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Restructuring the Classroom: Conditions for Productive Small Groups

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Moving beyond the general question of effectiveness of small group learning, this conceptual review proposes conditions under which the use of small groups in classrooms can be productive. Included in the review is recent research that manipulates various features of cooperative learning as well as studies of the relationship of interaction in small groups to outcomes. The analysis develops propositions concerning the kinds of discourse that are productive of different types of learning as well as propositions concerning how desirable kinds of interaction may be fostered. Whereas limited exchange of information and explanation are adequate for routine learning in collaborative seatwork, more open exchange and elaborated discussion are necessary for conceptual learning with group tasks and ill-structured problems. Moreover, task instructions, student preparation, and the nature of the teacher role that are eminently suitable for supporting interaction in more routine learning tasks may result in unduly constraining the discussion in less structured tasks where the objective is conceptual learning. The research reviewed also suggests that it is necessary to treat problems of status within small groups engaged in group tasks with ill-structured problems. With a focus on task and interaction, the analysis attempts to move away from the debates about intrinsic and extrinsic rewards and goal and resource interdependence that have characterized research in cooperative learning.

Cooperative learning has gained increasing acceptance in classrooms here and abroad as a strategy for producing learning gains, the development of higher order thinking, prosocial behavior, interracial acceptance, and as a way to manage academic heterogeneity in classrooms with a wide range of achievement in basic skills. Theoretically, small groups offer special opportunities for active learning and substantive conversation (Nystrand, 1986) that are essential for authentic achievement, a goal recommended in the current drive to restructure schools (Newmann, 1991). Small groups have also been widely recommended as a means to achieve equity (Oakes & Lipton, 1990).

The purpose of this review of research is to move beyond the general question of effectiveness of small group learning to conceptualize conditions under which the use of small groups in classrooms can be productive. Reviews of research on cooperative learning have been mainly concerned with its effectiveness in com-

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parison to traditional forms of instruction that are more competitive and/or individualistic. Early reviews (Sharan, 1980; Slavin, 1980) concluded that, in general, there were some significant positive effects on achievement and interracial relations that occur as a result of cooperative learning. Bossert (1988), in his review of research on cooperation, characterizes more recent meta-analyses on the now substantial body of research as suggesting that the benefits of cooperative learning activities hold for students at all age levels, for all subject areas, and for a wide range of tasks, such as those involving rote-decoding, retention, and memory skills as well as problem-solving abilities (Johnson, Johnson, & Maruyama, 1983; Johnson, Maruyama, Johnson, Nelson, & Skon, 1981). Bossert was, however, critical of the lack of knowledge about the ways in which various cooperative activities produce their positive effects. He was particularly critical of studies that employ a "black box approach" (p. 233) in which they compare a cooperative instructional method to a noncooperative method on outcome measures alone.

Despite the significant positive effects of cooperative learning in many studies, there was important variation in effectiveness between studies. In some of the early studies, cooperative learning was associated with results that were merely as good as those with more traditional forms of instruction and not necessarily superior. As research continued to accumulate, Davidson (1985), in a review of cooperative learning in mathematics education, found significant differences favoring cooperative versus traditional methods of instruction in a third of the studies; the remaining studies showed no significant differences according to type of instruction. A synthesis of "best evidence" taken from studies of secondary schools only (Newmann, & Thompson, 1987) concluded that, of the 37 comparisons, 68% favored cooperative learning over traditional forms of instruction. Moreover, the results of cooperative learning sometimes differed according to the ethnic or racial group of the student (Widaman & Kagan, 1987). Slavin (1983b) argued in a best evidence synthesis that cooperative learning is only effective when group rewards and individual accountability are present.

This variability in findings suggests that the advantages that can theoretically be obtained from cooperative learning can actually be obtained only under certain conditions. A thorough search of the recent research literature reveals that numerous studies have progressed beyond the black box approach to one in which various features of cooperative learning are manipulated so as to highlight the importance of particular conditions for success on different kinds of instructional outcomes. In addition, observational studies that examine processes of interaction in relationship to outcome variables are useful in highlighting which features of interaction are more important in assuring particular outcomes. Analysis of the conditions under which optimal features of interaction are likely to occur permits an inference concerning conditions for productivity.

This is an inductive and conceptual review of research rather than a meta-analysis. Although much of this research does not contain powerfully developed theoretical frameworks, these findings will be built on to develop several testable propositions concerning the conditions for productive small groups. These propositions are consistent with all the research articles reviewed unless otherwise specified.

Some Definitions

For the purposes of this review, *cooperative learning* will be defined as students working together in a group small enough that everyone can participate on a collective task that has been clearly assigned. Moreover, students are expected to carry out their task without direct and immediate supervision of the teacher. The study of cooperative learning should not be confused with small groups that teachers often compose for the purpose of intense, direct instruction—for example, reading groups.

This definition is both broad and sociological in character. It is broad in that it encompasses what is called collaborative learning, cooperative learning, and group work. It is sociological in its stress on task and delegation of authority rather than the more psychological concepts of common goals, rewards, and needs for other individuals in the group.

Techniques that are effective for one outcome variable may well be ineffective for another. Thus it is essential to distinguish among different meanings of productivity or effectiveness. The commonest definition of *productivity* for cooperative learning has been conventional academic achievement, of the kind that standardized achievement tests have measured in the past. This type of achievement stresses basic skills, memorization of factual materials, and the application of algorithms in areas such as mathematics.

Productivity can also be defined in terms of conceptual learning and higher order thinking. Some researchers advocate small groups because they believe that small-group processes contribute to the development of higher order thinking skills (Noddings, 1989). Noddings sees this school of thought as originating in the work of Dewey and the social constructivism of Vygotsky (1978). Because these researchers assume that such outcomes cannot be achieved without the creation of suitable discourse or conversation within the small groups or without a process of discovery, they define productive small groups as those that are engaged in high-level discourse. This alternative definition of productivity stresses conceptual learning and higher order thinking.

For those researchers concerned with equity, productivity is defined as the occurrence of equal-status interaction within the small groups. This is typically measured by comparisons of individual rates of participation for students of different statuses within the group. It is also possible to define productivity in this domain at the classroom level—that is, those classrooms in which there is very little difference between the participation rates for students of differing statuses within cooperative groups are more productive.

Finally, productivity may be defined in terms of desirable prosocial behaviors such as being cooperative or being friendly towards students of a different ethnic or racial group. Related to this type of outcome is a concern for the use of cooperative learning in a multiethnic setting. In this case, productivity is defined as positive intergroup relations.

Theoretical Focus of the Review

A central proposition of this review is that the relationship of the total amount of interaction within a group to achievement differs according to the nature of the task. Not all tasks assigned to cooperative groups are true group tasks. Some could be done as individuals and have the character of collaborative seatwork. In addition, some tasks have fairly clear procedures and may have "right answers," whereas others are what the sociologists call "ill-structured problems." Theoretically, the total amount of interaction should be far more critical for achievement gains when there is an ill-structured problem that is a true group task than when the task is more clear-cut and could be carried out by individuals.

Beyond sheer volume, the type of interaction that is the most effective, and thus the most desirable, will also vary with the nature of the task and the instructional objective. There is, for example, a major difference between the type of interaction useful for tasks with clear procedures and right answers when the objective is routine academic learning and the type of interaction desired when the objective is learning for understanding or conceptual learning and the task is ill-structured. For more routine learning, it is necessary for students to help each other to understand what the teacher or the textbook is saying, and it is helpful for them to offer each other substantive and procedural information. For conceptual learning, effective interaction should be more of a mutual exchange process in which ideas, hypotheses, strategies, and speculations are shared.

Given the most effective interaction for particular tasks and objectives, there are a number of factors that will affect how well that desired interaction is achieved. For example, if the main type of interaction desired is for students to offer each other assistance, then the motivation of students to do so as well as the preparation for constructive assistance of one another become important factors in predicting the relative success of the groups. If, on the other hand, an extensive mutual exchange of ideas and strategies is desired, then too sharp a division of labor or limited participation of low-status students may impede the very interaction necessary for the achievement of conceptual learning.

The discussion of specific studies is divided into two parts. The first part examines research on interaction and its relationship to productive small groups under varying task conditions. Having established the importance of interaction for attaining educational objectives under specified conditions, the second part focuses on factors that affect interaction.

With a focus on interaction, nature of the task, and productivity, this review is a reexamination of problems that have been debated for some time among researchers on cooperative learning. The hope is that by choosing to focus primarily on tasks and interaction rather than on interdependence, rewards, and individual accountability new light will be shed on some old problems. Rather than continue the current debate over which of the popular methods of cooperative learning are more effective, a less holistic mode of analysis is used to examine the evidence for each of the selected variables.

In describing and analyzing relevant research, more general propositions are inferred about conditions under which small groups will be more productive. It is these general propositions that comprise recommendations for future research. The propositions are based on a post hoc analysis of the research literature and its contradictions. Future researchers would do well to put these propositions to a new and general test.

