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Research Paper

Cooperative Learning: School Education

Education

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ABSTRACT

"Individual commitment to a group effort: this is what makes a team work, a company work, a society work, and a civilization work." --Vince Lombardi, Former Green Bay Packers Coach

The myth of individual genius and achievement--as opposed to cooperative efforts--is deeply ingrained in American culture. Americans seem deeply committed to the idea of the individual hero---a rugged self-starter who meets challenges and overcomes adversity. Sports, for example, are more often defined by individual superstars than by the quality of teamwork. Academic excellence is more often personified by the valedictorian than by academic teamwork.

This article would also focus on why cooperative learning essential and how to implement cooperative learning in science. Different methods of implementing cooperative learning are also included in this paper.

Introduction

Cooperative learning is a student-centered, instructor-facilitated instructional strategy in which a small group of students is responsible for its own learning and the learning of all group members. Students interact with each other in the same group to acquire and practice the elements of a subject matter in order to solve a problem, complete a task or achieve a goal.

Cooperative learning is an approach to group work that minimizes the occurrence of those unpleasant situations and maximizes the learning and satisfaction that result from working on a high-performance team. A large and rapidly growing body of research confirms the effectiveness of cooperative learning in higher education. Relative to students taught traditionally—i.e., with instructor-centered lectures, individual assignments, and competitive grading—cooperatively taught students tend to exhibit higher academic achievement, greater persistence through graduation, better high-level reasoning and critical thinking skills, deeper understanding of learned material, greater time on task and less disruptive behavior in class, lower levels of anxiety and stress, greater intrinsic motivation to learn and achieve, greater ability to view situations from others' perspectives, more positive and supportive relationships with peers, more positive attitudes toward subject areas, and higher self-esteem. Another nontrivial benefit for instructors is that when assignments are done cooperatively, the number of papers to grade decreases by a factor of three or four.

There are several reasons why cooperative learning works as well as it does. The idea that students learn more by doing something active than by simply watching and listening has long been known to both cognitive psychologists and effective teachers (5, 6) and cooperative learning is by its nature an active method. Beyond that, cooperation enhances learning in several ways. Weak students working individually re likely to give up when they get stuck; working cooperatively, they keep going. Strong students faced with the task of explaining and clarifying material to weaker students often find gaps in their own understanding and fill them in. Students working alone may tend to delay completing assignments or skipthem altogether, but when they know that others are counting on them, they are motivated to do the work in a timely manner.

The proven benefits of cooperative learning notwithstanding, instructors who attempt it frequently encounter resistance and sometimes open hostility from the students. Bright students complain about begin held back by their slower teammates; weak or unassertive students complain about being discounted or ignored in group sessions; and resentments build when some team members fail to pull their weight. Knowledgeable and patient instructors find ways to deal with these problems, but others become discouraged and revert to the traditional teacher-centered instructional paradigm, which is a lossboth for them and for their students.

In this chapter we describe cooperative learning methods that have been proven effective in avarietyof instructional settings. We then suggest ways to maximize the benefits of the approach and to deal withthe difficulties that may arise when cooperative learning is implemented.

What is Cooperative Learning?

According to Deutsh (1949); the effort of a student to reach his goal has, a) a supportive effect in the cooperative case, and b) an obstructive effect in the competitive case, and c) a neutral effect in the individualistic case on the other students.

Several definitions of cooperative learning have been formulated. The one most widely used in highereducation is probably that of David and Roger Johnson of the University of Minnesota. According to theJohnson & Johnson model, cooperative learning is instruction that involves students working in teams toaccomplish a common goal, under conditions that include thefollowing elements:

1. **Positive interdependence.** Team members are obliged to rely on one another to achieve the goal.If any team members fail to do their part, everyone suffers consequences.
2. **Individual accountability.** All students in a group are held accountable for doing their share ofthe work and for mastery of all of the material to be learned.
3. **Face-to-face interaction.** Although some of the group work may be parcelled out anddone individually, some must be done interactively, with group members providing one anotherwith feedback, challenging reasoning and conclusions, and perhaps most importantly, teachingand encouraging one another.
4. **Appropriate use of collaborative skills.** Students are encouraged and helped to develop andpractice trust-building, leadership, decision-making, communication, and conflict managementskills.
5. **Group processing.** Team members set group goals, periodically assess what they are doing wellas a team, and identify changes they will make to function more effectively in the future.

