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Improving Oral Presentation Skills of Graduate Engineering Students with Web-based Collaborative Problem-Posing and Self/Peer Assessment*

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The increasing focus on developing students' oral presentation skills has stimulated research on the integration of innovative learning strategies for oral presentation activities. Nevertheless, research focusing on applying innovative learning strategies to oral presentation activities in engineering courses is limited. To enhance oral presentation activities in engineering, the current study systematically integrated collaborative problem-posing strategies with self- and peer assessment into engineering statistics courses with 37 engineering graduate student participants in Taiwan. A one-group pretest-posttest quasi-experimental design was applied to investigate the effectiveness of web-based collaborative problem-posing with self- and peer assessment on engineering graduate students in engineering statistics courses. The correlations between students' self- and peer assessment and instructors' assessment were also examined to evaluate validity. The results indicated that the students' oral presentation performance significantly improved after the experimental teaching of web-based collaborative problem-posing with self- and peer assessment. Nonetheless, no statistically significant improvement was identified in students' motivation. Additionally, teacher assessments of oral presentation performance were highly correlated with peer assessments and moderately correlated with students' self-assessments. Limitations of the present research and recommendations for future research are provided.

Keywords: oral presentation; engineering courses; collaborative problem-posing; self-assessment; peer assessment

1. Introduction

1.1 Integration of Problem-posing Strategy for Student Oral Presentations

Since oral presentation skills are a fundamental soft skill for modern engineers, adequate instructional design to engage students with oral presentations is critical [13, 38]. Traditional pedagogy and assessment have been deemed inadequate, stimulating research into developing and applying innovative learning strategies for oral presentation activities [26, 37]. A considerable amount of research has addressed the integration of innovative learning strategies for oral presentations in higher education, although a limited amount of this research has focused on engineering courses [14, 48].

As a learning method that has attracted considerable attention, the problem-posing strategy has been applied to develop students' cognitive and affective skills in several disciplines [2, 9]. Problem-posing is a learning strategy that causes students to generate new problems based on what they consider essential or relevant in a given situation, in learning materials, or in educational activities and to resolve them [43, 54]. Compared with traditional methods in which peers ask questions following a student's oral presentation [1, 8], the integration of problem-posing in oral presentations encourages other students in the audience to resolve the questions posed by themselves. The posed questions provide informative feedback with which the presenter can monitor and confirm the understanding of the audience as well as valuable opportunities for them to immediately correct problem posers' misconceptions regarding the presentation [28]. In addition, problem-posing activities have the potential to motivate the audience, as problem-posers, to consider and engage with the presentation more because the understanding of the subject is fundamental in question-posing tasks [15].

Numerous studies have demonstrated that some students face difficulties in problem-posing tasks, which indicates that the challenge of problem-posing should be reduced by providing additional support if required [50, 52, 54, 55]. To reduce the

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difficulty of problem-posing tasks for students who lack prior experience with problem-posing or sufficient background knowledge, collaborative problem posing is recommended as an effective learning strategy that enhances students' learning achievement and learning motivation [44, 49, 50], reduces their anxiety and cognitive load [41, 49], and promotes their collaboration [12]. Although few studies have integrated problem-posing strategies in engineering courses, doing so has been found to positively influence students' cognitive and affective skills [31, 32]. To our knowledge, no studies have addressed the integration of collaborative problem-posing strategies in engineering courses, especially for oral presentation activities. The integration of collaborative problem-posing has educational value for both presenters and audiences.

1.2 Value of Self-assessment and Peer Assessment in Engineering Education

The application of alternative assessment approaches such as self-assessment and peer assessment in engineering education is recommended by numerous educators [25, 27, 34]. Thorough assessment of many higher-level cognitive skills required in engineering using objective tests is believed inadequate, and the application of nontraditional assessment, which suits the evaluation of high-level skills such as oral, communication, and collaboration skills is warranted, despite its risks [19, pp. 422–423]. Self- and peer assessments are highly effective in engineering education for teaching and learning; providing helpful feedback [7, 16, 36]; enhancing students' confidence [11], teamwork, and collaboration [5]; and reducing the workload of teaching staff [34, 47]. The aim of self- and peer assessment is to provide students with informative and valuable feedback, which effectively improves students' learning outcomes and learning motivation [6, 30]. In one study, peer assessment was highly correlated with teacher assessment, and self-assessment was moderately correlated with teacher assessment [22]. With clear and effectively designed criteria, the validity of both self- and peer assessment is believed to be high in engineering education, allowing for the evaluation of multiple high-level skills and reports on projects or laboratory tasks [19].