Collection of articles. The search of the literature was restricted to empirical research or to reviews of research and did not tap into the large literature written for practitioners on this subject. Eliminated were studies that contrasted a cooperative treatment to some kind of conventional academic instruction; selected were those studies or parts of studies that contrasted alternative forms of cooperative learning groups. Also omitted were discourse analyses and studies of peer response groups in the teaching of writing, peer tutoring, and studies of college-age students. Most of the studies selected for review took place in classrooms. A number of laboratory studies were dropped from consideration on the grounds that the experimental task bore no resemblance to a school task. A few laboratory studies were included because they used more applicable tasks and highlighted the effects of one of the factors under consideration. If the methodology were so grossly flawed that very little could be learned from a study, it was not included. Included were a number of modest qualitative studies of relatively few groups, detailing the nature of group interaction. The choice of which studies to include was dictated by the purpose of developing general propositions. All studies that met the above criteria were accepted for the review. Great care was taken to include studies that did not support the general propositions under development. Most of the relevant literature meeting these criteria was written in the 1980s.

Studies of Interaction

Several researchers have examined the nature of interaction taking place within cooperative groups. In these studies, students were given no special preparation for cooperative behavior. Students were typically instructed to work together, but there were no further attempts to structure interaction because the goal was to study "natural" cooperation.

Barnes and Todd (1977) carried out a pioneering study, recording detailed conversations of students engaged in a variety of creative problem-solving tasks. Many of their conclusions, based on a qualitative analysis of the interaction, foreshadowed issues that were to become central to the research of the 1980s. These included the nature of understanding that emerges from the group, the kinds of social and cognitive skills required of students for effective interaction, and the effects on interaction of variations in the type of task given to the group.

The transcripts from this study include some of the best examples in the literature of the social construction of knowledge. For Barnes and Todd, the meaning of a given contribution was often gradually negotiated through the interaction process. They cautioned researchers that meaning may not be explicit even to the speaker in an ongoing discussion, because criteria for relevance are negotiated moment by moment. Only when the conversation is over, by looking backwards, can a determinate meaning be assigned. These investigators made a distinction between operational meaning of the moment and subsequent reflective meaning.

Some of the groups studied by Barnes and Todd were far more effective than others. Useful behaviors included soliciting opinions, encouraging explicitness, pinpointing differences, and interrelating viewpoints. Some groups engaged in destructive interaction in which members were verbally attacked. These revealing transcripts produced the conclusion that students needed both social and cognitive skills for effective interaction. The social skills required included the ability to control progress through the tasks, the skills to manage competition and conflict, and the ability to modify and use different viewpoints as well as the willingness to give mutual support. Cognitive skills included constructing meaning for a given question, inventing a problem, setting up hypotheses, using evidence, and recreating experience.

Differences in the transcripts between groups carrying out different tasks led to the observation that the degree of unfamiliarity of the task to the students should be considered so as to keep the amount of uncertainty manageable. Other task dimensions that the investigators saw as important were how loosely or tightly structured was the task and whether there was one or multiple solutions to the problem. They also mentioned that having some concrete object for students to manipulate could make a difference in the effectiveness of the group.

Schwartz, Black, and Strange (1991) also take a constructivist view in trying to answer the question of why dyads are far more effective than individuals in inducting a general rule concerning a physical problem of the effects of multiple gears. Based on a study of interaction of dyads, they concluded that working pairs required subjects to create an agreed-on representation of the problem in order to communicate with each other. This representation allowed the group to abstract more successfully than single individuals. They recommend that cooperative learning should capitalize on the unique strengths of group learning by selecting tasks that involve abstractions and require and enable representational negotiation.

In contrast to these social constructivist views is the conclusion of Chang and Wells (1987) that, in order to be effective, groups must manage the process of solving problems with explicit talk. They define learning as problem-solving where the planning and execution of tasks are brought under conscious control. Groups support this process by making thinking explicit and available for inspection and revision. To work together, students have to specify goals more precisely, plan procedures, generate and select alternatives, and review or modify their plans. This problem-solving model deemphasizes the ongoing social nature of understanding.

Vedder (1985) also sees effective cooperative learning as a result of an explicit process. According to the theory of cooperative learning he developed from a more general view of teaching and learning, the children's role vis-à-vis each other should be that of teacher and pupil. For cooperative learning to be effective, Vedder reasoned that pupils must control and evaluate their partner's work. Also, help that is given should correspond to a model of a correct problem-solving process. After finding that cooperative groups did no better than the control condition on a set of geometry lessons, he performed an in-depth analysis of videotapes to see if students were actually regulating each other's problem-solving process. The pupils in the cooperative condition were taught how to regulate one another's solving of geometry problems. The analysis revealed that the students were fixated on finding the right answers which interfered with their attempting to regulate each other's process of problem-solving. They spent little time in thinking and talking about problem-solving strategies. They hardly used the resource card that contained useful information on problem-solving strategies.

Vedder was not the only researcher to be disappointed with the level of discourse that takes place in cooperative groups. In a study of small groups of students (ages 11 through 14) working with a computer and learning BASIC programming, Webb, Ender, and Lewis (1986) found that students performed all of their debugging statement by statement at the lowest abstract level. There was little long-range planning. Only with help from the instructor were they able to carry out plans at a more abstract level.

These studies suggest a useful generalization: If students are not taught differently, they tend to operate at the most concrete level. If teachers want high-level operation, particularly verbal, the students will require specific development of skills for discourse, either in advance of cooperative learning or through direct assistance when groups are in operation. The transcripts of Barnes and Todd suggest a similar proposition concerning interpersonal skills. These are not an automatic consequence of cooperative learning. Either through some kind of motivational device or through deliberate instruction in these social skills, something must be done to provoke the desired behaviors within cooperative groups.

Interaction and Achievement

There is an extensive literature on cooperative groups that correlates observed interaction with achievement, holding constant prior academic achievement. This literature presents a most interesting inconsistency, permitting the derivation of a general proposition concerning the conditions under which interaction will be related to achievement gains. On the one hand, there is a large body of meticulously conducted studies showing that the simple frequency of interaction on the part of individual students does not predict their achievement. Noreen Webb who is the investigator in many of these studies has also written several excellent reviews of this literature (1983, 1991). Most of these studies were conducted in mathematics classes where students were given problems to solve and were told to work together as a group, helping each other, and asking the teacher for help only when no one in the group could assist.

In contrast to this body of work stand a number of studies conducted on complex instruction in multilingual elementary classrooms. Complex instruction is a method of small group learning featuring open-ended discovery or conceptual tasks that emphasize higher order thinking skills. Each group in the classroom carries out a different task, all related to a central intellectual theme. Students have the opportunity to experience more than one of these tasks. *Finding Out/Descubrimiento*, a bilingual curriculum using concepts of science and math and designed to develop thinking skills, is used in conjunction with this method at the elementary level. Cohen and her colleagues consistently find that simple measures of frequency of task-related interaction are related to gains on computation and mathematical concepts and applications as well as on content-referenced tests. These results hold regardless of whether the unit of analysis is the individual learner or the percentage of students who are observed talking and working together in the classroom (Cohen & Intili, 1981; Cohen, Lotan, & Leechor, 1989). At the individual level, the frequency of students talking and working together in a task-related manner was positively correlated with the posttest scores on a content-referenced test in science, while holding constant the pretest scores (Cohen, 1984). This same variable of talking and working together had an independent effect on individual worksheet performance, as measured by quality of writing about results, conceptualization in mathematics, and inference (Stevenson, 1982). In an analysis of achievement on standardized tests of mathematics, Leechor (1988) concluded that task-related talk was a significant predictor of gains in mathematics for students who had reading scores at grade level or above as well as for students whose reading scores were below grade level. However, the linear correlation of participation with learning was more consistent in the low-achieving group than in the high-achieving group.

Task and interaction. What differences between these two bodies of studies could account for the differential effectiveness of simple interaction? The first difference lies in the working relationships between the group members. In the case of the group assignments in mathematics and the tasks given to the computer groups, the tasks could have been carried out by individuals. They were not inherently group tasks. A *group task* is a task that requires resources (information, knowledge, heuristic problem-solving strategies, materials, and skills) that no single individual possesses so that no single individual is likely to solve the problem or accomplish the task objectives without at least some input from others (Cohen & Arechevala-Vargas, 1987). The tasks used in complex instruction fit this definition of a group task. When working on a group task, members are interdependent in a reciprocal fashion. In other words, each actor must exchange resources with others before the task can be completed. This contrasts with many routine tasks used in cooperative learning where achievement depends on the stronger students helping the weaker students. This arrangement is also interdependent, but the interdependence is sequential as opposed to reciprocal—that is, one student's performance is dependent on another's, but the reverse is not true.

In the case of complex instruction, reciprocal interdependence is also produced by the system of classroom management in which each student is responsible for helping to ensure the success of all members. Each student has a role that has to do with the functioning of the group. Moreover, the students experience a week of skill-building activities in which they internalize norms of mutual assistance. Lastly, specific steps are taken to prevent the better students from doing all the helping and weaker students from accepting all of the help (Cohen & Cohen, 1991). In the studies reviewed by Webb, there was no such system of classroom management, nor was there any special training for cooperative relationships.

The second important difference lies in the nature of the work assigned to the groups. Computational or algorithmic mathematics assignments typically have a right answer that can be reached in well-structured ways while open-ended and discovery tasks, such as those used in complex instruction, do not have one right answer and are ill-structured problems; they are nonroutine problems for which there are no standard recipes or procedures. Under the conditions of a group task and an ill-structured problem, interaction is vital to productivity. In the case of a classroom setting, productivity is often defined in terms of achievement gains (see the first two definitions of productive small groups above). Unless the group members exchange ideas and information, they are unlikely to come up with creative solutions to their assignment or to discover underlying principles. This may be stated as a more general proposition:

> Given an ill-structured problem and a group task, productivity will depend on interaction.

