.25	7

Measures in **bold** are posttest measures. LAB is the teacher-constructed lab test. PASTEX is perceived learning. TEAMTOT is the mean team score on the tournaments. INDTOT is the mean individual score on the tournaments.

TABLE 13

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR ACHIEVEMENT MEASURES FOR TESTS AND POSTTESTS (STUDY 2)

GROUP-PERFORMANCE CONTINGENCY

HOMOGENEOUS GROUPING

MEASURE	LOW			MEDIUM			HIGH		
	M	SD	N	M	SD	N	M	SD	N
LAB	9.58	2.22	9	10.73	1.91	11	11.76	1.24	7
LAB	8.29	2.67	9	9.36	2.49	11	10.25	1.76	8
PASTEX	3.78	1.39	9	3.55	1.04	11	4.29	.76	7
PASTEX	3.78	.83	9	3.36	.92	11	3.83	.75	6
TEAMTOT	13.15	1.73	9	11.71	.91	11	12.00	.70	8
INDTOT	12.56	2.88	9	11.73	2.94	11	12.25	2.43	8

Measures in **bold** are posttest measures. LAB is the teacher-constructed lab test. PASTEX is perceived learning. TEAMTOT is the mean team score on the tournaments. INDTOT is the mean individual score on the tournaments.

TABLE 14

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR AFFECT MEASURES FOR TESTS AND POSTTESTS (STUDY 2)

PERFORMANCE-INDEPENDENT CONTINGENCY

HETEROGENEOUS GROUPING

MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
EMOTF1	1.78	.95	7	2.69	1.25	5	1.34	.54	5
EMOTFI	2.16	1.04	7	2.98	1.01	7	2.17	.94	6
EMOTF2	3.31	.91	7	2.69	.68	5	3.89	.54	5
EMOTF2	3.08	1.21	7	2.41	1.01	7	2.55	.77	6
EMOTF3	3.54	1.15	7	3.20	.87	5	4.15	.74	5
EMOTF3	3.07	1.27	7	2.75	1.04	7	3.63	1.21	6
SELF	2.95	.70	7	2.56	.42	5	3.70	.34	5
SELF	3.06	.67	7	2.89	.44	7	3.33	.41	6
COHESIV.	3.88	.68	7	2.93	.71	5	3.98	.29	5
COHESIV.	3.98	.70	7	3.09	.89	7	3.15	.79	6
EXPECT.	3.71	.76	7	3.60	.55	5	4.60	.55	5
EXPECT.	4.14	1.21	7	2.86	.90	7	3.17	1.72	6
COOP	4.50	.45	7	3.85	.67	5	4.07	.39	5
COOP	4.26	.35	7	3.43	.83	7	3.75	.70	6
INDIV.	2.73	.53	7	3.04	.48	5	3.02	.64	5
INDIV.	2.78	.77	7	3.21	.56	7	3.04	.75	6
COMPET.	3.37	.70	7	3.08	1.08	5	3.38	1.18	5
COMPET.	3.23	.85	7	2.98	1.08	7	3.08	1.01	6

Measures in **bold** are posttest measures. EMOTF1 is positive feelings. EMOTF2 is negative feelings. EMOTF3 is feelings of competence. SELF is self concept. COHESIV. is feelings of group cohesiveness. EXPECT. is future expectations. COOP. is perceptions of a cooperative classroom climate. INDIV. is perceptions of an individualistic classroom climate. COMPET. is perceptions of a competitive classroom climate.

TABLE 15

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR AFFECT MEASURES FOR TESTS AND POSTTESTS (STUDY 2)

INDIVIDUAL-PERFORMANCE CONTINGENCY

HETEROGENEOUS GROUPING

MEASURE	LOW			MEDIUM			HIGH		
	M	SD	N	M	SD	N	M	SD	N
EMOTF1	2.11	.93	10	1.98	.98	8	2.03	1.08	9
EMOTFI	2.60	.81	10	2.90	.86	8	2.02	1.06	7
EMOTF2	3.19	.65	10	3.11	.96	8	3.33	1.14	9
EMOTF2	3.11	.56	10	2.13	.84	8	3.41	1.19	7
EMOTF3	3.50	.71	10	4.09	.64	8	3.89	1.02	9
EMOTF3	3.13	.74	10	2.72	.86	8	3.86	.83	7
SELF	2.80	.57	10	2.76	.47	8	3.07	.60	9
SELF	2.50	.55	10	2.40	.33	8	3.16	.51	7
COHESIV.	3.74	.73	10	3.51	.57	8	3.63	.60	9
COHESIV.	3.64	.48	10	3.36	.52	8	3.90	1.02	7
EXPECT.	4.00	.94	10	3.13	1.13	8	4.00	1.00	9
EXPECT.	3.90	.99	10	3.00	1.31	8	3.57	.98	7
COOP	4.24	.58	10	4.13	.40	8	3.97	.39	9
COOP	3.94	.70	10	3.75	.75	8	3.86	.70	7
INDIV.	2.74	.63	10	3.19	.43	8	3.02	.64	9
INDIV.	2.89	.68	10	3.28	.51	8	2.94	.75	7
COMPET.	3.13	.84	10	3.09	.70	8	3.22	1.18	9
COMPET.	3.09	.92	10	2.85	1.02	8	3.34	1.01	7

Measures in **bold** are posttest measures. EMOTF1 is positive feelings. EMOTF2 is negative feelings. EMOTF3 is feelings of competence. SELF is self concept. COHESIV. is feelings of group cohesiveness. EXPECT. is future expectations. COOP. is perceptions of a cooperative classroom climate. INDIV. is perceptions of an individualistic classroom climate. COMPET. is perceptions of a competitive classroom climate.

TABLE 16

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR AFFECT MEASURES FOR TESTS AND POSTTESTS (STUDY 2)

	GROUP-PERFORMANCE CONTINGENCY								
	HETEROGENEOUS GROUPING								
MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
EMOTF1	2.00	.99	8	2.13	1.20	9	1.94	1.12	11
EMOTFI	2.78	.89	9	3.00	1.08	9	2.14	.86	9
EMOTF2	3.23	.75	8	3.14	1.15	9	2.91	1.15	11
EMOTF2	2.37	.75	9	2.51	.73	9	2.81	.76	9
EMOTF3	4.00	.90	8	3.39	1.38	9	3.50	1.25	11
EMOTF3	3.03	1.08	9	2.62	.78	9	3.58	.77	9
SELF	2.73	.78	8	2.73	.78	9	2.91	.85	11
SELF	2.24	.74	9	2.29	.55	9	2.86	.64	9
COHESIV.	3.35	.72	8	3.73	.63	9	3.45	.65	11
COHESIV.	3.00	.71	9	3.22	.83	9	2.93	.84	9
EXPECT.	3.50	1.07	8	3.44	1.59	9	3.55	1.44	11
EXPECT.	3.11	1.27	9	2.00	1.00	9	3.11	.93	9
COOP	3.97	.59	8	4.21	.57	9	3.90	.58	11
COOP	3.28	.72	9	3.41	1.09	9	3.54	.66	9
INDIV.	2.82	.76	8	2.99	.82	9	3.29	.56	11
INDIV.	2.99	.55	9	2.98	.81	9	3.12	.47	9
COMPET.	3.11	1.13	8	2.76	1.15	9	2.99	.67	11
COMPET.	2.60	.97	9	2.71	1.09	9	2.83	.82	9

Measures in **bold** are posttest measures. EMOTF1 is positive feelings. EMOTF2 is negative feelings. EMOTF3 is feelings of competence. SELF is self concept. COHESIV. is feelings of group cohesiveness. EXPECT. is future expectations. COOP. is perceptions of a cooperative classroom climate. INDIV. is perceptions of an individualistic classroom climate. COMPET. is perceptions of a competitive classroom climate.

TABLE 17

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR AFFECT MEASURES FOR TESTS AND POSTTESTS (STUDY 2)

PERFORMANCE-INDEPENDENT CONTINGENCY

HOMOGENEOUS GROUPING

MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
EMOTF1	1.37	.47	5	1.19	.20	6	1.33	.36	6
EMOTFI	1.63	.71	5	1.81	.56	6	1.71	.29	5
EMOTF2	3.60	1.05	5	3.74	.82	6	3.55	.77	6
EMOTF2	3.14	1.17	5	3.71	.78	6	3.23	.79	5
EMOTF3	4.20	.45	5	3.83	.47	6	4.08	.56	6
EMOTF3	4.15	.60	5	3.79	.73	6	3.90	.72	5
SELF	3.22	.50	5	3.32	.50	6	3.43	.44	6
SELF	2.92	.50	5	3.07	.38	6	3.44	.42	5
COHESIV.	4.11	.61	5	3.63	.65	6	3.43	.75	6
COHESIV.	3.24	1.24	5	4.02	.41	6	3.93	.46	5
EXPECT.	4.20	1.30	5	4.33	.82	6	4.50	.55	6
EXPECT.	3.80	1.30	5	3.83	.98	6	4.00	1.00	5
COOP	4.48	.29	5	4.02	.51	6	3.77	.72	6
COOP	3.20	.98	5	3.94	.79	6	3.65	.68	5
INDIV.	2.76	.55	5	2.96	.70	6	3.14	.53	6
INDIV.	3.38	.92	5	2.78	.63	6	3.40	.63	5
COMPET.	2.95	.21	5	2.77	.74	6	3.29	.75	6
COMPET.	2.73	.65	5	2.79	.79	6	3.38	.75	5

Measures in **bold** are posttest measures. EMOTF1 is positive feelings. EMOTF2 is negative feelings. EMOTF3 is feelings of competence. SELF is self concept. COHESIV. is feelings of group cohesiveness. EXPECT. is future expectations. COOP. is perceptions of a cooperative classroom climate. INDIV. is perceptions of an individualistic classroom climate. COMPET. is perceptions of a competitive classroom climate.

TABLE 18

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR AFFECT MEASURES FOR TESTS AND POSTTESTS (STUDY 2)

INDIVIDUAL-PERFORMANCE CONTINGENCY

HOMOGENEOUS GROUPING

MEASURE	LOW			MEDIUM			HIGH		
	M	SD	N	M	SD	N	M	SD	N
EMOTF1	2.00	1.10	7	1.38	.24	9	1.71	1.06	6
EMOTFI	2.31	.93	5	2.36	1.09	8	3.05	.30	3
EMOTF2	3.71	1.18	7	3.87	.67	9	3.33	.90	6
EMOTF2	2.54	.75	5	2.82	.65	8	2.00	.52	3
EMOTF3	3.63	.94	7	4.00	.43	9	4.58	.26	6
EMOTF3	3.25	.47	5	3.50	.82	8	2.92	.63	3
SELF	2.79	.79	7	3.01	.37	9	3.12	.44	6
SELF	2.40	.82	5	2.65	.44	8	2.53	.72	3
COHESIV.	3.60	.28	7	3.67	.52	9	3.83	.39	6
COHESIV.	3.24	.81	5	2.97	.93	8	3.37	.90	3
EXPECT.	4.29	.76	7	3.67	1.12	9	3.67	1.37	6
EXPECT.	3.40	.89	5	4.13	.83	8	3.00	1.73	3
COOP	4.04	.75	7	4.11	.47	9	4.29	.46	6
COOP	3.82	.63	5	3.84	.56	8	3.96	.63	3
INDIV.	3.22	.86	7	2.98	.73	9	3.02	.49	6
INDIV.	3.22	.62	5	3.10	.57	8	3.37	.57	3
COMPET.	3.21	1.03	7	2.76	.34	9	2.85	.65	6
COMPET.	3.03	.70	5	2.55	.95	8	2.54	.76	3

Measures in **bold** are posttest measures. EMOTF1 is positive feelings. EMOTF2 is negative feelings. EMOTF3 is feelings of competence. SELF is self concept. COHESIV. is feelings of group cohesiveness. EXPECT. is future expectations. COOP. is perceptions of a cooperative classroom climate. INDIV. is perceptions of an individualistic classroom climate. COMPET. is perceptions of a competitive classroom climate.

TABLE 19

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR AFFECT MEASURES FOR TESTS AND POSTTESTS (STUDY 2)

GROUP-PERFORMANCE CONTINGENCY

HOMOGENEOUS GROUPING

MEASURE	LOW			MEDIUM			HIGH		
	M	SD	N	M	SD	N	M	SD	N
EMOTF1	2.51	1.13	9	2.27	1.11	11	1.59	.42	7
EMOTFI	3.65	1.05	9	3.18	.81	11	2.55	.89	6
EMOTF2	3.02	1.45	9	3.03	1.21	11	3.51	1.02	7
EMOTF2	2.14	.86	9	2.05	.56	11	1.98	.55	6
EMOTF3	3.42	1.39	9	3.75	1.10	11	4.32	.43	7
EMOTF3	3.00	.99	9	2.32	.90	11	2.62	.54	6
SELF	2.71	.96	9	2.89	.62	11	3.11	.63	7
SELF	2.61	.99	9	2.38	.81	11	2.67	.46	6
COHESIV.	3.19	.75	9	3.17	.85	11	3.43	.53	7
COHESIV.	2.98	.83	9	3.15	.89	11	3.11	1.13	6
EXPECT.	3.78	1.86	9	3.45	1.04	11	3.86	1.46	7
EXPECT.	3.00	1.22	9	2.73	1.01	11	3.67	.82	6
COOP	4.03	.74	9	3.81	.64	11	3.84	.58	7
COOP	3.40	.74	9	3.50	.90	11	3.27	1.05	6
INDIV.	3.31	.74	9	2.97	.77	11	3.13	.56	7
INDIV.	3.44	.62	9	3.15	.64	11	2.89	.81	6
COMPET.	3.29	1.21	9	2.68	.83	11	3.29	1.21	7
COMPET.	3.42	.82	9	2.85	.84	11	2.79	.83	6

Measures in **bold** are posttest measures. EMOTF1 is positive feelings. EMOTF2 is negative feelings. EMOTF3 is feelings of competence. SELF is self concept. COHESIV. is feelings of group cohesiveness. EXPECT. is future expectations. COOP. is perceptions of a cooperative classroom climate. INDIV. is perceptions of an individualistic classroom climate. COMPET. is perceptions of a competitive classroom climate.

TABLE 20

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR MOTIVATION MEASURES FOR TESTS AND POSTTESTS (STUDY 2)

PERFORMANCE-INDEPENDENT CONTINGENCY

HETEROGENEOUS GROUPING

MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
LUCK	1.64	.69	7	2.30	.45	5	2.30	1.10	5
LUCK	1.64	.80	7	2.64	.99	7	2.58	.49	6
EFFORT	4.21	.49	7	4.10	.65	5	4.60	.65	5
EFFORT	3.50	1.15	7	3.43	.84	7	4.00	.84	6
ABILITY	3.64	.80	7	4.10	.74	5	4.10	.55	5
ABILITY	3.07	.79	7	3.21	.86	7	3.67	.88	6
DIFF.	3.14	1.11	7	3.20	.97	5	3.60	.96	5
DIFF.	3.43	1.02	7	3.71	.91	7	3.67	.88	6
EXTERNAL	2.24	.85	7	2.27	.43	5	1.93	.64	5
EXTERNAL	2.00	.86	7	2.33	.69	7	2.64	.69	6
STABLE	3.38	.95	7	3.07	.72	5	3.33	.82	5
STABLE	3.81	.77	7	2.90	.74	7	2.83	1.15	6
CONTROL	2.93	.35	7	3.00	.79	5	2.50	.71	5
CONTROL	2.29	.70	7	3.57	.89	7	3.25	.88	6
MASTERY	21.71	3.68	7	17.00	1.87	5	23.00	3.39	5
MASTERY	18.86	5.34	7	16.14	3.08	7	18.17	4.22	6
EGO	9.71	2.14	7	8.80	3.11	5	9.80	2.39	5
EGO	8.29	1.80	7	8.29	2.98	7	7.67	2.25	6
AFFILIAT.	11.00	2.89	7	8.80	1.92	5	10.80	1.30	5
AFFILIAT.	9.71	2.56	7	8.29	1.98	7	9.50	2.51	6
WORK-AV.	6.14	2.61	7	7.40	2.30	5	5.80	1.64	5
WORK-AV.	7.14	3.63	7	8.29	2.43	7	6.83	2.71	6

Measures in **bold** are posttest measures. LUCK, EFFORT, ABILITY, and DIFF. are attributions to luck, effort, ability, and task difficulty. EXTERNAL, STABLE, and CONTROL are the locus of causality, stability, and controllable attributional dimensions. MASTERY, EGO, AFFILIAT., and WORK-AV. are mastery, ego, affiliative and work-avoidance goals respectively.