Cooperative learning is not simply a synonym for students working in groups. A learning exercise onlyqualifies as cooperative learning to the extent that the five listed elements are present.

Cooperative Learning Structures

Cooperative learning can be used in for any type of assignment that can be given to students in lectureclasses, laboratories, or project-based courses. Following are some of the structures that have been used,with some recommendations for how they may

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be effectively implemented.

Problem Sets
Students complete some or most of their homework assignments in teams. The teams are encouraged toinclude only the names of actual participants on the solution set that they hand in. The students areinitially disinclined to leave anyone's name off, but eventually they get tired of letting nonparticipants("hitchhikers," in cooperative learning parlance) get good grades for work they didn't do and begin toomit names, at which point many hitchhikers—unhappy about getting zeroes on assignments—startcooperating.

The team gets a grade for the assignment, but eventually the performance of each team membershould be assessed and the results used to adjust the average team homework grade separately for eachteam member. Adjusting team grades for individual performance is one of the principal ways of assuringindividual accountability in cooperative learning, second only in importance to giving individual exams.

We recommend using a mixture of individual and team assignments in a lecture course rather thanhaving all assignments completed by teams. One obvious reason is to provide another measure ofindividual accountability. Another is that if there is a lot of dropping and adding in the first one or twoweeks of the course, it is better to wait until the class population stabilizes before forming teams.

We also suggest advising teams not to simply meet and complete each assignment together. One teammember is usually the fastest problem solver and begins almost every homework problem solution in thegroup sessions, and the other members then have to figure out how to get the solutions started for the firsttime on the individual tests, which is not a good time for them to have to do it. We recommend insteadthat all team members outline solutions individually before meeting to work out the details. On the firstfew assignments we require team members to sign and hand in their outlines to help them acquire thehabit.

Laboratories and Projects
Laboratories and projects may be carried out by teams (as they often are in traditional curricula), exceptthat again the team grades should be adjusted for individual performance.

The problem with team labs and projects as they are normally conducted is that there is no individualaccountability at all. The result is the familiar situation in which some team members do the bulk of thework, others contribute little and understand little or nothing about the project, everyone gets the samegrade, and resentment abounds. Adjusting the team project grades for individual performance goes a longway toward correcting these injustices. In addition, it is good practice to include some individual testingon every aspect of the project and have the results count toward the final course grade. If this is done,hitchhikers who understand either nothing or only the little they did personally will be penalized andperhaps induced to play a more active role in subsequent work.

Jigsaw
Jigsaw is a cooperative learning structure applicable to team assignments that call for expertise inseveral distinct areas. For example, in a laboratory exercise, areas of expertise might include experimentaldesign, equipment calibration and operation, data analysis (including statistical error analysis), andinterpretation of results in light of theory, and in a design project the areas might be conceptual design,process instrumentation and control, safety and environmental impact evaluation, and cost andprofitability analysis.

Peer Editing
When teams turn in written lab reports and/or give oral presentations, the usual procedure is for theinstructor to do the critiquing and grading. A powerful alternative is *peer editing*, in which pairs of groupsdo the critiquing for each other's first drafts (written) or run-throughs (oral). The groups then revise theirreports and presentations taking into account the critiquing teams' suggestions and then submit or presentto the instructor. This activity lightens the grading load for instructors, who end up with much betterproducts to grade than they would have without the first round of critiquing.

If a grading checklist or rubric is to be used for grading the team reports (which is always a goodidea), it should be shared with the students before the reports are written and used for the peer editing.This practice helps the students understand what the instructor is looking for and invariably results in thepreparation of better reports, and it also helps assure that the peer critiques are as consistent and useful aspossible. If several rounds of peer editing are done and the instructor collects and grades the checklists orrubrics for the first one or two rounds, the students will end up giving much the same rubric scores as theinstructor gives, and in good classes the instructor may only have to do spot checks of peer grades insteadof having to provide detailed feedback on every report.

Peer-Led Team Learning
In *peer-led team learning* (PLTL), lectures are supplemented by weekly 2-hour *workshops* in whichstudents work in six- to eight-person groups to solve structured problems under theguidance of trainedpeer leaders. The problems must be challenging and directly related to the course tests and otherassessment measures. The course professor creates problems and instructional materials, assists with thetraining and supervision of peer leaders, and reviews progress of the workshops. The materials promptstudents to consider ideas, confront misconceptions, and apply what they know to the solution process.