More specifically: given a problem with no one right answer and a learning task that will require all students to exchange resources, achievement gains will depend on the frequency of task-related interaction.

If general measures of interaction do not predict achievement when students are working on conventional school tasks with well-defined procedures that could be carried out as individuals, what does? The most consistent, positive predictor of achievement in these studies is the giving of detailed, elaborate explanations (Webb, 1983, 1991). In other words, the student who does the explaining is the student who benefits, controlling for how well he or she would have done based on past achievement/ability. Swing and Peterson (1982) also found that high achievers benefited from participation in heterogeneous groups, especially by giving explanations to others. Moreover, students with higher initial achievement/ability scores tend to give more explanations.

Giving of more detailed explanations is, in turn, related to the student's conception that better explanations are those that include specific content or information (Peterson & Swing, 1985). These concepts of a good explanation are significantly related to group achievement on seatwork with arithmetic tasks (Peterson & Swing, 1985).

The importance of giving explanations as a predictor of achievement gains did not hold up in studies of microcomputer learning. Webb summarizes the results of her first microcomputer study:

> The importance of specific verbal interaction variables for learning was less in this study than in previous studies of small-group work in the classroom. In the present study in contrast to nearly all previous studies, giving explanations did not help students to learn computer programming. Receiving explanations, found in some previous studies to be beneficial for learning, influenced only learning of the basic commands. (Webb, 1984a, p. 1086)

Similarly, in a subsequent study of students learning BASIC, Webb and her colleagues (Webb, Ender, & Lewis, 1986) found that giving explanations was not a predictor and that receiving explanations related to knowledge of commands, but not to interpreting programs or to ability to generate programs.

Some of the favorable effects of giving explanations may stem from what Fletcher (1985) calls *cognitive facilitation*. In a computer task calling for solving equations in an earth spaceship game, individuals who were told to verbalize their decisions did as well in problem-solving performance on the game as groups told to come to consensus (Fletcher, 1985). Both these conditions had superior results to those found for individuals working silently. There is parallel evidence of the favorable effects of cognitive facilitation at the group level. King (1989) formed groups of fourth graders who were provided with videotape modeling of "think-aloud problem solving." The group task was to reproduce a stimulus design using LOGO computer graphics. Groups were instructed to think aloud as they performed their task. More successful groups asked more task-related questions, spent more time on strategy, and reached higher levels of strategy elaboration than did groups who were less successful on the task.

The helpfulness of helping. How helpful are these elaborate explanations to the students who receive them? Receiving content-related explanations produced positive effects on achievement in only 3 of the 14 partial correlations in the studies surveyed (Webb, 1991). However, if students receive no answer when they request help, they clearly learn less than if they do get a response. Receiving no response to a request for help or a terminal response in which one is only given the right answer is consistently negatively related to achievement (Webb, 1991).

Webb (1991) points out that more important than the kind of help that a student receives is the match between the student's request for help and the kind of response received. For example, receiving less elaboration than is needed, such as asking for an explanation and being told only the correct answer, is negatively related to achievement. Another condition for effective helping, according to Webb (1992), is that the help received be applied to solve the problem. In a majority of cases, Webb found that students who expressed a need for help and met both these conditions performed well on an immediate and a later test. In contrast, students who did not meet these conditions were rarely successful on the delayed test. Navarrete (1985) also studied sequences of behavior surrounding help. The frequency of a sequence consisting of a student requesting help, receiving help, and returning to his or her task predicted gains in reading comprehension, while incomplete sequences such as receiving help without having asked for it or receiving no help when requesting it were unrelated to achievement.

Whether or not a student receives needed help has something to do with the nature of the request for assistance. Webb (1991) cites numerous studies that have found that specific requests are more successful than others in eliciting appropriate and adequate responses. The most extensive work on this subject has been done by Wilkinson and her colleagues (see, e.g., Wilkinson & Calculator, 1982).

Low-achievers undoubtedly are helped in the course of the interaction within cooperative groups in many ways outside of specific requests for help and adequate responses to those requests. Future research would do well to develop an understanding of the several different ways in which interaction in heterogeneous groups proves effective in assisting the learning of the low achiever. Available research often focuses on the fact that groups are heterogeneous or homogeneous with respect to achievement rather than on the nature of the interaction that occurs in the context of these two different kinds of groups.

Most models of cooperative learning advocate the use of heterogeneous groups because of the hypothesized benefits to low-achieving students of receiving instruction from high-achieving students or because of the desire to increase trust and friendliness between members of different social groups. There is considerable support in the research for the beneficial effects of heterogeneous groups on low-achieving students. Some researchers have focused specifically on this question of the effectiveness of heterogeneous versus homogeneous group composition. In studies of collaborative seatwork, Swing and Peterson (1982) found that students of low achievement benefited from participation in groups heterogeneously composed on achievement in comparison to participation in homogeneously low-achieving groups. Students of average achievement were the only ones not to benefit from their interaction with others of higher or lower achievement. They did better in homogeneous groups of average achievers.

In a study of homogeneous versus heterogeneous groups working on a computer-driven tutorial that did not relate to their work in the regular math classes, Hooper and Hannafin (1988) also report that low-achieving eighth-grade math students benefited from working with high-achieving students on a delayed posttest with questions covering factual recall, application, and problem solving. There were no differences in test performance by group composition, and group composition had little effect on the performance of high-achieving math students. The favorable effects for the low-achievers were restricted to the factual recall questions and not to the parts of the test that required higher level problem solving. Although Hooper and Hannafin wonder whether the higher level problem solving was inappropriate for the ability level of these students, it should be noted that the high-achieving students also did much worse on the application and problem-solving parts of the test than they did on factual recall. An alternative explanation for the failure of the cooperative learning to lead to gains in higher order thinking lies in the task instructions which had the students alternating roles of decision maker, advisor, and typist/advisor for every five questions. This sharp division of labor may have inhibited the type of interaction necessary for these more ill-structured problems.

There is evidence that lower achieving students are benefited by interaction with higher achieving students even when tasks demand higher order thinking. Children paired with a partner who had used a higher level cognitive rule on the pretest were significantly benefited and were able to function at a higher cognitive level on the posttest than on the pretest (Tudge 1990). Tudge (1990) concluded that it was exposure to high-level reasoning that made a difference as to whether a student would learn from another of greater competence. When the children's partner supported their predictions with reasoning at a higher level than that used by the target children, the latter were highly likely to improve. These effects of treatment conditions did not vary by age group; the study included pairs of kindergartners to fourth graders. By the same token, exposure to less-advanced reasoning in the course of interaction can have a negative effect on more developmentally advanced children. On a very challenging mathematical balance beam task, Tudge (1991) selected pairs homogeneous or heterogeneous as to the level of cognitive development they exhibited on a pretest on this task. Partners who were using more advanced rules to solve this problem, on the average, regressed in their thinking from pretest to posttest after interacting with a partner who had used a lower level rule on the pretest.

What can be concluded from this research? If the task is collaborative seatwork and if high-achieving students have the chance to give explanations, then heterogeneous groups will be especially beneficial for them. If the group is composed of only medium-achieving combined with low-achieving students, one would expect that the medium-achieving students would have the benefit of giving explanations. This proposition is predicated on the idea that the process of providing explanations is helpful for any student but that the better students in the group are more likely to engage in such behavior. If the task is very challenging and ambiguous and has an ill-structured solution, and if a heterogeneous pair is left alone to agree on an answer, then the confidence of the more developmentally advanced child can be shaken, and he or she may regress to a view of the matter that he or she held at a younger age. The only result that seems to hold unconditionally is the benefit to the low achiever of being in a heterogeneous group as compared to a homogeneously low-achieving group.

Interdependence and Interaction

Designers of cooperative learning tasks must contend with one consequence of using small groups. One may give a group a task, but, unless there is some reason for the group to interact, students may well tackle the task as individual work. This is especially the case if each individual must turn out some kind of worksheet or report. This is also the case if the instructor divides the labor so that each person in the group does a different part of the task; the group has only to draw these pieces together in sequential fashion as a final product. The consequence of either of these patterns is that there is comparatively little interaction; people do not gain the benefits of using one another as resources, nor is there any basis for expecting the prosocial outcomes of cooperation.

In the literature on cooperative learning, this problem is most typically addressed as one of the necessity for interdependence of the members of the group (Johnson & Johnson, 1990). In order to ensure interdependence through limiting resources or through setting a group goal, it is typically recommended that there be only one worksheet or report for the group. The object is to ensure that a group will be created because members are dependent on one another to achieve the group goal (positive goal interdependence) and will need to use one another's resources to attain that goal (resource interdependence).

Positive goal interdependence is a concept taken from Deutsch (1962) meaning that individuals perceive that they can achieve their goal if and only if the other individuals with whom they are cooperatively linked also achieve their goals (Johnson, Johnson, & Stanne, 1990). Positive resource interdependence exists when individuals can only achieve their goals when other group members provide needed resources. The Johnson model of cooperative learning advocates the use of both goal interdependence and resource interdependence. In a cognitively demanding computer simulation in which high school students had to apply both navigational and map reading skills to sail ships to the New World, conditions with both positive goal interdependence and resource interdependence led to better performance on the simulation than conditions with only one of these two types of interdependence (Johnson, Johnson, & Stanne, 1990).