TABLE 21

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR MOTIVATION MEASURES FOR TESTS AND POSTTESTS (STUDY 2)

INDIVIDUAL-PERFORMANCE CONTINGENCY

HETEROGENEOUS GROUPING

MEASURE	LOW			MEDIUM			HIGH		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
LUCK	2.45	1.19	10	2.06	1.15	8	2.72	1.25	9
LUCK	2.45	.64	10	2.25	1.31	8	3.21	1.11	7
EFFORT	4.00	.75	10	4.25	.83	8	4.50	.56	9
EFFORT	3.95	.96	10	3.56	1.08	8	3.57	1.30	7
ABILITY	3.95	.44	10	4.19	.80	8	4.22	.51	9
ABILITY	3.75	1.11	10	3.75	.71	8	3.50	1.15	7
DIFF.	3.45	.86	10	3.31	1.41	8	3.94	.95	9
DIFF.	3.60	.77	10	3.88	1.27	8	4.14	.90	7
EXTERNAL	2.00	.63	10	2.62	.92	8	1.81	.75	9
EXTERNAL	2.30	.62	10	2.71	.70	8	2.62	1.30	7
STABLE	2.60	.87	10	2.79	1.41	8	3.37	1.25	9
STABLE	2.63	.53	10	3.08	.81	8	2.76	1.45	7
CONTROL	2.90	.70	10	3.31	1.16	8	2.33	.83	9
CONTROL	2.70	.95	10	2.69	1.31	8	2.36	.75	7
MASTERY	21.20	4.10	10	20.28	4.39	8	21.56	3.39	9
MASTERY	20.80	3.55	10	21.13	5.11	8	23.00	4.22	7
EGO	10.10	2.23	10	8.63	2.39	8	9.78	2.39	9
EGO	7.80	2.39	10	7.63	3.54	8	10.43	2.25	7
AFFILIAT.	10.50	2.32	10	8.75	2.05	8	9.78	1.30	9
AFFILIAT.	9.20	2.30	10	8.63	3.25	8	9.14	2.511	7
WORK-AV.	7.40	2.80	10	6.88	3.18	8	5.78	1.64	9
WORK-AV.	6.60	3.55	10	6.25	2.31	8	5.43	2.71	7

Measures in **bold** are posttest measures. LUCK, EFFORT, ABILITY, and DIFF. are attributions to luck, effort, ability, and task difficulty. EXTERNAL, STABLE, and CONTROL are the locus of causality, stability, and controllable attributional dimensions. MASTERY, EGO, AFFILIAT., and WORK-AV. are mastery, ego, affiliative and work-avoidance goals respectively.

TABLE 22

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR MOTIVATION MEASURES FOR TESTS AND POSTTESTS (STUDY 2)

GROUP-PERFORMANCE CONTINGENCY

HETEROGENEOUS GROUPING

MEASURE	LOW			MEDIUM			HIGH		
	M	SD	N	M	SD	N	M	SD	N
LUCK	2.19	1.28	8	2.44	1.65	9	2.27	1.17	11
LUCK	2.83	.90	9	2.39	1.54	9	3.21	1.11	7
EFFORT	4.00	.75	10	4.25	.83	8	4.50	.56	9
EFFORT	3.95	.96	10	3.56	1.08	8	3.57	1.30	7
ABILITY	3.95	.44	10	4.19	.80	8	4.22	.51	9
ABILITY	3.75	1.11	10	3.75	.71	8	3.50	1.15	7
DIFF.	3.45	.86	10	3.31	1.41	8	3.94	.95	9
DIFF.	3.60	.77	10	3.88	1.27	8	4.14	.90	7
EXTERNAL	2.00	.63	10	2.62	.92	8	1.81	.75	9
EXTERNAL	2.30	.62	10	2.71	.70	8	2.62	1.30	7
STABLE	2.60	.87	10	2.79	1.41	8	3.37	1.25	9
STABLE	2.63	.53	10	3.08	.81	8	2.76	1.45	7
CONTROL	2.90	.70	10	3.31	1.16	8	2.33	.83	9
CONTROL	2.70	.95	10	2.69	1.31	8	2.36	.75	7
MASTERY	20.13	4.70	8	18.56	4.88	9	18.82	4.75	11
MASTERY	16.44	4.69	9	18.09	4.32	9	18.22	4.52	9
EGO	7.38	1.77	8	8.89	2.52	9	7.27	2.24	11
EGO	6.56	1.94	9	8.33	3.00	9	8.44	2.30	9
AFFILIAT.	9.12	2.42	8	10.00	2.96	9	7.45	1.51	11
AFFILIAT.	8.00	2.55	9	10.00	2.40	9	8.67	1.41	9
WORK-AV.	9.00	2.93	8	7.33	3.61	9	5.45	1.92	11
WORK-AV.	7.56	2.07	9	7.72	1.92	9	7.11	2.26	9

Measures in **bold** are posttest measures. LUCK, EFFORT, ABILITY, and DIFF. are attributions to luck, effort, ability, and task difficulty. EXTERNAL, STABLE, and CONTROL are the locus of causality, stability, and controllable attributional dimensions. MASTERY, EGO, AFFILIAT., and WORK-AV. are mastery, ego, affiliative and work-avoidance goals respectively.

TABLE 23

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR MOTIVATION MEASURES FOR TESTS AND POSTTESTS (STUDY 2)

PERFORMANCE-INDEPENDENT CONTINGENCY

HOMOGENEOUS GROUPING

MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
LUCK	2.50	1.54	5	2.00	.63	6	1.75	.42	6
LUCK	2.30	1.60	5	2.17	.75	6	1.90	1.02	5
EFFORT	4.30	.45	5	4.25	.76	6	4.50	.45	6
EFFORT	4.10	1.02	5	4.08	.80	6	4.40	.65	5
ABILITY	4.50	.35	5	3.58	.97	6	4.33	.61	6
ABILITY	3.80	.57	5	3.75	.69	6	3.80	.76	5
DIFF.	4.00	1.00	5	4.00	.71	6	3.83	.82	6
DIFF.	3.60	.89	5	3.42	.38	6	3.90	.96	5
EXTERNAL	1.80	.51	5	2.28	1.04	6	1.94	.53	6
EXTERNAL	2.20	.73	5	2.00	1.21	6	1.67	.62	5
STABLE	3.67	.88	5	3.11	1.59	6	3.33	1.30	6
STABLE	3.53	.99	5	3.39	1.25	6	3.60	1.40	5
CONTROL	3.10	1.14	5	2.58	.80	6	2.92	.38	6
CONTROL	2.30	.57	5	2.80	.88	6	3.30	.45	5
MASTERY	23.40	5.13	5	21.33	4.80	6	19.50	1.38	6
MASTERY	20.40	6.54	5	22.50	3.39	6	19.40	3.78	5
EGO	9.20	1.30	5	8.50	1.38	6	9.17	2.23	6
EGO	7.60	3.29	5	7.83	2.86	6	7.00	2.35	5
AFFILIAT.	9.50	1.58	5	8.17	2.64	6	8.00	3.10	6
AFFILIAT.	8.20	2.95	5	9.33	2.50	6	9.80	3.19	5
WORK-AV.	5.20	.84	5	5.50	1.52	6	5.67	1.63	6
WORK-AV.	10.00	3.16	5	5.83	1.94	6	5.80	2.77	5

Measures in **bold** are posttest measures. LUCK, EFFORT, ABILITY, and DIFF. are attributions to luck, effort, ability, and task difficulty. EXTERNAL, STABLE, and CONTROL are the locus of causality, stability, and controllable attributional dimensions. MASTERY, EGO, AFFILIAT., and WORK-AV. are mastery, ego, affiliative and work-avoidance goals respectively.

TABLE 24

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR MOTIVATION MEASURES FOR TESTS AND POSTTESTS (STUDY 2)

	INDIVIDUAL-PERFORMANCE CONTINGENCY								
	HOMOGENEOUS GROUPING								
MEASURE	LOW			MEDIUM			HIGH		
	M	SD	N	M	SD	N	M	SD	N
LUCK	3.07	.98	7	2.61	.65	9	2.42	1.43	6
LUCK	2.40	.65	5	2.81	1.13	8	2.33	1.15	3
EFFORT	4.07	.89	7	4.61	.65	9	4.42	.66	6
EFFORT	3.50	.94	5	4.50	.60	8	4.00	1.32	3
ABILITY	3.64	.56	7	3.61	.55	9	3.83	.82	6
ABILITY	3.30	.45	5	3.75	.80	8	4.17	1.04	3
DIFF.	3.93	1.06	7	3.89	.89	9	3.33	.41	6
DIFF.	2.90	1.19	5	3.88	.92	8	4.33	.76	3
EXTERNAL	1.71	.73	7	2.07	.40	9	2.72	1.24	6
EXTERNAL	2.60	.64	5	2.71	1.01	8	3.11	1.39	3
STABLE	3.19	.88	7	3.11	.67	9	2.67	.89	6
STABLE	2.73	1.04	5	2.33	.73	8	2.67	.33	3
CONTROL	2.29	.76	7	2.50	.83	9	2.83	.88	6
CONTROL	2.90	.65	5	3.06	.50	8	3.17	.29	3
MASTERY	20.71	1.98	7	21.44	3.05	9	21.83	5.12	6
MASTERY	20.80	5.02	5	19.50	1.31	8	18.33	1.53	3
EGO	8.86	2.27	7	8.33	2.92	9	8.67	2.16	6
EGO	9.80	1.30	5	6.75	2.25	8	7.67	1.15	3
AFFILIAT.	8.43	2.23	7	9.89	2.32	9	9.33	3.20	6
AFFILIAT.	10.00	2.12	5	8.50	1.69	8	8.33	.58	3
WORK-AV.	4.57	.98	7	5.78	2.28	9	6.33	2.50	6
WORK-AV.	7.00	3.08	5	5.50	2.14	8	6.00	1.00	3

Measures in **bold** are posttest measures. LUCK, EFFORT, ABILITY, and DIFF. are attributions to luck, effort, ability, and task difficulty. EXTERNAL, STABLE, and CONTROL are the locus of causality, stability, and controllable attributional dimensions. MASTERY, EGO, AFFILIAT., and WORK-AV. are mastery, ego, affiliative and work-avoidance goals respectively.

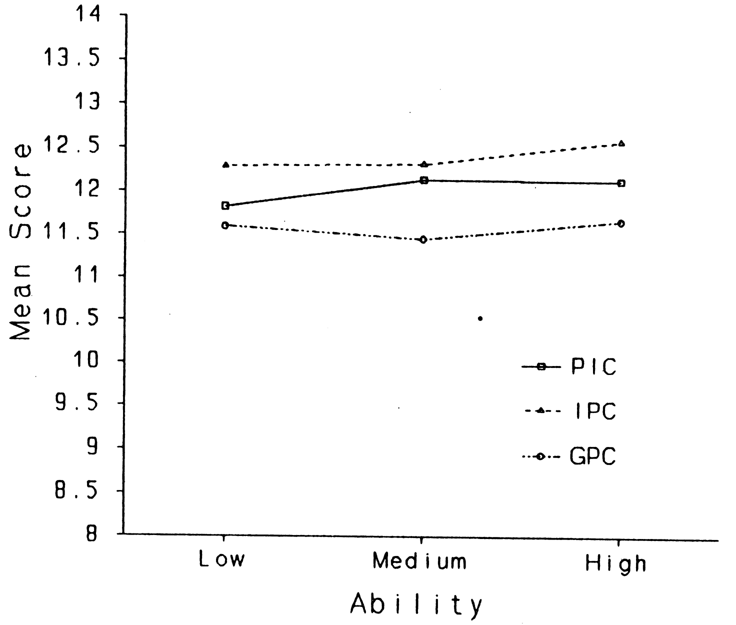
TABLE 25

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR MOTIVATION MEASURES FOR TESTS AND POSTTESTS (STUDY 2)

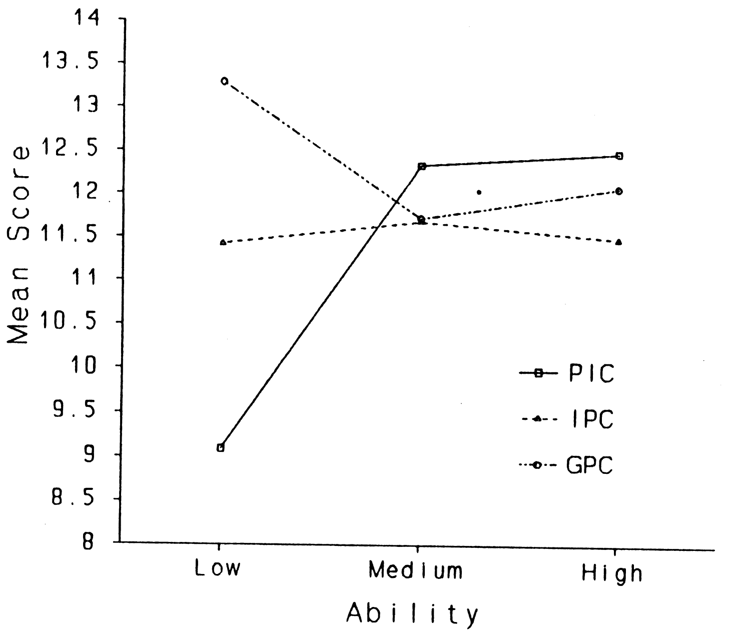
	GROUP-PERFORMANCE CONTINGENCY								
	HOMOGENEOUS GROUPING								
MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
LUCK	2.11	1.47	9	1.77	.56	11	2.21	.64	7
LUCK	3.06	1.29	9	2.27	.88	11	2.17	.93	6
EFFORT	3.94	.58	9	4.09	.86	11	4.64	.48	7
EFFORT	3.11	1.17	9	3.55	.99	11	4.08	.66	6
ABILITY	4.00	.51	9	4.00	.81	11	3.64	.56	7
ABILITY	3.56	.81	9	3.68	.68	11	3.75	.42	6
DIFF.	4.28	.36	9	4.05	.99	11	3.43	.98	7
DIFF.	3.72	.97	9	3.73	1.01	11	3.67	.88	6
EXTERNAL	1.81	.69	9	2.36	.89	11	2.00	.51	7
EXTERNAL	2.52	.50	9	2.85	1.31	11	2.28	.71	6
STABLE	2.52	1.23	9	3.06	1.03	11	3.05	.62	7
STABLE	2.74	.78	9	3.18	1.29	11	3.00	.60	6
CONTROL	2.94	.58	9	3.00	.45	11	2.86	.24	7
CONTROL	2.78	.57	9	3.27	.96	11	2.92	.20	6
MASTERY	19.89	4.28	9	18.55	4.87	11	19.57	3.10	7
MASTERY	20.44	5.27	9	17.09	5.58	11	16.83	6.01	6
EGO	9.78	2.44	9	8.18	2.64	11	9.29	2.81	7
EGO	9.22	2.95	9	7.55	3.21	11	7.67	3.20	6
AFFILIAT.	8.89	2.32	9	8.27	2.65	11	9.00	2.00	7
AFFILIAT.	8.11	3.02	9	8.36	3.20	11	9.17	3.31	6
WORK-AV	6.67	2.12	9	6.82	2.14	11	7.86	3.08	7
WORK-AV	7.56	2.46	9	6.27	2.45	11	8.67	2.73	6

Measures in **bold** are posttest measures. LUCK, EFFORT, ABILITY, and DIFF. are attributions to luck, effort, ability, and task difficulty. EXTERNAL, STABLE, and CONTROL are the locus of causality, stability, and controllable attributional dimensions. MASTERY, EGO, AFFILIAT., and WORK-AV. are mastery, ego, affiliative and work-avoidance goals respectively.

