

## Cooperative Learning Strategies for Large Classes

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### ABSTRACT

The last decade has brought increasing budget pressures on higher education systems. At many institutions, this has led to an increase in the number and size of large classes, which is generally not favored by students, parents, and faculty. However, at institutions, where large classes are a fact of life we are professionally obligated to focus on instructor and student needs and do whatever we can to improve teaching and learning in those classes.

The results of a national survey, conducted to determine how many institutions offer large engineering classes, indicate that 47% offer large size classes. It is also estimated that 76% of the engineering students attend at least one large class. Most of the large classes are offered at an introductory level and during the first two years of curriculum. The research shows that the student attrition rate is higher during their first two years. However, the research also indicates that effectively taught large classes are perceived better by students than some of the small size classes.

This paper describes several cooperative learning strategies which have been researched, tested, and proven to be effective in large classes. The strategies help in increasing class participation, problem solving, critical thinking, communication, collaborative learning, attention, and attendance. Over 80 to 90 percent of the students indicate that these strategies are useful in enhancing the teaching-learning process in large classes.

### I. INTRODUCTION

Cooperative learning involves students working in groups on problems or projects such that it fosters positive interdependence, individual accountability, leadership, decision making, communication, and conflict management skills [1]. Research indicates that cooperative learning also enhances short-term mastery, long-term retention, understanding of course material, critical thinking, and problem solving skills [2]. Recent literature [1-3] suggests a number of cooperative learning strategies, however, many of these strategies may not be as effective or practical in large classes because of the larger number of students. Teaching a large class itself is challenging. Introducing cooperative learning strategies in large classes is even more challenging. Felder [4] has described some innovative techniques including cooperative learning strategies for effectively teaching large classes. This paper describes some other cooperative learning strategies that were used in large Statics classes and provides results of student feedback on those strategies.

The second section describes the results of a nation-wide survey on large class offerings in engineering education. The third section describes cooperative learning strategies that were used inside or outside of a classroom. The results and conclusions are given in the fourth and fifth sections, respectively.

## **II. LARGE CLASS OFFERINGS IN ENGINEERING EDUCATION**

A nation-wide survey was conducted to determine the prevalence of large class offerings in engineering education. The survey polled the American Society for Engineering Education (ASEE) campus representatives to determine large engineering class offerings on their respective campuses. Campus representatives from seventy institutions responded to the survey. While the definition of a large class varies, 75 students was set as the threshold for a large class.

Responses indicated that 47% of the responding institutions offer one or more engineering classes with 75 or more students. The class sizes ranged from 75 to 400 with an average of 147 students. The largest class size in the other 53% of schools ranged from 18 to 70 with an average of 42. While only 47% of the institutions offer large engineering classes ( $n > 75$ ), the percentage of total students who attend such classes is much larger. Based on survey data, over three-fourths of students at reporting institutions attend large classes. Also, most of these large classes are offered in engineering science courses like statics, dynamics, introduction to electrical engineering, thermodynamics, introduction to material science, engineering economy, and evaluation of engineering data (statistics).

This survey indicates that a majority of undergraduate engineering students attend large classes. Thus, improving the teaching-learning process in these large classes would have a significant effect on engineering education. Recent studies[5,6] have confirmed that attrition rate among engineering students is higher during their initial years in college. Hence, improving large first and second year classes has potential for increasing engineering students' retention rates.

## **III. COOPERATIVE LEARNING STRATEGIES**

Cooperative learning, as indicated earlier, involves group work. Groups may be organized along informal or formal lines. Wankat and Oreovicz [3] define that, "Informal cooperative learning groups are formed on the spur of the moment for a particular short term task and then dissolved. Such groups are useful in the middle of a lecture, to assign students a task such as solving a problem, answering a complicated question, or developing a question for the professor. Engendering a more cooperative class atmosphere, these groups serve as a break when the students' attention falters, and gives them a chance to practice team work. For the instructor, informal groups are a good way to start experimenting with cooperative learning." One such informal group activity which can be done in a large class is described next.

