

Teamwork Assessment in Construction Undergraduate Courses

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Abstract

Teamwork skills are essential for construction engineers and managers. Therefore, University and college construction students need teamwork skills. When the instructors assign student teamwork activities, assessing and evaluating individual involvement and commitment to group projects is challenging. Generally, the students who are more dedicated and concerned about their grades work harder, and the group work should be distributed more evenly among the group members. On the other hand, the individual whose background is weaker in one or more aspects of the project may not be permitted or not guided by the teammates to perform in the project. Indeed, the teammates believe that it takes longer for a weaker student to finalize the project. As a result, the project sometimes does not improve the students' weak abilities, knowledge, and teamwork capabilities.

This research investigates the educator's methods at the undergraduate level for engineering and particularly construction engineering technology courses to analyze, assess, evaluate, and resolve teamwork problems. In addition to a literature review of the experienced and reported methods, the author shares different methods practiced in several years of teaching in various institutions and countries.

One of the methods with the better outcome is the student involvement in the assessment of their teammates. How to arrange peer assessment is one of the topics. The related forms, their repetition, their effect on the students, and how to attract the student's interest to the assessment are discussed. The practice of making teams more inclusive is also explained. The strength and weaknesses of different methods are shared and debated. Other ways of assessing and motivating the students to teamwork engagement are also applied.

This paper concludes with the teamwork assessment's suggestions, methods, and challenges. These methods can be helpful for the business's teamwork assessment, particularly in the construction industry.

Keywords: Teamwork, Group work, Peer assessment, teammate evaluation.

Background

Teamwork skills are crucial for construction engineers and managers. So, undergraduate construction students must develop teamwork skills for future job success. Therefore, construction engineering programs must demonstrate teamwork skills to pass the criteria for Accreditation Board for Engineering and Technology (ABET) [1].

More than seventy percent of employers expected the colleges to have more emphasis on “teamwork skills and the ability to collaborate with others in diverse group settings” based on a poll in 2009 on behalf of the Association of American Colleges and Universities (AACU) [2]. Many studies recognized teamwork as one of the essential skills among college graduates. Teamwork skills are significant for any type and level of job; however, their significance is more prominent and treasured in higher positions [3]. Teamwork impacts student development through collaborative assignments and projects [4].

Team member evaluations that give students specific feedback on a range of team behaviors and that benchmark their performance to that of their team members relate to students' positive perceptions of their team processes and their enthusiasm to work in future teams. [5]

Graupensperge et al. demonstrated the value in remaining socially connected with peers and maintaining role identities during the COVID-19 pandemic. [6]

Different meanings are used to define teamwork. Sometimes it refers to overall team performance or effectiveness [7]. Other times, the collaboration of individuals in the team is assessed. ABET aims to adopt teamwork as one of the actual learning outcomes in engineering and engineering technology [1]. Teamwork is referred to as individual skills in this paper. It relates to the team's effectiveness, functionality, leadership, responsibility towards its functions, and satisfaction of team needs [8].

Wiggins (1998) describes educative assessment as educating students and improving their performance in the future [9]. Based on that definition, Comprehensive Assessment of Team Member Effectiveness, or CATME, load onto five essential factors: (1) contributing to the team's work and a fair share of the teamwork, (2) interacting with teammates or effective communication, (3) keeping the team on track and stayed aware of fellow team members' progress, (4) expecting quality, and (5) having relevant knowledge, skills, and abilities [10]. In addition, group assignments must be appointed to evaluate student teamwork

[11].

Formulating and utilizing the operational definition of teamwork is necessary to assess and improve teamwork skills. It is also needed to guide the students. Furthermore, the results of teamwork assessment can be used to enhance the teaching of individual skills [12].

There are specific challenges in construction projects regarding multidisciplinary teamwork [13]. Communication and collaboration skills usually are underrated [14]. It is rarely an adequate concern to improve teamwork and management skills in the students [15].

Students often need to be educated about dysfunctional teams, resulting in contrary values about teamwork. [16] The characteristics of effective teams are related to the student's attitude toward working as a group. Improving these skills advances communication, interdependence, and emotional safety and enhances the sense of common purpose and the knowledge of their role in teams [17].

