
AC 2011-1055: USING PEER EVALUATION TO ASSESS INDIVIDUAL PERFORMANCE IN TEAM PROJECTS FOR FRESHMEN ENGINEERING STUDENTS IN THE MIDDLE EAST

Ghada Salama PhD, Texas A&M University at Qatar

Lecturer at Texas A&M ,Chemical Engineering Program

Beena Ahmed, Texas A&M University at Qatar

Using Peer Evaluation to Assess Individual Performance in Team Projects for Freshman Engineering Students in the Middle East

1. Abstract

Since 2003, Texas A&M University at Qatar (TAMUQ) has offered Bachelor of Science degrees in chemical, electrical, mechanical and petroleum engineering at Qatar Foundation's Education City campus. The mission of the Qatar campus is to replicate the undergraduate engineering program offered at the main campus and contribute significantly to the knowledge and research needs of Qatar and the region.

The Foundations of Engineering I (ENGR111) is a freshman course aimed at introducing all our new students to the profession of engineering. Upon entering university, most students enrolled in TAMUQ come prepared with adequate skills in Mathematics and the Sciences but have a limited understanding of the demands of the engineering profession. Hence the course introduces the students to the fundamental concepts of problem solving and engineering design, which lie at the heart of all engineering disciplines. As in today's world most engineering projects are completed by teams, it is imperative that the students understand what teamwork is at an early stage. Most of the freshmen students at TAMUQ have had limited exposure to teamwork in their high school careers, hence they need to be provided with the opportunity to develop these skills and be given appropriate feedback tools. In our global age, we need to interact with individuals from different cultures and disciplines, therefore teamwork skills are considered of utmost importance. These include strong leadership, effective communication, proper decision-making and conflict management. These skills might not come naturally to certain individuals and need to be cultivated.

In the ENGR111 course, the freshmen engineering are introduced to team work through group activities and projects. However, assessing individual student contributions to a group project is a difficult task. In this paper, we will present the range of assessment instruments used and their effectiveness. We will introduce our experiences in conducting group projects for freshmen, the assessment process and how the team members interpreted each others' performance. We will discuss the results obtained using standard peer evaluation techniques to assess individual performance in group projects. Peer assessments are successful when students know what is expected of them and have a correct understanding of their goals and benefits. We found that our students were not amiable to giving their critical opinions of each others' performance. Due to the culture of the local and regional background of students, they have a different perception on peer evaluations. Influenced by their cultural background, most students felt obliged to give their teammates a less critical evaluation of their group working skills.

We will discuss the pedagogical approach used to develop assessment methodologies to remedy the situation and the results obtained with them. These results will be analyzed and the effectiveness of these techniques in evaluating individual student performance discussed. We will show whether these methodologies were able to provide us with a better picture of the "inside story" of the collaborative work performed by our students.

2. Introduction

There is no doubt that we all agree on the importance of team work in any career especially engineering. No problem can be solved with the skills and knowledge of just one engineer. Solving the world problems requires the collaboration of people with various expertise and backgrounds ⁽¹⁾. An effective team member means a person that has effective communication skills, proper decision making and conflict management capabilities and sometimes an extra bonus is to have would be leadership abilities.

Teamwork might not usually come naturally to everybody; it's a skill that usually needs to be developed and practiced before one can apply it effectively. At our institution, engineering freshmen are introduced to team work through group activities and projects. The teaching style in these courses is based on project-based-learning. Students from all the four majors, Chemical, Electrical, Mechanical and Petroleum at the university attend these courses, and can have very different learning styles ⁽²⁾. We take advantage of the multidisciplinary environment that the freshman courses bring about, to have the students learn how to work in teams by assigning group projects ^(3,4). Many instructors agree that group projects are excellent learning exercises and training opportunities ⁽⁵⁾.

In addition to the importance of team work in the industry and work place, it is also an important method to enhance the technical learning experience of students. Students tend to learn better when they discuss the problem and try to come up with solutions ⁽⁶⁾. This is referred to as collaborative learning. They are also more likely to attain higher grades. It can enable students, to develop personal transferable skills of teamwork, communication, presentation, problem-solving, delegation and organization. They also acquire better understanding of the environment in which they would be working as professionals, because group work better simulates the professional environment of engineering organizations.