Achievement Measures. There were four measures of achievement used in this study: scores on a summative lab test, individual scores on the tournament or quiz, team scores on the tournaments, and perceived learning. There was a significant decrease in achievement, $F(1, 126) = 186.1$, $p < .001$, in this study also. The average scores on the lab pretest and posttest were 10.7 and 8.1, respectively. However, this decrease was significantly moderated by grouping, $F(1, 126) = 6.05$, $p = .02$, and reward contingency, $F(2, 132) = 5.04$, $p = .008$. Students who were in homogeneous teams (adjusted $M = 8.59$) outperformed students who were in heterogeneous teams (adjusted $M = 7.66$). Students who were rewarded on the basis of group performance (adjusted $M = 8.90$) outperformed students who were rewarded independently of their performance (adjusted $M = 8.01$). Both groups of students outperformed students rewarded on the basis of individual performance (adjusted $M = 7.46$). There was a significant interaction between reward contingency, grouping, and ability $F(4, 132) = 2.70$, $p = .03$, on group performance on the tournaments. Subsequent post-hoc analyses indicated that in homogeneous teams, medium and high ability students do equally well under all reward conditions. However, low ability students in homogeneous teams do significantly better when given a group reward (adjusted $M = 13.15$) than when given either an individual reward (adjusted $M = 11.42$) or a performance-independent reward (adjusted $M = 9.09$) (see Figure 7). Thus, both individual achievement and group performance are enhanced by a group reward.



(a)



(b)

Figure 7. The interaction between ability (low, medium, high) and reward contingency (performance-independent, individual-performance, group-performance) on tournament scores in homogeneous (a) and heterogeneous teams (b).

Affective Measures. There were nine measures of affective outcomes measured in this study: positive feelings, negative feelings and feelings of competence about learning biology, academic self-concept, future expectations of learning, feelings of group cohesiveness, and cooperative, individualistic, and competitive classroom climate. Overall, there were significant decreases on most of the affective measures over the period of instruction. However, this decrease in affect was moderated by reward contingency and grouping. Reward contingency significantly moderated the decrease in future expectations, $\underline{F}(2, 104) = 8.88$, $\underline{p} < .001$, group cohesiveness, $\underline{F}(2, 104) = 5.59$ $\underline{p} = .005$, self concept, $\underline{F}(2, 104) = 7.12$ $\underline{p} = .001$, and perceptions of a cooperative classroom climate, $\underline{F}(2, 104) = 3.61$, $\underline{p} = .03$. Students given group-performance contingent rewards had lower expectations of future learning, perceived a less cooperative classroom climate, were in less cohesive groups, and had lower self-concept than did students given performance-independent rewards (see Table 26).

Table 26. The influence of reward contingency on affect measures (Study 2).

	ADJUSTED MEANS		
MEASURE	**PIC**	**IPC**	**GPC**
FUTURE EXPECTATIONS	3.74	3.56	3.05
SELF CONCEPT	2.96	2.67	2.61
COHESIVENESS	3.57	3.38	3.10

PIC is Performance-independent contingency
IPC is Individual-performance contingency
GPC is Group-performance contingency

In addition, there were significant interactions between reward contingency and grouping on positive affect, $\underline{F}(2, 104) = 6.38$, $\underline{p} = .002$, negative affect, $\underline{F}(2, 104) = 3.15$, $\underline{p} = .05$, and feelings of competence, $\underline{F}(2, 104) = 5.65$, $\underline{p} = .005$. When students were rewarded on the basis of either group or individual-performance contingencies, grouping had no effect. However, when students were rewarded independently of performance, they felt significantly less negative, more positive and more competent learning biology in homogeneous groups (see Figures 8, 9 and 10).

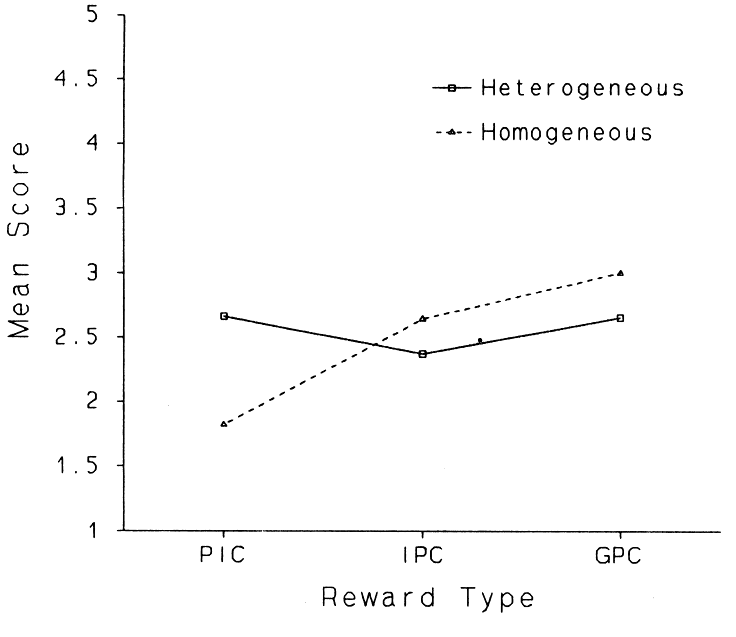


Figure 8. The interaction between grouping (heterogeneous, homogeneous) and reward contingency (performance-independent, individual-performance, group-performance) on negative feelings about learning biology.

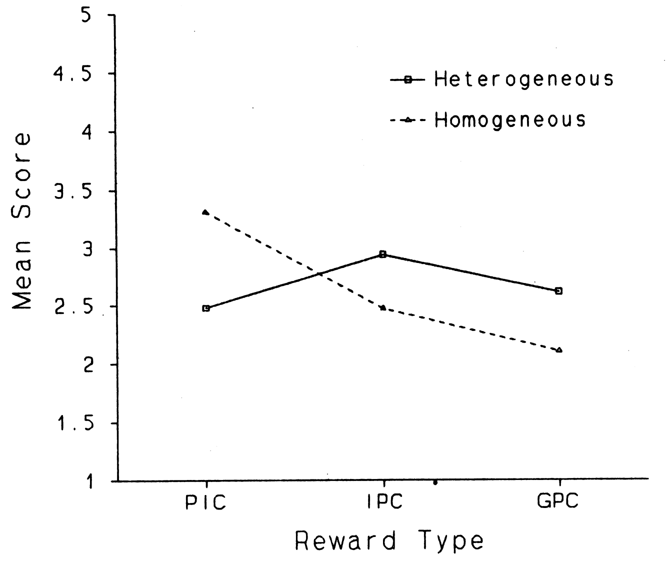


Figure 9. The interaction between grouping (heterogeneous, homogeneous) and reward contingency (performance-independent, individual-performance, group-performance) on positive feelings about learning biology.

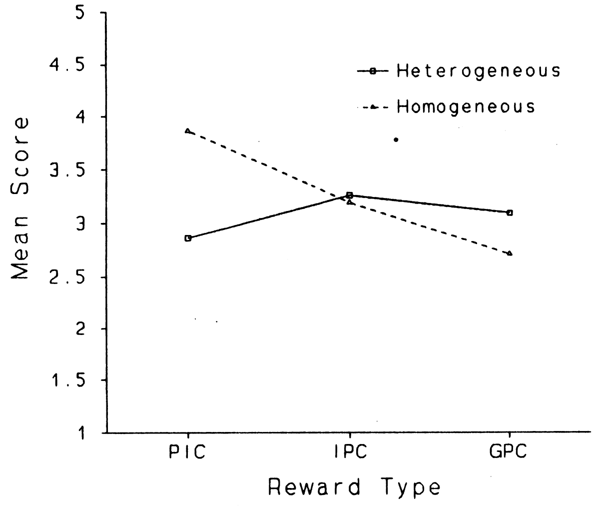


Figure 10. The interaction between grouping (heterogeneous, homogeneous) and reward contingency (performance-independent, individual-performance, group-performance) on feelings of competency about learning biology.

There were also significant interactions between grouping and student ability on positive affect, $F(2, 104) = 3.47$, $p = .04$, negative affect, $F(2, 104) = 2.51$, $p = .05$, and feelings of competence, $F(2, 104) = 4.82$, $p = .01$. Medium ability students had more positive feelings, less negative feelings, and felt more competent learning biology in homogeneous groups (see Figures 11, 12 and 13).

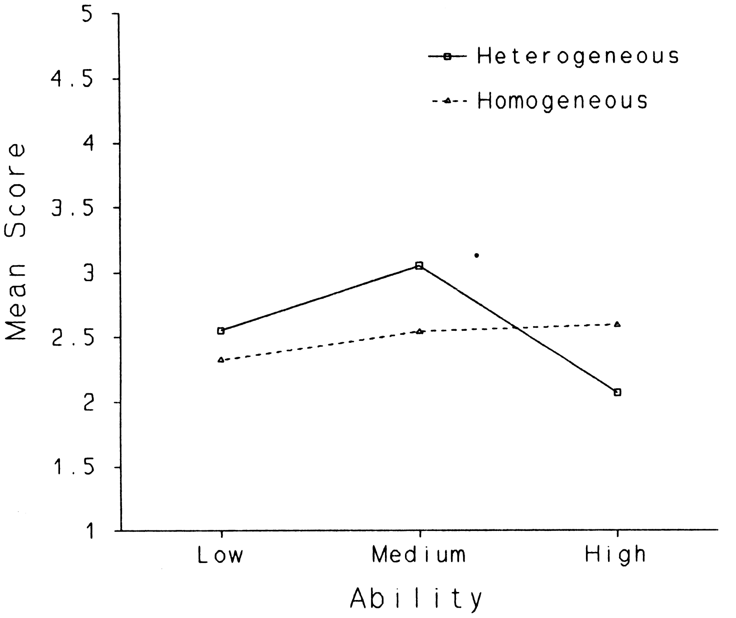


Figure 11. The interaction between grouping (heterogeneous, homogeneous) and student ability (low, medium, high) on negative feelings about learning biology.

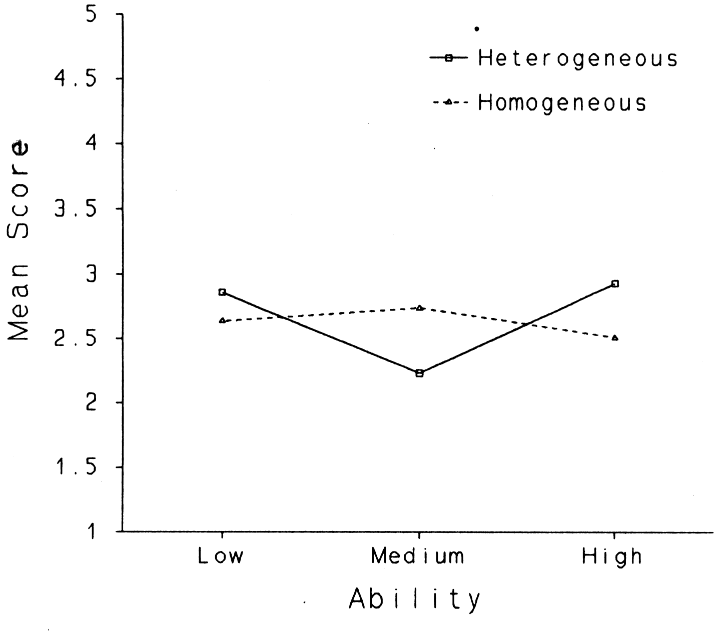


Figure 12. The interaction between grouping (heterogeneous, homogeneous) and student ability (low, medium, high) on positive feelings about learning biology.

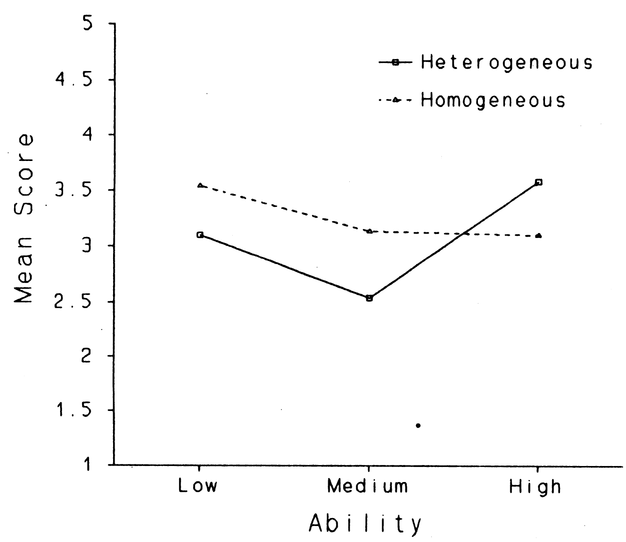


Figure 13. The interaction between grouping (heterogeneous, homogeneous) and student ability (low, medium, high) on feelings of competence about learning biology.

Thus, in this study also, the laboratory exercises had a negative impact on students feelings about learning biology. However, these were moderated by reward type, grouping, and ability. Although students learned more biology when rewarded on the basis of group performance, they felt more negative about learning biology, especially when working in heterogeneous groups. Heterogeneous grouping was detrimental to medium ability students' feelings about learning biology.

Motivational Measures. There were eleven measures of motivational outcomes in this study: attributions to effort, ability, difficulty, and luck, external, stable and controllable causal dimensions, orientation to mastery, ego, affiliative and work-avoidance goals. There were significant decreases in attributions to effort, $F(1, 105) = 22.10$, $p < .001$, and ability, $F(1, 104) = 13.65$, $p < .001$ over the instructional period. In addition, reward contingency significantly affected attributions to external causal dimensions, $F(1, 104) = 3.58$, $p = .03$ and stable causal dimensions, $F(1, 104) = 5.6$, $p = .005$. Students rewarded independently of performance made significantly less attributions to external and significantly more attributions to stable (adjusted Ms of 2.4 and 3.3, respectively) causal dimensions than did students rewarded on the basis of performance (either individual or group) (adjusted Ms of 2.7 and 2.8, respectively).

There was also a significant interaction between reward contingency and student ability, $F(1, 104) = 3.07$, $p = .02$. Low ability students made more attributions to luck when given rewards based on group performance (adjusted $\underline{M}$ = 3.0) than they did when rewarded on the basis of individual performance (adjusted $\underline{M}$ = 1.8) or when rewarded independently of performance (adjusted $\underline{M}$ = 2.2) (see Figure 14).