The pedagogical motives and rewards convene teamwork, but it also has drawbacks. The success of collaboration depends on a just and reliable assessment [18].

This paper studies the implemented approaches by the author to evaluate teamwork skills and their consequence for reaching effective teaching strategies and meaningful ways of assessing those skills.

Motivation

The evaluation of teamwork is rigorous. However, traditional assessment methods are needed to adequately review the group members' participation and efficiency. This continuous ongoing research has investigated different strategies to improve and assess teamwork and individual effectiveness and involvement of the students in group projects and teams.

This paper concentrates on the teammate or peer assessment methods and if and how they improve teamwork and assessment of the students. It was acquired if the students' peer assessment and sharing the class governance improve collaboration through teammate assessment.

Challenges

There are challenges regarding reasonable teamwork assessment. Several challenges are explained here, including choosing the team members, the debates and quarrels, and defining the team project.

Defining team projects

Two methods are used. Sometimes the projects are defined as similar or the same assignments. The other method is defining a larger project, dividing it into smaller portions, and assigning each to a different team or individual.

Assigning similar projects

For educational purposes, similar projects are usually assigned. Notably, similar projects are given to the different teams in a lab or design course. For an undergraduate lab course, e.g., soil mechanics lab, concrete lab, or surveying lab, the students execute similar or the same activities and prepare a team report for that lab test. For example, a project was designed for the course reinforced concrete II. Different groups are asked to develop similar projects; however, the material properties may be assumed to be different.

Assigning different parts of a larger project

Suppose a team or individual project has many different aspects. In that case, the instructor has found that the outcome is better if the work is divided into small sections and assigned to another team or individual. For instance, the projects which include ethical, environmental, and political aspects of construction are divided into smaller pieces. The students' work resulted in a deeper and more detailed investigation of the assigned topics than similar projects. In addition, the students will learn more from peers during the presentation by this method. Also, they practice working as a part of a larger team, which can be the entire class.

An example is a project to understand the interdisciplinary nature of construction projects and encounter the students with logical and critical thinking in the ethics, politics, environment, economy, and other disciplines related to civil and construction engineering projects on the local-global scales. A scenario of development and construction is defined. The structure supplies jobs but may cause environmental and social problems in a region with endangered species and heritage that may be negatively affected by the construction and building development.

Choosing the Team members

The outcome of the teams is related to the team member's participation. The team members can be chosen in different methods. The educator can choose the team members, or the students choose their teammates. Some instructors choose the team members randomly, and some have reasons for selecting a team. When the students can choose their teammates, they may choose their friends or those supposed to work better in the groups. The different methods applied for selecting the team members are discussed as follows:

Students choose their teammates.

The students like to choose the best choices to work within teams or the ones who are their friends when their schedules are similar, or they can work on time with each other. Suppose it is permitted to choose the teammates. In that case, it is a high possibility that bipolar groups are formed such that the stronger students in the course share the same groups, and the students who no other team like them as a team member ended up being the last group to be formed.

Setting Equivalent teams by the instructor

Another method of appointing team members is to use the prior familiarity of the educator with each student's knowledge and team involvement so that the average of the groups performs approximately equivalently. The team members are selected so that strong and weak students are in the same group. It seems fair as the students' outcomes are more similar in different groups, as it simulates the real-world condition. Moreover, it allows the students to learn more about the course and teamwork for all the members. Mostly, the reports have acceptable to high quality by this method, which is one of the advantages.

However, significant problems are needed to select the team members. The common problem is that the group members need to work more.

In some cases, stronger students in the course do most of the assigned work, and the weaker students do not assist as expected. So, the more vulnerable students continue to hand over their duties to other team members or do not act in the team. That results in the condition that the better students learn the most and take most of the time related to the assigned project with little help or without using other team members. It might also result in unnecessary debates in the teams. Even if the weaker students are highly interested in learning and being responsible in the group, their teammates may not allow them, as the other members may disapprove of their work quality and speed.

