DOCUMENT RESUME

ED 351 207 SE 053 432

AUTHOR	Blosser, Patricia E.
TITLE	Using Cooperative Learning in Science Education.
INSTITUTION	ERIC Clearinghouse for Science, Mathematics, and Environmental Education, Columbus, Ohio.
SPONS AGENCY	Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE	Jan 93
CONTRACT	RI88062006
NOTE	11p.; Part of the series, The Science Outlook: An Informational Bulletin produced by ERIC/CSMEE.
AVAILABLE FROM	ERIC Clearinghouse for Science, Mathematics, and Environmental Education, Suite 310, 1200 Chambers Road, Columbus, OH 43212 ($1.50).
PUB TYPE	Information Analyses - ERIC Clearinghouse Products (071) -- Guides - Classroom Use - Teaching Guides (For Teacher) (052)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*Cooperative Learning; Elementary Secondary Education; *Group Activities; *Literature Reviews; Peer Teaching; Research Reports; Science Education; *Science Instruction; *Staff Development; Student Projects; Teacher Education; Teaching Methods

ABSTRACT

This bulletin focuses on cooperative learning with an emphasis on its use in science classrooms. A comprehensive review of the educational literature on cooperative learning is presented. Major sections of this document include the following: (1) why cooperative learning in science? (2) some characteristics of cooperative learning; (3) some varieties of cooperative learning; (4) research on cooperative learning; (5) cooperative learning in science classrooms; (6) some questions and controversies related to cooperative learning; (7) cooperative learning: benefits revisited; and (8) staff development and cooperative learning. (PR)

The Science OutLook
An informational bulletin from ERIC/CSMEE

ERIC CSMEE

Using Cooperative Learning in Science Education

by: Patricia E. Blosser

Clearinghouse for Science, Mathematics, and Environmental Education January 1993

This ERIC-CSMEE Information Bulletin focuses on cooperative learning, with an emphasis on its use in science classrooms. Although this approach to instruction has existed for many years, it has not been a common instructional technique in science. Several of the more recent elementary science curriculum projects, however, incorporate cooperative learning as an essential technique. The BSCS elementary school science program, "Science for Life and Living: Integrating Science, Technology, and Health," a K-6 program uses cooperative learning throughout its curriculum. The curriculum developers explain their choice by saying that cooperative learning promotes academic achievement, facilitates classroom and materials management, and enhances students' self-esteem (Wooley et al, 1990:32).

Although teachers frequently assert that they use group work in science all the time, particularly in lab activities, those persons whose area of expertise is cooperative learning maintain that group work and cooperative learning are not synonymous. Cooperative learning is more than telling your class, "Get your desks moved into groups of four." Part of the purpose for producing this bulletin is to provide additional information about the characteristics of cooperative learning and how it differs from other group work.

Why Cooperative Learning in Science?

Roger and David Johnson (1991) answer this question by pointing out that a quick look through the table of contents of scientific journals will illustrate the cooperative nature of scientific inquiry if the reader focuses on the number of authors of most journal articles. In addition, observation in science classes in which hands-on activities are taking place will usually reveal students working in pairs or small groups.

Writing in *Science for All Americans*, Rutherford and Ahlgren (1990: 189) in their discussion of effective teaching and learning of science, mathematics and technology say:

> The collaborative nature of scientific and technological work should be strongly reinforced by frequent group activity in the classroom. Scientists and engineers work mostly in groups and less often as isolated investigators. Similarly, students should gain experience sharing responsibility for learning with each other. In the process of coming to common understandings, students in a group must frequently inform each other about procedures and meanings, argue over findings, and assess how the task is progressing. In the context of team responsibility, feedback and communication become more realistic and of a character very different from the usual individualistic textbook-homework-recitation approach.

Johnson and Johnson consider the primary responsibilities of education to be learning and socialization, both of which are social processes (1987: 69). However, Glasser says that, in today's typical classroom, students work alone and are frequently reminded not to talk and to keep their eyes on their own work (Gough, 1987: 659).

Students need to be actively involved in their own learning, even at the college level. About five percent of time in college classes is spent in active participation. More than one-half of college students commute to class daily. More than 40% are enrolled part-time. The amount of student learning and personal development that occurs is directly proportional to the quality and quantity of student involvement in the educational program (Cooper and Prescott, 1989).

Common approaches to instruction are competition, cooperation, and individual work. It is *not* the purpose of this bulletin to advocate that cooperative learning displace the other two forms of instruction. Johnson and Johnson (1987: 67) contend "...There is clear evidence that American students see school as a competitive experience where it is vital to be at the top of your class and beat most of the other students..." Johnson and Johnson further hypothesize, based on their research and that of other individuals, that if the competitive and individualistic goal structures of American education were to be less dominant and if cooperative learning were used more widely and more often, students would learn more science and mathematics, like these subjects to a greater degree than they now do, come to feel better about themselves as science (or mathematics) students, and to have a more healthy attitude toward the acceptance of differences in their classmates (1987: 68).

Johnson and Johnson also assert that the research data on cooperative learning show that its use leads to students learning more material, feeling more confident and motivated to learn, exhibiting higher achievement, having greater competence in critical thinking, possessing more positive attitudes toward the subject studied, exhibiting greater competence in collaborative activities, having greater psychological health, and accepting differences among their peers (1984, 1987). They point out that patterns of student interactions in classes and the effects of these interactions on learning are relatively ignored in preservice and inservice education, and are vastly underestimated as a factor in learning (1987: 46).