There were also significant decreases in mastery, $\underline{F}(1, 105) = 5.12$, $\underline{p} = .03$ and ego goals, $\underline{F}(1, 105) = 10.84$, $\underline{p} = .001$. There was a significant interaction between reward contingency and grouping on mastery goals, $\underline{F}(1, 104) = 2.99$, $\underline{p} = .05$. Students who were rewarded independently of performance reported more mastery goal in homogeneous teams than did students rewarded similarly but in heterogeneous teams (see Figure 15).

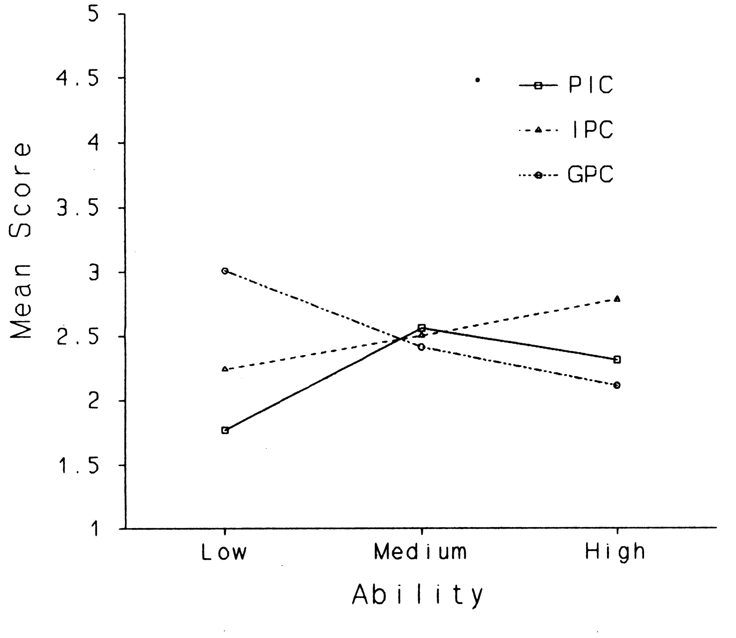


Figure 14. The interaction between grouping (heterogeneous, homogeneous) and student ability (low, medium, high) on attributions to luck as causes of learning biology.

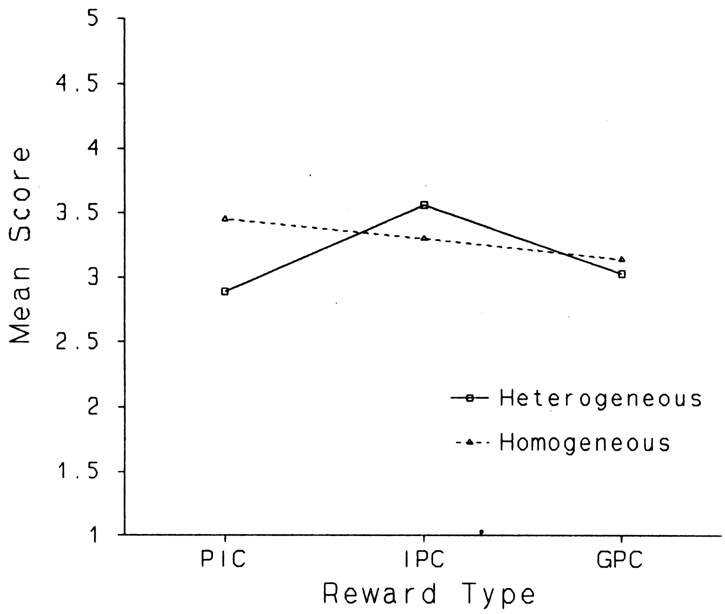


Figure 15. The interaction between grouping (heterogeneous, homogeneous) and reward contingency (performance-independent, individual-performance, group-performance) on mastery goals.

Thus, in this study also, the laboratory exercises had a negative impact on students' motivation (a reduction in ego and mastery goals and a reduction in causal attributions to ability and effort). The effects on motivation were moderated by reward type, grouping, and ability. Thus, group-performance contingent rewards and heterogeneous grouping were detrimental to low ability students' motivational outcomes.

Observations. In order to understand how reward type and grouping mediate their effects on the above outcomes, we also collected observational data on student interactions. The average frequency of observed behaviours varied among the different groups, from a high of 4.36 to a low of 2.60

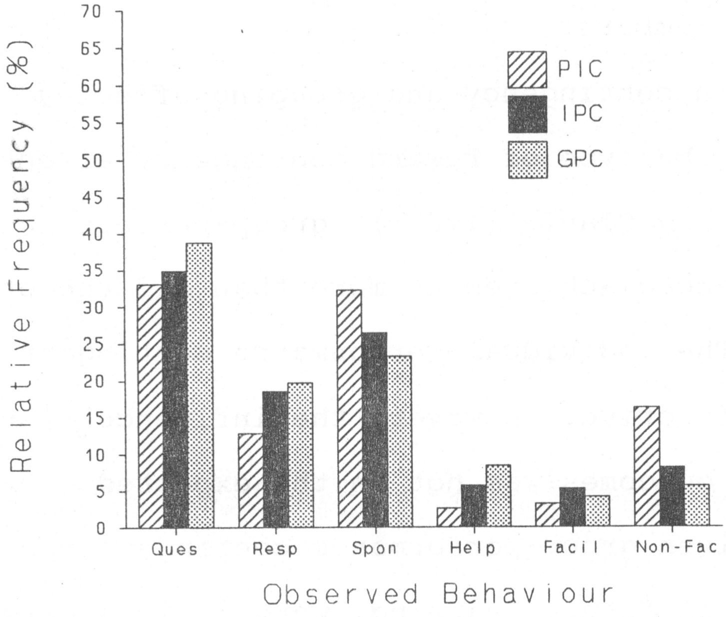
interactions per minute. The relative frequency of the behaviours which occurred under the different instructional strategies are presented in Figures 16.

First, we found a significant effect of reward contingency on frequency of questioning, $F(2, 61) = 3.61$, $p = .03$, frequency of responding, $F(2, 61) = 3.52$, $p = .03$, and frequency of making spontaneous statements, $F(2, 61) = 4.12$, $p = .02$. Students who received a reward which was contingent on their individual performance asked a significantly greater number of questions, but were less likely to respond to questions posed by other group members, and less likely to make spontaneous statements, such as summarizing.

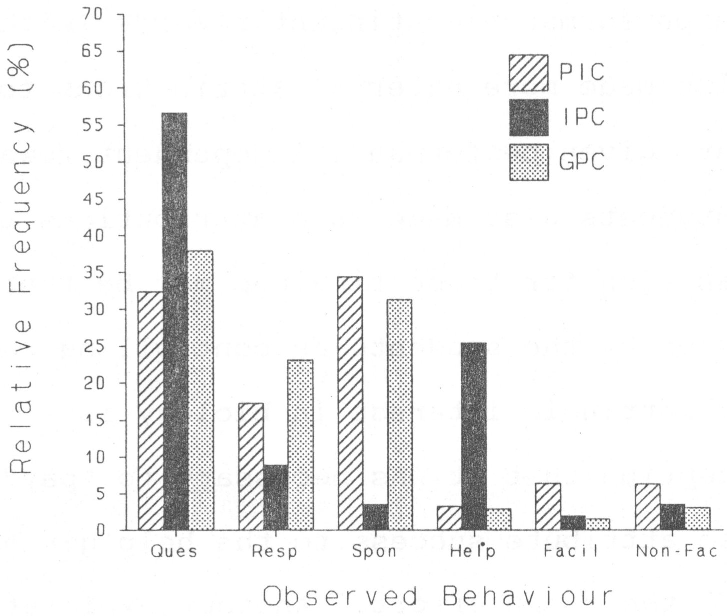
Second, we found a significant interaction between reward contingency and grouping for seeking help outside the team, $F(5, 61) = 7.61$, $p < .001$. Students who were in heterogeneous teams and who were rewarded on the basis of individual performance sought help from sources outside of the team more than did students under the same reward conditions but in homogeneous teams.

Third, we also found significant effects of both grouping, $F(1, 61) = 3.79$, $p = .008$, and reward contingency, $F(2, 61) = 3.79$, $p = .03$, on the frequency of non-functional behaviours. Students who received rewards independent of performance and students who were in homogeneous teams exhibited a greater number of non-functional group behaviours.

Thus, we found that heterogeneous teams and performance-contingent rewards reduced non-functional behaviours. However,



(a)



(b)

Figure 16. Relative distribution of observed behaviours in homogeneous (a) and heterogeneous groups (b) as a percentage of total behaviours.

if the rewards were given on the basis of individual performance, although students asked for more help, they were less likely to get it from their team members.

Discussion. Both reward contingency and grouping affected cooperative learning. The type of reward contingency affected achievement as reported by Slavin (1983b); group-performance contingent rewards enhanced achievement more than did the other reward contingencies. The individual-performance contingent reward was the least effective. However, the influence of reward type on other learning outcomes was not in the expected direction. Students given group-performance contingent rewards had lower expectations of future learning, were in less cohesive groups, and had lower self-concept than did students given performance-independent rewards. Students motivational outcomes were also adversely affected by the group-performance contingent rewards. Students given performance-contingent rewards (either individual or group) also made more external attributions to success than did students given performance-independent rewards. Moreover, low ability students also made more attributions to luck. A possible explanation for these findings may be that extrinsic rewards are seen by the students as controlling rather than informative. Their intrinsic interest in biology is subverted by their perception that it was necessary to "pay" them to learn. They may also attribute success to the help given by the group rather than to their own effort. Another explanation may be that the knowledge that their performance affects others causes anxiety. Such anxiety may be detrimental to future expectations, group cohesiveness and self-concept.

Grouping affected achievement in an unexpected manner; students in homogeneous groups outperformed students in heterogeneous groups. There are a number of possible explanations for this finding. Learning biology well requires the active engagement of the student in his or her learning. The students in this study are young adults (18 to 21 years old). They may be especially sensitive to the image they portray to their peers. Thus, in heterogeneous groups, low ability and medium ability students may participate less because of feelings of academic inferiority. On the other hand, high ability students may reduce their participation to prevent appearing to "show-off". Another explanation for the superiority of homogeneous grouping may be that self-pacing is especially important in learning and practising a skill (such as mathematics or experimental biology). In heterogeneous groups, the pace is too slow for some and too fast for others. Providing better explanations rarely helps a student having difficulty observing an organism with a microscope. Neither does it benefit the high ability student providing the explanation. Another explanation for the superiority of homogeneous grouping may be that the disparity in learning goals among the team members of heterogeneous groups is too large for effective group work.

There were significant interactions between grouping and ability on the affective measures such that medium ability students had more positive feelings, less negative feelings and felt more competent learning biology in homogeneous groups. Thus, as also reported by Webb (1988), medium ability-students do not appear to benefit by heterogeneous grouping. Webb (1985) has reviewed the investigations on the effect of group composition on peer interactions. She has demonstrated that medium ability children in heterogeneous groups have significantly less of their questions answered, participate less, and achieve less than both the low ability children in the heterogeneous groups and the medium ability children in homogeneous groups. She suggested (Webb, 1980) that the hesitation of medium ability children to participate in heterogeneous groups may reflect their low perceived status relative to high ability children such as is found in the organizational psychology literature, where the presence of high ability group members inhibits the participation of medium ability group members. Low ability children may not be equally impaired since in heterogeneous groups, the high ability children "take them under their wings". This may suggest that medium ability students are thought to not need help relative to low ability students and not able to give help relative to high ability students resulting in decreased participation and feelings of alienation.

There were significant interactions between grouping and reward contingency on the affective measures. When students were rewarded independently of performance, they felt more positive working in homogeneous groups; however grouping had no affect on students feelings when they were rewarded on the basis of performance. This may reflect the negative effects of extrinsic rewards that are not alleviated by working with similar others.

In addition, there was a significant three-way interaction among reward contingency, grouping, and ability on team performance on the tournaments. Low ability students in heterogeneous groups given performance-independent reward did not perform as well on the tournaments as did low ability students in heterogeneous teams given group-performance contingent rewards. These findings may reflect that if students are assigned to heterogeneous teams, some form of "reinforcement" may be necessary to encourage teammembers to enjoy learning and to help the low ability students master the material. Such reinforcement is not necessary when students are assigned to homogeneous teams. The intrinsic satisfaction of working together is sufficient.

Observations of student behaviours confirmed that when students were given rewards based on individual-performance they asked questions but neither elaborated spontaneously nor helped group members. If they were in heterogeneous groups, they sought help from outside the group (from either the teacher or the laboratory assistant) more often than if they were in homogeneous teams. Heterogeneous grouping and group-performance contingent rewards reduced the incidence of off-task behaviours.

The above results demonstrate that although group rewards have positive effects on achievement, they seem to have negative impact on other learning outcomes. Students not only need to achieve success, they also need to expand their cognitive and motivational repertoires. Performance-contingent rewards and heterogeneous grouping may focus students on specific learning tasks (and reduce off-task behaviours); however, they may also have the unintentional effects of eliminating some of the spontaneous interactions that leads to the other learning outcomes.

Study 3. The questions addressed in this study were 'Do student individual differences (i.e., gender, prior performance, or status) and group characteristics such as degree of academic heterogeneity moderate the effectiveness of cooperative learning?'. The degree of academic heterogeneity was defined as the coefficient of variation of the lab pretest within each team. The pretest and posttest scores for all achievement, affect and motivation measures are presented in Tables 27 to 32.

Achievement Measures. There were four measures of achievement used in this study: scores on a summative lab test, individual scores on the tournament, team scores on the tournaments, and perceived learning. There was a significant decrease in achievement, $F(1, 72) = 250.1$, $p < .001$. Gender and prior performance significantly interacted to moderate achievement, $F(2, 79) = 4.57$, $p = .013$. Female student with low prior performance scores did significantly better on the achievement post-test than did male students with low prior performance scores (an adjusted M of 8.7 compared to an adjusted M of 6.3); however, there were no differences between male and female students with medium and high prior performance scores. Gender significantly moderated the influence of group composition

TABLE 27

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR ACHIEVEMENT MEASURES FOR PRETESTS AND POSTTESTS (STUDY 3)

	HETEROGENEOUS GROUPINGS								
MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
LAB	9.51	4.50	20	10.39	3.84	22	10.92	6.36	20
LAB	6.81	3.70	20	8.71	4.75	21	9.84	4.32	20
PASTEX	3.05	1.31	19	3.90	1.14	21	3.75	1.25	20
PASTEX	2.86	.95	14	3.68	.75	19	4.06	.77	16
TEAMTOT	11.88	1.83	20	12.29	1.61	22	12.11	1.98	20
INDTOT	12.20	3.02	20	12.27	2.43	22	12.45	3.41	20

Measures in **bold** are posttest measures. LAB is the teacher-constructed lab test. PASTEX is perceived learning. TEAMTOT is the mean team score on the tournaments. INDTOT is the mean individual score on the tournaments.

TABLE 28

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR ACHIEVEMENT MEASURES FOR PRETESTS AND POSTTESTS (STUDY 3)

	HOMOGENEOUS GROUPINGS								
MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
LAB	9.54	3.99	16	9.94	5.16	20	11.21	4.30	19
LAB	7.25	3.44	15	9.44	2.85	20	11.10	2.76	19
PASTEX	3.06	1.06	16	3.42	.84	19	3.42	1.46	19
PASTEX	3.23	.93	13	3.19	1.05	16	3.57	.94	14
TEAMTOT	12.15	2.24	16	11.90	1.35	20	11.74	1.70	19
INDTOT	12.63	2.63	16	11.90	3.14	20	11.74	2.28	19

Measures in **bold** are posttest measures. LAB is the teacher-constructed lab test. PASTEX is perceived learning. TEAMTOT is the mean team score on the tournaments. INDTOT is the mean individual score on the tournaments.