In this paper we will discuss the methodology adopted to introduce freshmen students to the team based project work and the assessment criteria used. We will also present an analysis of the assessment process, issues observed, results obtained and suggested solutions.

3. Individual assessment in group work

When it comes to assigning grades for such group projects it is not a difficult task for an instructor to evaluate the work and performance of a team as a whole but to evaluate each member's effort separately can be challenging. The assessment of individual contributions in team-orientated, project-based learning can be subjective and thus not repeatable. The common criticism of group work by both teachers and students is related to a situation when the same assessment or grade is given to all group members irrespective of the contribution or efforts individual members of the group have made. For individual accountability it is essential to implement methods to ensure that every member in the team fulfills their duties and they are correctly assessed for it. There are two other problems with group work, namely, the existence of so called free-riders in the team and that the work submitted is a collection of individual contributions rather than a consolidated team effort.

Intentionally and actively involving students in assessing their own and their peers' contribution to group work using some form of peer and self-assessment tools may resolve these issues. One

way to evaluate team performance is through peer assessment, which according to Keith ⁽⁷⁾ is described as an arrangement wherein learners can consider and identify the level, value, or quality of a product or performance of other learners who share their status. Several researchers believe that the issue of disparate contributions can be addressed effectively using a grading system that gives appropriate weight to individual contributions and to the group's collective achievement ⁽⁸⁾. The students' peer ratings, when adequately used, can give an instructor a better understanding of the dynamics that take place within individual groups ⁽⁹⁾. Peer evaluation by the students also provides the instructor with information about the individual contribution made by students outside the normal class time.

However in previous semesters peer evaluation was found to be non-trivial to implement at TAMUQ. Due to the local culture and regional background of the students at TAMUQ, they had a different perception on the peer evaluation process. Students did not take advantage of the peer evaluation process to describe to the instructor the exact picture of the dynamics and performance of the team members, preferring instead to relate these issues directly to the instructor. This only became obvious to the authors at the end of the projects after grades were posted and the instructors were deluged by student complaints but could not find evidence to support these claims in the peer evaluation forms. What was observed was that mainly influenced by their cultural background, students considered it inappropriate to provide negative criticism about team mates. Students also refrained from accurately reporting the situation due to the fact that the students at TAMUQ commonly share their course grades. Hence, they know their team mates can easily determine if the grade received has been altered due to input from the peer evaluation. Also since the TAMUQ campus is relatively small, the students are aware that they will be working with these same peers again throughout the years hence it is important that they maintain good relationships with these peers. Not only is negative criticism frowned upon, but can also be taken personally when received. A large number of the students knew each other previously from high school or socially, some being even from the same extended family or tribe hence complicating the situation. Furthermore as Qatar is a small country with limited employers, students realize that grievances can be continued into the workplace, if by chance they or their family members end up working at the same company.

Students also struggled in correctly using the provided forms to accurately reflect individual contributions. The instructors asked the students to provide multiple assessments not only at the end of the project but also during it. This provided the students with the opportunity to familiarize themselves with the peer evaluation process. These results were analyzed and used in evaluating individual student performance. The peer evaluations were able to provide a somewhat better picture of the "inside story" on student collaborative work in team projects.

Peer evaluation was performed using a standardized form (see appendix) in which students were asked to assess each team member on the following criteria.

- a. Attended all team meetings and contributed to the activities.
- b. Met deadlines by the team.
- c. Contributed good ideas in the team activities.
- d. Participated in the team activities throughout the semester.
- e. Quantity of work in the team activities throughout the semester.
- f. Helped keep the team organized, cohesive, and progressing toward completion of the goals.

- g. Showed concern for the feelings of other team members.
- h. Demonstrated a positive attitude toward the team.
- i. Listened to the ideas of other team members.
- j. Encouraged other team members to contribute to discussions.

Students had to rank each of the criteria from 1 to 10 and then sum the total of all the points such that the total points awarded to the team members in a three member team should add up to 300. So if a team member was given more than 100, then another team member must score less than 100. The output from these forms was a weighting factor which was used to determine the percentage of the team grade that each team member would obtain. A weighting factor higher than one for a student would result in their individual grade for the assessment being higher than the team grade whereas a weighting factor lower than one would mean that the student would receive a grade lower than the overall team grade for the project.