Some Characteristics of Cooperative Learning

David and Roger Johnson and Robert E. Slavin have published numerous articles and books on cooperative learning. The Johnsons (1984) have identified four basic elements in cooperative learning: (1) interdependence among students seeking mutual goals through combined efforts, (2) face-to-face interaction among students, (3) individual accountability for mastery of the material covered, and (4) appropriate use of interpersonal and small-group skills by students. The Johnsons say that effective implementation of cooperative learning involves specifying instructional objectives; placing students in appropriate learning groups; explaining to students the academic tasks and cooperative methods to be used in achieving these tasks; monitoring the progress of the groups and, when necessary, intervening to provide assistance; and evaluating student achievements with student input.

Slavin (1989) cautions that, in recent years, cooperative learning has been proposed as a solution to many problems in education. Slavin thinks that under certain circumstances, the use of cooperative learning can help educators achieve many of their goals. He points out, however, that all forms of cooperative learning are not equally effective for all goals. Because achievement is a frequently desired goal, Slavin stresses that two conditions must be present if achievement effects are to be produced: (1) a group goal that is important to the group must be present and (2) individual accountability must be necessary—the success of the group must depend on the individual learning of all group members. If one condition is present, but not the other, the method is less effective in Slavin's opinion (1989: 31).

Slavin is concerned that teachers do not really understand what is involved in cooperative learning. In his opinion, possibilities exist to oversell cooperative learning as well as to undertrain teachers in its use (1990: 3). The Johnsons agree with Slavin's contention that training takes more than one three-hour inservice session. They say that teachers need to use cooperative learning procedures regularly for several years to become proficient and that teachers need to be given classroom assistance as they attempt implementation (1984: 4).

To review, cooperative learning involves:

- positive interdependence
- face-to-face interaction among students
- individual accountability for mastering the assigned material
- appropriate use of interpersonal and small-group skills.

For those readers who are still saying, "But I do that all the time…," Figure 1 provides a comparison of cooperative learning and small group activities.

Some Varieties of Cooperative Learning

This information bulletin is not sufficiently long enough to accommodate detailed discussions of the more common varieties of cooperative learning. Readers who wish to learn more are advised to consult one or more of the publications listed in the references and to conduct their own searches of the ERIC database for additional references and information.

Circles of Learning. In early publications of David and Roger Johnson referred to as "Learning Together." Later, they published a book entitled *Circles of Learning*, (1984) which appears to provide a more recent title for this method. Its implementation involves 18 steps: (1) clearly specify instructional objectives; (2) limit group size to no more than six; (3) structure groups for heterogeneity relative to ability, sex, ethnicity; (4) arrange groups in circles to facilitate communication; (5) use instructional materials to promote interdependence among students; (6) assign roles to ensure interdependence; (7) explain the academic task; (8) structure positive goal interdependence; (9) structure individual accountability for learning so that all group members must contribute; (10) structure inter group cooperation; (11) explain criteria for success; (12) specify desired behaviors; (13) monitor students' behavior continually for problems with the task or with collaborative efforts; (14) provide task assistance; (15) intervene to teach collaborative skills, if necessary; (16) provide closure to lesson with summaries by students and teacher; (17) evaluate the students' work; and (18) assess group functioning through ongoing observation during lessons and discussion of group process after the lesson or unit is completed (Johnson et al., 1984: 26-40).

Jigsaw. This cooperative learning method was developed by Aronson (*The Jigsaw Classroom*, 1978). (There are now two additional versions: Jigsaw II and Jigsaw III). In Aronson's method, each student in a five-member group is given information that comprises only one part of the lesson. Each student in the group has a different piece of information. All students need to know all information to be successful. Students leave their original group and form an "expert group", in which all persons with the same piece of information get together, study it, and decide how best to teach it to their peers in the original group. After this is accomplished, students return to their original groups, and each teaches his/her portion of the lesson to the others in the group. Students work cooperatively in two different groups, their group and the expert group. Grades are based on individual examination performance. There is no specific reward for achievement or for the use of cooperative skills (Knight & Bohlmeyer in Sharan, 1990: 3).

Jigsaw II. This modification was developed by Robert Slavin. In it, competition occurs between learning teams who compete for specific group rewards, which are based on individual performance. Points are earned for the team by each student improving his/her performance relative to his/her performance on previous quizzes (Knight & Bohlmeyer in Sharan, 1990: 4). Also, all students read a common narrative and then each is assigned a topic upon which to become an expert. This version saves the teacher from having to prepare different sets of reading materials.

Jigsaw III. This method, developed by Spencer Kagan, is for use in bilingual classrooms. Cooperative groups consist of one English speaker, one non-English speaker, and one bilingual student. All materials are bilingual (Knight & Bohlmeyer in Sharan, 1990: 4).

Student Teams-Achievement Divisions (STAD). This method, developed by Slavin, involves competition among groups. Students are grouped heterogeneously by ability, gender, race, ethnicity. Students learn materials in teams and take quizzes

Figure 1

COOPERATIVE GROUPS	SMALL GROUPS
Positive interdependence. Students sink or swim together. Face-to-face oral interaction.	No interdependence. Students work on their own, often or occasionally checking their answers with other students.
Individual accountability: each pupil must master the material.	Hitchhiking: some students let others do most or all of the work, then copy.
Teachers teach social skills needed for successful group work.	Social skills are not systematically taught.
Teacher monitors students' behavior.	Teacher does not directly observe student behavior, often works with a few students or works on other tasks (grades papers, prepares next lesson, etc.).
Feedback and discussion of students' behavior is an integral part of ending the activity before moving on.	No discussion of how well students worked together, other than general comments such as "Nice job" or "Next time, try to work more quietly."