The peer leaders clarify goals, facilitate engagement of the students with the materials and one another,and provide encouragement, but do not lecture or provide answers and solutions.

Discussion
A good give-and-take discussion can produce unmatched learning experiences as students articulate their ideas, respond to their classmates' points, and develop skills in evaluating the evidence of their own and others' positions."

- **Think-pair-share**: As probably the best known cooperative learning exercise, the think-pair-share structure provides students with the opportunity to reflect on the question posed and then practice sharing and receiving potential solutions. Its simplicity provides instructors with an easy entry into cooperative learning and it is readily adaptable to a wide range of course constructs.
- **Three-step interview**: This structure can be used both as an ice-breaker which introducesstudents to one another and to provide students with a venue for soliciting opinions,ositions, or ideas from their peers. Students are first paired and take turns interviewing each other using a series of questions provided by the instructor. Pairs then match up and students introduce their original partner. At the end of the exercise, all four students have had their position or viewpoints on an issue heard, digested, and described by their peers.

Reciprocal teaching
Slavin (1996), in a review of hundreds of studies, concluded that "students who give each other elaborated explanations (and less consistently, those who receive such explanations) are the students who learn most in cooperative learning."

- **Note-taking pairs**: Poor note-taking leads to poor performance. Designing an exercise which requires students to summarize their understanding of a concept based on notes taken (with directed questions such as what is the definition of a concept, how is it used, what are the three most important characteristics of a topic) and receiving reflective feedback from their partner provides students the opportunity to find critical gaps in their written records.
- **Jigsaw**: For more complex problems, this structure provides students the opportunity to develop expertise in one of many components of a problem by first participating in a group solely focused on a single component. In the second stage of the exercise, groupsare reformed with a representative from each expert group who together now have sufficient expertise to tackle the whole problem.

Graphic organizers

"Graphic organizers are powerful tools for converting complex information in to meaningful displays...They can provide a framework for gathering and sorting ideas for discussion, writing, and research."

Group grid: Students practice organizing and classifying information in a table. A more complex version of this structure requires students to first identify the classification scheme that will be used.

- **Sequence chains**: The goal of this exercise is to provide a visual representation of a series of events, actions, roles, or decisions. Students can be provided with the items to be organized or asked to first generate these based on a predetermined end goal. This structure can be made more complex by having students also identify and describe the links between each of the sequenced components.

Writing

The Writing across the Curriculum Clearinghouse at Colorado State University encourages the use of written assignments across the campus because is teaches students to communicate information, to clarify thinking and to learn new concepts and information.

- **Dyadic essays**: Students prepare for the in-class portion of this exercise by developing an essay question and model answer based on assigned reading. Students typically need to be guided to develop questions that integrate material across classes as opposed to ones that simply recite facts presented in the reading. In class, students exchange essay questions and write a spontaneous answer essay. Students then pair up, compare and contrast the model answer and the spontaneously generated answer. Subsequently, questions and answers can be shared with the larger class.
- **Peer editing**: As opposed to the editing process that often appears only at the final stage of a paper, peer editing pairs up students at the idea generation stage and peers provide feedback throughout the process. For example, the relationship begins as each student in the pair describes their topic ideas and outlines the structure of their work while their partner asks questions, and develops an outline based on what is described.

Problem solving

Research by mathematics educators Vidakovic (1997) and Vidakovic and Martin (2004) shows that groups are able to solve problems more accurately than individuals working alone.

- **Send-a-problem**: Students participate in a series of problem solving rounds, contributing their independently generated solution to those that have been developed by other groups. After a number of rounds, students are asked to review the solutions developed by their peers, evaluate the answers and develop a final solution. (Example: Understanding the Impact of (Fiscal and Monetary) Policy)
- **Three-stay, one-stray**: Even students working in groups can benefit from the feedback of additional peers. In this structure, students periodically take a break from their work (often at key decision making points) and send one group member to another group to describe their progress. The role of the group is to gain information and alternative perspectives by listening and sharing. The number of times the group sends a representative to another group depends on the level of complexity of the problem. This method can also be used to report out final solutions.

Implementing Cooperative Learning

The benefits of using cooperative learning are well supported by theory and well established by classroomresearch, but the method is not without its problems, most of which have to do with individual studentresistance and dysfunctional teams. Many techniques have been developed that minimize the problems,most of which involve addressing one or more of the five criteria for cooperative learning.