However, interdependence of either type does not necessarily solve the problem of guaranteeing interaction. When there is a strong division of labor, but the group is committed to turn out a single end product, one may say the group is interdependent, but there is still no strong motivation for the group to interact and solve problems as a group. The limitation of goal interdependence is illustrated by the computer simulation study just cited; goal interdependence alone did not promote more effective performance. One may speculate that, although the three group members were given the same goal of getting all three ships to the New World, if they divided the labor and each attempted to sail one ship, then there might have been minimal interaction possibly reducing understanding and problem-solving success. Simple resource interdependence has similar problems with respect to interaction. When group members are simply dependent on one another for resources (sharing information in the case of the navigation task) but do not share a goal, achievement is also impaired because interaction consists of one person trying to get information from another but perhaps wanting to avoid wasting time by giving information. Simple resource interdependence, in this study, was associated with the poorest results (Johnson, Johnson, & Stanne, 1990).

Simple resource interdependence is also present in the *jigsaw* procedure (Aaronson, Blaney, Sikes, & Snapp, 1978) where members are oriented to their individual performance but obtain information from peers who become "expert" on their topic after work in specialized groups. There were no achievement differences in this study between jigsaw and traditional instruction even though the tasks were of the routine, social studies variety. Huber and Eppler (1990) note that slow-learning members of jigsaw teams do not necessarily return from their expert group sessions knowing more than their team members. There is, in this case, no particular motivation to interact with and to help these slow-learning team members to learn.

We propose a reformulation of this problem, not so much in terms of interdependence, but in terms of the type of interaction fostered by these differing task instructions. A proposition for future research is as follows:

- Effects of resource and goal interdependence on productivity will be mediated by the amount and type of interaction stimulated by these task arrangements.
- Resource interdependence alone will be associated with lower participation rates on the part of those students who stand to gain most by receiving assistance than will resource and goal interdependence combined.
- Resource and goal interdependence, taken one at a time, are not sufficient conditions for activating group participation.

The organizational concepts of sequential and reciprocal interdependence introduced earlier in this review pertain more directly to the type of interaction that takes place in the group and thus will have considerable heuristic value for research on productive small groups.

Reward interdependence. One task condition that has the power to stimulate students to participate and to help one another is the presence of rewards to the group based on the performance of each individual member. This is sometimes referred to as *reward interdependence*.

No aspect of cooperative learning has been as controversial as the issue of giving rewards to groups on a competitive basis. This issue has become enmeshed in the ideological controversy over cooperation versus competition as has the issue of extrinsic versus intrinsic rewards for students and their relationship to learning. The best known research and reviews of research on this topic have been those of Robert Slavin (1983a, 1983b, 1987). After reviewing 41 studies of cooperative learning that contrasted cooperative treatments of various types with traditional, individualistic learning, he came to the following conclusion: Achievement is enhanced by cooperative learning when cooperating pupils are rewarded as a group, while each pupil is individually accountable for his or her learning (1983a). In the most widely disseminated of the various models of cooperative learning developed by Slavin and his colleagues, a technique referred to as the STAD procedures, individuals take a test on their own learning and receive individual grades. For the purpose of public recognition, a group score or team score is awarded that is a composite of how well each individual has done relative to his or her own past performance. Certificates are awarded to the team with the highest score, or the winning score is published in the class newspaper or posted on a bulletin board. Slavin's conceptualization of how cooperation leads to achievement emphasizes individual accountability as strongly as group rewards. He states, "Learning is enhanced by provision of group rewards if and only if group members are individually accountable to the group for their own learning. Individual accountability can be created either by providing specific group rewards based on members' learning or by having students perform unique tasks and providing incentives for students to learn from each other" (Slavin, 1983b, p. 59).

Because all the comparisons that Slavin uses are experiments contrasting one of the cooperative learning techniques with whole class or individual instruction, his generalization is based on how consistently cooperative learning conditions of various types bring superior results to a noncooperative situation. His strong generalization, however, implies a contrast between differing approaches to cooperative learning that systematically vary individual accountability and the presence or absence of group rewards. Bossert also makes this point in his review of the literature: "Slavin has not clearly tested the value of group contingencies within the Student Team Learning methods" (Bossert, 1988, p. 233). Vedder (1985) was highly critical of Slavin's review for the same reason as well as for counting as positive studies those where only the minority students made significant gains in achievement. He sharply disagrees with Slavin's characterization of some of the studies as having positive outcomes.

Slavin is, however, making an important theoretical point concerning the motivation of individuals to put out effort and to interact in the group setting. He is particularly critical of giving a group a single task that could conceivably be done by one person. In this case, he argues that positive goal interdependence is insufficient to motivate everyone's effort. In a study designed to make direct comparison of differing reward conditions for learning in cooperative settings, Yueh and Alessi (1988) contrasted three junior high school mathematics classes using computer-assisted instruction in groups. In a version of cooperative learning known as Teams Games Tournaments, the members of each group completed a drill with the computer accompanied by discussion; they then competed in new tournament groups composed homogeneously on a standardized mathematics achievement test. The competition went on for several days with the top-scoring student at each table moving on to a table of higher achieving students and the bottom-scoring student moving down a table. At the end of the tournament competition, actual prizes were awarded according to the reward conditions of the classroom. An achievement test with items directly based on the content of the CAI (computer-assisted instruction) and items based on application of principles was administered. One class received scores based on their individual performance in the tournament. A second class received scores based on the average of their group, while a third class was awarded scores on the combination of individual and group performance. In each case, prizes were awarded to the top-scoring individual, group, or those with the highest combined group and individual score. Data were analyzed at the level of the group. The class with the combined individual and group rewards did significantly better on the items measuring direct learning than the other two classes. There were no differences on the items requiring application.

Okebukola (1985) directly contrasted Teams Games Tournaments, STAD procedures, jigsaw, and the Learning Together model (based on the Johnsons' approach to cooperative learning). From a theoretical point of view, both Teams Games Tournaments and STAD procedures employ competitive, extrinsic reward interdependence as well as individual accountability. The jigsaw technique, as explained above, does not have an explicit group goal or reward, but students are dependent on one another for information. The Learning Together model (circa early 1980s) featured both goal and resource interdependence, but it did not employ competitive, extrinsic reward interdependence, nor did it allocate scores to individuals. Theoretically, it did not have a strong feature of individual accountability. On a test of science achievement employing both lower and higher level cognitive items, although all the cooperative methods were superior to independent study or to traditional whole class instruction, the Learning Together model produced the least favorable achievement results of the cooperative methods, and the STAD procedures produced the most favorable results. The Johnsons (1990) also describe several studies in which they have been involved in which the use of reward contingencies in connection with goal interdependence provided more favorable achievement results than goal interdependence alone.

The effectiveness of reward interdependence, however, should not be taken to mean that it is not possible to hold individuals accountable or to motivate them to participate without such reward contingencies. Such rewards are not used in Group Investigation, which compared favorably to STAD in producing achievement on items measuring higher order thinking (Sharan et al., 1984), nor are they used in complex instruction where the activities are intrinsically interesting. Complex instruction has also been found to produce significant achievement gains (Cohen, 1991). Slavin's original proposition about the necessity of reward interdependence and individual accountability would appear to apply better to the kinds of collective or collaborative seatwork tasks that are so common in cooperative learning, where it is of vital importance to motivate those who could do the task by themselves to interact and to assist those who are having difficulty. These are not group tasks, as defined earlier in this article, because they could be carried out by one individual. Reward interdependence does not appear to be necessary for achievement when students are motivated to complete a challenging and interesting group task that requires everyone's contribution for a good outcome. This proposition appears to hold at least when individual accountability is maintained by other strategies such as requiring individual reports or making individuals responsible for some portion of the end product.

Offering rewards on a competitive basis, although effective in increasing motivation of team members to work together, may have negative effects on intergroup relations, more specifically on the perceptions that team members have toward other teams. Miller, Brewer, and Edwards (1985) report an experimental study in which the reward structure varied: In the cooperative condition, subjects were told that the problem solutions of the two teams would be evaluated jointly to determine their joint eligibility for a small monetary reward; in the competitive condition, they were told that the team with the better product would be eligible for a reward. After an initial phase of work as separate teams, the teams convened to discuss and to arrive at a final consensus. In the cooperative condition on a postexperimental measure, team members were more willing to allocate rewards to individuals on the other team and held more favorable perception of members of the other team than in the competitive condition. Similarly, a meta-analysis of studies of heterogeneous classrooms contrasting cooperation with and without intergroup competition showed that perceived personal attractiveness of nonteam members was lower with intergroup competition (Johnson, Johnson, & Maruyama, 1984).

In addition to this issue of the effect of competition on perceptions of out-group members, there is some evidence that methods using competition such as Teams Games Tournaments and STAD procedures are ineffective for particular categories of students (Widaman & Kagan, 1987). While Anglo-American students showed significantly greater gains in spelling in the personally competitive technique of Teams Games Tournaments (TGT) than in STAD or in traditional classrooms, Mexican Americans showed significantly greater gains in traditional classrooms than in STAD or TGT. A study of TGT in the learning of mathematics has also shown that the failure of one's team can have a negative effect on one's individual achievement in a way that is independent of prior achievement and individual outcome (Chambers & Abrami, 1991). Moreover, the effect of participating on an unsuccessful team using STAD procedures was negative in mathematics achievement for those students characterized as "learned helpless" (p. 7) and had no effect on those students characterized as "mastery-oriented" (Abrami, Chambers, D'Apollonia, & De Simone, 1992, p. 7).

