

---

## **AC 2012-4400: EVALUATION OF COOPERATIVE LEARNING ASSIGNMENTS AS A SUPPLEMENT TO HOMEWORK TO IMPROVE STUDENT LEARNING**

### **Dr. Craig A. Chin, Southern Polytechnic State University**

Craig A. Chin received his Ph.D. in electrical engineering from Florida International University in 2006. He is currently an Assistant Professor in the electrical and computer engineering technology at Southern Polytechnic State University. His research interests include biomedical signal processing, pattern recognition, and active learning techniques applied to engineering education.

### **Dr. Garth V. Crosby, Southern Illinois University, Carbonale**

Garth V. Crosby is an Assistant Professor in the Department of Technology at Southern Illinois University, Carbondale (SIUC). He is also an Adjunct Professor in the Department of Electrical & Computer Engineering. Crosby received his B.S. degree in electronics from the University of the West Indies, Mona, Jamaica. He obtained his M.S. and Ph.D. degrees from Florida International University in computer engineering and electrical engineering, respectively. Crosby's overall research purpose is to create secure and trusted solutions for emerging and future networks and systems. These include wireless sensor networks, wireless body area networks, cyberphysical systems, and cloud infrastructures. He also is active in researching strategies in active learning to advance engineering education. He has served as a reviewer for several conferences and journals publications, including IEEE INFOCOM, IEEE Transactions on Systems, Man and Cybernetics: Part C, and Elsevier's Ad Hoc Network Journal. He has also served as a National Science Foundation (NSF) reviewer. He is a Senior Member of IEEE, the National Society of Black Engineers (NSBE), and Eta Kappa Nu.

# **Evaluation of Cooperative Learning Assignments as a Supplement to Homework to Improve Student Learning**

## **Abstract**

Homework is an indispensable tool for a college instructor, because it enables greater coverage of course content by placing the responsibility for learning to be done outside the classroom. However, it may not be the most effective method for learning essential problem-solving skills. We propose a method that will utilize cooperative learning assignments as a supplement to the instructor-led example and individual homework paradigm. Our intent is to produce an improvement in the problem-solving skills of the students and their academic achievement on a whole.

Cooperative learning is an instructional approach in which students work in groups on a learning task. The five essential elements required for implementing a cooperative learning technique in a classroom are positive interdependence, individual accountability, face-to-face promotive interaction, appropriate use of interpersonal and teamwork skills, and regular self assessment of team functioning. The cooperative learning assignments will include the elements listed previously and will be compared to individual, graded homework assignments in terms of its effectiveness in improving student learning. This method was utilized for a class in an electrical engineering technology program. The method of evaluation used to ascertain the effectiveness of each strategy was a student-evaluation questionnaire. The results of the questionnaire show that our proposed method was effective in increasing student understanding of the learning objectives assigned for a lesson. Based on this preliminary study, it proposed that this methodology be implemented for an entire semester and have student grades compared statistically with a control group which is only exposed to the standard instructor-led example and individual homework scenario.

## **Introduction**

For most college courses, it is a pragmatic reality that a significant portion, if not the majority, of student learning must occur outside of the classroom in order for an instructor to cover the extensive content of these courses. Homework is an essential tool for promoting this outside-the-class learning process. In addition to this, homework provides an opportunity for a student to develop problem-solving skills, which are essential in engineering and technology courses of study.

A typical method for teaching key problem-solving skills in an engineering course is to have representative examples presented to the class by an instructor and have the class follow the procedures for solving these problems. Homework will then be assigned, where the problems given may be categorized as follows: i) problems that are either very similar to those presented in class, enabling the mastery of procedures taught in class and ii) problems that vary significantly from the class examples, requiring students to extrapolate upon the procedures presented in class.

This method has two disadvantages: i) the use of instructor-led problem-solving sessions is not the most effective method for actively engaging students in the learning process and ii)

individual homework assignments do not provide a readily available means of assistance if a student gets stuck during a solution process nor do they allow for expeditious corrective feedback if the student makes an error.

It has been our experience, as professors in electrical engineering technology, that homework assignments often go undone or are improperly done whether these assignments are made to count towards an individual grade or not. The inability or unwillingness of students to complete homework assignments in a thorough fashion results in this method producing little in the way of improvement of the students' understanding of the course content, which manifests itself as lower grades received on their various forms of assessment.

Cooperative learning is an instructional approach in which students work together in groups on a learning task (e.g. assignment, project or laboratory) that is structured to have the following essential elements<sup>1,2</sup>:

1. *Positive interdependence.* This refers to the need to have every team member involved in achieving the group task. This is implicitly encouraged, because if any group member fails to do their part, the whole group suffers the consequences.
2. *Individual accountability.* Each member will be held responsible for completing his/her contribution to accomplishing the group task and understanding the contributions of the other members.
3. *Face-to-face promotive interaction.* Although some of the group work may be distributed among group members to be done individually, there must be some work that has to be done interactively, with members providing one another with questions, feedback, and instruction.
4. *Appropriate use of interpersonal and teamwork skills.* In accomplishing the group task, students will be encouraged to develop leadership, decision-making, communication, conflict resolution, and time management skills.
5. *Regular self assessment of team functioning.* Teams should be required to periodically assess what they are doing well together and what areas require improvement.