(adapted from Ellis and Whalen, 1990: 15)

as individuals. Individual scores contribute to a group score. The points contributed to the group are based on a student's improvement over previous quiz performance. Slavin considers this method appropriate for a variety of subjects, including science, if the focus is on material with single right answers (Slavin, 1988: 9).

Teams-Games-Tournaments (TGT). Developed by DeVries and Slavin, this method involves the same use of heterogeneous teams, instructional format, and worksheets as does STAD for the learning of information. For the tournament, students from different teams are placed in groups of three students of comparable ability. In TGT the academic game replaces quizzes. Although study teams stay together for six weeks, tournament table composition changes weekly.

Slavin advises teachers against using tournament scores for individual quiz grades and suggests that quizzes be used as well as midterm and final examinations. He suggests that TGT can be used two to three days a week in science to learn basic concepts, with laboratory activities taking place on the other two days. It is also possible to alternate TGT with STAD on a weekly basis. Students appear to enjoy the challenge of the tournaments and, because they compete with others of comparable ability, the competition is fair (Slavin, 1988: 19).

Group Investigation. This method, developed by Sharan and others, emphasizes more student choice and control than do other cooperative methods. Students are involved in planning what to study and how to investigate.

Cooperative groups are formed on the basis of common interest in a particular aspect of a general topic. All group members help plan how they will research the topic and divide the work among themselves. Then each carries out his/her part of the investigation. The group synthesizes and summarizes the work and presents their findings to the class (Sharan and Sharan, 1990: 17).

This method is an attempt to combine democratic process and academic inquiry. The teacher needs to adopt an indirect style of leadership, acting as a resource person while providing direction and clarification as needed. The teacher's task is to create a stimulating work environment.

There are six specific stages involved in Group Investigation. In the first, the teacher identifies the general topic and helps the students, through discussion, to identify subtopics. Students work in groups of two to six. Students identify important points to investigate and how to organize for group study. They also need to decide how members are going to exchange information. The teacher may begin this stage by asking the class "What would you like to know about...?" A short lecture might be used to stimulate interest. A variety of relevant materials might be available for students to examine. Students can then raise questions, which are listed on the chalkboard, or they can meet in buzz groups to generate questions prior to this listing.

In the second stage, students work together to plan how they will carry out the investigation of their subtopic or set of questions. In addition to generating a listing of who will investigate what and deciding how to proceed, the groups may identify the resources they will need.

The third stage is probably the longest in this method. During this time, students work on their investigations. The teacher, in addition to helping students locate resources, needs to review with each group the activities that are planned for a particular class period.

In the fourth stage, students work together in their groups, analyzing and evaluating the information they have obtained. Students need to decide what are the essential parts of their investigation and plan how to present this information to the rest of the class. In addition to integrating the information, they have to decide how best to teach it. To facilitate the presentations which take place in a later stage, the teacher forms a steering committee made up of a representative from each group. This steering committee then coordinates the presentations and use of materials and provides recommendations to make certain the content of each presentation is meaningful and interesting.

In the fifth stage, each group presents a summary of the results of its investigation so that all students gain a broad perspective of the general topic. This will involve several class periods.

The sixth stage involves the evaluation of reports and presentations as well as individual learning. Students provide feedback to groups. In addition, each group submits a number of questions to the teacher to be used on the final examination. They also provide the correct answers or criteria for judging the adequacy of a response. When the examination is given, they answer all questions except those their group submitted. The teacher needs to solicit student feedback about the topic, the process, and suggestions for increasing students' effectiveness as investigators (Sharan and Sharan, 1990: 17-20; Knight & Bohlmeyer in Sharan, ed., 1990: 6-7).

Group Investigation gives students control over their learning, allows them to work together collaboratively, and to study what interests them. It appears to promote student responsibility for learning while emphasizing collaborative skills.

Kagan, in an article in *Educational Leadership* (Dec. 89/Jan 1990: 12-15), discusses structures for cooperative learning. Kagan considers "structures" to be content-free ways of organizing social interaction in classrooms. These structures involve a series of steps and do not have content-bound objectives. Kagan classified these structures according to major instructional focus: team building, class building, communication building, mastery, concept development, and multifunctional. Structures may have academic and/or social functions. Kagan believes that it is comparatively easy for teachers to master one structure at a time, whereas mastering cooperative learning methods may be overwhelming (1990: 15).

Kagan contends that structures may be used with almost any subject matter, at a wide range of grade levels, and at various points in a lesson plan. Structures may be combined to form multistructural lessons in which each structure serves as a building block, providing a learning experience upon which subsequent structures can expand (1990: 12).

In this same issue of *Educational Leadership*, Totten and Sills identify and briefly describe 10 publications they consider to be seminar works offering the reader a comprehensive discussion of cooperative methods (1990: 66).