1.3 Web-based Collaborative Problem-posing and Peer Assessment

With the rapid development of technology, problem-posing tasks and self- and peer assessment can be conducted using a web-based learning system rather than traditional paper-based approaches [9, 45]. Web-based learning systems are believed to entail several benefits: accessibility, time-saving, high processing speeds, and considerable storage space [18]. In addition, web-based systems can better be used to engage students in multiple learning tasks with fewer time and place restrictions compared with traditional paper-based approaches [53]. Using a web-based workspace to engage students in collaborative problem-posing and peer assessment can elicit positive student responses and satisfaction with problem-posing because of the ease of idea exchange and the immediacy of feedback [29]. Similar positive results were obtained in another study that investigated the effectiveness of collaborative problem-posing with peer feedback in programming courses [49]. Students exchanged programming problems and conducted coding reviews in the Moodle learning management system, which provides editing, commenting, and review functions. This resulted in students' higher self-efficacy and lower cognitive load compared with students undertaking collaborative learning without an integrated problem-posing approach. In addition, compared with traditional paper-based approaches, web-based learning systems simulate an interactive environment that would facilitate students' collaboration and enhances the quality of posed questions [29]. The feasibility, usability, and availability of web-based learning systems in collaborative problem-posing and peer assessment have been thoroughly documented and were referred to by the present research.

1.4 Purpose of the Study

Based on the abovementioned information, this study focused on investigating the effect of collaborative problem-posing with self- and peer assessment in engineering statistics courses on graduate engineering students' oral presentation performance and motivation. The correlation between graduate engineering students' self- and peer assessment and teachers' assessment was analyzed to verify the validity of their self- and peer assessment. An educational experiment was conducted with 37 graduate engineering students from a public university in southern Taiwan. The three research questions were as follows:

RQ1: Does collaborative problem-posing with self- and peer assessment cause a significant improvement in graduate engineering students' oral presentation performance?

RQ2: Does the use of collaborative problem-posing with self- and peer assessment cause a significant improvement in graduate engineering students' motivation?

RQ3: Are graduate engineering students' teacher, peer, and self-assessment of oral presentation performance correlated?

2. Research Method

2.1 Research Design

The research design is shown in Table 1. A one-group pretest–posttest quasi-experimental design was applied to investigate the effect of collaborative problem-posing strategy with self- and peer assessment on graduate students in engineering statistics courses. A total of 37 graduate engineering students from the department of engineering science at a public university in the south of Taiwan (76% men and 24% women) participated in the research. The experimental teaching lasted nine weeks.

2.2 Research Instruments

2.2.1 Oral Presentation Performance Rubric

To ensure the validity of self- and peer assessment, a rubric for evaluating oral presentation performance was developed. As shown in Table 2, the rubric included three dimensions: a theoretical foundation, problem-solving, and topic-related literature. Each dimension was rated from 1 to 10 points, with 1 being the lowest score and 10 being the highest. In addition, students evaluated the oral skills exhibited and presentation content for all three dimensions. Accordingly, a group's oral presentation performance score was the sum of the scores for the three dimensions, with a maximum score of 30 points. The scoring standard was developed by the teacher and two teaching assistants and instructions on applying the criteria were given to the students before the presentations. The students conducted group oral presentations twice. The first presentation, before the intervention, was the oral presentation performance pretest, and the second was the posttest.

Table 1. Research design

Before Intervention	Pretest	Intervention	Posttest
X1 (O1)	O2	X2 (O3)	O4

X1: Traditional approach embedded in oral presentation activities.
X2: Web-based collaborative problem-posing with self- and peer assessment embedded in oral presentation activities.
O1: First oral presentation performance.
O2: Pretest of students' motivation.
O3: Second oral presentation performance.
O4: Posttest of student's motivation.

