AC 2008-1480: PEER ASSESSMENT OF TEAM WORK AND COLLABORATIVE LEARNING IN CONSTRUCTION/CIVIL ENGINEERING

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Peer Assessment of Teamwork and Collaborative Learning in Construction/Civil Engineering

Recently, employers have indicated that they are not totally satisfied with the individualistic approach of the average engineering graduate. This may be due to the fact that in many companies team goals, team contributions, and team rewards often supersede individual actions. The findings of a past study suggest that students have accepted the concepts of collaborative teaching and learning, as well as team projects. In fact, many believe that these concepts develop critical thinking and leadership skills. However, this investigation of the peer assessment process suggests that not all students are doing their share in team work projects. Unfortunately, this is a problem with team assignments that may be difficult to solve. Nevertheless, comments indicate that a course utilizing the concepts of collaborative learning and teamwork was interesting, informative, and could be of assistance to respondents in future endeavors. This paper discusses these concepts.

Introduction

Presently and in the past, engineering faculty often utilized the lecture method for classroom instruction. However, classroom discussion, collaborative learning/teaching, and team experiences are generally thought to be required for the enhancement of critical thinking and leadership skills. Nevertheless, the concept of group learning and especially discussion may, at times, be difficult to initiate, because students have generally competed against each other since the first grade. However, today teamwork is often more important than individual actions in many companies.

This paper reviews the importance of communication skills, the concept of collaborative learning/teaching, and presents the results of an investigation of student peer assessment of team projects. The data for the study were obtained from a survey of students enrolled in civil/construction engineering courses that were taught for a number of years.

Collaborative Learning

Collaborative learning may be described as an intellectual endeavor in which individuals act jointly with others to become knowledgeable of some particular subject matter. Unfortunately, collaboration may sometimes be called cheating. However, upon graduation most individuals become part of an industrial or university team and are required to collaborate with the members of the group. Today, teamwork is especially important to engineering students. A recent paper indicates that there are challenges related to group learning[10]. It was found that "It was more difficult teaching the students how to function effectively as a team than it was teaching them some of the more advanced technical tools." Another study suggests that students indicate only moderate support for group or team work[13].

Table 1. Teaching Methods and Techniques

Student perception of teaching techniques	Mean Value	Standard deviation	Median
Formal lectures	3.2	1.9	3.0
Lecture/discussion/problem solving	1.2	0.6	1.0
Thought-provoking questions and discussion	2.3	1.1	2.0
Opportunity for student input	1.8	0.6	2.0
Challenged by the subject matter	2.0	1.1	2.0
Group Interaction	1.8	0.6	2.0
Working in teams	1.4	0.7	1.0
Exploring alternatives (i.e. brain storming)	2.3	1.3	2.0
Homework assigned, not collected	3.4	2.0	4.0
Homework collected, graded, and returned	3.3	2.3	2.0
Take-home examinations	2.1	1.2	2.0
Field-trips	1.9	1.0	2.0
Outside speakers and/or visual aids	1.6	0.7	1.0
Computer assignments	1.8	1.6	1.0

In this regard, the findings of a recent study, illustrated in Table 1, suggest that students prefer the use of thought-provoking questions and discussion in the classroom[5]. They also appreciate the opportunity for student input, like to be challenged by the subject matter, and enjoy group interaction. In addition, they perceive that working in groups and teams is an excellent experience. They also believe that the development of communication skills will be a benefit for them in their future endeavors. Students, therefore, appear to have accepted that collaborative learning, teamwork, and communication skills are important aspects of the curriculum. Similar findings have also been obtained in other studies [13]. Here, it was determined that students "indicate significant support for report writing" and "very significant support for oral presentations."

Communication Skills

It has been mentioned and mandated that the development of communication skills is important for engineering students[2]. In fact, it has been written that engineers must become involved in broader issues and various nontechnical groups[14].

Recently, numerous actions have been taken to involve students in the teaching and learning process in specific classes. A comprehensive team design project is often required. The teams are composed of three to five students. Typical topics in the past involved the design of temporary facilities needed at a construction site, hazardous waste remediation, and project management. An oral presentation, with discussion and a written team engineering design report, is required. As in past studies, the students have expressed the belief that working in teams is an excellent learning experience.