After discussing a concept for about 15 to 20 minutes in a class, a multiple choice question is displayed using an overhead projector. Students discuss an answer to the question

in an informal setting with neighboring students. The voice level during this one or two minute period goes up, reflecting the level of interaction and collaboration going on in the classroom. At the end of this period, all students are requested to raise a flashcard displaying a letter corresponding to an answer to the multiple choice question. The flashcard method allows active learning, collaborative learning, and 100% participation in large classes. It also allows students to assess how much they have understood and gives an instant assessment to the instructor about student understanding of the concepts just discussed. The multiple choice questions can be easily formulated to test knowledge and comprehension aspects of student learning as defined by Bloom's Taxonomy [7]. The taxonomy (knowledge, comprehension, application, analysis, synthesis, and evaluation) provides a useful structure in which to categorize questions. A useful handbook on designing and managing multiple choice questions at all levels of the taxonomy was developed at the University of Cape Town, South Africa, and can be accessed over the world wide web [8]. Additional details on the basic flashcard method, without group activities, are given in reference [9].

After two years of experience with informal group activities, formal group activities were introduced in the Fall 1997 semester in a large Statics class. At the beginning of the semester, students were requested to provide their cumulative GPA, their grade in the calculus I (prerequisite) class, the number of hours they work per week on paid jobs, the number of course credits they have registered for, etc. A composite index was determined based on the above information and was used to divide the class into three categories: top, middle, and bottom. Every student was given a letter code (x, y, or z) depending upon the category they belonged to. The students were not informed as to what the letter code represented or how the group codes were determined. This was done so that students do not feel either superior or inferior. In one of the class periods, in the last five minutes, students were asked to gather in 3 corners of the room depending on their codes and groups of three students were formed by randomly selecting one student from each corner. This in itself proved to be a fun activity in the large class.

The students were assigned four group projects during the semester. Assigning three to four projects in a semester is ideal. Assigning more projects makes it difficult for students to meet often, as their schedules are usually full with several activities. The projects were chosen so they can get acquainted with each other, recognize and appreciate their strengths and weaknesses in different areas, develop positive interdependence, collaborate to achieve a common goal, learn from each other, and also have fun. The four projects were a) shooting basketball from a free throw line and determining their percentage success rate; b) finding their learning styles and discussing similarities and differences in their learning styles; c) generating a creative item like a joke, cartoon, or poetry, and coming to a consensus about which is the best item from their group, and d) designing an optimum roof truss.

The formal groups were encouraged to study together and prepare for examinations. The group members also took collaborative quizzes in the class. During such a quiz the group members discussed how to solve a given quiz problem in the first three to four minutes. At that time no writing was permitted. This activity greatly enhances their capabilities in problem solving, critical thinking, teamwork, and communication skills. In the next 15 minutes, they solved the quiz problem individually, just as in a regular quiz.

## IV. RESULTS

The students in the large Statics class were asked for their opinion on integrating soft skills like cooperative learning (teamwork), active learning, problem solving, and critical thinking, in all their courses. The results are shown in Table I. They indicate that between 85 to 97 percent of the students believe that the integration of soft skills into their courses are either very important or important. The students considered problem solving (97%) and critical thinking (95%) skills to be of most importance.

**TABLE I**  
**Importance of Integrating Soft Skills in Academic Courses**

What is your opinion on integrating the following soft skills in your courses?