Despite these negative effects on achievement of some features of competitive reward systems, it should be noted that the evidence linking STAD to gains in cross-racial friendships is strong (Slavin, 1983a). The many studies documenting the connection between cooperative learning and improved intergroup relations, regardless of whether or not elements of competition are also employed, are not reviewed here because they compare the cooperative condition to traditional classroom structure.

Recommendations for the Study of Interaction

This section reviews studies of interaction in small groups and its relationship to effectiveness. I have recommended the use of a key distinction of whether or not the task of the group is a true group task and whether or not the nature of the assignment is routine with clear procedures and answers or is a problem with an ill-structured solution. This distinction helps to explain why the sheer volume of interaction fails to predict interaction in studies of collaborative seatwork using routine mathematical assignments, while it is a powerful predictor of learning when tasks are open-ended, conceptual in nature, and require reciprocal interdependence of the participants.

As have many other students of cooperative learning, I argue that the problem of motivating members to work as a group is of critical importance in ensuring effectiveness. However, the previous ways of looking at this problem in terms of resource, goal, and reward interdependence can be improved by introducing the variable of the type of task and interaction into propositions concerning the effects of interdependence. I examine propositions concerning the effects of resource and goal interdependence on interaction as well as effectiveness. I propose that the necessity for both resource and goal interdependence for effective groups arises because either of these conditions by themselves will not activate adequate group participation. Furthermore, task arrangements can have a direct effect on interaction that will mediate the effects of resource and goal interdependence. I also amend Slavin's propositions concerning the importance of reward interdependence and individual accountability as necessary and sufficient conditions for learning gains to apply more specifically to collaborative seatwork and routine learning. Clearly, there is evidence that cooperative learning groups with true group tasks and conceptual learning can be effective without reward interdependence.

Factors Affecting Interaction

Structuring the Interaction: Task Instructions

There are a number of ways in which the designers of group-work tasks attempt to ensure interaction from the participants. These range from simple task instructions, in which students are told to help one another or to discuss and come to consensus, to detailed procedures concerning how and what is to be discussed. In some cases, the interaction may even be scripted with specific conversational strategies that students practice before attempting the group task (e.g., Spurlin, Dansereau, Larson, & Brooks, 1984). In an attempt to raise the level of discourse and to ensure its effectiveness, some investigators and developers have instructed groups in specific ways that they should talk with one another. Assigning students particular roles is another way to get group members to take responsibility for active participation in the group. However, roles do not have a consistent effect on group interaction. If the labor is divided and each person is given a different role, such as artist, script writer, presenter, and so forth, the result may be each person quietly working on his or her task; there may be very little interaction at the group level. In contrast, a role such as group facilitator may have the effect of fostering interaction.

The problem as posed by some researchers (Brown & Palinscar, 1986; Yager, 1985) is whether it is effective to structure the interaction within small groups. Certainly, those investigators moving from a position of social constructivism would be opposed to such interference with the process of negotiation of meaning. From the perspective of this reviewer, the most useful research question to ask is not whether structuring interaction is productive but under what conditions it is productive. What conditions constrain the interaction or hinder full exchange from all participants in the group? Whether or not procedures that constrain and direct interaction are effective has to do with the kind of interaction that is necessary for optimal outcomes, given the nature of the learning outcomes that are desired.

Constraining the interaction. Let us start with two studies of the effects of structured oral discussion on tests of achievement and retention of map skills in social studies. Yager (1985) studied the effects of structured oral discussion on seventh- and eighth-grade students working on a map unit involving assignment sheets and desk-size world maps. Heterogeneous groups met 45 minutes per day for 25 days. Following 15 minutes of teacher instruction, students in the structured condition were randomly assigned the role of learning leader or learning listener. The responsibility of the leader was to restate and summarize the main points of the day's lesson while the learning listener was to ask probing questions, encourage the leader to explain better, recall areas of content left out, and discuss ideas or facts summarized incorrectly. This condition was contrasted with unstructured groups that were simply told to discuss the material after the teacher's initial instruction. The structured conditions did significantly better on the unit test and on a later test of retention. Similar results for this type of structured oral discussion were achieved with second graders working on a map unit where the instructional objectives were measured by factual recall (Yager, Johnson, & Johnson, 1985).

Structured oral discussion has some similarity to reciprocal teaching developed by Brown and Palinscar (1986). This technique also structures the interaction, not with roles but with specific strategies of questioning, clarifying, summarizing, and predicting. These strategies are designed to improve comprehension of reading and to serve as a self-testing mechanism. Reciprocal teaching has been shown to be effective on retention and comprehension of reading. However, with one exception, the research on reciprocal teaching does not fit the definition of cooperative learning used in this review because the teacher directly supervises the students who play the role of teacher. In one exploratory study (Palinscar, Brown, & Martin, 1987), students were allowed to play the role of teacher after 10 days of reciprocal teaching instruction, working with groups that operated independently of the classroom teacher. The gains indicated by the tutees in these groups on the comprehension assessments were comparable to those made by students working with their adult teachers in former studies.

The general inference that can be drawn from this research is that, when the learning task is factual recall, understanding of the assigned reading, or application of procedures and concepts in a relatively routine fashion, structuring the interaction through roles and scripts can be very effective. Such strategies probably owe their effectiveness to their capacity to raise the level of discourse and to ensure that disengaged students are drawn into participation.

Limited exchange processes. Interaction can also be constrained by telling the groups that their principal task is to complete individual worksheets and that they should consult with one another and help one another. These are the task instructions used in the studies reviewed by Webb; Slavin's STAD procedures also use these instructions. In the STAD procedures, there is an additional reward feature, discussed above. Important for this discussion are two features: (a) These instructions are typically given in connection with tasks that have well-structured solutions; (b) there are only a certain number of types of interaction that need take place in this context. Students can exchange information, explanations, or they can request assistance. They have no need to discuss how to proceed as a group, nor do they have to discover anything as a group or to negotiate any meanings. There is very little room for extensive controversy except for arguments over what is the right answer or procedure. It should be noted that this kind of limited cooperative interaction is typically used for conventional school tasks such as computational mathematics assignments, or understanding and being able to recall reading assignments.

In an extensive field experiment, Slavin's STAD techniques were compared to Sharan's Group Investigation method with respect to effects on learning outcomes as well as on the development of prosocial, cooperative behaviors (Sharan et al., 1984). Group Investigation fosters more extensive kinds of interaction than the STAD method. Groups are given the task of developing elaborate presentations for the class. They must work together in planning this presentation and must develop procedures for dividing the labor on the component research tasks. After collecting the information, they must coordinate individual contributions into a unified group product. The experiment took place in a desegregated junior high school in Israel; classes were English as a Second Language and Literature, and they were untracked. Sharan et al. (1984) characterize important differences between the two techniques: With STAD, the teacher transmits the information, or a text transmits the information. The teacher emphasizes information and/or skill acquisition. In Group Investigation, the information is gathered by the pupils using a great variety of learning sources. The tasks stress problem-solving interpretation, synthesis, and application of information. In STAD, peer communication is primarily for rehearsal of teacher-taught materials. Pupils interact sporadically or in dyads as contrasted with group interaction necessary for the Group Investigation techniques where interactions are based on mutual exchange.

The results on the literature tests were instructive. On high-level questions, the Group Investigation classes did significantly better than the STAD classes. On the low-level questions, STAD classes performed significantly better than the Group Investigation classes. On the tests of English, both these cooperative methods were more effective than traditional instruction, but they were not different from each other with the exception of the listening comprehension scale, where the Group Investigation classes were superior. This study illustrates how differences in the type of interaction fostered by the task and task instructions are associated with different learning outcomes. For relatively low-level outcomes, the limited interaction model with its focus on acquiring information and correct answers is adequate and often superior. For higher order thinking skills, the interaction must be more elaborate and less constrained.

What about the STAD procedure is less effective for higher order thinking objectives? When Ross used STAD procedures for developing higher order thinking skills in two experiments (1988), he found that the cooperative groups using STAD procedures did no better than students working independently on practice worksheets following 20 minutes of teacher-directed dialogue. In the cooperative condition, students worked on the same worksheets as were used in the whole-class treatment. Each student was to complete his or her worksheet after conferring extensively with peers. Ross's worksheets take abstract problem-solving, such as learning how to represent problems effectively, and translate these skills into step-by-step problem solving through algorithms. The use of these worksheets was clearly more effective than a third treatment where problem solving was embedded in the content knowledge, but there were no worksheets and no explicit direction or encouragement for developing problem-solving skills. However, these experiments do not tell us how well students would have done with these materials if an exchange that was less constrained by worksheets were fostered between the students.