Debates and quarrels

Another practical challenge is the debates and quarrels in the groups. The problem is that most educators need to reflect on the claims. The estimates below are not precise as they are related to the students who show their worries or share with the educator. Notably, there might be concerns from both sides.

The complaints related to stronger students

Most of the claims are from stronger students as they expect others to help, but their teammates must assist with their share of the work as desired. Based on the reported debates, it is estimated that about 70% of the reported claims have been related to stronger students, which claimed the lack of participation of other members in the group. About 40% of the claims are ones in which one of the students in the group does not help others, and 20% of the shares are ones in that more than one of the team members does not collaborate. About 10% of the claims were when the team members were absent from the one person doing all the report preparation and other work.

The claims about being avoided

Contrary to the previous type of debates, some students complain that a member or a few members of their team do all of the duties individually or by themselves and do not allow anybody else to assist, follow up with the activities, or be educated with. Again, that relates to the students who believe in teamwork and wish to assist the team but need help finding the opportunity to help. This type of debate is reported to the educator about 10% of the time.

The answer of those who do most of the activities or all the job is that they believe that other team members lack the knowledge, preparation, dedication, attitude, or motivation to follow their tasks. They expect good grades and want to take advantage of the opportunity because of the low quality of the product of other team members. So, the reality is that they prefer to sacrifice teamwork rather than entrusting the project portions to be implemented by other team members.

Teamwork planning debates

In some groups, there are problems in planning and scheduling as to deciding individual duties. Some debates occur because other team members need to follow their preplanned tasks, timeline, and due times. These problems are common in undergraduate groups but only are reflected by the professor if the group loses points as the overall work quality is low or their work output is submitted late. That is also estimated to be around 10% of the debates, reflecting the educator.

Another problem was that the students claimed they could not continue working with each other; this can occur at different times of the term. That is about 5% of the reflected debates.

Other debates rarely are reflected. For example, the educator is estimated to be about 5% of the discussions.

Teammate assessment approaches

Some typical group work problems are concluded from the debates, which are reflected and reported to the educator. However, their proportion is different from the reflected internal discussions estimated above. Team assessment methods are practiced to improve understanding of the condition of the teams. There are concerns if the students being allowed to assess their teammates. The researcher believes that is a good practice that leads the students to understand that if they are not assisting fairly, the teammates might reveal that they are not helping. Also, they learn about the teamwork criteria. So, it must be explained that the students are respected to associate in the course assessment.

Different methods are practiced to improve teammate assessment and team effectiveness. The assessment process, the criteria, the questions to be asked, and the number of times the students are assessed are essential aspects of peer teammate assessment investigated in this research.

Number of team members

Team members depend on the project, available equipment, and course. However, it is known that 2 to 6 members in different classes are in the researcher's experience.

Number of assessments

The number of times the team members evaluate each other is essential.

When the teammates evaluate each other in a team, just for one time at the end of the project, it is like a final audit and cannot help modify the group during the project. One final assessment demonstrated that the students are kinder and need to reflect on their problems and team history in their evaluation. One-time teammate evaluation at the end of the project time does not add perceptible value to the team for team improvement.

On the contrary, if the teammate assessment is repeated many times in a course project or lab course, there is a high possibility that the students need to be more accurate in their responses and be tired of the reaction. For instance, the weekly assessment is ineffective, and dealing with the results could be hard for the professor.

For a one-course term period of a project or lab teamwork, the best approach would be between two to three times assessments during the term, such that if there is a problem in each group, it can be reflected.

In addition, the educator recognizes and may interfere with improving group involvement. However, a survey analyzer software can be prepared and used to assist in weekly assessment results, if the number of questions is in the future.

Teammate assessment methods

Two different approaches are applied to the teammate assessment questionnaires. The author uses a combination of both methods.

Ranking teammates

In this method, the students rank their teammates. So, they need to choose who involves the best in their team and who is the worst. Also, they have space for their additional notes. The most important information is the ranking assessment of the students. However, it seldom provides additional notes. Mostly the students refrain from writing letters about their teammates, particularly if they have yet to have hot debates among the group. Also, the students prefer to answer precise questions such as grades or points. So, if they are just asked to write comments, there will be fewer replies.