TABLE 29

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR MOTIVATION MEASURES FOR PRETESTS AND POSTTESTS (STUDY 3)

	HETEROGENEOUS GROUPINGS								
MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
LUCK	2.16	.83	19	2.16	1.03	22	1.80	.91	20
LUCK	2.29	.73	14	2.34	.96	19	2.44	1.03	16
EFFORT	4.32	.56	19	4.07	.81	22	4.52	.55	20
EFFORT	4.14	.53	14	4.11	.70	19	4.50	.61	17
ABILITY	3.58	.63	19	3.84	.73	22	4.05	.78	20
ABILITY	3.68	.82	14	3.87	.70	19	4.34	.65	16
DIFF.	3.66	1.00	19	3.82	.84	22	3.63	.90	20
DIFF.	3.71	.78	14	3.97	.72	19	4.03	.90	16
HELP	3.08	1.15	19	3.50	1.13	22	2.85	.95	20
HELP	3.25	.89	14	3.53	.99	19	3.09	.88	16
SUPERF.	2.07	.31	19	2.03	.56	22	1.96	.43	20
SUPERF.	2.17	.52	14	2.25	.59	19	2.03	.42	16
ACTIVE	3.34	.57	19	3.52	.72	22	3.74	.51	20
ACTIVE	3.02	.75	14	3.34	.76	19	3.66	.70	16
MASTERY	3.35	.72	19	3.20	.68	22	3.78	.63	20
MASTERY	3.22	.80	14	3.20	.74	19	3.57	.73	17
EGO	3.26	.81	19	2.77	1.10	22	3.60	.76	20
EGO	2.81	.94	14	2.81	1.22	19	3.40	.91	16
AFFILIAT.	3.18	.85	19	3.25	.75	22	3.43	.96	20
AFFILIAT.	3.43	.76	14	3.18	.82	19	3.25	.89	16
WORK-AV.	2.25	1.05	19	2.30	.78	22	1.97	.64	20
WORK-AV.	2.21	.66	14	2.47	.85	19	2.19	.82	16

Measures in **bold** are posttest measures. LUCK, EFFORT, ABILITY, DIFF. and HELP are attributions to luck, effort, ability, task difficulty and help. SUPERF. and ACTIVE are superficial and active task engagement. MASTERY, EGO, AFFILIAT., and WORK-AV. are mastery, ego, affiliative and work-avoidance goals respectively.

TABLE 30

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR MOTIVATION MEASURES FOR PRETESTS AND POSTTESTS (STUDY 3)

	HOMOGENEOUS GROUPINGS								
MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
LUCK	2.13	1.20	16	2.40.	.77	20	1.50	.76	19
LUCK	2.69	.97	13	2.34	1.19	16	2.29	1.20	14
EFFORT	4.00	.68	16	4.10	.58	20	4.26	.65	19
EFFORT	3.54	.83	13	4.19	.51	16	4.32	.80	14
ABILITY	3.88	.74	16	4.13	.53	20	3.76	.69	19
ABILITY	3.58	.79	13	4.25	.71	16	3.75	.89	14
DIFF.	3.78	1.11	16	4.05	.79	20	3.58	.92	19
DIFF.	3.85	.83	13	3.75	.82	16	3.61	.68	14
HELP	2.88	1.09	16	3.40	.88	20	3.21	.96	19
HELP	2.88	.65	13	3.53	.83	16	3.43	1.09	14
SUPERF.	2.27	.59	16	3.57	.71	20	1.96	.55	19
SUPERF.	2.35	.54	13	3.49	.57	16	2.21	.87	14
ACTIVE	3.61	.69	16	4.10	1.29	20	3.58	.59	19
ACTIVE	3.10	.65	13	3.94	1.34	16	3.21	.87	14
MASTERY	3.53	.68	16	3.23	.74	20	3.38	.62	19
MASTERY	2.86	.68	13	3.24	.96	16	3.20	.81	14
EGO	3.19	.84	16	3.10	.91	20	3.04	1.20	19
EGO	3.20	.98	13	2.75	.92	16	2.86	.97	14
AFFILIAT.	3.38	.94	16	3.45	.71	20	3.32	.79	19
AFFILIAT.	2.73	.93	13	3.03	.88	16	3.04	1.01	14
WORK-AV.	2.63	1.15	16	2.63	.78	20	2.04	.82	19
WORK-AV.	2.26	.84	13	2.52	.96	16	2.60	.93	14

Measures in **bold** are posttest measures. LUCK, EFFORT, ABILITY, DIFF. and HELP are attributions to luck, effort, ability, task difficulty and help. SUPERF. and ACTIVE are superficial and active task engagement. MASTERY, EGO, AFFILIAT., and WORK-AV. are mastery, ego, affiliative and work-avoidance goals respectively.

TABLE 31

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR AFFECTIVE MEASURES FOR PRETESTS AND POSTTESTS (STUDY 3)

	HETEROGENEOUS GROUPINGS								
MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
COHESIV.	3.77	.59	19	3.54	.73	22	3.36	.88	20
COHESIV.	3.28	.89	13	3.52	.82	19	2.94	.84	17
EXPECT.	3.95	1.22	19	3.86	1.11	21	4.35	.67	20
EXPECT.	3.57	1.02	14	3.58	1.35	19	4.31	.70	16
EMOTF1	2.97	.81	19	2.55	.77	22	3.21	.76	20
EMOTF1	2.66	.77	14	2.73	.88	19	2.89	1.12	16
EMOTF2	2.05	.72	19	2.32	.95	22	1.71	.60	20
EMOTF2	2.90	.75	14	2.69	.94	19	2.45	1.05	16
EMOTF3	3.87	.63	19	3.80	.82	2	4.23	.50	20
EMOTF3	3.04	.69	14	3.61	.76	19	3.53	.89	16

Measures in **bold** are posttest measures. EMOTF1 is positive feelings. EMOTF2 is negative feelings. EMOTF3 is feelings of competence. COHESIV. is feelings of group cohesiveness. EXPECT. is future expectations.

TABLE 32

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR AFFECTIVE MEASURES FOR PRETESTS AND POSTTESTS (STUDY 3)

	HOMOGENEOUS GROUPINGS								
MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
COHESIV.	3.37	.76	15	3.57	.71	20	3.57	.95	18
COHESIV.	2.47	.83	12	3.49	.57	16	3.53	1.16	14
EXPECT.	4.19	.75	16	4.10	1.29	20	4.42	.61	19
EXPECT.	3.33	.89	12	3.94	1.34	16	3.71	.99	14
EMOTF1	3.04	1.02	16	2.79	.99	20	3.32	.74	19
EMOTF1	2.09	.80	13	2.66	.84	16	2.80	.92	14
EMOTF2	2.49	1.34	16	2.32	.88	20	1.64	.66	19
EMOTF2	3.48	1.32	13	2.56	1.04	16	2.59	1.21	14
EMOTF3	3.70	.81	16	3.86	.80	20	4.21	.42	19
EMOTF3	2.60	.80	13	3.59	.72	16	3.36	1.18	14

Measures in **bold** are posttest measures. EMOTF1 is positive feelings. EMOTF2 is negative feelings. EMOTF3 is feelings of competence. COHESIV. is feelings of group cohesiveness. EXPECT. is future expectations.

on perceptions of having learned biology well, $F(1, 51) = 6.58$, $p = .013$. When students were assigned to heterogeneous groups, there were no differences in perceptions of having learned biology well between male and female students (adjusted Ms of 3.4 and 3.5, respectively). However, when students were assigned to homogeneous groups, female students felt that they had learned biology well more than did male students (adjusted M 3.9 and 3.2, respectively).

Affective Measures. There were five measures of affective outcomes in this study: positive feelings, negative feelings and feelings of competence about learning biology, future expectations of success, and feelings of group cohesiveness. There were significant decreases in future expectations of success, $F(4, 46) = 4.42$, $p = .04$, positive feelings about learning biology, $F(4, 46) = 4.99$, $p = .03$, feelings of competence about learning biology, $F(4, 46) = 3.85$, $p = .06$, and feelings of group cohesiveness, $F(4, 46) = 14.87$, $p < .001$.

Prior performance significantly moderated feelings of group cohesiveness, $F(2, 55) = 4.06$, $p = .023$, and feelings of competence, $F(2, 58) = 6.65$, $p = .003$. Students who had low prior performance scores felt less cohesiveness towards the group (adjusted M of 3.0) than did students who had moderate and high prior performance scores (adjusted Ms of 3.5 and 3.4 respectively). They also felt less competent (adjusted M of 2.8) than did students who had moderate or high performance scores (adjusted Ms of 3.7 and 3.4, respectively).

Status, prior performance and grouping interacted significantly on students' expectations of future success, $F(4, 56) = 2.72$, $p = .039$. Figure 17 illustrates that for high status students in either homogeneous or heterogeneous groups, future expectations of success are positively related to prior experience. However, for low status students future expectations are positively related to prior experience only when they were in homogeneous groups, while for medium status students, only when they were in heterogeneous groups. Low status, low performing students had higher expectations in heterogeneous groups (adjusted Ms 4.5 versus 2.7) as did medium status, high performing students (adjusted Ms 4.2 versus 3.5).

Prior performance and the degree of group heterogeneity significantly interacted to moderate students' positive feelings towards learning biology, F (4, 46) = 4.61, $p = .04$, and students' feelings of competence, $F(4, 46) = 3.85$, $p = .06$. As teams became more heterogeneous, high performing students had less positive feelings about learning biology and felt less competent while low performing students had more positive feelings about learning biology and felt more competent (see Figures 18, 19).

Motivational Measures. There were eleven measures of motivational outcomes in this study: attributions to effort, ability, difficulty, luck, and help, orientation to mastery, ego, affiliative and work-avoidance goals, active and superficial engagement in learning. In this study also, there were

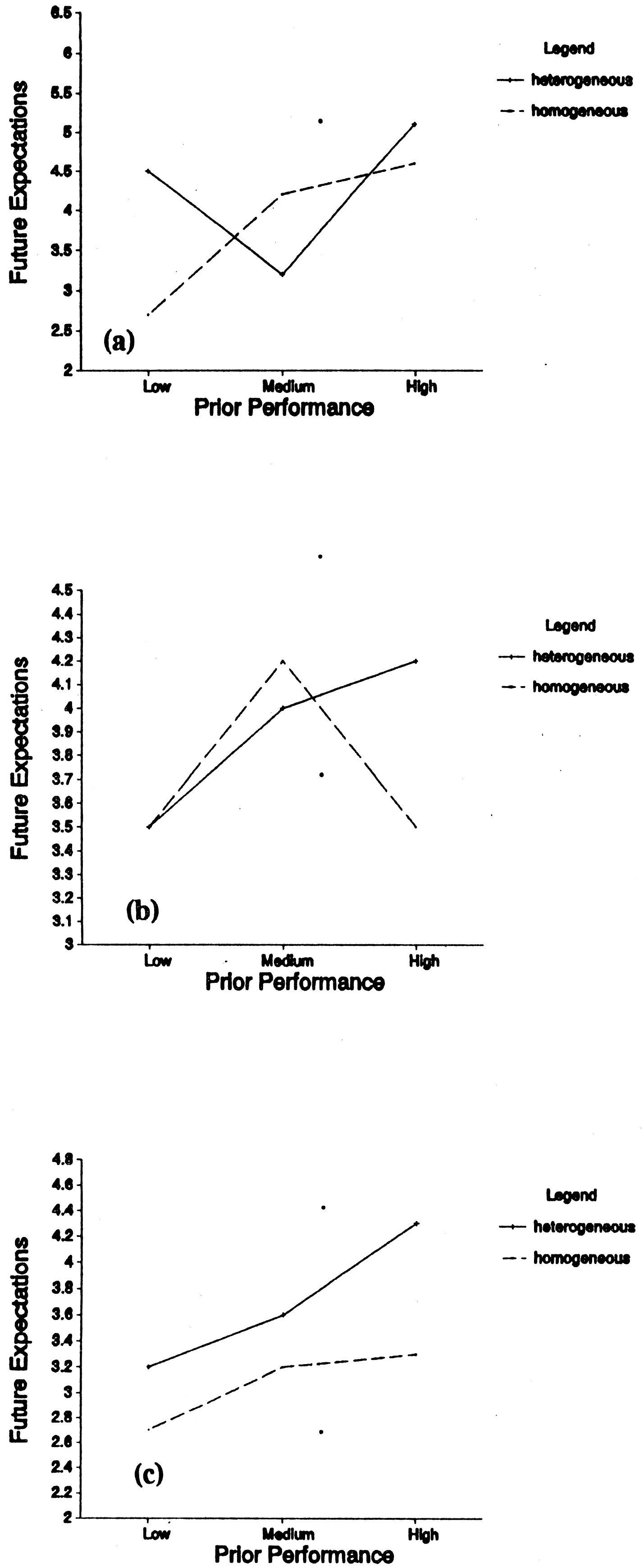


Figure 17. Interaction between prior performance (low, medium, high) and grouping (heterogeneous, homogeneous) for low (a), medium (b), and high (c) status students on future expectations.

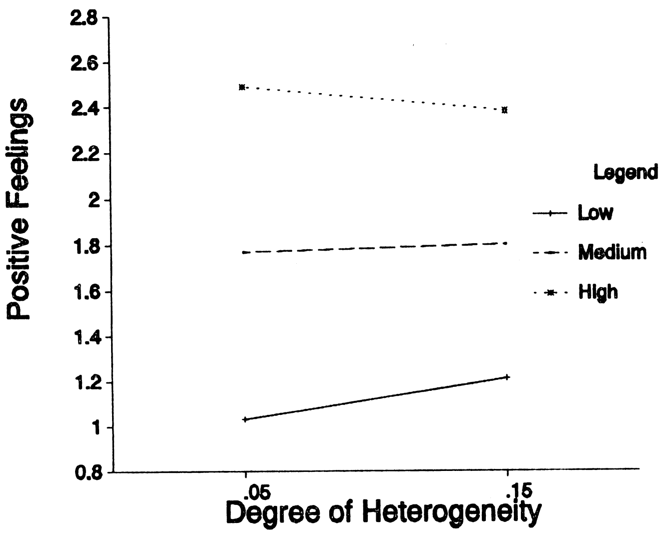


Figure 18. The interaction between student prior performance (low, medium, high) and the degree of group heterogeneity on positive feelings about learning biology.

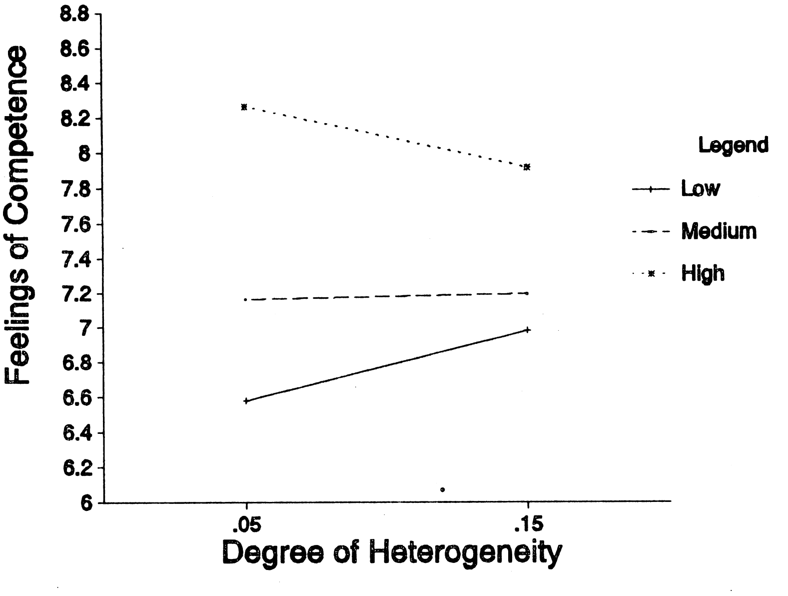


Figure 19. The interaction between student prior performance (low, medium, high) and the degree of group heterogeneity on feelings of competence in learning biology.

significant decreases in mastery goals, ego goals, and active task-engagement, $F(1, 85) = 4.93$, $p = .03$, $F(1, 85) = 4.17$, $p = .04$, and $F(1, 85) = 6.65$, $p = .01$, respectively. There was also a significant increase in attributions to luck, $F(1, 85) = 10.01$, $p = .002$. Gender significantly moderated work-avoidance goals, $F(1, 58) = 5.01$, $p = .029$. Male students had significantly higher work-avoidance goals than did female students (adjusted *M*s 2.5 and 2.2, respectively).