Inadvertently, we learn something about this alternative from a teacher who failed to follow detailed procedures for having students discuss the worksheets (Ross & Raphael, 1990). In this study, the interaction was supposed to be even more controlled than in Ross's previous studies of cooperative learning. Students were to read worksheets and work on the task individually, share answers, compare their answers to those on the feedback sheets, and then discuss discrepancies between student answers and the exemplary answer on the feedback sheet. The objective here was to develop the ability to make comparisons. One of the two teachers followed the procedure precisely, while the other allowed students to work out their own procedure. The latter teacher obtained much better results. More important than this result was the finding that there was much more interaction in her groups. Students made more factual and conceptual contributions in those unstructured groups with higher rates of interaction. Achievement outcomes were more favorable for groups where students more frequently contributed facts and concepts. These unintended results suggest that too much structure of a task that involves higher order thinking skills is dysfunctional because it impedes conceptually oriented interaction. As with scripting and roles that limit the nature of the interaction, the limited exchange processes (in conjunction with the reward features of the STAD procedures) are effective for acquiring information and other conventional school tasks. It should be noted that this effectiveness occurs in conjunction with teacher and textual presentation of information.

Hertz-Lazarowitz (1989) makes the distinction between low-cooperation group tasks, where students simply share materials or information or divide the labor so that each person's contribution can be joined together as a final product, and high-cooperation tasks where students must interact as they work together, discuss planning, decision making, and division of labor as well as substantive content. In a study of interaction among 782 students, grades 3–8, in Israel, she found that, of cooperative tasks, only 31% could be classified as high cooperative. Most relevant to this discussion is the finding that, whereas 56% of the interaction in low cooperative tasks was about information, in high cooperative tasks, 70% of the interaction had to do with application. These findings suggest that more conceptual interaction takes place in high-cooperation tasks.

Nystrand, Gamoran, and Heck (1991) make a similar distinction between group-work tasks that are only collaborative seatwork and tasks that permit the students to define their problem and to engage in autonomous production of knowledge. On a test of understanding of literature that included conceptual questions, they found that ninth-grade classes spending more time in cooperative groups that demanded production of knowledge scored significantly higher on the test than classes spending less time in such groups. If the researchers did not divide the small group work in this way, the overall use of small groups had a negative relationship with scores on the test.

If, as was argued above, interaction is critical for achievement gains for group tasks with ill-structured solutions, then factors that affect the amount and richness of interaction will affect productivity for such tasks. Tasks with higher order thinking skills as their objectives are typically, but not necessarily (see Ross, 1988), seen by developers as open-ended tasks with ill-structured solutions. The general proposition to examine is the following:

> When the teaching objective is learning for understanding and involves higher order thinking, task arrangements and instructions that constrain and routinize interaction will be less productive than arrangements and instructions that foster maximum interaction, mutual exchange, and elaborated discussions.

Salomon and Globerson (1989) make a similar point:

> But such highly structured procedures as found in scripted cooperation, reciprocal teaching, or group attempts to gain rewards may not be the most

desirable arrangements for when teams have to engage in more complex, free exploratory activities on a prolonged basis. (p. 96)

Hertz-Lazarowitz (1989) as well as Nystrand, Gamoran, and Heck (1991) imply that, unless groups determine their own procedures, their interaction will be less elaborated. However, there are studies of cooperative learning with rather elaborate procedures spelled out for the students that do not result in a limited or concrete type of interaction. On the contrary, the literature suggests that the way the instructions set up the problem, suggest procedures, and specify roles can do much to create interaction that is markedly superior to that produced by simply asking a group to reach consensus.

The research on the benefits of controversy within cooperative learning (Johnson & Johnson, 1985; Smith, Johnson, & Johnson, 1981) is the best example of how elaborate procedures and use of student roles can foster high level discussion leading to conceptual understanding. In these two studies, students in the controversy condition worked in four-person groups over several classroom sessions. First, two-person pairs, having been provided with relevant information, prepared opposing sides of a debate concerning conservation versus economic interests on the interesting topic of the proposed reintroduction of wolves into Minnesota. Within the pairs, each student played a relevant role such as farmer or rancher. Following this preparation, the pairs presented their opposing sides. The opposite pair was motivated to listen very carefully because the next phase required the pairs to switch sides and argue, using the information that had been presented. Finally, the entire group had to arrive at a consensual view of the issue and to write a group report.

In one study (Smith, Johnson, & Johnson, 1981), the controversy condition was compared to a concurrence condition where each small group could study the material in any way they wished, with the stipulation that they were to avoid arguing. The controversy condition not only promoted higher achievement on a test and better retention on a second test than the concurrence-seeking condition but, more pertinent to this discussion, there was a greater search for information and more cognitive rehearsal. On the achievement test, students were asked to take multiple perspectives in a way that tested their grasp of the concepts. Students who had experienced the controversy condition, not surprisingly, were better able to take multiple perspectives. In another study (Johnson & Johnson, 1985), the controversy condition was compared to a jigsaw debate in which students representing each role and position prepared their case in a first phase. In the next phase, the four-person groups were reassembled and carried out a formal debate. The students were told that they were responsible for learning about all these positions. The controversy condition promoted the most verbal rehearsal and exchange of assigned materials, the most active search for more information, and the most reevaluation of the students' own position.

Note the elaborate way in which the discussion was controlled in the controversy condition by the discipline of having to take sides and by having to play roles. Despite the elaborate structuring of interaction, the quality of the discussion in the controversy condition was superior to that in the concurrence or the debate conditions. The comparison with the debate condition illustrates that the power of this technique to foster higher level discussion does not lie solely in having to take sides. The instructions to the controversy groups fostered a reciprocal exchange in which the outputs of each actor became inputs of each other actor. Having examined the issue carefully from all sides, the group was well prepared for an in-depth discussion when they tried to come to consensus.

Roles. When the group is working on problems with ill-structured solutions, roles can also be used to foster interaction that leads to conceptual gains. Working with classrooms using complex instruction, Zack (1988) showed that the use of a facilitator role was associated with an increase in talking and working together on discovery problems using math and science concepts. Talking and working together, in this setting, predicted gains in tests of mathematics concepts and applications (Cohen, Lotan, & Leechor, 1989). Using the same approach of complex instruction, Ehrlich (1991) studied a special adaptation of the commonly used role of the reporter. The reporter was given a special worksheet and time to discuss with the group the answers to a set of questions in preparation for his or her report to the class as a whole. The enhanced reporter's job was to encourage the group to think and talk together and, as a group, to create answers to the questions on the special form. These questions were timed at the beginning of the task, in the middle, and at the end. They were designed to encourage science-thinking behaviors. For example, the group was asked to specify their predictions for the science experiment, their observations, the inferences from their observations, and the extent to which their predictions were supported by their observations. Fourth-grade classes receiving this treatment were compared with classes using the same curriculum and techniques for cooperative learning, but the reporters were allowed to prepare their report for the class pretty much as they saw fit. Classroom observations revealed that there was a greater incidence of student interaction with one another when they used the reporter form than when groups were not using the form. On a criterion problem-solving task at the end of the year, groups from classes that had experienced the enhanced reporter form demonstrated more science-thinking behaviors. These behaviors included asking thinking questions, requesting justification, predicting, hypothesizing, inferring, and concluding (Ehrlich, 1991).

Here was the use of a role and a specific set of topics for the groups to discuss that fostered an abstract level of interaction, encouraging the children to use the language of science in a way that was distinctly new for all of them. Yet this interaction was not scripted or micromanaged. The children were free to search for the answers to these questions in ways they found productive. The distinction is a subtle one; task instructions can profitably set problems for discussion, specify roles, ask questions, determine procedures, all without constraining the full discussion of a problem with an ill-structured solution. However, this review would suggest that moving beyond these strategies for structuring the interaction to introduce worksheets that specify steps to solutions, to introduce strategies for talking about the content, or to constrain the discussion by having one student play the role of the teacher and the other the learner would be counterproductive for solving problems with ill-structured solutions designed to foster the development of higher order thinking. Herein lies the dilemma: If teachers do nothing to structure the level of interaction, they may well find that students stick to a most concrete mode of interaction. If they do too much to structure the interaction, they may prevent the students from thinking for themselves and thus gaining the benefits of the interaction.

Ensuring Equity in Interaction

There are systematic inequalities in participation among members of cooperative groups. Moreover, these inequalities are related to academic status differences between students; low status students interact less frequently and have less influence than high status students (Hoffman, 1973; Rosenholtz, 1985; Tammivaara, 1982). *Status* is here defined as an agreed-on rank order where it is generally felt to be better to be high than low rank. In the studies cited, despite the fact that the tasks demanded no academic skills, those students who were perceived to be better readers or better at schoolwork were more active and influential than those students perceived to have less academic ability.

Several studies have further helped to rule out the possibility that some kind of actual ability difference is the source of this difference in rates of participation. In an analysis of interaction in cooperative learning groups of junior high school students of mathematics, Webb and Kenderski (1984) found that test scores did not predict the frequency of giving explanations. Rather, test scores relative to other members of the group predicted how frequently members gave explanations. The effect of measures of relative ability rather than absolute ability suggests that the determinant of interaction was the difference in perceived ability in mathematics within the small groups. Dembo and McAuliffe (1987) created an artificial distinction of average and above-average ability with a bogus test of problem-solving ability, described as relevant to an upcoming experimental task. Higher status students (defined as those publicly assigned above-average scores on the bogus test) dominated group interaction on the experimental task, were more influential, and were more likely to be perceived as leaders than low status students.

Academic status is the most powerful of the status characteristics in the classroom because of its obvious relevance to classroom activities. In responding to hypothetical learning groups on a questionnaire, students were much more likely to approve of leadership behavior on the part of a good student than on the part of Whites or males (McAuliffe, 1991). Leadership behavior from those described as poor students was likely to be disapproved.