The students were given a detailed explanation of the purpose of the peer evaluation process and its effect on the overall project grade for themselves and their partners. Penalties were imposed on those students who failed to participate in this process. Students were discouraged to rank each other equally (i.e. give themselves 100 each)

4. Team-based projects in the course

There were three different projects introduced to the students throughout the semester for this freshmen course. The projects were executed in teams of three or four and the individuals were selected by the instructors.

The first project was a three week assignment which mainly focused on sharpening their research skills together with their oral communication skills. Here the students were asked to conduct some research on a topic related to engineering and prepare a fifteen minute presentation on their findings. To determine individual contribution, at the end of the project the students were asked to submit a peer evaluation form as described above.

In their second project, the students had three weeks to graphically investigate and analyze data provided by the instructor using MATLAB and then produce a poster presenting the results obtained. The team members had to create a group of MATLAB functions to plot and analyze the provided data. The poster and the MATLAB code were assessed by the instructor. To determine individual contribution to the project, halfway through the project, the students were asked to complete an informal, unannounced questionnaire during class about their contribution and their team members' contribution as well as the amount of time they spent on the project. At the end of the project the students had to submit another completed peer evaluation form. The students were made aware that the results of the peer evaluation form would be compared to the informal survey completed during the project to identify any distortion.

The third project was much more challenging for the students and lasted for four weeks. The teams had to build a robot using the LEGO robot kit provided. Two teams worked together to cap a hypothetical oil well for the "robo-plugger" project. One robot had to carry two golf balls (i.e. the concrete well plugs) from a central storage area to two separate pipes leading to the leaking well. The second robot had to push the two balls through two separate open pipes leading to the entrance of the leaking well to stop the flow oil. In this project the students were

thoroughly familiarized with the main components of an engineering design problem. The project involved multiple processes and had several milestones that had to be completed along the way. It was a hands-on project that involved constructing an autonomous robot using sensors, motors and mechanical parts like pulleys, axles, and beams in the LEGO educational robot kits. The students were essentially given a scaled down version of a full blown engineering design project.

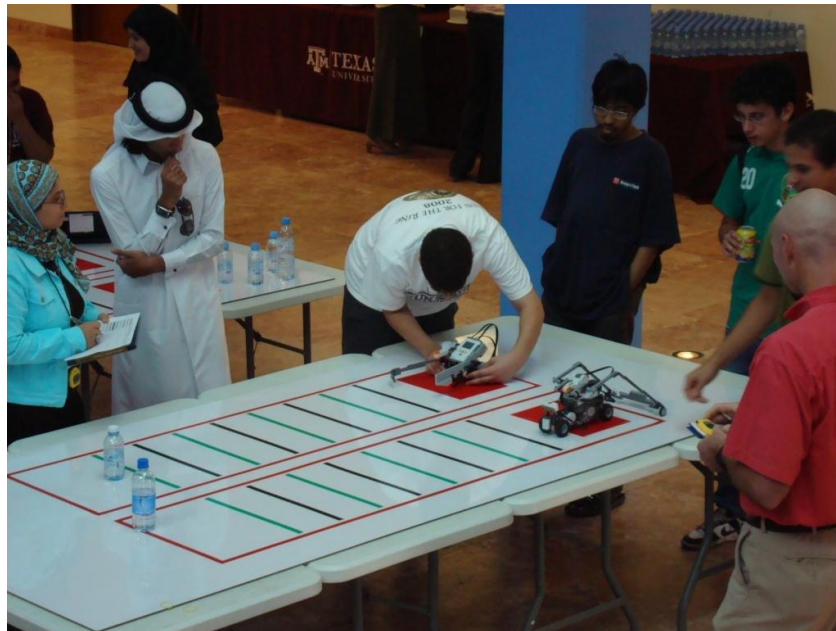


Figure 1: Robot in Project 3

In this project to reduce the level of biasing observed in the earlier projects, the students were asked to perform two online peer assessments, one halfway through the project and the other at the end of the project. It was hoped that the repeated use of peer evaluations would create a learning effect in the students and improve the reliability of the results. The assessments were made online to ensure that the forms were correctly filled as in print versions students often provided incorrect quantification of contributions making accurate assessment difficult. The final weighting factor for each member was obtained by taking the average of both evaluation results.

5. Peer evaluation results

The results of all the peer evaluations conducted in the three projects were combined to observe any patterns and variations as well as any improvements in the results due to the changes made in the way the peer evaluations were conducted. The results are presented in Table 1 and Figures 2 and 3.