Gender and prior performance also interacted significantly to moderate ego-goals, $F(2, 58) = 3.2$, $p = .05$. Whereas, high performing male students had higher ego goals than did low and medium performing male students (adjusted *M*s of 3.4, 2.7, and 2.7, respectively), prior performance had no effect on the ego goals of female students (adjusted *M*s of 2.7, 3.1, and 2.8, respectively).

Prior performance also significantly moderated attributions to effort, $F(2, 59) = 4.48$, $p = .015$. As might be expected, low performing students made lower attributions to effort than did medium and high performing students (adjusted *M*s of 3.7, 4.2, and 4.4, respectively).

Gender and prior performance interacted significantly to moderate attributions to help from others as the cause of success, $F(2, 58) = 3.35$, $p = .042$. Medium performing female students attributed success to help from others (adjusted *M*s 3.6) more than did high performing female students or low performing male students (adjusted *M*s 2.8 and 2.7, respectively).

Prior performance and status also interacted significantly to moderate active engagement, $F(4, 58) = 3.09$, $p = .022$. Low and medium status students became more actively engaged as a function of their prior performance; however, prior performance did not influence the active engagement of medium status students (see Figure 20).

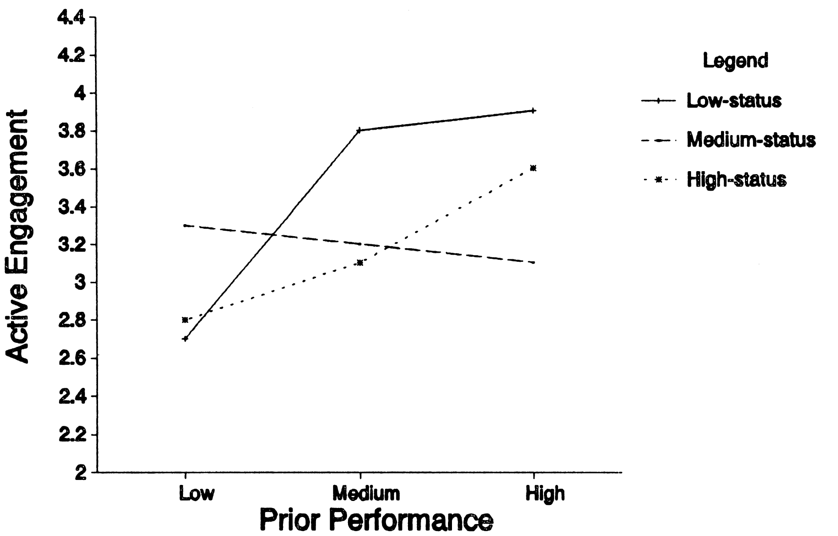
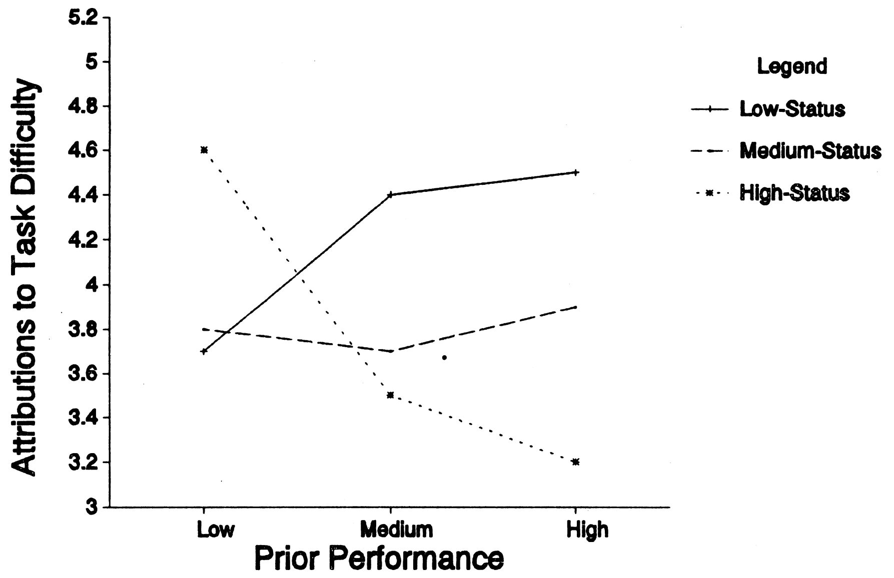
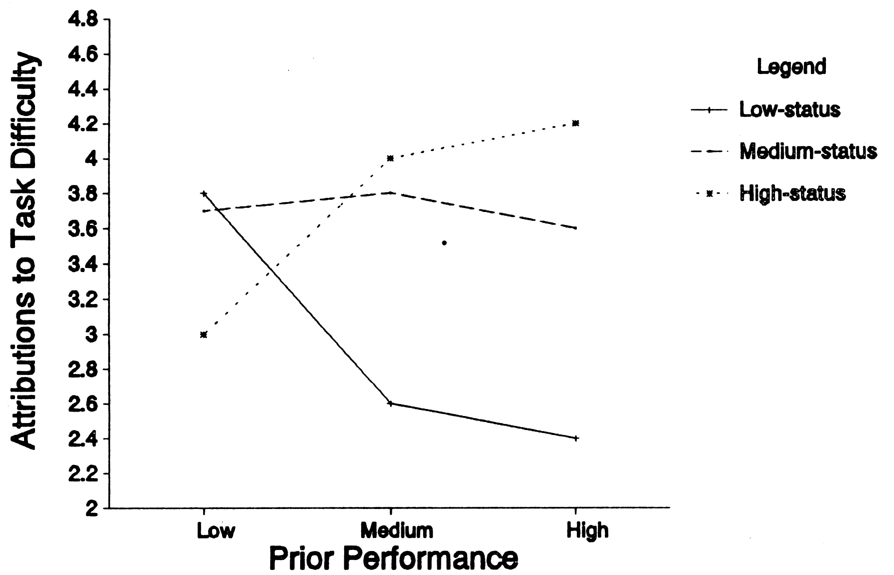


Figure 20. The interaction between prior performance (low, medium, high) and status (low, medium, high) on active engagement.

Gender, status and prior performance interacted significantly, $F(4, 58) = 6.25$, $p < .001$, to moderate students' attributions to task difficulty as causes of their success (see Figure 21). Prior performance did not influence medium status students of either gender. However, for female students, prior performance was *positively* related to attributions to task



(a)



(b)

Figure 21. The interaction between prior performance (low, medium, high) and status (low, medium, high) on female (a) and male (b) students.

difficulty for low status students; while, for males it was *positively* related to attributions to task difficulty for high status students. On the other hand, for female students, prior performance was *negatively* related to attributions to task difficulty for high status students; while for males it was *negatively* related to attributions to task difficulty for low status students.

The degree of group heterogeneity significantly moderated affiliative goals, $F_{change}(3, 47) = 6.08$, $p = .02$. Students developed more affiliative goals in more heterogeneous groups (see Figure 22).

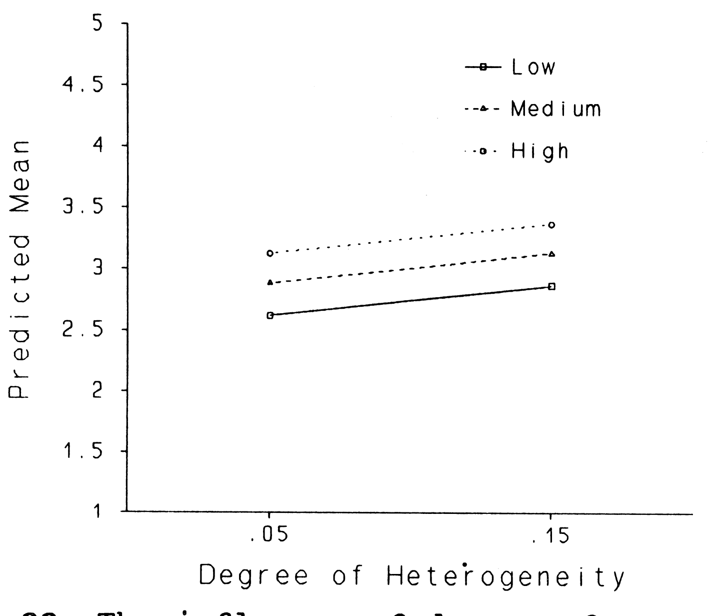


Figure 22. The influence of degree of group heterogeneity on affiliative goals.

Prior performance also interacted significantly with the degree of group heterogeneity to moderate work-avoidance goals, $F_{change}(4, 46) = 4.54$, $p = .04$, and superficial learning, $F_{change}(4, 46) = 4.63$, $p = .04$. Low performing students developed more work-avoidance goals and were more superficially engaged in learning in homogeneous groups. However, high performing students demonstrated the opposite pattern (see Figures 23 and 24).

Observations. In order to understand how individual differences and group characteristics interact to affect the above outcomes, we also collected observational data on student interactions. These data are presented in Tables 33 and 34. Because of the method of collecting the data, differences in the overall frequency of the behaviours between groups were not observed (Kouros *et al.*, 1992). Rather, the probability that a particular student would engage in one of the coded behaviours was estimated. The relative frequencies of the different behaviours is presented in Figure 25. Students spent most of their time giving information and on individual lab work. There were very few instances of either belittling or supportive verbal statements. Likewise there were very few instances of off-task behaviours.

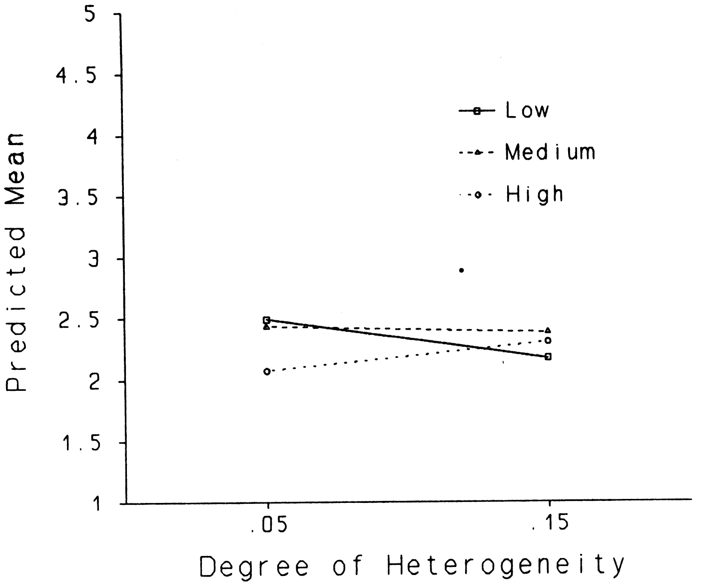


***Figure 23*. The interaction between student prior performance (low, medium, high) and degree of group heterogeneity on work-avoidance goals.**

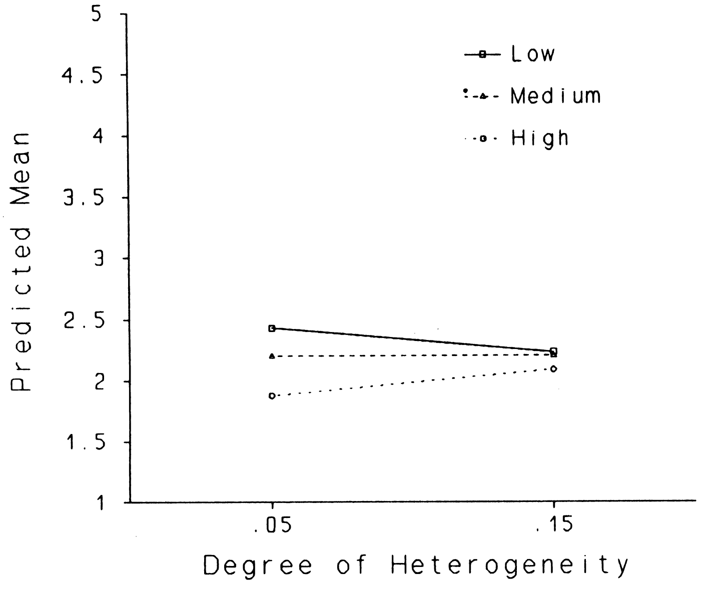


***Figure 24*. The interaction between student prior performance (low, medium, high) and degree of group heterogeneity on superficial task engagement.**

TABLE 33

MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR OBSERVED BEHAVIOURS (STUDY 3) (FREQUENCY PER 3 MINUTES)

	HETEROGENEOUS GROUPINGS								
MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
HELP (S)	2.08	1.59	20	2.44	1.60	21	3.11	1.61	20
HELP (T)	1.74	1.34	19	1.61	.74	21	1.55	.84	19
INFORM (S)	9.01	3.85	20	10.84	5.17	22	11.60	2.75	20
INFORM (T)	4.53	2.40	19	4.31	3.61	21	4.25	2.13	20
SUPPORT (S)	.05	.22	19	000	000	20	.06	.18	18
SUPPORT (T)	.06	.18	18	.03	.11	20	000	000	18
BELIT (S)	.05	.17	18	.08	.32	20	.05	.17	18
BELIT (T)	.02	.07	18	.04	.16	20	.04	.18	18
INDIV.	6.51	2.11	20	6.96	3.44	22	7.44	2.71	20
OFF	.32	.50	18	.41	.90	21	.28	.45	18
LISTEN	4.36	3.58	19	4.25	3.73	21	1.47	1.57	18
READ	.30	.47	18	.46	.91	20	.71	.83	19
DEPART	.06	.20	18	.02	.09	20	.05	.21	19

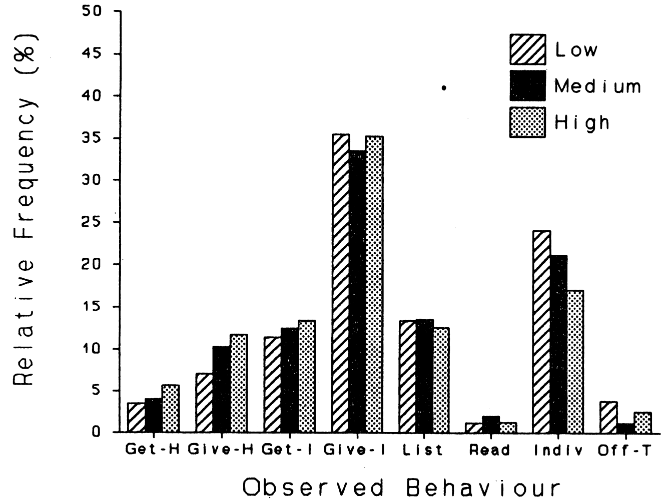
HELP (S) is getting help, HELP (T) is giving help, INFORM (S) is giving information, INFORM (T) is being given information, SUPPORT (S) is supporting peers, SUPPORT (T) is being supported by peers, BELIT (S) is belittling peers, BELIT (T) is being belittled by peers, INDIV is non-verbal on-task work, OFF is off-task behaviours, LISTEN is listening passively to others, READ is reading manual to peers, DEPART is leaving group.