Questionnaires

Another approach is asking specific questions. The students usually are not interested in the questionnaires, which need text answers. Most students answer only briefly if asked a question they must explain about the other teammates or team condition. Instead, the students prefer grade-based questionnaires like those that evaluate their instructors and the courses at the end of the terms.

The questions in the teammate assessment questionnaires

Several types of questions were prepared, and the student responses were tested. The details of different versions of the provided questionnaires are presented at the conference.

The first series of teammate assessment questionnaires are based on the researcher's understanding of what is essential. Some of the assessments were question-based, and some were based on ranking. A sample of the ranking-based questionnaire with a few additional questions is attached in attachment 1.

The second questionnaire is adopted from the ABET training papers. It had five categories of Contribution, Take Responsibility, Other Viewpoints, and Management skills and more than ten subcategories. For each type, two to four subcategories were asked to be evaluated. Again, the students needed to show more interest in answering any questions. It is demonstrated in attachment 2.

The author provided good questions for an understanding of the team's condition. However, many questions were there to answer, so the students were asked for just the five categories and kept the subcategories on the page to better understand each type. Indeed, it was found that five questions are the optimum number of questions in an assessment questionnaire to be graded by the students for each teammate. Therefore, the questionnaire format is also changed such that the students grade all their teammates on the same page, as is attached in attachment 3. Also, the ranking of the teammates is added in this form, such that both evaluation methods of ranking and assessment questions are provided in the same document form.

Problems related to the student's response to teammate assessment

The students may not perform the teammate assessment or need to answer the questions honestly. These problems are discussed below.

Mandated assessment

As the students need to answer similar questions about each of the teammates, they may need to be more enthusiastic about answering the questionnaires, and some may not evaluate their peers.

To resolve this problem, the educator announces their teammate's assessment to guarantee that the students answer the questionnaires. A part of the assessment grade was related to their evaluation

of other team members. For example, if the team included five members, 20% of the student assessment grade relates to teammates' assessment.

Investigation about the validity of the assessment

The results here are based on reviewing the filled student evaluation forms and discussing them with the students. It was seen that some of the students copied the same evaluation for their teammate assessment for each of the teammates. Remarkably, they usually grant total points to their teammates. It is noticed that students typically do not read the evaluation form questions and answer random answers or fill out the teammate assessment forms by repeating similar grades. The higher the number of questions, the less possibility that the students will read the questions.

The researcher explained to the students that no one is expected to have perfect capabilities to improve the validity of student peer assessment. The students are respected by contributing to the class governance through teammate evaluation. It is mentioned that their feedback assists the class governance. It also helps to clarify the teamwork problems and lacks. It improves the group's understanding of the teamwork criteria.

To ensure that the students evaluate other students fairly, they are informed that they are expected to read each question and answer each question differently. Furthermore, they are told that the evaluation is based on more than the total points. So, a student whose peers have yet to grant the entire points is not necessarily losing a grade, and comparing the students' results in the group will result in their teamwork grade. That means the students who have graded the lowest points or weakest ranking by every other team member will be graded low for participation. Others are not affected negatively.