2.2.2 Students' Motivation

In the study, a motivation scale adapted from the Instructional Materials Motivation Survey was applied to evaluate students' confidence and their level of anticipation of learning activities or material [10, 23]. The measurement used a 7-point Likert scale with nine questions. The Cronbach's α value of the scale was 0.9.

2.3 Web-based Learning System

The present research developed a problem-posing system for engaging graduate engineering students in collaborative problem-posing with self- and peer assessment that included three main functions: First, the problem-posing interface, which posed multiple-choice or open-ended questions to elicit answers, detailed explanations, and image or video uploads related to the posed questions (Fig. 1). Students used this function to pose problems based on teacher requirements. Second, the assessment function included self- and peer assessment (Fig. 2). Students assessed their own and others' problems using the system interface, providing quantitative and qualitative assessments. Third, the assessment display function displayed assessments from the problem posers and the evaluators in different forms and colors, including radar charts and word clouds (Fig. 3 and Fig. 4). Radar charts were used to display two types of quantitative

Table 2. Oral presentation performance rubric

Dimension	1–3 points	4–7 points	8–10 points
Theoretical Foundation	The presentation group is unfamiliar with the theoretical foundation of the topic(s), and their oral presentation lacks fluency and requires improvement.	The presentation group is familiar with the theoretical foundation of the topic(s), and their oral skills are fluent, with room for improvement.	The presentation group is familiar with and thoroughly understands the theoretical foundation of the topic(s) and communicates it clearly to the audience.
Problem-Solving	The exercise computation process/SPSS operating procedures/exercise solutions are confusing or incorrect and not clearly communicated to the audience.	The exercise computation process/SPSS operating procedures/exercise solutions are mostly correct and clearly communicated to the audience but could be improved.	The exercise computation process/SPSS operating procedures/exercise solutions are correct and clearly communicated in a structured manner to the audience.
Topic-Related Literature	The collected topic-related literature is inadequate or inappropriate and not clearly presented.	The collected topic-related literature is adequate and appropriate, and clearly presented, with room for improvement.	The collected topic-related literature is comprehensive and appropriate, and clearly presented in a structured manner.

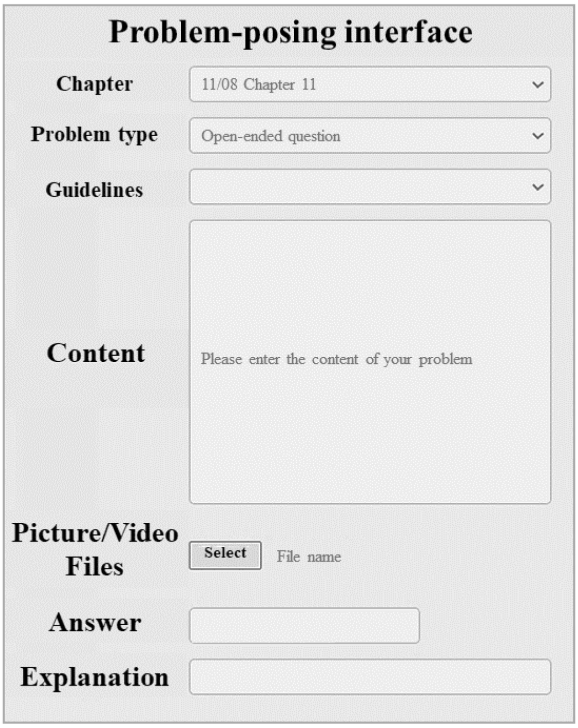

Fig. 1. Problem-posing interface.