Differences in perceived academic ability are not the only sources of inequality within cooperative groups. Differences in perceived attractiveness or popularity—that is, peer status—can also act as the basis for status differentiation (Webster & Driskell, 1983). Popularity is often highly correlated with academic status, as in the classrooms studied by Rosenholtz and Wilson (1980).

Differences in social status such as gender, race, and ethnicity can also affect interaction of schoolchildren (Cohen, 1982). However, these effects have primarily been demonstrated in laboratory studies where students do not know each other. In classrooms, race and ethnicity often correlate with academic status; as a result, it has been difficult to document these effects separately in groups composed of students in a single classroom (Cohen, 1982). Only when academic status is uncontrolled can one see the effects of ethnicity in classroom studies. In a study of Middle Eastern and Western Jews in classrooms in Israel, Sharan and Shachar (1988) gave mixed-ethnic groups a discussion task and observed that Western Jews took significantly more turns at speaking than the Middle Eastern Jews and used significantly more words per turn.

Webb (1984b) found some strong evidence of the effects of gender in classroom groups of seventh and eighth graders studying mathematics. In majority-female groups, females directed most of their interaction to males and showed lower achievement than males. In majority-male groups, males tended to ignore females and showed somewhat higher achievement than did females. These differences were not observable in groups with equal numbers of males and females. Although girls are less active and influential than boys in cooperative groups of adolescents, gender does not appear to operate as a status characteristic in the early elementary years (Leal, 1985; Lockheed, Harris, & Nemceff, 1983).

Status problems make small group discourse nonproductive according to at least two of the definitions of productivity: inequitable interaction as well as unequal learning outcomes. Inequities in participation based on gender, race, and ethnicity within cooperative groups should be a source of serious concern for those who recommend cooperative learning for heterogeneous settings. If the participants in cooperative learning have preexisting stereotypes about lesser competence of minorities and women confirmed in their group experience, then the effects of cooperation are far less desirable than many proponents of the technique would have us believe.

These inequalities in participation are worrisome for another reason: They are linked to learning gains. Cohen (1984) demonstrated that the status of a student was correlated with interaction within the small group. Interaction, in turn, was a predictor of learning gains. This review has already cited research showing those conditions under which interaction is related to achievement gains. Clearly, the operation of these status effects is particularly detrimental to small-group productivity where interaction is critical for learning.

Status characteristic theory (Berger, Cohen, & Zelditch, 1966; Berger, Cohen, & Zelditch, 1972) provides an explanation for these effects of status as well as a basis for several interventions designed to equalize status within the groups. Status characteristics, a central concept of this theory, are defined as socially evaluated attributes of individuals for which it is generally believed that it is better to be in the high state than the low state.

Status generalization is the process by which status characteristics come to affect interaction and influence so that the prestige and power order of the group reflects the initial differences in status. When the educator gives a group a collective cooperative task, status differences based on academic ability become activated and relevant to the new situation, even if the task does not require the academic ability in question. The high status student will then expect to be more competent and will be expected to be more competent by others. The net effect is a self-fulfilling prophecy whereby those students who are seen as having more ability become more active and influential than those students who are seen as having less ability. When status generalization takes place, not only are low status students cut off from access to the resources of the group, but the group lacks the contributions and ideas of all its members. The process by which specific status characteristics generalize to new collective tasks is the same as that by which diffuse status characteristics such as race, ethnicity, and gender affect interaction.

The multiple ability treatment is an intervention in which teachers convince students that many different abilities are relevant to the group task (e.g., reasoning, creativity, and spatial problem solving). Moreover, if the teachers are successful in using the multiple ability treatment, students believe that each member of the group will be good at some of these abilities and that no member of the group will be good at all these abilities. In Tammivaara's laboratory study (1982) and in S.J. Rosenholtz's classroom experiment (1985), a multiple ability treatment substantially weakened status effects. In nonexperimental classroom conditions, Cohen, Lotan, and Catanzarite (1988) showed that the effects of status on interaction were reduced by a multiple ability treatment, though not eliminated. In a classroom setting, a successful multiple ability treatment requires the use of a multiple ability curriculum. If the assignments to groups are restricted to conventional academic skills, then it is unlikely that students or teachers would believe that every student would have at least one of the requisite intellectual abilities or that no student would have all the abilities required.

Assigning competence to low-status students is a second intervention designed to ensure equity within cooperative groups. This treatment requires the teacher to observe students within groups as they work on multiple ability tasks. When a low-status student demonstrates competence on an important intellectual ability (such as spatial reasoning or scientific thinking), the teacher publicly provides an evaluation of that student describing specifically what he or she has done well, what ability he or she is displaying, and why this is an important resource for the group. Teachers who use these two status treatments more frequently have more equal-status interaction within their cooperative learning groups than teachers who use status treatments less frequently (Cohen, 1988).

Several propositions emerge from this review on equity within cooperative groups. In order to maximize productivity of cooperative learning, it is necessary to modify the effects of status. When the task is of a more routine variety, good effects can be achieved with scripted interaction and turn-taking, both of which will cut down on the possibilities for status to affect interaction. When the task is an ill-structured problem, however, it is necessary to treat differential expectations for competence in order to achieve maximum interaction and productivity.

When cooperative learning is used to improve intergroup relations, the concerns are not only that there be equal-status interaction but also that students of different groups learn to treat one another as persons rather than as members of social categories. On the basis of experimental work, Miller, Brewer, and Edwards (1985) caution teachers to avoid making the explicit use of racial or ethnic identity a basis for team formation. For the same reason, they advise against a mechanical composition of groups in which the percentage of each social category is always the same. For example, if a class were 30% African American, the teacher might make a third of each group African-American. In a laboratory analogue of this situation, these experimentalists created new social categories based on the results of a pretest in which subjects were randomly assigned to two groups called *dot overestimators* and *dot underestimators*. When assignment to groups was explicitly based on these categories, with one out-group member and two in-group members, those in the minority status showed more bias toward the other group than when assignment to groups was noncategorical. These findings on salience of social categories should also apply to gender; teachers should avoid composing groups so that they always have half males and females.

Classroom Factors Affecting Interaction

In addition to the design of the group-work task itself, several classroom strategies will affect the interaction and productivity of the small groups. Considerable attention is paid to these factors in many thorough staff development programs in cooperative learning.

Training students for cooperation. Many developers of cooperative learning models have observed that groups quite frequently fail to show behaviors that one might call cooperative; in fact, close examination of some groups reveals negative and insensitive behavior as well as refusal to assist one another in any meaningful way. The behavior called for in cooperative small groups is radically different from the behavior required in conventional classroom settings. Therefore, some developers of cooperative learning strongly recommend team-building or skill-building activities prior to cooperative learning that are designed to develop the prosocial behaviors necessary for cooperation as well as some specific skills for working successfully with others. Or, adapting techniques from group dynamics, they suggest that groups should become aware of their interpersonal and work processes as they work and take time to discuss how they are doing as a group.

Available research on the effectiveness of such strategies suggests that investing in such preparation and time spent on group process can definitely make for more productive groups. Swing and Peterson (1982) experimented with training fifth graders in task-related interaction and, more specifically, in improving explaining skills. The preparation included a practicum in explaining in which each student had the chance to explain a problem and to receive feedback from training personnel. The trained groups were compared on a test of mathematics achievement to control groups who participated in identical collaborative seatwork tasks but received no training in interaction. The trained groups had significantly higher rates of task-related interaction and provided and received more higher order explanations than the control groups. Although there were no statistically significant differences in achievement and retention between the two conditions, trained students with low scores on the pretest outperformed control students with similar scores on the pretest. Low-achieving students who more often provided and/or received conceptual explanations during seatwork obtained higher achievement scores.

Similarly, in collaborative seatwork on vocabulary words, Lew, Mesch, Johnson, and Johnson (1986) trained students in collaborative skills of sharing ideas and information, keeping the group on task, praising and encouraging the contributions of others, and checking to make sure everyone in the group understood what was being taught. Moreover, the teacher awarded bonus points toward the quiz grade if all group members were observed to demonstrate three out of four cooperative skills. The addition of training in cooperative skills, plus the reward contingency for cooperative behavior, was necessary before cooperative groups produced superior achievement results to individual study. Positive goal interdependence and academic reward contingencies were not enough by themselves to produce superior achievement results.

Giving students specific feedback on their cooperative behaviors and asking them to reflect on how the group is behaving with respect to specific skills can have good results as well. A combination of these two strategies of teacher feedback and group processing proved more effective on a complex computer simulation problem than either the large-group processing alone or the condition where no processing took place (Johnson, Johnson, & Stanne, 1990; Johnson, Johnson, Stanne, & Garibaldi, 1990). The Group Investigation method also provides extensive feedback on cooperative behavior, a feature that is not present in the STAD procedures to which it has been compared (Sharan et al., 1984). In an evaluation of the effects of Group Investigation and STAD, students from both conditions were asked to copy a Leggo figure from a model. The students from the Group Investigation classrooms showed more cooperative behavior and less competitive behavior than the students from STAD classrooms (although either of these two cooperative methods produced more cooperative behavior and less competitive behavior than the classes that had received traditional whole-class instruction).