Forming teams

Instructors should form teams rather than permitting students to choose their own teammates. Whenstudents self-select into teams, the best students tend to cluster, leaving the weak ones to shift forthemselves, and friends cluster, leaving some students out of groups and excluding others from cliqueswithin groups. Moreover, when graduates go to work in industry or business, they will be required towork in teams and will have no voice in the team formation, and their job performance evaluation willdepend as much on their ability to work with their teammates as on their technical skills. Since that'swhat they'll be doing then, the job of their instructors is to prepare them for it now.

The following criteria are recommended for team formation:

1. *Form teams of* 3–4 *students for most tasks.* When students work in pairs, the diversity of ideasand approaches that leads to many of the benefits of cooperative learning may be lacking. Inteams of five or more, some students are likely to be inactive unless the tasks have distinct andwell-defined roles for each team member.
2. *Make the teams heterogeneous in ability level.* The unfairness of forming a group with only weakstudents is obvious, but groups with only strong students are equally undesirable. The members ofsuch teams are likely to divide up the homework and communicate only cursorily with oneanother, avoiding the interactions that lead to most of the proven benefits of cooperative learning.

In heterogeneous groups, the weaker students gain from seeing how better students approachproblems, and the stronger students gain a deeper understanding of the subject by teaching it to others.

3. If the assignments require work being done outside class, form teams whose members havecommon blocks of time to meet during the week.
4. When students in a particular demographic category are historically at risk for dropping out,don't isolate members of that category in a team. Students belonging to at-risk populations arealso at risk for being marginalized or adopting passive roles when they are isolated in teams.

Promoting positive interdependence

• *Assign different roles to team members (e.g. coordinator, recorder, checker, group processmonitor), rotating the roles periodically or for each assignment.* The coordinator reminds teammem-

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bers of when and where they should meet and keeps everyone on task during team meetings;the recorder prepares the final solution to be turned in; the checker double-checks the solutionbefore it is handed in and makes sure the assignment is turned in on time.; and the monitor checksto be sure everyone understands the solutions and the strategies used to get them. In teams ofthree, the coordinator may also assume the duties of the monitor.

- *Use Jigsaw to set up specialized expertise within each team.*
- *Give a bonus on tests (typically 2–3 points) to all members of teams with average test gradesabove (say) 80%.* The bonus should not be tied to each person on the team getting a certain grade,which would put too much pressure on weaker members of the team and make it impossible forteams with one very weak student to ever get the bonus. Linking the bonus to the team averagegrade gives all team members an incentive to get the highest grade they can and motivates thestronger students to tutor their teammates.
- *If an oral report is part of the team project, a short time before the report is given the instructorarbitrarily designates which team member should report on each part of the project.* Normallydifferent team members take primary responsibility for different parts of the project and report onthose parts, making it unnecessary for their teammates to understand what they did. When theproposed technique (which should be announced when the project is first assigned) is adopted,each student must make sure everyone on the team can report on what he or she did. This methodprovides both positive interdependence and individual accountability.

Providing individual accountability

- *Give individual tests that cover all of the material on the team assignments and projects.* Testsare frequently not given in traditional project-based courses such as laboratories and capstoneresearch or design courses. Even if the tests only count for a relatively small portion of the coursegrade, their presence works against the familiar phenomenon of some team members doing littleor none of the work and getting the same high course grades as their more responsible teammates.
- *In lecture courses (as opposed to project-based courses), include group homework grades in thedetermination of the final course grade only when a student has a passing average on theindividual exams.* This policy—which should be announced in writing on the first day of class—is particularly important in required courses that are prerequisites for other courses in the corecurriculum.
- *Make someone on the team (the process monitor) responsible for ensuring that everyoneunderstands everything in the report or assignment that the team hands in.* The monitor shouldalso make sure everyone participates in the team deliberations and that all ideas and questions areheard.
- *Make teams responsible for seeing that non-contributors don't get credit.* A policy that onlycontributors' names should go on assignments and reports should be announced at the beginningof the course, and reminders of the policy should be given to students complaining abouthitchhikers on their teams. Most students are inclined to cut their teammates some slack initially,but if the the hitchhikers continue to miss meetings or fail to do what they were supposed to do,eventually the responsible team members get tired of being exploited and begin to implement thispolicy.
- *Use peer ratings to make individual adjustments to team assignment grades.* In a fairly simple buteffective peer rating system, students rate one another on specified criteria for good teamcitizenship and the ratings are used to compute individual multipliers of the team grade that mayrange from 1.05 to 0. An on-line system currently under development called CATME(Comprehensive Assessment of Team Member Effectiveness] computes a similar adjustmentfactor but also provides detailed feedback to team members on the skills and attitudes they needto work on and alerts the instructor to the existence of problematic situations. The ratingsshould be based primarily on responsible team behavior and not the percentages of the total effortcontributed by each team member. Schemes of the latter sort move instruction away from thecooperative model toward individual competition, with a consequent loss in the learning benefitsand skill development that cooperative learning promotes.
- *Provide last resort options of firing and quitting.* When a team has an uncooperative member andeverything else has been tried and failed, the other team members may notify the hitchhiker inwriting that he/she will be fired if cooperation is not forthcoming, sending a copy of the memo tothe instructor. If there is no improvement after a week or if there is and the behavior laterresumes, they may send a second memo (copy to the instructor) that he/she is no longer with theteam. The fired student should meet with the instructor to discuss options. Similarly, studentswho are consistently doing all the work for their team may issue a warning memo that they willquit unless they start getting cooperation, and a second memo announcing their resignation fromthe team if the cooperation is not forthcoming. Students who get fired or quit must find a team ofthree willing to accept them; otherwise they get zeroes for the remaining assignments.