Discussion of the results

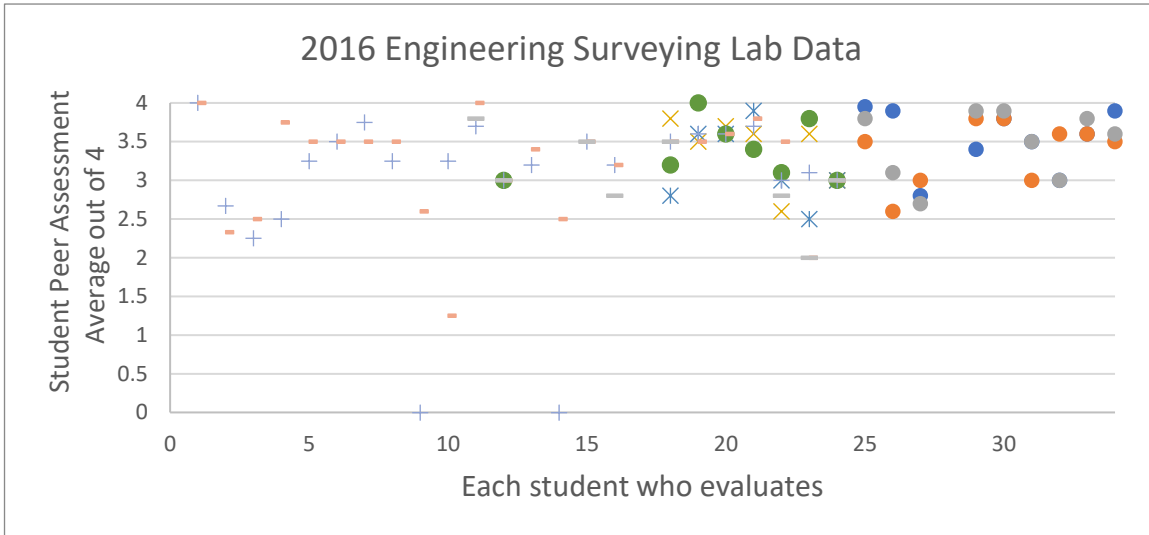
Most of the time, students fill out the evaluation form relatively using this method. However, there are still conditions that only some students read the questionnaire and grade the questions randomly so that the average grade reflects their idea about a teammate.

If the method results in a relatively honest evaluation, it provides a good understanding of the lack and abilities of teamwork among the students. So, the instructor can plan for next time, such that he emphasizes the lacks and improve them. However, evaluating these results of all categories is not included in this paper, as the primary goal of this paper is to provide the evaluation method rather than the results of the evaluation.

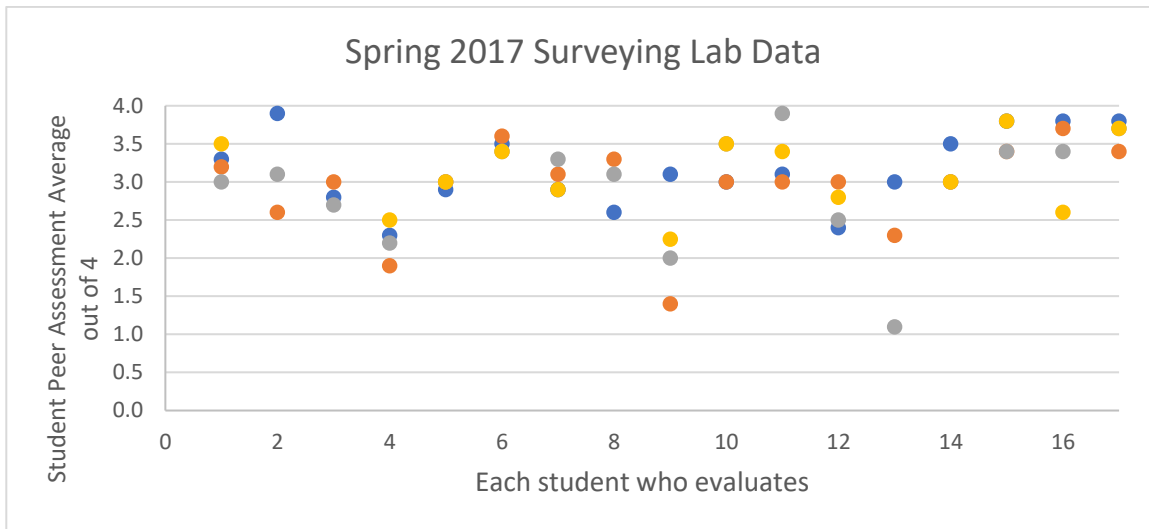
A demonstration of examples of the data results is summarized here. The data that are discussed are not the categories in the forms. They are the average evaluation of students. Figure 1 (a to c) shows the students' peer assessment of their teammates during the Engineering Surveying lab course in different years. Each point in the chart is the average for all categories of a form used to evaluate a teammate. Each number in the horizontal direction is a student. Each student evaluates other teammates. That is why each student in the horizontal direction has several related numbers in the vertical direction. The vertical direction results for each student number, in the horizontal

direction is the average evaluation number for each evaluation form of the teammates. So, the number related to the vertical direction points for each student is provided for each teammate.