All these studies utilized very specific behaviors, whether in pretraining or in feedback and group processing. The importance of specificity is illustrated by the failure of a procedure utilized by Huber and Eppler (1990). Half the groups of fifth graders who participated in jigsaw learning with group reward contingencies rated their own cooperative process by means of a 6-point scale. They rated polarities such as friendly–hostile, hardworking–careless. Students were provided with the three most positive and three most negative ratings of their own group members on graph paper. They were then asked to discuss for 5 minutes what went wrong during the last session and how they could improve cooperation next time. The process feedback had no effect on achievement.

The behaviors must not only be specific but also directly relevant to the desired behaviors in the particular tasks that the teacher has assigned to the groups. In working with cultural diversity in the classroom, Miller and Harrington (1990) recommend a direct linking of group process skills to the team's task goals as opposed to human relations training programs that emphasize the general development of sensitivity, receptivity, openness, and reciprocity. Their rationale is that the former approach promotes more personalized interaction that helps people treat one another as persons rather than as members of categories. For example, Johnson, Johnson, Stanne, and Garibaldi (1990) selected for processing the behaviors of summarizing ideas and information of all group members, encouraging active oral participation of all members, and checking for agreement among members each time a decision was made that was relevant to a group working on a computer simulation. During the student-led processing, each member was assigned responsibility for ensuring that all members engaged in one of the three social skills.

When there is no preparation for cooperative interaction, mixed gender groups have been shown to work quite differently from single gender groups and can present problems of unwanted male dominance. Mixed-gender pairs working on a LOGO programming exercise exhibited social dominance by the boys; girls were less motivated and successful (Siann & Macleod, 1986). Underwood and McCaffrey (1990) studied pairs of students (10 and 11 years of age) on a computer task filling in missing letters from words. They were not told how to work together. Single-sex pairs were more productive than mixed-sex pairs. Unlike the single-sex pairs, there was no improvement for mixed-sex pairs in their group performance over their individual performance. Single-sex pairs worked by discussion and agreement with each member of the pair contributing. Keyboard control was shared. In contrast, the mixed-gender pairs tended not to work by negotiation but simply divided the labor with one taking over the keyboard and the other instructing the typist with little discussion of alternative solutions.

In computer tasks, the students left to their own devices may well choose the division of labor of "thinkist" and "typist" in which there is relatively little interaction and argument. This is evidently especially likely to happen with young boys and girls who have often been observed to have strained and uneasy relationships with one another in the early elementary years. Students require preparation and instruction for the level of interaction that is considered desirable for the task. If this preparation had been undertaken, it is unlikely that mixed-gender groups would represent a special problem, although this is an empirical question for future research.

In sum, either pretraining or processing of the group while they are at work on the task can be effective in improving the productivity of small groups. There are several ways in which these procedures probably operate to improve the functioning of the group. They reduce interpersonal conflict; they increase the probability of specific behaviors that have been linked to learning outcomes, and they help the members of the group to take responsibility for one another and for what is happening in the group. Thus, they help to solve the key problem of motivation to participate. However, it is unlikely that these procedures will be effective unless they are both specific and relevant to behaviors that lead to the group goal. One note of caution: If the group is given an ill-structured problem, the procedures should not be so specific to what the group is supposed to say and think that they succeed in micromanaging the process of thinking and talking.

Teacher role. Obviously, when students are working independently in small groups, the teacher's role changes. She or he cannot be everywhere at once telling people what to do; whenever the teacher tries to tell the class something directly, the interaction in the small groups comes to an abrupt halt. Within small groups, the self-directed nature of student talk tends to disappear when the teacher arrives (Harwood, 1989).

The management of cooperative learning requires the teacher to deal with instruction that has become quite complex; instead of the whole class working on the same task, there may be as many as six or seven groups working at their own pace, or, in some cases, each group may be working on a different task. The sociologist refers to the latter pattern of work as a highly differentiated technology. What do teachers do when faced with such a complex mode of instruction? In a study of complex instruction, involving discovery learning with multiple learning centers and students permitted to move on to new centers when they finished their worksheets at the previous center, there was considerable variability in the number of learning centers in operation (Cohen & Intili, 1981). Some teachers simplified the technology by operating only three learning centers, each with an adult (a teacher, an aide, and a parent volunteer) directly supervising the center. Clearly, some teachers were unable or unwilling to delegate authority—that is, to let go and to allow the children to solve problems for themselves. If the teachers were unable to delegate authority (as measured by the number of students under direct adult supervision), there were fewer learning centers in operation, the percentage of students talking and working together was lower, and, as a consequence, the average learning gains were lower. Those classrooms with the greatest learning gains were precisely those where teachers were successful in delegating authority so that more children could talk and work together at multiple learning centers.

The larger the number of groups that a teacher is trying to manage, the lower the probability that she will use direct instruction and direct supervision in which she exerts detailed control over how tasks are executed (Cohen, Lotan, & Leechor, 1989). Moreover, when there are a larger number of groups, direct supervision is unrelated to student disengagement (Rosenholtz, 1981). When multiple groups are in operation, lateral relations or talk between the students, rather than direct supervision, predict engagement.

Cooperative learning can become complex along other dimensions besides the differentiation into multiple groups and materials. As discussed above, tasks given to the groups can be relatively routine procedures, or they can be problems with ill-structured solutions. If interaction is critical because the small-group task is a problem with an ill-structured solution, the extent to which the teacher applies direct supervision will diminish the possibilities and opportunities of students communicating with one another. If the teacher, as an authority figure, takes responsibility for their task engagement, students will not assume responsibility for solving problems related to the task. In two data sets, based on classrooms using complex instruction, Cohen, Lotan, and Leechor (1989) found that the rate at which the teacher used forms of direct instruction when students were working in small groups was negatively related to talking and working together among the students. Direct supervision is the obverse of delegation of authority. This research provides support for a general sociological principle formulated by Perrow (1967). Once technology has become more uncertain, two necessary changes should be made in order to maintain or increase organizational productivity: delegation of authority to the workers and more lateral communication among the workers. In educational terms, this means that, when cooperative learning tasks are nonroutine problem-solving or discovery tasks, it is necessary for the teachers to avoid direct supervision and to foster talking and working together within the small groups.

Learning to delegate authority to groups is not an easy task for teachers. Cohen and Intili (1981) found, as reported above, that teachers were afraid of losing control of the classroom and thus reduced the number of groups so that they could use direct supervision. These researchers responded by developing a new system designed to assure the teachers that they could still be in control of the classroom even though the authority was delegated to groups of students. They required that students move on to a new learning center only when the whole group had completed its task and worksheet. Furthermore, behavior was controlled through a system of systematic training in cooperative norms and the allocation of a different role to each group member. The introduction of this new system resulted in a significant increase in the percentage of students in small groups and a reduction in the use of direct supervision, along with a sharp increase in the proportion of students observed talking and working together on the task (Cohen & De Avila, 1983).

Summary of Contextual Forces

In this section, I have reformulated the question of whether or not to structure interaction as a question of the conditions under which interaction should be structured to obtain maximal effectiveness. For example, it may be hypothesized that too much structuring may impede conceptually oriented interaction, particularly if it micromanages what group members are to say and think about. The same type of structure may be highly productive when groups are trying to learn a lesson the teacher has imparted or to absorb information on a given topic.

Status factors can affect interaction within small groups and, indirectly, their productivity. Particularly when the task is conceptual and nonroutine, one must treat expectations for competence so as to modify status effects if productivity is to be maximized.

Finally, there are two classroom factors that have been shown to affect interaction. Not only is training for cooperation necessary for effective groups, but the recommended behaviors should be specific and directly relevant to desired behaviors if cooperative interaction is desired. One cannot neglect the role of the teacher in fostering interaction within productive small groups. Our final proposition concerns the importance of delegation of authority in fostering interaction for groups engaged in group tasks with ill-structured solutions.

Conclusion

The research on cooperative learning has been moving past the necessity to defend this strategy as a legitimate method of instruction that can help students to learn. As the research has developed, there has been a tendency to become mired in ideological conflicts concerning the desirability of competitive elements embedded within cooperation and the use of extrinsic versus intrinsic rewards. Additionally, as questions are raised about what types of cooperative learning are the most productive, they tend to be answered by unconditional generalizations and by research designs that compare one of the popular models of cooperative learning with another.

By focusing on factors that make for a productive discourse within small groups, this analysis has raised questions concerning the kinds of discourse that are productive of different types of learning. Furthermore, the focus has been on the factors that affect discourse rather than factors that directly impact achievement gains. In other words, with interaction the central issue, the question becomes: What kinds of interaction are necessary for different kinds of outcomes? And what are the task instructions, student preparation, and teacher role that foster the desired type of interaction?

This analysis moves away from the fruitless debates about intrinsic and extrinsic rewards and goal and resource interdependence that have tied the field into theoretical and ideological knots for some time. Instead, I have recommended that propositions be conditionalized on whether or not the assignment given to the group is a true group task and whether or not it is a problem with an ill-structured solution. Research on the effects of interaction and on structuring interaction should be conditionalized according to these dimensions. Even the relationship of reward contingencies to achievement may vary as a function of whether or not the task is a true group task with high intrinsic interest. A focus on task and interaction can assist researchers, staff developers, and practitioners in moving on to a second generation cooperative learning that is more firmly based on detailed knowledge of what makes these groups productive.

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