Help students develop teamwork skills

- *Establish team policies and expectations.* As part of the first assignment, have teams generate andsign a list of policies and expectations
- *Provide for periodic self-assessment of team functioning.* Every 2–4 weeks, have teams respondin writing to questions such as:

How well are we meeting our goals and expectations?
What are we doing well?
What needs improvement?
What (if anything) will we do differently next time?

- *Give students tools for managing conflict.* Caution them that dealing with conflicts quickly andrationally can avoid later serious problems that are almost certain to arise if they attempt to ignorethe conflicts. Introduce them to *active listening*:

  – Students on one side of a dispute make their case without interruptions, then students on theother side have to repeat it to the initial group's satisfaction,
  – The second side then makes its case uninterrupted, and the first side has to repeat it to thesecond side's satisfaction.
  – The students then work out a solution. Once the students have articulated their opponents'cases, the solution frequently comes very easily.

The instructor should facilitate active listening sessions for groups in conflict, mainly makingsure the rules of the procedure are followed.

- *Use crisis clinics to equip students to deal with difficult team members.* Two to three weeks aftergroup work has begun, you will start hearing complaints about certain problematic teammembers, such as hitchhikers or dominant students who insist on doing the problems their wayand discount everyone else's opinions. Use these characters as bases for ten-minute *crisis clinics*in class, in which the students brainstorm and then prioritize possible group responses to specifiedoffending behaviors. At the end of this exercise, the teams leave armed with severalexcellent strategies for dealing with the problem, and the problem students in the class

are onnotice that their team members are likely to be ready for them in the future, which may inducethem to change their ways.

Conclusion

Cooperative learning refers to work done by student teams producing a product of some sort (such as aset of problem solutions, a laboratory or project report, or the design of a product or a process), underconditions that satisfy five criteria: (1) positive interdependence, (2) individual accountability, (3) face-to-faceinteraction for at least part of the work, (4) appropriate use of interpersonal skills, and (5) regularself-assessment of team functioning. Extensive research has shown that relative to traditional individualand competitive modes of instruction, properly implemented cooperative learning leads to greaterlearning and superior development of communication and teamwork skills (e.g. leadership, projectmanagement, and conflict resolution skills). The technique has been used with considerable success in allscientific disciplines, including chemistry.

The benefits of cooperative learning are not automatic, however, and if imperfectly implemented, themethod can create considerable difficulties for instructors, most notably dysfunctional teams and studentresistance or hostility to group work. This paper offers a number of suggestions for forming teams,satisfying the five defining criteria of cooperative learning, and minimizing the problems. Instructors whohave never used the approach are advised to move into it gradually rather than attempting a fullscaleimplementation on their first try, and to increase the level of implementation in subsequent courseofferings. To an increasing extent, they should see the learning benefits promised by the research, and astheir expertise and confidence in implementing the method continue to grow, student evaluations of theteam experience should improve concurrently. Most importantly, instructors who are successful in usingcooperative learning in their classes will have the satisfaction of knowing that they have significantlyhelped prepare their students for their professional careers.

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