Research on Cooperative Learning

Johnson and Johnson have extensively reviewed the literature on cooperative learning identifying a study that dates back to 1987 (Brandt, 1987:16). They identify a variety of outcomes of cooperative learning. Achievement increases for all ability levels (high, medium, low); higher-level thinking processes can result; a deeper level of understanding is possible; critical thinking is promoted; more positive peer relationships result; students exhibit better social skills and provide more social support for their peers; and a higher level of self esteem can result (Brandt, 1987:17). In addition, there is a fringe benefit: as teachers teach their students how to be a part of a productive group and manage conflict, teachers also learn those social skills and can use them with their colleagues (Brandt, 1987:18-19). Johnson and Johnson cite 19 studies which provide evidence that cooperative learning promotes higher achievement than do competitive or individual learning experiences (in Champagne and Hornig, 1987:73). They also report a meta-analysis of 122 studies of cooperative learning done between 1924 and 1981. The 286 findings were analyzed using three different methods: voting, effect size, and z score. All methods of analysis resulted in the same finding: cooperative learning tends to promote higher achievement than does competition or individual work, with this finding holding for all age levels, all subject areas, and a variety of tasks (Johnson et al, 1984:15).

Johnson and Johnson also conducted a meta-analysis of 98 studies focused on the relative impact of cooperation, competition, and individual work on interpersonal attraction among homogeneous and heterogeneous samples of students. These studies were published between 1944 and 1982 and resulted in 251 findings. Cooperative learning appeared to promote greater interpersonal attraction among homogeneous groups of students, students from different ethnic groups, handicapped and non handicapped students (1984:20). Again, the three methods of analysis were used in this study and the results did not differ with the method.

Slavin is critical of any research reports on cooperative learning that do not last at least four weeks or more. Slavin identified 70 studies that evaluated various cooperative learning methods for periods of four weeks or longer; 67 involved measurement of effects on student achievement. All compared the effects of cooperative learning to traditionally taught control groups, with teachers and classes either randomly assigned to cooperative or control groups or matched on pretest achievement level and other factors. When these 67 studies were reviewed, 41 (61%) had significantly greater achievement in cooperative classes. No differences were found in 25 studies (37%). In only one study did the control group outperform the cooperative group (1991: 75-76).

Slavin maintains that if cooperative learning is to be effective, both group goals and individual accountability must be present. In the 44 studies in which these conditions were met, 37 studies (84%) contained reports of significant positive achievement effects. There were 23 studies in which group goals and individual accountability were lacking. Only four of these studies (17%) reported positive effects on student achievement, and two of these four studies involved the use of Group Investigation (1991: 76-77).

Slavin reported that, in his review, achievement effects of cooperative learning were found to be about the same degree at all grade levels (2-12); in all major subjects; and in urban, rural, and suburban schools. Effects were equally positive for high, average, and low achievers. Positive effects were found for outcomes such as self-esteem, inter group relations, acceptance of academically handicapped students, and ability to work cooperatively (1991: 71).

Newmann and Thompson (1987) reviewed 27 reports of "high quality" research on cooperative learning at the secondary level. They chose to prepare this review because much cooperative learning research involves elementary pupils. Because of the differences between secondary and elementary education and students they wished to see if effects on achievement were different. In addition, they were looking for alternatives to "frontal teaching". The studies they reviewed involved five major cooperative learning techniques: Student Teams-Achievement Divisions (STAD), Teams-Games-Tournaments (TGT), Jigsaw, Learning Together, and Group Investigation.

The 27 studies yielded 37 comparisons of cooperative learning versus conventional/control (frontal teaching) groups. Cooperative learning was favored at the .05 level of significance for 25 comparisons (68%). Twenty-eight comparisons were used to compute effect sizes that ranged from .87 to 5.15. Although most studies involved grade 7, the greatest success with cooperative learning was in grades 8 and 9. Science was the subject involved in most studies. However, studies involving mathematics or language arts had the highest success rates. The most consistently successful method was STAD, and the least successful, Jigsaw.

Newmann and Thompson suggest that more research on the use of cooperative learning with secondary students is needed, and that researchers should investigate the interaction of method, level of thought, student background characteristics, and student status within the group. They also encourage investigators to examine the specific types of verbal interaction within groups that are most likely to boost achievement (1987:6). They agree with Slavin that group reward and individual accountability and cooperative task structure are needed for effective cooperative learning. They speculate that lack of these elements may be why Jigsaw is less successful than other methods.

Newmann and Thompson reported that the fewest studies (six) involved grades 10-12. The success rate for these studies was 33%. The authors think that teachers perceive high school students as not being interested in cooperative learning or that teachers consider they have too much information to cover in a limited time with students. In their opinion, this is an area in need of staff development, as well as further research.

Cooperative Learning in Science Classrooms

Not all of the studies reported in this section are reports of research, but research studies do constitute the majority of the literature reviewed. All reports deal with science teachers and students. Studies are presented by increasing grade level of the students involved.

Jones and Steinbrink (1989, 1991) have developed a cooperative learning approach that they call Home Teams-Expert Groups. Their method is a modification of Jigsaw II, using task groups with science textbooks. They justify their approach by saying that teachers spend more time with textbooks than they do with laboratory equipment and other science materials. Research on the Home Teams-Expert Groups approach appears to consist of master's projects and some course assignments. Most of the results favor this approach to cooperative learning. Average students have maintained or slightly improved their performance on unit tests while lower ability students have made "dramatic improvement" (1991:135). The students involved in most studies were elementary and intermediate pupils. One researcher has speculated that the important factor in student test score improvement is the use of focused study items (these appear to be parallel forms of test items, as shown in Figure 2 (p.545) of the 1989 article):

> Cohen (1991) reported on the use of a method called Finding Out/Descubrimiento in an interactive, multiability mathematics/science curriculum designed to foster the development of thinking skills in children in grades 2-5. Data collected on student performance on the Comprehensive Test of Basic Skills show highly significant gains in language arts, reading, and mathematics subtests, and in science when this subtest was included in 1983-84 (1991:31).