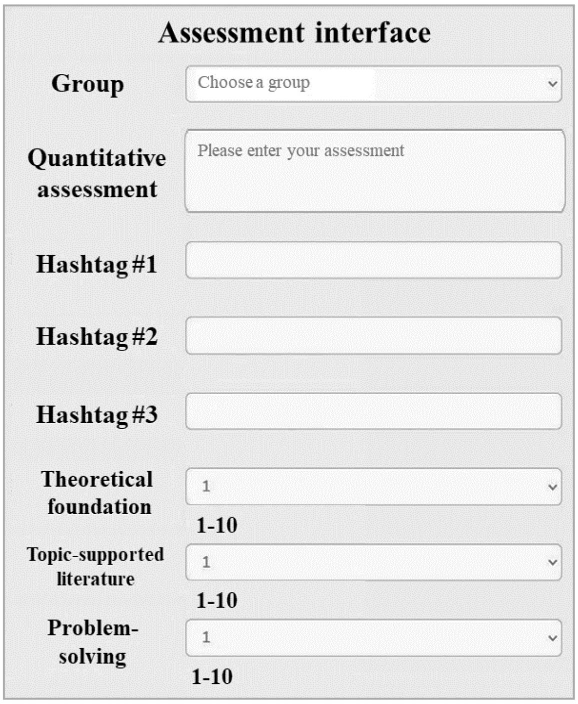

Fig. 2. Assessment interface.

assessment in two colors, providing students with a statistical comparison of their own (light grey) and peer feedback (black) to assist them in monitoring their own performance. Word clouds were used to display two types of qualitative assessment in two colors and different sizes, prompting students to compare their own qualitative evaluation (light grey) and that of their peers (black). The major functions of the system are summarized in Table 3.

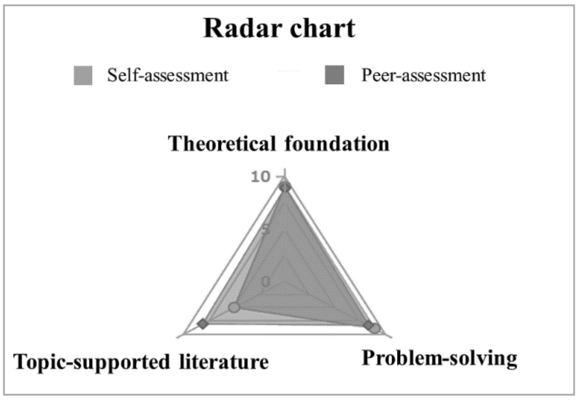

Fig. 3. Radar chart.

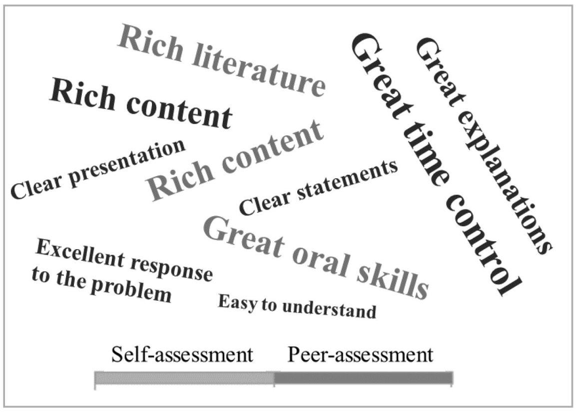

Fig. 4. Word clouds.

2.4 Instructional Design

2.4.1 Course Description

The engineering statistics course was an elective subject for graduate students in the Department of engineering science that lasted 18 weeks. The course mainly focused on the integration of statistical tools in statistical engineering problem-solving processes and taught the students how to apply learned knowledge and analysis methods to solve mathematical problems encountered in engineering research. The course was conducted using a traditional approach to oral presentation activities for 5 years, which included group oral presentations related to engineering statistics and post-presentation questions and answers.

2.4.2 Research Procedure

The research procedure is illustrated in Fig 5. A total of 37-course students were randomly divided among nine groups and assigned an oral presentation topic related to engineering statistics. Before the experimental teaching, a traditional group presentation approach with post-presentation ques-

Table 3. Major web-based learning system functions

Major function	Description
Problem-Posing	This function mainly enables users to generate their choice of multiple-choice/open-ended questions. In this interface, when the user poses a question, they have to complete the "Chapter," "Problem Type," "Guidelines," "Content," "Pictures/Video files," "Answer," and "Explanation" fields.
Assessment	This function is mainly for assessment of the posed questions, including "self-assessment" and "peer-assessment." In this interface, the user completes the "Group," "Qualitative assessment," "Hashtag #1–3," and quantitative assessment fields. The dimensions and scores in the qualitative assessments can be adjusted by the teachers.
Assessment Display	This function mainly enables the display of the received assessments in different forms and colors. Radar charts are used to display qualitative assessments in different colors for problem posers themselves and their peers. Word clouds are used to display qualitative assessment hashtag phrases in different sizes and in two different colors for phrases from problem posers themselves and their peers.