TABLE 34

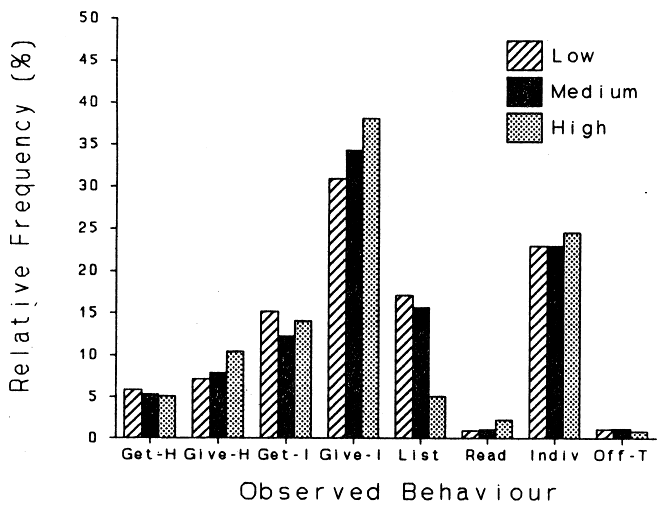
MEANS, STANDARD DEVIATIONS AND SAMPLE SIZES FOR OBSERVED BEHAVIOURS (STUDY 3) (FREQUENCY PER 3 MINUTES)

	HOMOGENEOUS GROUPINGS								
MEASURE	**LOW**			**MEDIUM**			**HIGH**		
	M	**SD**	**N**	**M**	**SD**	**N**	**M**	**SD**	**N**
HELP (S)	2.15	1.40	16	2.92	1.46	20	3.76	2.35	19
HELP (T)	1.02	.77	15	1.11	.78	20	1.79	1.34	19
INFORM (S)	10.54	3.14	16	9.42	2.27	20	11.00	3.16	19
INFORM (T)	3.49	2.42	16	3.70	1.97	20	4.42	2.39	19
SUPPORT (S)	000	000	14	.05	.16	20	000	000	17
SUPPORT (T)	.07	.19	14	.12	.30	20	000	000	17
BELIT (S)	.06	.19	14	.10	.25	20	.02	.07	17
BELIT (T)	.07	.20	14	000	000	20	000	000	18
INDIV	6.87	2.71	16	5.99	3.57	20	5.42	3.62	19
OFF	1.11	1.41	14	.32	.68	20	.66	1.13	19
LISTEN	4.36	2.57	14	3.63	3.39	20	3.41	3.20	19
READ	.35	.69	14	.64	.85	20	.42	.78	20
DEPART	.03	.11	14	.17	.58	20	.09	.27	19

HELP (S) is getting help, HELP (T) is giving help, INFORM (S) is giving directions, INFORM (T) is being given information, SUPPORT (S) is supporting peers, SUPPORT (T) is being supported by peers, BELIT (S) is belittling peers, BELIT (T) is being belittled by peers, INDIV is non-verbal on-task work, OFF is off-task behaviours, LISTEN is listening passively to others, READ is reading manual to peers, DEPART is leaving group.



(a)



(b)

Figure 26. Distribution of observed behaviours in homogeneous (a), and heterogeneous (b) groups.

The degree of group heterogeneity significantly influenced giving help, $\underline{F}_{change}(2, 46) = 3.9$, $\underline{p} = .05$. As the degree of heterogeneity increased, less help was given (see Figure 27). There were significant influences of gender, $\underline{F}(1, 81) = 5.51$, $\underline{p} = .02$, prior ability $\underline{F}(2, 81) = 6.19$, $\underline{p} = .003$, and status $\underline{F}(2, 81) = 3.5$, $\underline{p} = .035$, on giving help to others. Female students gave more help than did male students ($\underline{M}$ of 3 *vs* 2.4). High performing students gave more help than did low performing students ($\underline{M}$ of 3.3 *vs* 2.2). High status and medium status students gave more help than did low status students ($\underline{M}$s 3.2, 2.9, and 2.0, respectively).

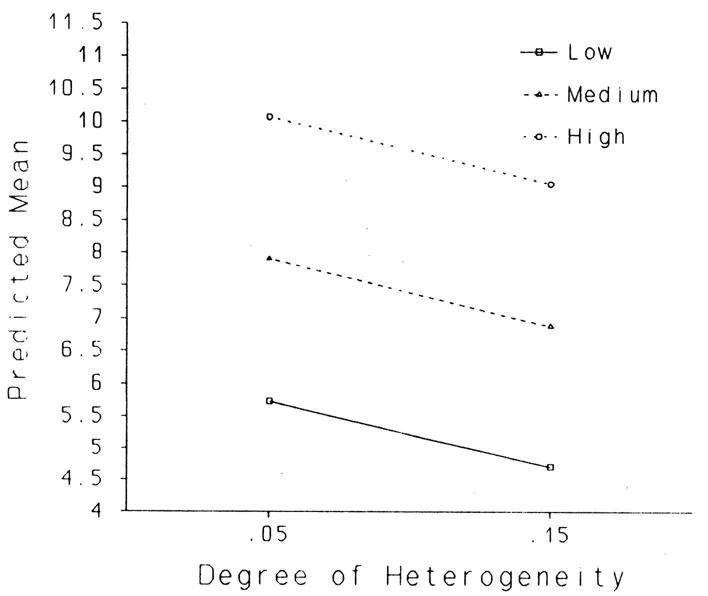


Figure 27. The influence of degree of group heterogeneity on frequency of giving help.

There was a significant grouping by prior performance interaction $\underline{F}(2, 78) = 3.78$, $\underline{p} = .027$, on getting help. There was no differences in the amount of help received by low, medium, and high performing students in heterogeneous teams ($\underline{M}$s of 1.6, 1.6, and 1.4, respectively). However, in homogeneous teams, high performing students received more help than did either medium performing or low performing students ($\underline{M}$s of 1.7, 1.2, and 1.0, respectively).

There was a significant influence of status on giving information, $\underline{F}(2, 82) = 11.2$, $\underline{p} < .001$. High status students gave more information than did medium status students, who in turn, gave more information than did low status students ($\underline{M}$s of 11.9, 10.9, and 7.7, respectively).

There was a significant influence of status on receiving information, $\underline{F}(2, 80)$. High and medium status students received more information than did low status students ($\underline{M}$s of 4.6, 4.4, and 2.7, respectively).

The degree of heterogeneity significantly influenced the extent of belittling others, $\underline{F}_{change}(2, 46) = 9.5$, $\underline{p} = .003$. As the degree of heterogeneity increased, students engaged in more belittling behaviours (see Figure 28). Gender and grouping significantly interacted, $\underline{F}(1, 72) = 6.07$, $\underline{p} = .016$, to moderate belittling behaviours. Female students belittled others to a greater extent when they were in homogeneous teams ($\underline{M}$s of .15 and .01, respectively); while male students, belittled others to a

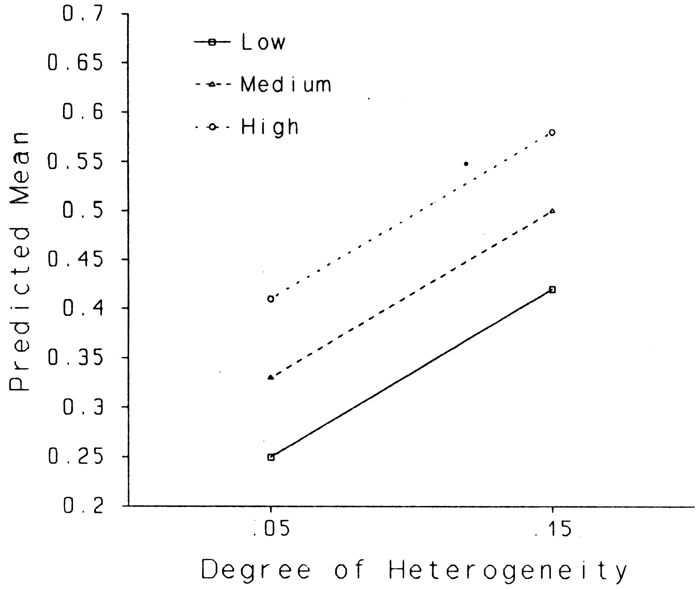


Figure 28. **The influence of degree of group heterogeneity on frequency of belittling others.**

greater extent when they were in heterogeneous teams (Ms of .01 and .08, respectively). Female students in homogeneous teams belittled others more than did male students in heterogeneous teams (Ms of .15 and .08, respectively). Likewise, the degree oh heterogeneity significantly influenced the frequency of being belittled by others, F( ). The frequency of being belittled increased as the degree of heterogeneity increased (see Figure 29).

Gender, prior-performance, and grouping interacted significantly to moderate off-task behaviour, $F(2, 75) = 5.20$, $p = .008$. Low performing male students were significantly more off task than any other students in either grouping condition (M of 1.76 compared to .37).

There was a significant interaction between prior performance, $\underline{F}(2, 76) = 4.4$, $\underline{p} = .016$, and status, $\underline{F}(2, 76) = 9.64$, $\underline{p} < .001$, on listening-in (to other students' interactions). High performing students listened-in less than did medium performing and low performing students ($\underline{M}$s of 3.3, 4.4 and 4.6, respectively. Low status students listened-in more than did either medium status or high status students ($\underline{M}$s of 6.2, 2.9, and 3.4, respectively).

There was a significant interaction between gender and grouping on reading the laboratory manual to others, $\underline{F}(1, 75) = 5.0$, $\underline{p} = .028$. When students were in heterogeneous groups, there were no gender differences in the frequency at which male and female students read the laboratory manual aloud to their peers. However, in homogeneous groups, female students read the lab manual aloud more than did male students ($\underline{M}$s of .71 and .22, respectively).

Discussion. Individual characteristics (*i.e.,* gender, prior performance and status) and the group characteristic, degree of heterogeneity, moderated achievement, affect, and motivation. Female students who had low scores on the lab pretest achieved higher scores on the lab posttest than did similar performing male students. However, there were no differences in achievement on the lab posttest between female and male students who had medium or low scores on the lab pretest. Female students in homogeneous groups also perceived that they had learned more than did male students in homogeneous groups. This may suggest that low performing female students are more prepared to learn in groups than are low performing male students. It may be that low performing male students lack the social skills required for effective team work.

A second possibility, suggested by this study, is that low performing male students are more concerned with protecting status than are female students. Thus, prior performance influenced male students', but not female students', ego goals. Male students who had high scores on the lab pretest had higher ego goals than did male students who had medium or low scores.

Other possibilities, suggested by this study are that male students have more work-avoidance goals and are more off-task than are female students. Thus low performing male students do not benefit from group work unless attention is focused on their behaviour in groups.

Students who had low scores on the lab pretest felt less competent and less part of their group than did students who had medium and high scores on the lab pretest. This may suggest that students need to know they have something to contribute to the group in order to benefit maximally from group work. Elizabeth Cohen (1986) has designed specific interventions in *Finding Out/Descubrimiento* to obviate status problems associated with differential competence in cooperative learning strategies. However, students had more affiliative goals when they had been in heterogeneous groups. Thus, devising group activities in such a manner that everyone has someone to help, and in turn is helped by everyone else may facilitate effective cooperative learning.

One would expect future expectation of success to be a positive function of prior performance. This expectation is met for high status students in both·homogeneous or heterogeneous groups. However, future expectation of success is a positive function of prior performance for low status students only when they are in homogeneous groups, and for medium status students, only when they are in heterogeneous groups. In both cases, the future expectations of medium performing students do not follow the expected pattern. Low status, medium performing students appear to have lower expectations in heterogeneous groups than would be predicted on the basis of their prior performance. This may suggest, as indicated by Webb (1985), that medium performing students of low status do not get sufficient attention in heterogeneous groups. On the other hand, medium status, medium performing students in homogeneous groups have higher expectations of future success than would be predicted on the basis of their prior performance. This may suggest that these students benefit greatly from working together with students of similar abilities.

As the degree of heterogeneity increased, positive feelings towards learning biology and feelings of competence were enhanced for students who had low scores on the lab pretest. On the other hand, the feelings towards learning biology and feelings of competence for students who had high scores on the lab pretest were diminished.

Gender, status, and prior performance also moderated students' attributions to task difficulty as causes of their success or failure. For female students, attributions of task difficulty were positively related to prior performance for low status students, but negatively related for high status students. Thus, as high status female students experienced success they made fewer external attributions. However, as low status female students experienced success they made more external attributions. On the other hand, for male students, attributions of task difficulty were negatively related for low status students, but positively related for high status students. Thus, as low status male students experience success they make fewer external attributions. However, as high status male students experience success they make more external attributions. Since an increase in external attributions is mal-adaptive, this finding would suggest that cooperative learning would benefit high status female but low status male students.

Prior performance does not appear to influence medium status students to the same degree that it does low and high status students (positive feelings, feelings of competence, active engagement, attributions to task difficulty). It may be that medium status students do not participate in small group work to the same extent as low and high status students.

Female students give more help than do male students. However, as the groups become more heterogeneous, less help is given and students who had high scores on the lab pretest receive less help. Male students in homogeneous groups also engaged in the most off-task behaviours. Thus, students in homogeneous groups, especially male students and less-able students, may require assistance in working in groups and in helping others.

In addition, more information was given by high and medium status students. In turn, these students also received more information. Low status students also were more frequent "bystanders" - listening in to the other students interact. Thus, status within a group may govern the flow of information, with low status students being excluded.

Although both belittling others and being belittled increased as the degree of heterogeneity increased, female students belittled others more when they were in homogeneous groups. However, male students belittled others more when they were in heterogeneous groups.

CONCLUSIONS

Cooperative learning enhanced the learning outcomes of all students, but was especially benefical for low-ability students. Performance contingent rewards (whether group-performnace or individual-performance contingent) did not appear to be necessary, and may have detrimental side effects. Since most students appear to enjoy working together such rewards may not be necessary. There are large differences in the degree of heterogeneity among groups (of the order .05 to .15) when students are assigned to heterogeneous groups by the method suggested by Slavin (1990). We suggest that the method be adapted to prevent extremely heterogeneous groups. For example the class can be subdivided into two subgroups and students be assigned to moderately heterogeneous groups within each subgroup.

We found a large number of interactions among gender, prior performance and status on learning outcomes. It appears that female and male students respond differently to the experience of working in small groups. we intend to explore these differnces in future research.

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TEAMS-GAMES-TOURNAMENTS (TGT)

Philosophy and Overview Robert Slavin and his colleagues at Johns Hopkins University have developed a number of student team learning strategies based on the belief that students are not always intrinsically motivated to learn the subject matter and that, in traditional educational settings, students do not have equal opportunities to succeed. Given these two assumptions, Teams-Games-Tournaments (TGT) was designed to both provide equal opportunity for all students to succeed and to extrinsically motivate students to encourage and help each other learn. The major elements of TGT are the following:

Students: a) are assigned to teams, b) are taught by the teacher, c) then study in their teams, d) engage in academic tournaments and bring points to their respective teams; and e) have their teams recognized for doing well through newsletters and awards.