Empirical evidence has shown that cooperative learning results in higher individual achievement when compared to competitive or individualistic methods<sup>3</sup>. Furthermore, empirical evidence also supports that various forms of small-group learning are effective in promoting greater academic achievement, more favorable attitudes toward learning, and increased persistence in science, mathematics, engineering and technology courses and programs<sup>4</sup>. There are three likely reasons for cooperative learning working so well. Firstly, cooperative learning is an active learning method, and it has been accepted by cognitive psychologists that individuals learn more by doing than by watching and listening<sup>5</sup>. Secondly, weak students have a readily available resource for assistance (other group members) if they get stuck, or if they begin to follow an erroneous path to a solution. Thirdly, strong students will often discover and fill in gaps in their own knowledge as they clarify and explain to their weaker group members.

In summary, homework is an indispensable tool for a college instructor, because it enables greater coverage of course content by placing the responsibility for learning to be done outside the classroom. However, it may not be the most effective method for learning essential problem-solving skills. Our proposed method will utilize cooperative learning assignments as a

supplement to the instructor-led example and individual homework paradigm. Our intent is to produce an improvement in the problem-solving skills of the students and their academic achievement on a whole.

The remainder of the paper will provide the implementation details of our method, describe how the method was evaluated, present the evaluation results, infer from the results what worked well, and chart a course for improvements for future implementations of the method.

## **Method**

### *Implementation Details*

The cooperative assignment method was first implemented in a data communications class in an electrical engineering technology program. The class size was 29 students and consisted of a mixture of juniors and seniors.

Cooperative assignments were given after the completion of each chapter with the intent of giving each student a more thorough understanding of salient concepts taught in that chapter. The time allotted for each group assignment was 20 minutes and was given at the end of a class period. Once the 20 minutes had expired, each group would submit a single report. The answers for assignment were posted online after the corresponding class period for student review. Each group assignment was graded, and counted towards 10% of a students' final grade. Individual homework was also assigned on a per chapter basis, but was not graded.

The group size was set at three members, though one group had only two members. Group members were assigned on a random basis by the professor and remained intact for the entire semester. Each group member was assigned one of three roles (solver, recorder, checker), with roles rotating with each successive assignment. The responsibilities associated with each role are as follows:

#### *1. Solver*

- This member is responsible for performing the calculations recommended by group members for the solution of each question.
- He/she will report the results of each calculation to the recorder

#### *2. Recorder*

- This member is responsible for recording the solution for each question in an assignment.
- He/she must ensure that the solution is legible, neat, and show the salient steps in obtaining the final answer.

#### *3. Checker/Manager*

- The checker's responsibility is to review each solution completed by the recorder and solver to ensure its correctness.
- The checker is also responsible for ensuring efficient communication between group members and that the assignment is completed on time.

The correspondence between implementation components and cooperative learning elements are presented in Table 1.

**Table 1 – Correspondence between Cooperative Learning Elements and Implementation Components**

<b>Cooperative Learning Element</b>	<b>Implementation Component</b>
Positive interdependence	Group assignments count toward individual grade, Assignment of specific group roles
Individual accountability	Tests and quizzes are based in part on the content of the cooperative assignments
Face-to-face promotive interaction	Assignment of specific group roles, and limiting group size to three members
Appropriate use of interpersonal and teamwork skills	Keeping the teams intact for the entire semester
Regular self assessment of team functioning	Not addressed

In order to allow students to compare the cooperative learning method to the traditional method of instructor-led examples and individual homework, two chapters during the semester were reviewed using the traditional method. Specifically, individual homework assignments were assigned for each of these two chapters. The assignments were graded and additional homework review questions were also posted.

#### *Evaluation Method*

The effectiveness of the cooperative learning method was evaluated by a questionnaire that sought to capture student views on the following topics:

- i. Effectiveness of cooperative assignments in promoting learning
- ii. Effectiveness of the implementation of cooperative assignments
- iii. Group assignments as a tool for developing interpersonal and teamwork skills
- iv. Comparison of individual homework assignments and group assignments

Two categories of questions were used to ascertain student views: Likert-Scale and open-ended questions. The Likert-Scale questions allowed students to indicate their agreement or disagreement to a statement by selecting one of five numbers on a scale of 1 – 5. The scale values correspond to an individual’s level of agreement or disagreement according to: 1 represents strongly disagree, 2 represents disagree, 3 represents neutral, 4 represents agree, and 5 represents strongly agree.

#### **Results**

There were 25 respondents to the questionnaire. The results of responses to the Likert-Scale questions are summarized by calculating the average of scale values for each question. These results are presented in Tables 2 – 5.