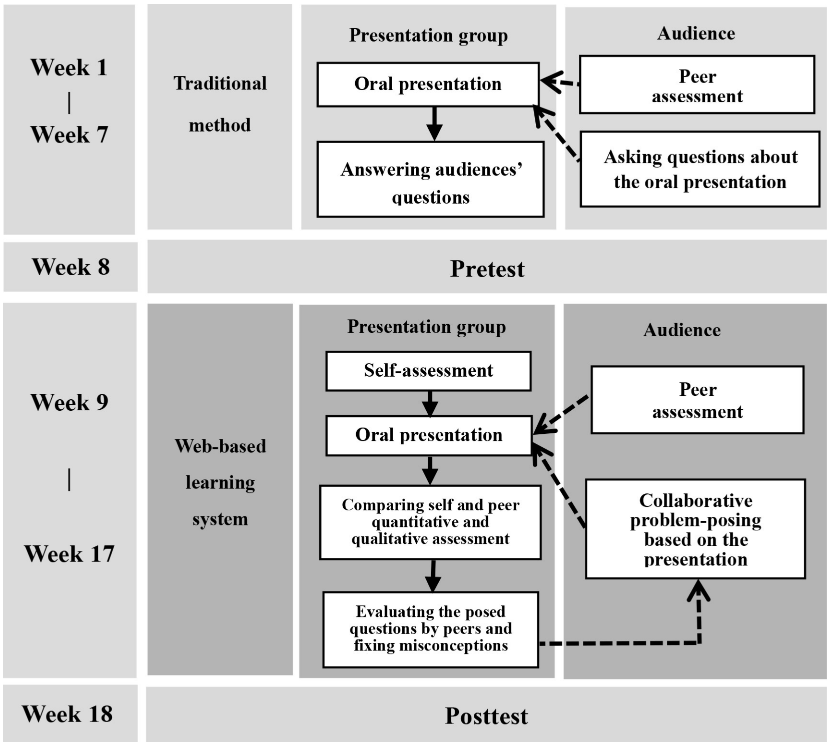

Fig. 5. Research procedure.

tions and answers was used for 7 weeks [1, 8]. The experimental teaching applied collaborative problem posing with self-and peer assessment as an instructional intervention from midterm to the end of the term (9 weeks). During the experimental teaching, the presentation groups were asked to self-assess using the oral presentation performance rubric before the presentation was conducted. During the oral presentation, other groups, which constituted the audience, evaluated the presentation quantitatively and qualitatively and collaboratively posed one problem related to the key topic of the presentation with a solution. Afterwards, the presentation group received feedback displaying a comparison of the self-and peer quantitative and qualitative assessments (presented using radar charts and word clouds), enabling a deeper understanding of their performance. Finally, the presentation group was asked to evaluate and provide feedback on the questions posed by other groups and address any audience misconceptions.

3. Results

3.1 Oral Presentation Performance

The students' oral presentation performance scores are shown in Table 4. The results of the paired sample t-test indicated that students' oral presentation performance was significantly improved after the experimental teaching of collaborative problem-posing with self- and peer assessment (t = 6.33, $p < 0.01$). In addition, the oral presentation performance rating ($d = 0.79$) exhibited a moderate effect size.

Table 4. Results of paired sample *t*-test for first and second oral presentation performance

Round	Mean	SD	*t*	*d*	diff.
First	25.05	1.06	6.33**	0.79	Second>First
Second	25.97	1.25			

*$p < 0.05$, **$p < 0.01$.
Effect sizes: $d = 0.2$–0.5 (small), $d = 0.5$–0.8 (moderate), and $d \geq 0.8$ (large).