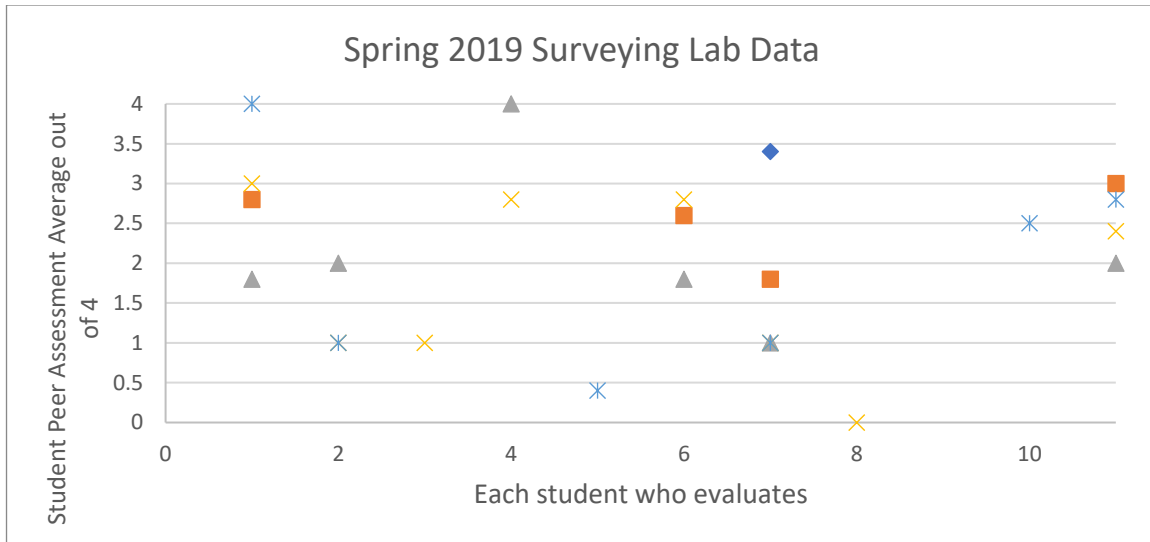
The instructor ensured the teammates' grades were kept the same if their average grade was 80% or more. The reason for the assessment is not to decrease their teammates' grades but it assists the instructor in understanding the students' lack in a particular item for the following years. The scatter is more when the students know that their evaluation did not reduce the grade of their teammate. Observing the changes in the numbers in the three years approves this matter as the instructor assured this policy more in the following years.



(a)



(b)



(c)

Figure 1. The students' peer assessment during the Surveying lab in different years

Figure 2 shows an example of the average results for a team peer assessment in a course on soil mechanics. It was library research and presentation. A number replaces the names of the students. For example, if a student's name is Robert, it is replaced with Student#1. This student evaluated the report preparation of the other two students, as well as their presentation collaboration. The appeared evaluation numbers are the average of the evaluation categories in a form. So, each student evaluated two other students twice, as shown in the table under Figure 2. That is a condition that the best presentation differs from the best preparation. The best-valued report preparation evaluated by the peer team members is Student#1. But the best presentation peer review is Student#3.