Jones (1990) worked with teachers and students in grades 3, 4, and 5 in two rural elementary schools to compare the effectiveness of cooperative learning (versus traditional work of pairs of pupils) in moving students through misconceptions about temperature. Students were pretested, participated in a cognitive conflict activity, and posttested at the end of instruction. Although conflict training did result in changes in students' concepts of temperature, the cooperative learning approach was no more effective than the control.

Rosebery (1991) studied students who were using *Cheche Konnen* (Haitian Creole for "Search for Knowledge") as a part of collaborative scientific inquiry. As part of their investigation of student taste preferences for water from first, second and third floor drinking fountains in their school, the seventh and eight grade students studied water acidity, salinity, and purity and learned chemistry, biology, and hydrogeology. As students investigated, they learned science content, improved their mathematics skills, scientific reasoning skills, and language and literacy (1991:29).

Conwell et al. (1988) interviewed 28 students who worked in cooperative learning groups in intermediate science classrooms in an urban system. The researchers reported several findings. Students perceived their science achievement positively. Nearly two thirds rated their level of self-esteem as high. White students, particularly white females, felt positive about themselves when working in groups. More than three fourths of the students interviewed enjoyed working with everyone in their group. Students had no preferences based on race or sex for team mates. However, the overall response of black students to group work was not so positive as that of white students. White females, regardless of achievement level, felt better about themselves when working in a group, compared to working alone in science (1988:26).

Kinney (1989) studied the effects of cooperative learning on the achievement of ninth-grade students in a multicultural general biology class. Kinney's cooperative learning model involved two days of specifically designed cooperative learning activities followed by an individual chapter test on the third day. Day one involved the use of STAD. On day two, students were given their graded tests and worksheets for 10 to 15 minutes of study and then played Teams-Games-Tournaments (TGT) for the rest of the period. Laboratory activities took place between the three-day cycles. Black students of both sexes showed significant increase in achievement over their counterparts in the control group for short term effects (1989:5). Both black and white students in the experimental group had a significant increase on chapter test scores.

Okebukola (1986) investigated the effect of cooperative work on student attitudes toward the science laboratory. Ninth grade biology students in two schools participated in the study. Attitudes were measured using the Attitude Toward Laboratory Work Scale, with references to "chemistry" in the instrument being changed to "biology." The scale was administered as both a pretest and a posttest. Posttest results indicated that students in the experimental treatment held significantly more favorable attitudes toward laboratory work than did students in the control group. Attitudes of male students were more favorable than those of females in the experimental group, but, regardless of sex, attitudes of students in the experimental group were still more positive than those of control group students.

Lazarowitz et al. (1988) used a modified Jigsaw method with Group Investigation to teach two biology units (the cell, plants) to tenth grade students. Four general biology classes were used, with two classes randomly selected to serve as the experimental group. Different teachers and aides worked with the experimental and control classes. Students in the experimental group participated in three days of team-building activities before the first unit was introduced. Students in the control classes studied the same units but worked individually.

Aides were asked to observe and record on-task behavior, observing each student for 30 seconds at a time, three times during a class period. The two units involved seven weeks of classes. Aides reported that students in the experimental group exhibited a greater amount of on-task behavior both during and after the experiment than did those in the control group.

When achievement was measured, students in the experimental classes had higher scores on the cell unit, but those in the control classes had higher scores on the plant unit (1988:483). The researchers speculated that the cell unit involved more investigation and required more inquiry and high-level thinking than did the plant unit, which contained more information gathering and observation activities. They inferred that differences in the materials and nature of the tasks may have influenced achievement results (1988:485).

Lararowitz (1991) also reported another study in which the same combination of cooperative methods was used with ninth grade general biology students. Six teachers and 201 students studied cell division. No significant differences between groups were found on pretest scores. On the posttest the experimental group scored significantly higher on all comparisons. In the cooperative group girls scored higher than boys (1991:20). At the end of the study, all students took the Learning Environment Inventory (LEI). Students in the cooperative group perceived their science classrooms as having a more benign atmosphere than did those in the control group (1991:21).

Sherman (1989) conducted a seven-week study involving two high school biology classes of approximately equal abilities. Students in the experimental class used Group Investigation while those in the control group worked independently as individuals. All students were told that 25% of their grade for that marking period would be based on a report of major biomes of the world. In the experimental class, each heterogeneous cooperative group was assigned a major biome. Students within each group were allowed to select one of the required major subtopics to investigate for the group report (which was both written and oral). All in the group would receive the same grade for the report. Students in the control class were allowed to choose a major biome (with the same five subtopics) to study individually.

Students were pre- and posttested with a 40-item multiple choice test. While posttest scores were significantly higher for both groups, there were no significant differences on pre or posttest scores between treatment groups. Sherman concluded that both methods were effective, but neither was superior. He speculated that lack of difference between groups might have been due to length of time involved or to the fact that the treatment came in the final ten weeks of the school year when friendships and working alliances among students were too fixed to be amenable to change (1989: 59).