Table 1: A summary of the data obtained in the peer evaluation process in the projects

	Self assessment				Partner assessment			
	project 1	project 2	project 3		project 1	project 2	project 3	
			mid	end			mid	end
average	102.49	100	102.82	103.92	97.56	98.9607	97.18	96.08
minimum	91	98	94	98	60	29	68	72
maximum	150	149	132	136	114	102	106	102
st. dev.	8.49	1.20	6.91	6.07	6.74	9.39	6.91	6.07

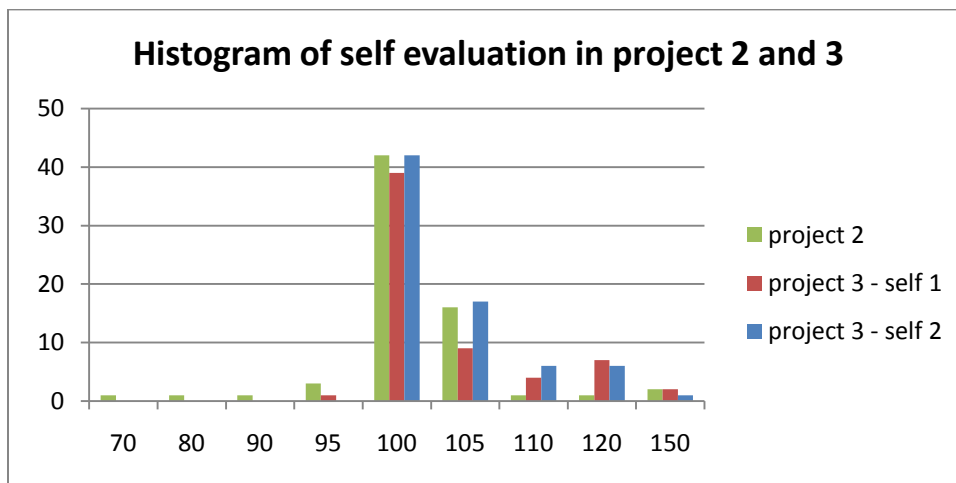


Figure 2: A histogram of the self evaluations given by the students in projects 2 and 3

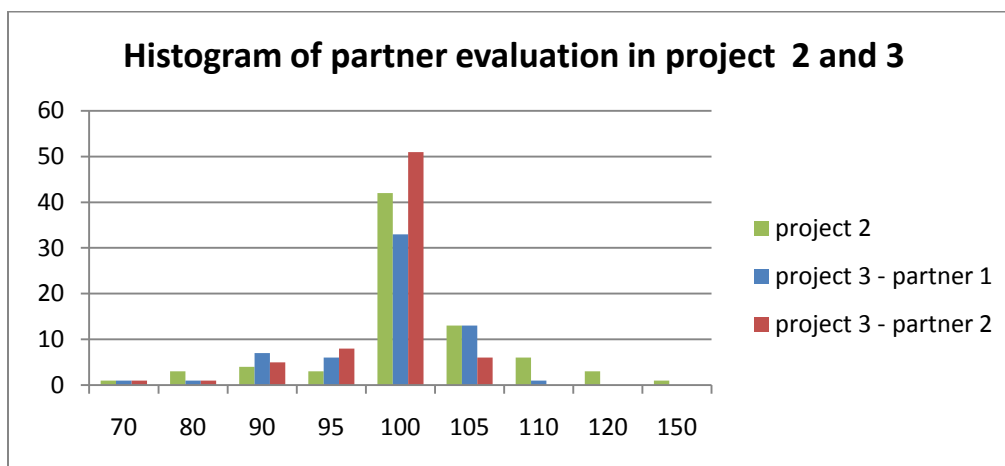


Figure 3: A histogram of the partner evaluations given by the students in projects 2 and 3

The results in Table 1 and Figures 2 and 3 show an interesting trend. In all the three projects the students on average ranked their contribution to the project more than their partners. The self evaluation average was 102.3 whereas the partner evaluation average was 97.45. The minimum value that the students gave themselves in these three projects was between 91 to 98, whereas the

maximum value was between 132 to 150. The range over which the average of the minimum scores varied was much smaller than the maximum. For their partners, the minimum scores given by the students ranged from 29 to 72 whereas the maximum varied over a much smaller range of 102 to 114. The histograms in Figures 2 and 3 also show a higher number of scores less than 100 given by students to their partners than those given to themselves in the later projects. The number of students who gave themselves scores of less than 100 and their partners more than 100 actually decreased as the term progressed. This shows that the students consistently either felt that their contribution to the projects was more than their partners or wanted to give the instructors that impression. In either case, this implies that they understood the value of the process and its effect on their grade.