It is known that the assessment and feedback process is vitally important in the ABET *Engineering Criteria*[3]. In this regard, studies have been conducted involving the students and alumni practitioners of the Civil Engineering Department concerning various ABET criteria that must be satisfied[7,8]. In particular, an investigation of educational attributes suggests strong student and practitioner support for the ability to function on multidisciplinary design teams and the ability to communicate effectively[6].

Collaborative Teaching

In an effort to increase collaborative learning and enhance the communication content of the curriculum, the Civil Engineering Department has offered, for a number of years, an elective course designed to involve students in the teaching and learning process. The course is often assigned a special topic number and usually has the title "Hazardous Waste Management." The class generally consists roughly of the following four grading sections:

1. 30% - lectures on temporary facilities required on a construction site
2. 20% - lectures on general concepts of construction safety
3. 35% - student seminars (oral collaborative teaching and written presentations) on hazardous waste site remediation
4. 15% - comprehensive team design project

The grading is usually based on the following distribution:

- 10% - examination I
- 20% - examination II

- 30% - examination III or final
- 20-25% - seminar (oral collaborative teaching presentation and written report)
- 20-25% - collaborative team design project (oral and written report)

As shown above, roughly 50% of the class time and 40% of a student's grade is based on collaborative teaching and learning experiences.

In the seminar section of the Hazardous Waste Management Course, one or two students are assigned a chapter to present from a hazardous waste, safety, or construction textbook. These collaborative oral teaching presentations are required to be informative, educational, and interesting (i.e. not boring). Handouts, overhead and power point presentations, and examples of personal protective equipment are utilized. An attempt is made to conduct a lengthy discussion of the material under consideration. However, it has been found that the concept of collaborative learning, and especially discussion, can be difficult at times to initiate in engineering students. In addition to the collaborative oral teaching presentation, a written report is required of each student or team.

Peer Assessment

Peer assessment of student work by fellow students may yield results that cannot be utilized for many applications. This is due to the fact that students have a tendency to dislike grading each other. In order to revisit this concept, students enrolled in three different classes--Engineering Project Management, Fall Semester; Seminar, Spring Semester; and Hazardous Waste Management, Summer Session—were requested to be involved in the peer review process. It was emphasized that the peer review grades were not be used to calculate the final class averages.

Unfortunately, no useable data from the Seminar course was obtained. The students rated their peers at roughly the same high values. Nevertheless, one could deduce that they all participated in the oral and written team projects, and there were no slackers. The results from the forty-two (42) students enrolled in the Hazardous Waste Management course were a bit different. Here, seven students were rated by their peers at a low level and, most likely, did not contribute to the team process. As shown in Table 2, the mean class average of low-rated students is 71.81%. This is slightly below the class average of 74.31%. It appears that the low-rated individuals are overall average students. They just did not avail themselves of the opportunity to work as members of a team.

Table 2. Hazardous Waste Management (Students with low peer assessment)

Team work	Student average	Class average
Final Project (Group 1)	72.68	74.31
Final Project (Group 2)	75.06	74.31
Final Project (Group 3)	66.42	74.31
Oral Seminar (Group A)	71.10	74.31
Oral Seminar (Group B)	72.54	74.31
Homework Project (Group I)	71.10	74.31
Homework Project (Group II)	73.74	74.31
Mean	71.81	74.31

Table 3. Engineering Project Management (students with low peer assessment)

Team Work	Student Average	Class Average
Final Project (Group 1)	74.16	74.59
Final Project (Group 2)	79.39	74.59
Final Project (Group 3)	68.78	74.59
Final Project (group 4)	73.41	74.59
Mean	73.94	74.59

The data in Table 3 involving forty-four (44) students enrolled in an Engineering Project Management course show results similar to that in Table 2. Here, four students were rated at a low level in the peer review process involving the team project. Their mean average was 73.94%. This value is roughly the same as the class average of 74.59%. As in the Hazardous Waste Management, the individuals who were rated by their peers in the low range are not poor students. Again, for some reason, they did not avail themselves of the opportunity to work as members of a team.

Numerous companies require references during the hiring process. One question often asked is whether the prospective employee has good team working skills. The data in Tables 2 and 3 suggest that roughly 10-15% of the students do not exhibit an interest for working in teams

in a particular class. This action may inhibit their future work-place experiences if they are hired by a firm that emphasizes team work.