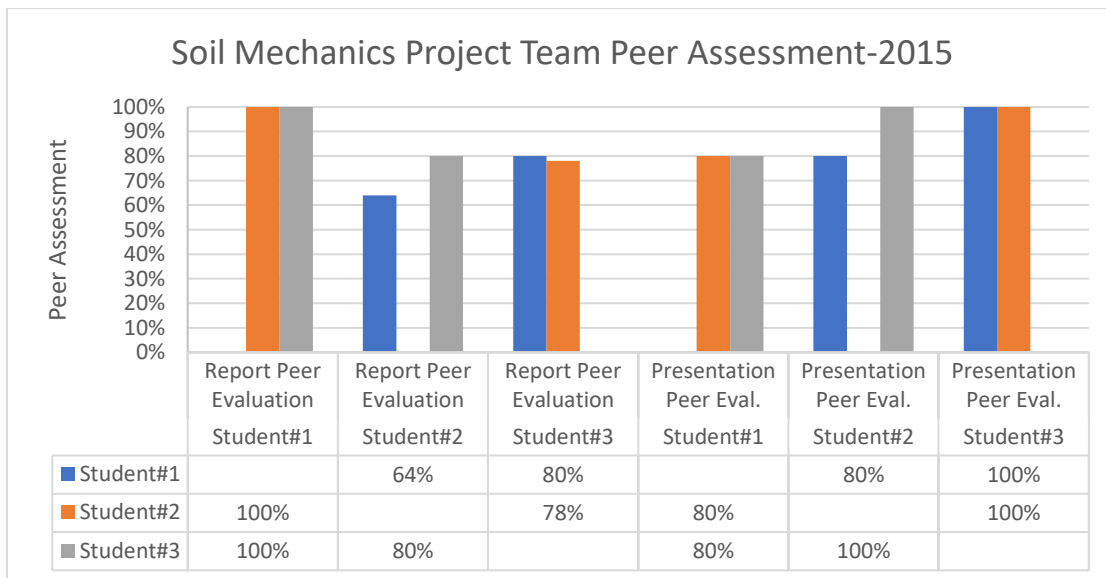


Figure 2. The Peer Evaluation of a team of three students by their teammates

Figure 3. shows the evaluation submitted by other class students about the presentation of each of these team members in Figure 2. Students #1 and #2, and #3 are the same, and the evaluation is for the same course project. This time the presentation of the team members is provided by 10 other students who attended the team’s presentation. Ten other students evaluated the presentation of this team member. Other students of the class preferred the presentation of Student#3 in first position, Student#1 in second place, and Student #2 in third place. The first ranking of the presentation by the other students in class is similar to the teammates, but only for some team members. The data for Figure 3 is provided in Table 1.

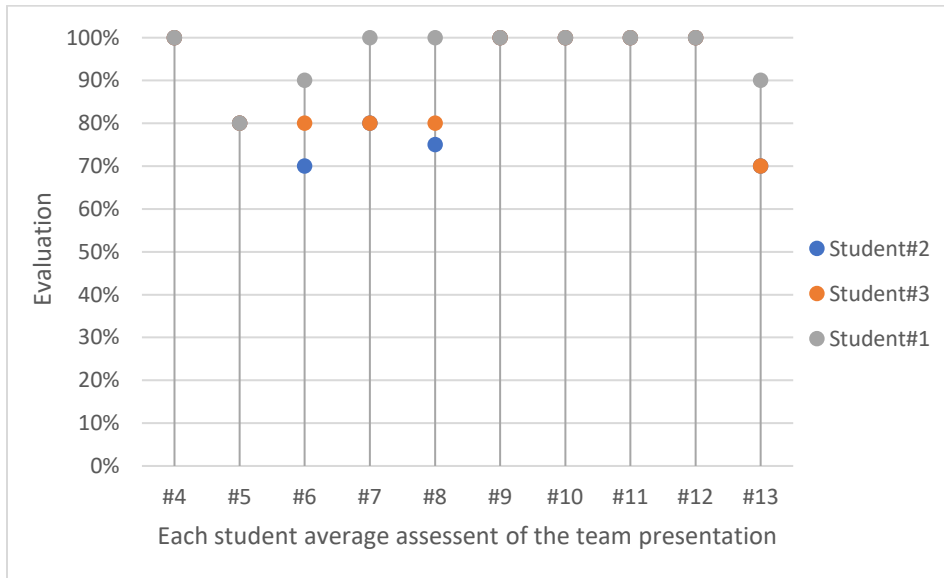


Figure 3. Presentation evaluation of the three team members in the previous figure by other students in the class is provided in Table 1.