Scale: A) Very Important      B) Important      C) Neutral  
        D) Not Important        E) Not Important at all

Soft Skills	Percentage Responses*				
	A	B	C	D	E
Cooperative Learning (teamwork)	39	46	15	-	-
Active Learning	40	51	8	1	-
Problem Solving	57	40	2	1	-
Critical Thinking	59	36	4	1	-

\* **Number of responses = 95**  
**Student Enrollment = 101**

The students were then asked to rate the specific activities (done in the Statics class) regarding their usefulness in either learning the subject matter or fostering soft skills. The results, given in Table 2, show that informal group discussions inside a classroom were perceived to be very useful or useful by 84% of the students. On the other hand, formal group projects done outside the classroom were perceived to be very useful or useful by only 62% of the students. Among the four specific projects, basketball shooting and creative exercises were perceived to be very useful or useful by only 42 and 47 percent of the students, respectively. The optimal design of the roof truss was perceived to be very useful or useful by 90 percent of the students.

**TABLE 2**  
**Usefulness of Specific Strategies**

Please rate the following strategies in terms of learning the subject matter or fostering soft skills.

Scale: A) Very Useful B) Useful C) Neutral  
D) Not Useful E) Not Useful At All

Strategies	Percentage Response*				
	A	B	C	D	E
Informal in-class group activities	42	42	15	1	-
Basketball Shooting	3	39	28	11	8
Creative Exercise	11	36	28	18	7
Learning Style Exercise	9	53	23	12	3
Roof Truss Design	54	36	7	2	1
Overall, formal group projects	11	52	26	12	-
Group Discussion Before the Quizzes	75	23	2	-	-

\* **Number of response = 95**  
**Student enrollment = 101**

The group discussion by the formal group members before the quizzes was perceived to be very useful or useful by 98 percent of the students. This particular result is amazing, it does not require any additional effort by an instructor, and it fosters problem solving, critical thinking, collaborative learning, and communication skills. The collaborative quizzes still show variations, suggesting that the individuals who understood the subject matter do better than others who are ill prepared. The preliminary comparison of collaborative quizzes and regular quizzes indicate that the average scores ( $\bar{X} = 7.80$ ,  $s = 2.01$ ,  $n = 595$ ) in the collaborative quizzes is slightly higher (statistically insignificant at the 0.05 level) compared to the average score in the regular quizzes ( $\bar{X} = 7.74$ ,  $s = 2.41$ ,  $n = 609$ ). However, not everyone is receiving high scores. This does show accountability in terms of individual's understanding of the subject and preparedness. More detailed analysis is being done to see the effect of collaborative quizzes on the top, middle, or bottom thirds of the class.

## V. CONCLUSIONS

A nation-wide survey indicates that large classes are prevalent in engineering education. However, the good news is that large classes can be made more effective by implementing suitable strategies. This paper describes formal and informal group activities to foster soft skills like problem solving, critical thinking, cooperative learning, and communication. The Accredited Board for Engineering and Technology and Employers also expect these skills in our graduates. The methods described in this paper, especially the flashcard method, a design

project by a group, and collaborative quizzes, do not take a significant amount of instructor time or resources and are effective in large classes.

Several other strategies like daily homework, daily attention quizzes, and quick feedback on the web were also incorporated in this large class [10]. The attendance in the class ranged from 85 to 98 percent which is much higher than the average large class attendance reported in the literature [11]. Students were asked to rate learning in this class compared to learning in other classes on a scale of A) very good to E) very poor. Overall, 97 percent of the students indicated that learning in this class was very good or good compared to learning in other classes.

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## **BIOGRAPHY**

SUDHIR I. MEHTA is a professor of Mechanical Engineering at North Dakota State University. He has 3 years of industrial and 19 years of academic experience in the areas of engineering education research, instrumentation, controls, robotics, design optimization, and machine vision. He has developed 2 CD-ROM's containing hypermedia based instrumentation and communication resource modules. He has also developed innovative techniques for active learning, collaborative learning, and quick assessment. Dr. Mehta received the Carnot Award for the best teacher of the year, four times, from the students of Pi Tau Sigma Society. He was named the 1997 North Dakota Professor of the Year by the Carnegie Foundation. His e-mail address is mehta@badlands.nodak.edu.