Table 5. Results of paired sample t-test for students' motivation

Variable	Mean	SD	*t*	diff.
Pretest	43.31	7.17	0.47	n.s.
Posttest	43.89	10.00		

*$p < 0.05$, **$p < 0.01$.

3.2 Student Motivation

The student's motivation scores are shown in Table 5. The results of the paired sample *t*-test demonstrate that the students' pre- and posttest motivation did not differ significantly after the experimental teaching of collaborative problem-posing with self-and peer assessment ($t = 0.47$, $p > 0.05$).

3.3 Correlation Between Teacher, Peer, and Self-assessment of Oral Presentation Performance

3.3.1 Correlation Between Teacher and Self-assessment of Second Oral Presentation Performance

The correlation between teacher and self-assessment of the second oral presentation performance is shown in Table 6. Teacher and self-assessment of the second oral presentation performance exhibited a statistically significant ($p < 0.01$) moderate correlation ($r = 0.64$).

3.3.2 Correlation Between Teacher and Peer Assessment of the Second Oral Presentation Performance

The correlation between teacher and peer assessment of the second oral presentation performance is shown in Table 7. Teacher and peer assessment of the second oral presentation performance exhibited a statistically significant ($p < 0.01$) strong correlation ($r = 0.7$).

Table 6. Correlation between teacher and self-assessment of second oral presentation performance

Measure	Mean	SD	*r*	R^2
Teacher	25.97	1.25	0.64**	0.41
Self	27.47	1.25		

*$p < 0.05$, **$p < 0.01$.

Table 7. Correlation between teacher and peer assessment of second oral presentation performance

Measure	Mean	SD	*r*	R^2
Teacher	25.97	1.25	0.7**	0.49
Peers	25.47	1.01		

*$p < 0.05$, **$p < 0.01$.

4. Discussion

The present study investigated the effect of an innovative learning strategy using web-based collaborative problem-posing with self- and peer assessment of graduate students' oral presentation performance and motivation in engineering statistics courses. In addition, the correlation between teacher, peer, and self-assessment of oral presentation performance was examined. Some further discussions are as follows:

4.1 Oral Presentation Performance (RQ1)

The results demonstrated that the graduate engineering students' oral presentation performance was significantly improved after web-based collaborative problem-posing with self- and peer assessment embedded in oral presentation activities. The improvement of students' oral presentation performance, including the oral skills and presentation content, is supported by several studies demonstrating similar positive effects of integrated problem-posing on students' learning outcomes [44, 49, 50]. The problem poser's understanding of a topic is fundamental in problem-posing tasks [15]; thus, students in these tasks develop a deeper understanding of the subject content learned, which enhances their learning outcomes [51]. In the present study, students as the audience applied the information received from the oral presentation to construct meaningful problems and solutions collaboratively. Students who presented reflected on their presentations and addressed the audience's misconceptions and lack of clarity. The following is a question posed by an audience member with their assumed answer from a chapter on hypothesis testing with the presenter's feedback:

- Audience member's question: "Please explain why the alpha level (significance level) is mostly set at 0.05 in hypothesis testing. Are there any restrictions to the setting of the alpha level?"
- Audience member's answer: "I guess this is because of the convenience of calculation or testing or due to the type of hypothesis testing, but I am still eager to know if it can be another

value different from 0.05 under some circumstances."

- Presenter's feedback: "In fact, this is a crucial question of this chapter and the essential component of hypothesis testing! It seems like the part explaining the setting of the alpha level was not clear enough in our presentation. The significance level for hypothesis testing is generally set at 0.1, 0.05, or 0.01, with the most common value being 0.05, which means that a persuasive reason is required to adjust the level in your research. The reason for setting the level at 0.05 is not the convenience of calculation or testing or the type of hypothesis testing. If you increase the significance level from 0.05 to 0.10, it will lower the evidentiary standard. By contrast, decreasing it from 0.05 to 0.01 increases the standard. For example, in paternity testing, as a rigorous test, the level would be set at 0.01, which indicates an error rate higher than 1% is prohibited."