Step 1. Assignment of students to teams.

a. Ranking the students. The first step in assigning students to teams is to rank them from strongest to weakest according to their present level of functioning in the subject matter to be learned cooperatively. The ranks should be the most accurate prediction of each individual's present level of understanding and can be based on test scores, prior grades, or teacher judgments-- whichever is best. This may present a difficult judgment; do the best you can.

b. Deciding on the number and size of teams. The second step is to decide on the number of teams the class will be divided into. Each team should have four members, if possible. Extra students will go toward five member teams. To decide on how many teams there will be, divide the number of students by four. The whole number quotient is the number of teams. For example, a class of 32 students yields eight four member teams. A class of 35 students also yields eight teams but there will be five four member teams and three five member teams.

c. Assigning students to teams. The third step is to divide the class of ranked students into three sections; the top 25%, the bottom 25%, and the remainder. First, take those students (anywhere from one to three students) from the midpoint of the middle group you will need to make up the fifth members of the five student teams. Next, assign students to each team beginning at the top of the high performing students and going down, beginning at the bottom of the low performing students and going up, and beginning at the centre of the average-performing students and going away from the centre in both directions. This procedure is illustrated in Figure 1.

Figure 1. Assigning Students to Teams

Section	Rank Order	Team Name
top performers	1	A
	2	B
	3	C
	4	D
	5	E
middle performers	6	E
	7	D
	8	C
	9	B
	10	A
	11	*
	12	*
	13	A
	14	B
	15	C
	16	D
	17	E
bottom performers	18	E
	19	D
	20	C
	21	B
	22	A

Each team will now have one high able student, two middle able students, and one low able student. You should now have four member teams which are equally varied in terms of the prior achievement of individual team members. Furthermore, the assignment process should result in teams which are about equal in the average prior achievement of their team members. (To double check this compute the mean [and variance] of the ranks for each team. These values should not differ from team to team as illustrated in Figure 2.)

Figure 2. Checking Team Assignments

Team Name	Student Rank	Team Name	Student Rank	Team Name	Student Rank
A	1	B	2	C	3
A	10	B	9	C	8
A	13	B	14	C	15
A	22	B	21	C	20
D	4	E	5	For each team:	
D	7	E	6	Mean =	11.5
D	16	E	17	SD =	7.5
D	19	E	18		

* These students will be assigned to teams as the fifth members after teams are checked for heterogeneity for other variables (gender, ethnicity, etc.).

Now check the teams for ethnic, racial, and/or sex balance. You may exchange students of similar prior achievement on different teams to achieve a better team mix or to avoid combining students who just cannot work together. For example, if 25% of your class are minority students, you may want to have one member of every team be a minority student. Finally, assign the extra students to five member teams. This should not effect the average prior achievement of the teams.

Step 2. Class presentation.

The teacher presents a specific lesson on the topic being covered in the unit. It is important that the learning objectives are made clear so that students know exactly what they are expected to learn. Likewise, the teacher should ensure that all students have grasped the concepts of the lesson before they engage in team practice to secure the practice. Thus, the teacher's role changes from delivering instruction to coaching learning. Students also take on more responsibility for their own, and their teammates', learning.

Step 3. Team study.

The team study replaces all of the independent seatwork and some of the teacher presentation that is used in traditional instruction. The desks or tables should be arranged so that team members can easily communicate with each other. Students share worksheets and answer sheets; thus, resource-interdependence is present.

It is recommended that teachers stress that students do their best "for the team" and that teams do the best for their members. Thus, within-team interdependence is encouraged. Students are reminded that the learning goal is not only individual mastery but includes team-mastery. Although, students will be tested individually, the whole team cannot succeed unless everyone understands the material.

The teacher should circulate and give help to groups if no one on the team knows the answer. To further encourage team learning the teacher should avoid answering questions from individual students unless it is clear the student has checked with the group first. Alternately, teams may elect a representative to ask questions. Finally, individual homework can be assigned but it should not be the team worksheets.

Step 4. Tournaments.

Academic games are held weekly, where students in three-member ability-homogenous tournament tables compete to answer questions on the material they have studied and win points for their team. Three is the ideal size but tournament tables as large as five players can be used. Each table consists of students representing different teams. This equal competition makes it possible for students at all levels to contribute equally to their team scores.

Step 4A. Assignment to tournament tables.

The required number of tournament tables is the number of students divided by three. List students from top to bottom according to the performance used to assign students to teams. Assign the bottom three students to Table 7, the above three to Table 6, and so on. If there are 1 or two students remaining, assign them to the top two tables as shown in Figure 3.

Step 4B. Tournaments.

The students participate by attempting to answer objective questions, usually multiple choice, which are selected by choosing from a deck of numbered 3" x 5" cards, shuffled to be in random order. All the tournament tables are given the same set of questions.

Figure 3. Assigning Students to Tournament Tables

Rank Order	Team Name	Tournament Table	Rank Order	Team Name	Tournament Table
1	A	1	12	E	4
2	B	1	13	A	4
3	C	1	14	B	5
4	D	1	15	C	5
5	E	2#	16	D	5
6	E	2#	17	E	6*
7	D	2	18	E	6*
8	C	3	19	D	6
9	B	3	20	C	7
10	A	3	21	B	7
11	D	4	22	A	7

* or # These team members will be competing at the same tournament table. It would be preferable to exchange student 16 for 17 and student 4 for 5 in setting up the tournament tables.

THE RULES OF TGT

1. To start the game, shuffle the deck of number cards and place it face down on the table. Also place the answer sheet face down on the table. Decide who will be player number 1. Play proceeds in a clockwise direction from player number 1.

2. Each player, in turn, takes the top card from the deck, reads the item corresponding to that number aloud, and does either a. or b. below:

   a. states that he or she does not know the answer and asks if another player wants to give an answer. If no one answers, the card is placed on the bottom of the deck. If another player gives an answer, he or she follows the procedure described under alternative b.

   b. Answers the question immediately and asks if anyone wants to challenge the answer. The player to the left of the person giving the answer has the right to challenge first and give a different answer. If he or she passes, the next player to the left can challenge.

3. When there is no challenge, the player to the right checks the answer:
   a. if the answer is correct, the player keeps the card.
   b. if the answer is wrong, the player puts the card on the bottom of the deck.

4. When there is a challenge and the challenger gives an answer:
   a. if the answer is correct, the challenger receives the card.
   b. if the challenger is incorrect and the original answer is correct, the challenger must give up one of his or her other cards, if any, and place it on the bottom of the deck.
   c. if both the challenger's answer and the original answer are **wrong**, only the card in play is placed on the bottom of the **deck**.

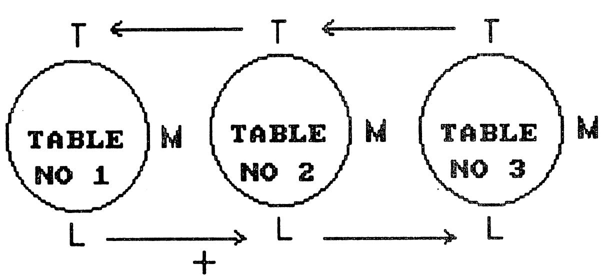
5. The game ends when there are no more cards in the deck. Each player counts up the number of cards he or she has and records this number as the score on the game score sheet. The player with the most cards is the winner.

Step 4C. Bumping.

After the first tournament, students change tables depending on their performance. This "bumping" will allow students to reach their true level of performance if they have been initially misassigned. In addition, "bumping" serves to vary the composition of the tournament tables and to continually motivate students to work hard.

BUMPING MECHANISM

After the first week, students change tables depending on their performance in the most recent tournament. The winner (top, T) at each table is "bumped up" to the next higher table (e.g., from Table 3 to Table 2) and the low scorer (L) is "bumped down" as diagrammed below. M stands for the middle scorer who remains in place for the next tournament.



Step 5. Distribution of Points.

After each game, points are distributed to each tournament player as described below and brought to the team to calculate team scores as shown in Figure 4. Thus a student can contribute a maximum of 6 or a minimum of 2 to the team score.

Figure 4. POINT DISTRIBUTION

THREE-PLAYER GAME

Player	No Ties	Tie for Top	Tie for Low	3-Way Tie
Top Scorer	6	5	6	4
Middle Scorer	4	5	3	4
Low Scorer	2	2	3	4

FOUR-PLAYER GAME

Player	No Ties	Tie Top	Tie Mid	Tie Low	3-Way Tie Top	3-Way Tie Low	4-Way Tie	Tie Top & Low
Top Scorer	6	5	6	6	5	6	4	5
High Middle	4	5	4	4	5	3	4	5
Low Middle	3	3	4	3	5	3	4	3
Low Scorer	2	2	2	3	2	3	4	3

<u>Step 6.</u> Team recognition.

The teacher calculates the team scores by recording each student's score on a team summary sheet. The team score is the average score over all team members points. As soon as possible after the tournament, teams are recognized and congratulated for their performance via weekly newsletters distributed to each student or bulletins posted in the classroom. At the end, appropriate rewards (e.g., certificates, buttons, etc.) should be distributed to the deserving teams during a recognition ceremony.

Although some researchers criticize TGT for including face-to-face competition (Kagan, 1989), Slavin included it as a means of introducing a "game" element to engage the interest of students that were otherwise bored by the material.

Source Readings

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LEARNING BIOLOGY

Directions to the Student

During the next several weeks your biology labs will be structured so that you will work together in small teams to learn the material cooperatively. Your biology teacher has decided to use this approach, which was designed by the Centre for the Study of Classroom Processes at Concordia University, because cooperative learning often increases student achievement and course enjoyment. You will learn more about this approach in the training session.

On the following pages are questions about you and your learning. These questions were also developed at Concordia University so that we might better understand how you and your classmates learn biology when working cooperatively. We would, therefore, appreciate your taking the time to complete the questionnaire. Of course, you may elect not to complete all or part of it. If so, we would appreciate learning your reasons.

The questionnaire asks about you and, consequently, there are NO right or wrong answers. It is important that you give your own opinion.

Please do not talk or share your answers with other students. Furthermore, the answers will be treated confidentially. Your teachers and your classmates will not be shown your individual answers. Therefore, please answer the questions honestly. Your answers will not affect your grades in any way.

At the beginning of each section of the questionnaire are a set of instructions. If you have any questions about how to answer raise your hand. Do not shout questions out.

Answer each question directly on the answer sheets and not the test booklet. Please answer every question. If you have difficulty choosing an answer, pick the one answer which is best or comes closest to describing you. Please work at a steady pace. Do not spend too much time on any one question.

Before we begin, make sure that you have filled in your name, ID number, and course section number on the answer sheets.

Please go to the next page...

APPENDIX 2

BELIEFS ABOUT LEARNING

DIRECTIONS: These questions concern your beliefs about how you and your classmates learn biology. Please use the following five-point response scale to indicate the answer which best describes what you believe.

Response Scale:

not at all important				**extremely important**
a.	**b.**	**c.**	**d.**	**e.**

1. Whether they did well or poorly, how important do you think your classmates' effort was in their learning biology?
2. Whether they did well or poorly, how important do you think luck was in your classmates' learning biology?
3. Whether they did well or poorly, how important do you think your classmates' ability was in their learning biology?
4. Whether they did well or poorly, how important do you think the difficulty of the subject was in your classmates' learning biology?
5. Whether your classmates did well or poorly, how important do you think help from others was in your classmates' learning?
6. Whether you did well or poorly, how important do you think your own effort was in your learning biology?
7. Whether you did well or poorly, how important do you think luck was in your learning biology?
8. Whether you did well or poorly, how important do you think your own ability was in your learning biology?
9. Whether you did well or poorly, how important do you think the difficulty of the subject was in your learning biology?
10. Whether you did well or poorly, how important do you think help from others was in your learning?
11. How well have you learned biology in the past?
12. How well do you expect to learn biology in the future?

Please go to the next page...

APPENDIX 2

FEELINGS ABOUT LEARNING

DIRECTIONS: These questions concern your feelings when learning biology. Read each statement and choose the one answer which best describes how you feel about learning biology using the following scale.

Response Scale:

not at all				**a great deal**
a.	**b.**	**c.**	**d.**	**e.**

13. dissatisfied
14. happy
15. thankful
16. proud
17. hopeful
18. disappointed
19. competent
20. confident
21. angry
22. confused
23. sad
24. lost
25. worried
26. hopeless
27. satisfied
28. contented
29. joyful
30. incompetent

Please go to the next page...

REASONS FOR LEARNING BIOLOGY

DIRECTIONS: Students have a lot of different thoughts and feelings while they are doing biology. We want to know how true each of these statements are for you. Read each statement and choose the one answer which best describes **how you** feel about learning biology using the following scale.

Response Scale:

not at all true			**very true**
a.	**b.**	**c.**	**d.**

For these items do not use alternative e.

31. The work makes me want to find out more about the topic.
32. I feel involved in my work.
33. I wish we could have more time to spend on biology.
34. I want to learn as much as possible.
35. I want to work with my friends.
36. It's important to me that the teacher thinks I do a good job.
37. I want to do as little as possible.
38. I want to find out something new.
39. I want to talk to others about the work.
40. It is important to me that I do better than other students.
41. I just want to do what I was supposed to and get it done.
42. It is important to me that I really understand the work.
43. I want to help others with their work.
44. I want the others to think I am smart.
45. I want to do things as easily as possible so I don't have to work very hard.

Please go to the next page...

46. I try to figure out how the work fits with what I have learned in biology.

47. I often guess so I can finish early.

48. I ask myself questions as I go along to make sure that the work makes sense to me.

49. I write some things down.

50. I explain or write down ideas and concepts in my own words.

51. I check to see what other classmates are doing and do it too.

52. I pay attention to ideas I think I am supposed to remember.

53. I skip the difficult parts.

54. I check my biology text or use other materials such as charts when I am not sure of something.

55. I just do my work and hope it is right.

56. I try to figure out the difficult parts on my own.

57. I copy down someone else's answers.

58. I go back over the things I do not understand.

Please go to the next page...

APPENDIX 2

GROUP COHESION SCALE

DIRECTIONS: These questions concern your **EXPECTATIONS** of learning in groups during the upcoming biology labs based on your prior experience. Read each statement and choose the one answer which best describes how you feel using the following scale.

Response Scale:

not at all (none)				**completely (all)**
a.	**b.**	**c.**	**d.**	**e.**

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59. How many of your group members do you expect will fit what you feel to be the ideal of a good group member?

60. To what degree do you feel that you will be included by the group in the group's activities?

61. How attractive do you expect to find the activities in which you will participate as a member of your group.

62. If most of the members of your group decided to dissolve the group by leaving, would you try to dissuade them?

63. If you were asked to participate in another project, do you expext you would like to be with the same people again?

64. How well do you expect to like the group you are in?

65. Do you feel that working with a group enables you to attain your personal goals?

66. Compared to other groups, how well do you expect your group to work together?

67. Do you expect to have feelings of *belongingness* with your group?

68. How positive do you expect your feelings to be about the group with which you will work?

Please go to the next page...

APPENDIX 2

BIOLOGY AND YOU

DIRECTIONS: These questions concern your feelings and beliefs about your present biology course. Read each statement and choose the one answer which best describes how you feel using the following scale.

Response Scale:

not at all (very negative)				a great deal (very positive)
a.	**b.**	**c.**	**d.**	**e.**

69. The amount you have learned in the course so far.
70. Your enjoyment of the course.
71. The overall effectiveness of your biology course.
72. The overall quality of the biology labs.
73. The amount you have learned in the biology labs.
74. Your enjoyment of the biology labs.
75. Your general feelings and attitudes toward your classmates.
76. Your general feelings and attitudes toward biology.
77. The importance of learning biology.
78. The usefulness of working with others.
79. The importance of earning a high course grade.

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