Roblee (1991) used group work with an unruly, late-afternoon high school chemistry class. Students were placed in groups of four, composed of people who did not ordinarily work together, and were assigned roles in a hypothetical company. They were then presented with a problem to solve in which they had to use their chemistry knowledge to analyze and interpret information. As students became more confident in their problem solving skills, both participation and level of motivation increased (1991: 23).

Scott and Heller (1991) advocate the use of group work in science to encourage female and minority students. Their argument is that traditional classroom competition inhibits learning by pupils who lack confidence in their abilities to be successful in a subject. They contend that cooperative group work benefits all students, and provide some suggestions for cooperative activities in physics. They advocate the use of the Jigsaw method for reinforcing difficult reading material, preparing research projects and demonstrations, and reviewing for a test (1991: 28).

Basili and Sanford (1991) conducted an investigation of the use of conceptual change strategies in small cooperative group settings in community college chemistry classes, using a pretest-posttest control-group experimental design. Four intact sections of introductory chemistry at a suburban community college were involved. All sections had the same course content, identical homework problems, and examinations. Students in the experimental group were taught to make concept maps. The experimental group had five 50-minute lecture/discussion classes and a sixth class period in which they worked in groups of five. Group work involved explaining responses to questions assigned in advance of the group session and the construction of a concept map (that all agreed to) to hand in.

Audio tapes of student interaction in the four sections were analyzed as part of the data. Upon analysis of the tapes, researchers found a significantly lower proportion of misconceptions for four of the five concepts on the posttest for the experimental group. Analysis of individual verbal behavior during the small-group work indicated that some group tasks encouraged students to interact in ways supportive of conceptual change (1991: 298-299). However, it also revealed that poor group leaders prevented effective discussion by rushing through questions and imposing their views of the purpose of the task (1991: 302).

Rice and Gabel (1990) worked with preservice elementary teachers enrolled in college chemistry. Two instructors taught four sections of chemistry, with each instructor having one experimental group and one control group. Students were assigned to do laboratory work in heterogeneous groups based on grade point averages. Slavin's model of a team report and bonus point system involving six quizzes was used. In the conventional classes, students performed the laboratory work in pairs of their own choosing and submitted individual reports.

The researchers were interested in the effects of cooperative work on achievement, development of laboratory skills, development of specific science concepts, student attitude toward science and science teaching as related to level of reasoning ability, different learning preferences, and comfort level with science. When data were analyzed, students in the control classes outperformed those in the experimental classes on the 60 comparisons involved in the study (1990: 12).

Some Questions and Controversies Related to Cooperative Learning

Cooperative Learning and the Gifted. Parents sometimes object to having their gifted children involved in cooperative work, claiming that it exploits the child's abilities and cuts down on individual exploration. Slavin counters this argument by saying that research on ability grouping in elementary and secondary schools finds no achievement benefits of between-class grouping (e.g. high, middle, and low fourth grades or advanced, general, and basic tracks). This "no difference" finding is the same for high, average, and low achievers. For the gifted, the top 3-5%, the research is more murky, but most reviewers conclude that there is support for *acceleration* programs, but not for *enrichment* programs (1991:22-23). He admits that there is "... no long-term research on the effects of garden variety cooperative learning on the gifted" (1991: 23). Nevertheless, Slavin thinks that cooperative learning is good for gifted students because they are most likely to be able to provide elaborated explanations (a behavior closely associated with learning gains).

Johnson and Johnson (1991) say that gifted students, and high achievers, should sometimes work alone, should sometimes compete, and should sometimes work in cooperative groups. They have conducted nine studies, over a 15-year period, of high-ability and gifted students in cooperative learning. They have found mastery and retention of assigned material higher in cooperative work than in competitive and individual learning. When these students were given a task to be solved that could involve higher-level or lower-level reasoning strategies, they more frequently used higher-level strategies when working cooperatively than when working competitively or individually (1991: 25). They cite a study involving physics students in which gifted students used expert reasoning strategies when working in cooperative groups but used novice strategies when working alone.

Johnson and Johnson believe there are five benefits for gifted students who work cooperatively: (1) learning with expectation of teaching to others results in learning at higher cognitive levels than learning to pass a test; (2) explaining increases the level of cognitive reasoning, retention, and achievement; (3) checking explanations of others increases achievement; (4) cognitive growth requires social interaction and intellectual arguments; (5) viewing issues from a variety of perspectives promotes higher-level reasoning and cognitive growth (1991: 25).

When gifted students work with peers of lower ability, they are involved in cognitive restructuring and practice with the information being studied. The Johnsons do not believe that an all-gifted group has any advantages over heterogeneous groups. They advocate that, if teachers separate out their gifted students for enrichment, they should also involve them in cooperative work in heterogeneous groups. Gifted students should be helped to focus on the desire to tackle difficult tasks, not on winning over others (1991: 27).

The Use of Group Rewards. Slavin and Kohn have polar positions on the use of group rewards in cooperative learning (Graves, 1991: 77). Slavin is concerned with improving student achievement and believes that group rewards, based on the individual achievement of each group member, are important, Kohn (1991) thinks rewards undermine intrinsic motivation and considers group rewards to be "group grade grubbing." Kohn advocates that teachers look at the curriculum and ask if it has intrinsic appeal and autonomy (lets students make choices), and if it fosters the creation of a community within the classroom. Kohn is in favor of the use of Group Investigation because it does allow students to have control over what they will study and how they will gather information.