Both the presenters and audience members engaged more and applied more high-order skills during collaborative problem-posing than in the simple question-and-answer section of the traditional approach. This finding, although preliminary, suggests that the integration of collaborative problem-posing in oral presentation activities had educational value in providing learning benefits for presenters and audience members.

4.2 Student Motivation (RQ2)

Contrary to the results of several studies in which collaborative problem-posing strategies and self- and peer assessment enhanced student motivation or confidence [11, 49, 50], we found no statistical difference in graduate engineering students' motivation after the web-based collaborative problem-posing with self- and peer assessment embedded in oral presentation activities. A possible explanation for this is that engineering statistics is considered a difficult, complex, and unenjoyable subject for graduate engineering students, especially those with no prior knowledge of statistics [21, 33]. Some students report negative attitudes toward statistics, which is believed to be challenging to make motivating students and developing their confidence in this subject [39].

4.3 Correlation Between Teacher, Peer, and Self-assessment (RQ3)

Teacher and peer assessment of the second oral presentation performance exhibited statistically significant strong correlation. Similar findings [20, 22, 35] have indicated that peer assessment is strongly correlated with teacher assessment, which indicates the high validity of the peer assessment in the present research. Peer assessment is considered suitable for the evaluation of high-level skills, such as oral skills, and can be reliably and feasibly integrated into engineering education [16]. Using appropriate scoring rubrics, students were able to provide high-quality assessments of peers' performance that agreed strongly with those of instructors [56].

Teacher and self-assessment of the second oral presentation performance exhibited statistically significant moderate correlation. Other studies have similarly identified a moderate correlation between self- and teacher assessment that is not as strong as that between peer and teacher assessment [4, 22, 40]. This may be explained by the fact that students consider the amount of effort exerted in a task during self-evaluation, whereas teachers and peers do not. Students assess the work or performance of peers more critically because of their perspective as an outsider. It was also found that the mean self-assessment score ($M = 27.47$) was higher than the mean teacher assessment score ($M = 25.97$), which indicates that students in the study overestimated their oral presentation performance. A possible explanation is that the students may have considered their efforts and the cost of preparation for the oral presentation, which was a complex and difficult task. This finding, although preliminary, suggests that students may experience difficulty in evaluating themselves objectively and critically, especially in a complex learning task or regarding intangible skills such as oral skills.

4.4 Limitations and Future Research

The first limitation of the present research is that no comparison group was studied. The lack of a comparison group limited the experimental design of the study to a one-group pretest–posttest quasi-experimental design. The disadvantage of this design is that the determination of the improvement attributable to the experimental procedures, intervention, or treatment lacked robustness [3]. Future research should consider including a comparison group to compare different learning strategies and determine the relative effectiveness of web-based collaborative problem-posing with self- and peer assessment.

A collaborative problem-posing approach with self- or peer assessment is considered beneficial for students' learning [29, 49]. Nevertheless, this is the first study to integrate web-based collaborative problem-posing with self- and peer assessment into engineering courses, especially for oral presentation activities, which lacks prior research to support the effectiveness of this innovative learning strategy on students' learning. This study demonstrates the positive impact on students' learning of the strategy in the engineering field. Web-based collaborative problem-posing with self- and peer assessment could be applied to different learning activities in engineering in future research, which would provide more evidence regarding the learning benefits of the new strategy.

5. Conclusion

In response to the limited number of integrated collaborative problem-posing strategies in engineering education, especially in oral presentation activities, the present research systematically integrated web-based collaborative problem-posing with self- and peer assessment in an engineering statistics course and examined its effect on graduate engineering students' oral presentation performance and motivation. Our finding demonstrated that collaborative problem-posing with self- and peer assessment embedded in oral presentation activities enhanced students' oral presentation performance. In addition, peer assessment of oral presentation performance was correlated strongly with teacher assessment, which indicated that peer assessment is a reliable nontraditional assessment method that warrants application in evaluating high-order skills in engineering education. The findings of the study, although preliminary, may provide validation of a new learning strategy for student oral presentations in engineering courses at higher educational institutions.

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