Table 4. University Class Evaluation (Maximum value is 5.0)

Number	Student Question	Value
1	Course helped me achieve its learning objectives	4.71
2	Syllabus was accurate	4.64
3	Assignments aided learning	4.62
4	Stimulated my interest in the subject	4.57
5	The instructor's teaching aids/methods, including technology, helped students learn	4.5
6	Understood the subject matter	4.5
7	Overall, the instructor is a good teacher	4.64
8	Attended class sessions and related, required meetings	4.85
9	Had a strong desire to take this course	4.69
10	What percentage of the time were you prepared for class (i.e. having completed all reading and assignments)	4.64
11	Gives students opportunity to participate in class discussions when appropriate	4.79
12	Treats students fairly	4.71
13	Available outside of class	4.93
14	Tests cover course material	4.64
15	Reasonable assignments	4.64
16	Returns tests/papers in a timely manner	4.93
17	Adequate notice for exams	5.0
18	Makes course interesting	4.71
19	Class length	5.0
20	Fundamental concepts are made clear	4.71
21	Lecture planning	4.57
22	Class attendance worthwhile	4.64
23	Answers questions effectively	4.79

During the fall semester of 2005 & 2006 at Chadron State College, accounting students were required to complete group oral & written reports in several of the upper division courses. Through the required oral reports & subsequent questioning, it became clear that the work load had not been shared equally by the group members. The majority of groups seemed to have students who contributed a bare minimum, if any, work to the project. These groups also contained a member who performed a disproportionate share of the work. Therefore, it appears that the challenges with group projects & learning are not limited to engineering students.

Class Evaluation

In order to evaluate the Hazardous Waste Management course, the university computer evaluation system was utilized during the summer session in 2007. The results are illustrated in Table 4. The ratings are similar to those obtained from approximately 200 students enrolled in the course over a 10-year period. In particular, the findings indicate a generally strong positive relationship between the faculty member and students enrolled in the class. Nevertheless, the functions that student instructors were involved with, such as #5, instructor/student teaching methods; #6, understood the subject matter; and #21, student lecture planning were rated lower than the other items. In contrast, faculty functions, such as #13, available outside of class are highly rated.

Table 5. Course Evaluation Comments

Comment	Student Comment
1	I especially like the team project and oral presentations. The project was very practical but made me think.
2	Hazardous waste-site management was my favorite course during my entire academic career. An oral seminar and written report was assigned to each student. In addition, a computer program and team design project was required. In brief, it covered many things with which an engineer should be involved.
3	This class gave me an understanding of temporary facilities and hazardous waste-site remediation. It also gave me the chance to improve my public speaking skills.
4	I would prefer the department offer more such courses that are really interesting and could be quite helpful to me in the future.
5	The atmosphere in the class was relaxed, which helped me learn.
6	I appreciate the teaching techniques, which produced a very interesting and informative course.
7	The student presentations were sometimes difficult to understand. However, some were much better than others
8	I was not sure of taking this class when it was first described to me. However, the class was very interesting and educational and I'm glad I was enrolled in the course.

In a previous investigation, the respondents were requested to comment on the Hazardous Waste Management course[9]. A representative of sample comments is listed in Table 5. As shown, comments 1-6 and 8 generally state that the class was interesting, informative, and could be of assistance to the respondents in the future. However, there may be a concern with comment 7: "The student presentations were sometimes difficult to understand." Overall, the evaluations indicate that involving students in collaborative teaching and learning process has been well-received by those enrolled in the class. However, this feedback may also suggest that some students should be encouraged to increase their seminar skills so that their presentations are more understandable to the participants in the course.

Summary and Conclusions

It has been written that classroom discussion, collaborative teaching/learning, and cooperative team experiences are generally required to develop critical thinking, communications, and leadership skills in students. The paper shows that courses which utilize these concepts enjoy outstanding evaluation from students. This investigation also suggests that students accept the concept of collaborative learning and teaching in the classroom. In addition, comments from students and future employers indicate that courses utilizing the concepts of collaborative learning and especially team design projects are useful in a work environment. Nevertheless, roughly 10 – 15% of the students were rated by their peers at a low level for their participation in team work projects.

It is time for the engineering faculty to utilize these resources and initiate the development of collaborative teaching/learning, teamwork, communication, and critical thinking skills in the courses under their direction. Practitioners must also recognize that future graduates may wish to apply these concepts in the work place.

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