Kohn believes that a carefully structured cooperative environment that offers challenging learning tasks, that allows students to make key decisions about how they will perform these tasks, and that emphasizes the value (and skills) of helping each other learn is a sufficient alternative to extrinsic motivators (1991: 86).

Graves (1991) suggests that teachers ask themselves three questions: (1) Are there forms of group rewards that minimize the possible negative effects on intrinsic motivation? (2) Under what conditions will reliance on intrinsic motivation be most likely to achieve academic goals? and (3) Under what conditions may extrinsic group rewards continue to be necessary and useful? Graves considers extrinsic rewards to be damaging when (1) students would do the work without them, (2) students see them as an attempt to control and manipulate. He believes extrinsic rewards are least damaging when (1) the tasks are ones students are unwilling to do on their own, (2) the rewards are largely symbolic in form rather than being "payment," (3) the rewards are social rather than tangible, or (4) they are unanticipated (1991: 78).

Cooperative Learning: Benefits Revisited

Cooperative learning prepares students for today's society. It promotes active learning—students learn more when they talk and work together than when they listen passively. It motivates, leads to academic gains, fosters respect for diversity, and advances language skills (Mergendollar and Packer, 1989). It breaks down stereotypes and leads to an increase in self-esteem (Uscher, 1986). It builds cooperative skills, such as communication, interaction, cooperative planning, sharing of ideas, decision making, listening, taking turns, and exchanging and synthesizing ideas (Sharan and Sharan, 1987: 24). It is a method of promoting academic achievement that is not expensive to implement (Lyman and Foyle, 1988).

Staff Development and Cooperative Learning

Although cooperative learning is inexpensive to implement, it takes time and practice for teachers to become skilled in its use. Edwards and Stout (1990) emphasize the importance of not neglecting the direct teaching of social skills for cooperation before beginning academic assignments. These social skills include staying with the group, using quiet voices, giving direction to the group's work, encouraging participation, explaining answers, relating present learning to past learning, criticizing ideas without criticizing people, asking probing questions, and requesting further rationale (Johnson & Johnson, 1990: 31). Also, when in doubt about group size, start small (two to three people).

Edwards and Stout say that cooperative learning is useful when students are practicing a new concept, when discussion and higher order thinking skills are required, or when small group brainstorming is needed. They advise teachers wishing to try this method to enlist colleagues in trying it in their classrooms so that a support group can develop (1990: 40).

References

Aronson, E. et al. (1978). *The Jigsaw Classroom.* Beverly Hills, CA: Sage Publications.

Basili, P. A., & Sanford, J. P. (1991). Conceptual change strategies and cooperative group work in chemistry. *Journal of Research in Science Teaching, 28*(4), 293-304.

Brandt, R. (1987, November). On cooperation in schools: A conversation with David and Roger Johnson. *Educational Leadership, 45*(3), 14-19.

Champagne, A. B., & Hornig, L. E. (Eds.). (1987). *Students and Science Learning.* Washington, DC: American Association for the Advancement of Science.

Cohen, E. G. (1991, April). Finding out/descubrimiento: Complex instruction in science. *Cooperative Learning, 11*(3): 30-31.

Conwell, C. R. et al. (1988, November). *Students' perceptions when working in cooperative problem solving groups.* Paper presented at the North Carolina Science Teachers Association Convention. (ERIC Document Reproduction Service No. ED 313 455)

Cooper, J., & Prescott, S. (1989, March). *Cooperative learning: Kids helping kids, teachers helping teachers.* Materials packet for Higher Education component of AACTE Symposium. (ERIC Document Reproduction Service No. ED 310 067)

Edwards, C., &. Stout, J. (1989, December-1990, January). Cooperative learning: The first year. *Educational Leadership, 47*(4), 38-41.

Ellis, S. S., & Whalen, S. F. (1990). *Cooperative learning getting started.* New York: Scholastic Press.

Gough, P. B. (1987, May). The key to improving schools: An interview with William Glasser. *Phi Delta Kappan, 68*(9), 656-662.

Graves, T. (1991, April). The controversy over group rewards in cooperative classrooms. *Educational Leadership*, 48 (7), 77-79.

Johnson, D. W. et al. (1984). *Circles of learning, cooperation in the classroom.* Alexandria, VA: Association for Supervision and Curriculum Development.

Johnson, D. W., & Johnson, R. T. (1989, December-1990, January). Social skills for successful group work. *Educational Leadership, 47*(4), 29-33.

Johnson, D. W., & Johnson, R. T. (1991, April). What cooperative learning has to offer the gifted. *Cooperative Learning, 11*(3), 24-27.

Johnson, R. T., & Johnson, D. W. (1987a). Cooperative learning and the achievement and socialization crises in science and mathematics classrooms. In Champagne and Hornig (Eds.), *Students and science learning* (pp. 67-93).

Johnson, R. T., & Johnson, D. W. (1987b, September). How can we put cooperative learning into practice? *The Science Teacher, 54*(6), 46-50.

Johnson, R. T., &. Johnson, D.W. (1991, April). So what's new about cooperative learning in science? *Cooperative Learning, 11*(3): 2-3.

Jones, G. (1990). *Cognitive conflict and cooperative learning.* Paper presented at the annual meeting of the National Association for Research in Science Teaching. (ERIC Document Reproduction Service No. ED 319 598)

Jones, R. M., & Steinbrink, J. E. (1991, April). Home teams: cooperative learning in elementary science. *School Science and Mathematics, 91*(4), 139-143.