However the difference in the scores given by the students to themselves and their teammates was not substantial and the distribution did not change over the three projects. In project 3, where two evaluations were conducted, the students' evaluation of their own contribution increased slightly from 102.82 to 103.92 by the end of the project whereas they decreased the contribution made by their partners from 97.18 to 96.08. The difference between self and partner assessment only changes from 4.93 in Project 1, to 1.04 for project 2 and 7.84 for project 3. Similarly there is a small variation in scores in the minimum and maximum scores given for both self and partner evaluations. These small variations between the self and partner evaluation scores indicate that the repeated use of peer evaluations was having only a slight effect in changing the mindset of some of the students. Most of the students were not inclined to express their criticism of their team mates as dictated by their cultural norms, despite realizing its importance.

In the presented histograms, it can be seen that most of the scores in all three evaluations are around the 100 mark. This indicates that despite the implementation of repeated peer evaluation throughout the project, and the learning effect associated with it. It was not possible to completely change the cultural inclinations of the students. The self assessment made by the students shown in Figure 2 has a slightly higher number of scores higher than 100 in the second peer assessment for Project 3 compared to the other peer assessments indicating only a minimal change in how the students approach peer-evaluation. Similarly the histogram in Figure 3 has a higher number of scores lower than 100 for the second assessment for Project 3 as compared to the other peer assessments.

6. Conclusions

In this paper we have presented an analysis of the peer evaluation process used to help assess individual contributions in team projects. The results indicate that the repeated use of the peer evaluation process was not of significant benefit in obtaining a better assessment of individual performance. Cultural influences prevented students from honestly utilizing the peer evaluation process. The process implemented by the instructors did not change the attitude of students towards honestly and accurately evaluating individual team member performance. Change was observed in the mindset of a minimal number of the students, indicating that an alternative method needs to be adopted to accurately assess individual contribution. The authors recommend integrating additional assessment methodology into the projects to improve the results including techniques, such as having students log work spent on their project, asking them to provide detailed reports of tasks performed, conducting informal interviews of the team members and providing incentives to students for providing accurate peer evaluations.

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Appendix

A sample of the peer evaluation form

Appendix

Peer Evaluation Form

Student Name:

Section:

Project Title:

Please rate all members of your **TEAM**, including yourself on the following questions. Rank each of the questions from 1 to 10. For question 11, the sum total of all the points awarded to the team members should add up to 300. So if you gave some team member more than 100, then there must be some other team member that scores less than 100. The instructors will use this as a recommendation for the awarding of a individual grade. They reserve the right to change the individual score as they see fit. After you have completed assigning points for individuals on your team, the points will be used as a guide to get a weighting factor for your team grades. For example: If your team earns 75 points for your team project, and your team assigns you an average of 85% on this team evaluation, you would probably receive a 64 for your project grade subject to instructor approval.

Member Names =>			
1. Attended all team meetings and contributed to the activities			
2. Met deadlines by the team.			
3. Contributed good ideas in the team activities			
4. Participated in the team activities throughout the semester.			
5. Quantity of work in the team activities throughout the semester.			
6. Helped keep the team organized, cohesive, and progressing toward completion of the goals.			
7. Showed concern for the feelings of other team members			
8. Demonstrated a positive attitude toward the team.			
9. Listened to the ideas of other team members			
10. Encouraged other team members to contribute to discussions.			
11. Overall Contribution to the Team			

Overall Contribution should add up to 300; any individual grade below 70 or above 120 for a team member (in the overall contribution category) must be justified with comments on the back of this form

How satisfied are you with your group's performance? Very satisfied Satisfied Slightly dissatisfied Very dissatisfied other

Who is the leader of your group? _____

Is there anyone on your team that you feel is either doing an exceptional job or is holding your group back, i.e. you could not have done it without them, you would never want to serve on a team with them again, or •••? If so, use the back of this form to detail who it is and what is the situation?