Table 1. The data of the Presentation evaluation of the three team members in Figure 3 by other students in the class

Student Evaluator	Student#1	Student#2	Student#3
#4	100%	100%	100%
#5	80%	80%	80%
#6	90%	70%	80%
#7	100%	80%	80%
#8	100%	75%	80%
#9	100%	100%	100%
#10	100%	100%	100%
#11	100%	100%	100%
#12	100%	100%	100%
#13	90%	70%	70%

Student Opinions

In summary, the presented peer evaluation methods have been improved every year. The researcher provided a survey questionnaire about the students' assessment of this method. The students' overall perception of this peer evaluation method gradually increased yearly. The average of the student's response to this method is presented here in the lab classes for the terms of Spring and Fall 2022. 92% of students were confident that peer evaluation outcomes result in better collaboration of teammates. 86% of the students agreed that their teammates improved after their first evaluation as the instructor approached and met the students. All the students liked that they could be apparent, transparent, and honest in their assessment without worrying about negatively affecting their peers unless the team evaluation showed a meager teammate average. 96% of the students believe teamwork affects their grades using this peer evaluation method. 80% of the students thought that the peer evaluation assists the instructor in improving the deficiency categories for the future. All the students encourage and appreciate the opportunity to participate in the assessment and governing the class.

Conclusion

This paper concludes with suggestions, methods, and challenges of teamwork assessment in undergraduate students. These methods can also be modified and used for the business's teamwork assessment, particularly in the construction industry.

The group condition can be observed if the teammate's assessment is valid and honest. That consequences in implementing improvement methods to the teams.

Peer assessment respects the students as their feedback affects their grades, and they participate in class management.

For a one-course term period of a project or lab teamwork, the best approach would be between two to three times team assessments by the students during the term, such that if there is a problem in each group, it can be reflected. The educator may interfere with improving group involvement.

The methods need to be applied as an online teamwork assessment tool to be used and analyzed. A survey analyzer software can assist in weekly assessment results if the number of questions is low.

After practicing and modifying several methods, the author still believes that more research is needed to optimize and improve the validity of the team assessments, mainly through the teammates' evaluation forms.

The students demonstrated an excellent response towards this method that encourages teamwork collaboration and includes students in the class governance and improvement.

Teamwork evaluation and improvement are essential and challenging. Other questions must be discussed and investigated in more detail in future research. How does the educator assess the students? What is the rationale of the teammate assessment for grading? How much of the project grade relates to the report, peer teammate grade, instructor's grade, presentations, and periodic evaluations?

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Attachment 1- An example of a Ranking Questionnaire

Teammate Evaluation

The group which is evaluated:

Presentation Date:

Project Title:

Your Full Name:

Group No:

Teammate Name:

Rank and mark the members of your group.

	Mark (Out of five)
1.	
2.	
3.	
4.	
5.	

How do you evaluate teamwork in your group?

What were your problems as a team?

Additional comments about the project and the team and teammates

Attachment 2- An example of a Questionnaire with details

**Design Project
Teammate Evaluation**

Your Full Name:

Group No: Teammate Name:

Topic	Grade				
	0	1	2	3	4
	Any	Weak	Moderate	Good	Excellent
Contribution					
Concept Understanding					
Share Information with others					
Take Responsibility					
Fulfill Team Role's Duties					
Participate in finalizing the project.					
Shared work equally					
Other Viewpoints					
Helping teammates					
Cooperate, teammates,					
Listen to other teammates.					
Follows team decisions					
Management skills					
Make fair decisions					
Manages the team- when needed- in a proper method					
Overall					
Your overall evaluation of your teammate					

Attachment 3- An example of a Suggested Questionnaire

LAB Teammate Evaluation

Lab title:

Your Full Name:

Group No:

Name of Teammates					
Rank the Teammates					
Grades 0-5 (5 excellent, 0: no work)					
Contribution					
Concept Understanding					
Share Information with others					
Take Responsibility					
Fulfill Team Role's Duties					
Participate in finalizing the project.					
Shared work equally					
Other Viewpoints					
Helping teammates					
Cooperate, teammates,					
Listen to other teammates.					
Follows team decisions					
Management skills					
Make fair decisions					
Manages the team- when needed- in a proper method					
Overall					
Your overall evaluation of your teammate					