**Table 2 – Average Scale Values for Effectiveness of Cooperative Assignments in Promoting Learning Questions**

Statement	Average Scale Value
The chapter review group assignments have increased my understanding of the learning objectives assigned for each chapter.	4.1

**Table 3 - Average Scale Values for Effectiveness of the Implementation of Cooperative Assignments Questions**

Statement	Average Scale Value
The appointment of specific group roles enabled the group to accomplish the exercises more effectively.	3.5
The rotation of group roles enabled me to have a deeper learning of the course content.	3.2
Enough class time was allocated to accomplish the group assignments.	2.2
Requiring a group assignment after each chapter is the appropriate frequency for learning effectively.	3.8
Group assignments should be held more frequently.	2.8
Group assignments should be held less frequently.	2.8

**Table 4 - Average Scale Values for Group Assignments as a Tool for Developing Interpersonal and Teamwork Skills Questions**

Statement	Average Scale Value
The group chapter review assignments required that I demonstrate my ability to function effectively in teams.	4
The group chapter review assignments required that I demonstrate my ability to communicate effectively.	4.2
The group chapter review assignments required that I demonstrate a respect for diversity.	4.3
The group chapter review assignments required that I demonstrate a commitment to quality of work and timeliness.	3.7

**Table 5 - Average Scale Values for Comparison of Individual Homework Assignments and Group Assignments**

Statement	Average Scale Value
The chapter review group assignments were more effective than individual homework assignments in increasing my understanding of the learning objectives assigned for each chapter.	3.3

One of the key points that the student responses to the open-ended questions revealed was that students found cooperative assignments to be effective in helping them understand the learning objectives of each chapter. The primary reasons given were that the assignments allowed them to discuss potential solutions, they were able to solve questions together, and they were able to receive help from other group members in solving the questions. The main problem students had with the current implementation of this cooperative learning method was that they often found

that the time available to them to complete these group assignments was less than they desired. In this regard, they felt that individual homework assignments were more effective than cooperative learning assignments, because these assignments allowed them to learn at their own pace.

## **Discussion**

An examination of Table 2 indicates that the majority of students found the cooperative learning method to be effective in helping them understand the learning objectives assigned for each chapter. Table 3 makes clear that there is a need for improvement in the manner in which this method is implemented. In particular, there needs to be a better compromise between the scope of an assignment and the amount of time allocated to complete it. An important benefit of cooperative assignments brought out by Table 4, is that they are an effective method for helping the students to develop interpersonal and teamwork skills. This aspect is especially important when one considers that most engineering work environments require work to be done cooperatively, requiring interpersonal, as well as, technical skills. Therefore, these assignments will directly prepare students for the demands of a real work environment. Table 5 shows that student views are essentially neutral as to whether cooperative assignments were more effective than individual homework assignments in increasing their understanding of the learning objectives. This may be because each method has its strengths and weaknesses. Cooperative assignments may be a more effective method of learning, due to the reasons previously posited, but because learning must be constrained to limits of class time, some students may feel that they are being rushed into learning at a faster pace than they are comfortable with. In addition to this, it is impossible to cover the entire content of a course using in-class cooperative assignments. This further reinforces the point that individual homework is still a necessity.

As we consider future implementations of this method, the following improvements are recommended:

- i. Rationalization of the questions posed in cooperative assignments so that they only focus on the most important lesson objectives. Any questions that are removed during this rationalization process should be assigned as individual homework. This should ensure that the pace of learning during cooperative assignments is manageable to a larger proportion of the class population, and the most effective learning method is targeted to the key learning objectives of the course.
- ii. A component needs to be added to enable regular self assessment of team functioning. An example of this would be to periodically provide group members with a survey that would require them to assess how well the group is functioning and suggest methods for improvement.
- iii. A statistical comparison between this method and the instructor-led example and individual homework method must be performed. Both methods will be utilized for an entire semester on two different sections of the same course and the student grades will be analyzed statistically. This should provide a more objective means for determining if this method enables an improvement in academic achievement.

## References

1. R. M. Felder, D. R. Woods, J.E. Stice, Armando Rugarcia, "The Future of Engineering Education: II Teaching Methods that Work," *Chemical Engineering Education*, vol. 34, no. 1, 2000, pp. 26–39.
2. R.M. Felder and R. Brent, "Cooperative Learning," Chapter 4 of P.A. Mabrouk, ed., *Active Learning: Models from the Analytical Sciences*, ACS Symposium Series 970. Washington, DC: American Chemical Society, 2007, pp. 34-53.
3. D. W. Johnson, R. T. Johnson,, and M.B. Stanne., "Cooperative Learning Methods: A Meta-Analysis," *Methods*, vol. 1, 2000, pp. 1-33.
4. L. Springer, M E. Stanne, and S. Donovan, "Effects of Small-Group Learning on Undergraduates in Science, Mathematics, Engineering, and Technology: A Meta-Analysis", *Review of Educational Research*, vol. 69, no. 1, 1999, pp. 21-51.
5. "How People Learn: Brain, Mind, Experience, and School," 2<sup>nd</sup> ed., J. Bransford, A. L. Brown, R. R. Cocking, Eds. Washington, DC: National Academies Press, 2000.