Jones, R. M., & Steinbrink, J. E. (1989, November). Using cooperative groups in science teaching. *School Science and Mathematics, 89*(7): 541-551.

Kagan, S. (1989, December-1990, January). The structural approach to cooperative learning. *Educational Leadership, 47*(4), 12-15.

Kinney, J. H. (1989, May). *A study of the effects of a cooperative learning program on the achievement of 9th grade multi-cultural general biology classes.* (ERIC Document Reproduction Service No. ED 309 096)

Kohn, A. (1991, February). Group grade grubbing versus cooperative learning. *Educational Leadership, 48*(5), 83-87.

Knight, G. P., & Bohlmeyer, E. M. (1990). Cooperative learning and achievement: Methods for assessing causal mechanisms. In S. Sharan, (Ed.), *Cooperative learning: Theory and research* (pp. 1-22). New York: Praeger Publishers.

Lazarowitz, R. et al. (1988). Academic achievement and on-task behavior of high school biology students instructed in a cooperative small investigative group. *Science Education,* 72(4), 475-487.

Lazarowitz, R. (1991, April). Learning biology cooperatively: An Israeli junior high school study. *Cooperative Learning, 11*(3), 19-21.

Lyman, L., & Foyle, H. C. (1988). *Cooperative learning strategies and children.* (ERIC Document Reproduction Service No. ED 306 003)

Mergendollar, J., & Packer, M. J. (1989). *Cooperative learning in the classroom: A knowledge brief on effective teaching.* (ERIC Document Reproduction Service No. ED 322 146)

Newmann, F. M., & Thompson, J. A. (1987, September). *Effects of cooperative learning on achievement in secondary schools: A summary of research.* (ERIC Document Reproduction Service No. ED 288 853)

Okebukola, P. A. (1986). Cooperative learning and students' attitudes to laboratory work. *School Science and Mathematics, 86*(7), 582-590.

Rice, D. C., & Gabel, D. L. (1990). *Cooperative learning in a college science course for preservice elementary teachers.* (ERIC Document Reproduction Service No. ED 320 773)

Robblee, K. M. (1991, January). Cooperative Chemistry. *The Science Teacher, 58*(1), 20-23.

Rosebery, A. S. et al. (1991, April). Cheche konnen: Collaborative scientific inquiry in language minority classrooms. *Cooperative Learning, 11*(3) 28-20.

Rutherford, F. J., & Ahlgren, A. (1990). *Science for all Americans.* New York: Oxford University Press.

Scott, L. U., & Heller, P. (1991, January). Team work works. *The Science Teacher, 58*(1), 24-28.

Sharan, S. (Ed.). (1990). *Cooperative learning: Theory and research.* New York: Praeger Publishers.

Sharan, Y., & Sharan, S. (1989, December-1990, January). Group investigation expands cooperative learning. *Educational Leadership, 47*(4), 17-19.

Sharan, Y., & Sharan, S. (November, 1987). Training teachers for cooperative learning. *Educational Leadership, 45*(3), 20-25.

Sherman, L. W. (1989, January). A comparative study of cooperation and competitive achievement in two secondary biology classrooms: The group investigation model versus an individually competitive goal structure. *Journal of Research in Science Teaching, 26*(1), 55-64.

Slavin, R. E. (1988a, October). Cooperative learning and student achievement. *Educational Leadership, 46*(2): 31-33.

Slavin, R. E. (1991, February). Group rewards make group work work, response to Kohn. *Educational Leadership, 48*(5), 89-91.

Slavin, R. E. (1989, December-1990, January). Here to stay—or gone tomorrow? *Educational Leadership, 47*(4), 3.

Slavin, R. E. (1989, December-1990, January). Research on cooperative learning: Consensus and controversy. *Educational Leadership, 47*(4): 52-54.

Slavin, R. E. (1988b, June). *Student team learning: An overview and practical guide.* Washington, DC: National Education Association.

Slavin, R. E. (1991, February). Synthesis of research on cooperative learning. *Educational Leadership, 48*(5): 71-82.

Slavin, R. E. (1991, April). What cooperative learning has to offer the gifted. *Cooperative Learning, 11*(3): 22-23.

Totten, S., & Sills, T. M. (1989, December-1990, January). Selected resources for using cooperative learning. *Educational Leadership, 47*(4), 66.

Uscher, C. (1986, August). *Cooperative learning in the urban classroom.* (ERIC Document Reproduction Service No. 273 717)

Wooley, S. F. et al. (1991, April). The BSCS elementary science program: A cooperative learning approach. *Cooperative Learning, 11*(3): 32-33.

ERIC/CSMEE
1200 Chambers Rd., Rm 300 Columbus, OH 43212

About the author

Patricia E. Blosser is a Professor in the Department of Educational Studies at The Ohio State University. She coordinates the post-degree program and teaches courses in science curriculum, science supervision, and related seminar topics. She is past president of AETS, of NARST, and has been District Director of Region VI of NSTA twice.

OERI This bulletin was funded by the Office of Educational Research and Improvement, U.S. Department of Education under contract no. RI-88062006. Opinions expressed in this digest do not necessarily reflect the positions or policies of OERI or the Department of Education.

ERIC Educational Resources Information Center. The nationwide information system initiated in 1966 by the U.S. Department of Education. ERIC is the largest and most frequently used database in the world.

SE 053 432