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Research Article

Peer-Based Learning as a Method of Enhancing the Problem-Solving Performance of Marine Transportation Students

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ABSTRACT

The study aimed to evaluate the effect of peer-based learning on the problem-solving skills of students in marine transportation, providing evidence-based suggestions for the development of maritime curricula. During the second semester of the 2024–2025 academic year, 80 third-year students enrolled in SEAM 6 (Trim, Stability, and Stress of a Vessel) at the College of Maritime Education, Dr. Yanga's Colleges, Inc., participated in the true experimental design. Participants were randomly assigned to either a peer-based learning group or a conventional individual learning group. Validated problem-solving activities were employed to collect data, and t-tests were used in the statistical analysis to identify performance differences between groups. Results showed that students who engaged in peer-based learning consistently performed better than those in the traditional learning group, as seen by their noticeably higher exercise scores, according to the data. The t-test results highlighted the practical value of the findings by confirming statistical significance and demonstrating a significant effect size. A training program was created in response to these findings to encourage the incorporation of peer-based teaching techniques in skill-based marine courses. These findings provide empirical evidence for the implementation of cooperative learning methodologies in maritime training programs, demonstrating their effectiveness in technical education. By highlighting how peer engagement improves student comprehension, skill development, and overall competency, the study advances educational philosophy. Practically, peer-based learning can promote improved performance in technical topics and a deeper grasp of the material. Future research is recommended to investigate the impact of peer-based learning on information retention.

Keywords: *Problem Solving, Peer-based Learning, Performance, Marine Transportation*

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Background

Collaborative learning strategies are crucial, as evidenced by the global movement in pedagogy from teacher-centered to learner-centered approaches. This change reflects broader educational reforms that prioritize communicative competence, critical thinking, and student autonomy over the transmission of passive knowledge. Group work is one of these tactics that is becoming increasingly acknowledged as a potent teaching method, encouraging participation, peer interaction, and deeper learning (Asrida & Aksari, 2025). According to Duka-Pante (2021), students' knowledge and life skills can be effectively developed through a peer-facilitated approach. Peers can convey delicate topics like substance abuse and mental health in a non-threatening and easier-to-understand manner (Hasel et al., 2016, as cited by Tamayo et al., 2024)

Hence, offering plenty of opportunities for experiential learning, activity-based learning encourages students to participate actively in class. Opportunities and the best possible learning environment should be given to students so they can develop their knowledge and abilities. It would increase knowledge of ideas and theories in their most fundamental forms. It engages students more and improves learning (Kanchana, 2019).

Similarly, the researchers aim to introduce peer-based learning to marine transportation students in problem-solving related to a vessel's trim, stability, and stress. As stated by Laia et al.'s (2022) study, adopting differentiated instruction aligns with satisfying students' various learning needs. Peer-based learning occurs when a group of students collaborates to learn or solve a problem. Peer groups can achieve levels that individuals could not have attained on their own, with the assistance of students who are more proficient in higher-level thinking or argumentation. Moreover, peer interaction is beneficial for learning mathematics, as indicated by some empirical data cited by Shyr et al. (2021).

Additionally, empirical evidence suggests that peer interaction has benefits for mathematics learning. It was then found that mathematics learning was enhanced when peers gave explanations and asked each other questions. Such a process also enables students to clarify concepts and reorganize their thinking. Similarly, this study aims to determine whether peer-based learning in computing, trim, stability, and vessel stress can significantly affect the problem-solving performance of marine transportation students. Consequently, a development program for the college was proposed based on the results of the study.

As stated by many experts, education helps pupils develop their ability to think critically, use reason, and solve problems. Akhdinirwanto et al. (2020) noted that problem-solving is an activity that involves deciding which course of action is most suited to one's abilities, which entails moving from the current situation to the desired one. Additionally, Ince (2018) stated that problem-solving is characterized as an individual's ability to manage a problem. It can also be described as the procedure required to bridge the gap between the intended and actual circumstances in a situation influenced by previously observed or previously unknown variables. Furthermore, problem-solving necessitates building knowledge to address challenges and may require applying specific tactics to mitigate unfavorable circumstances.

Furthermore, the cognitive process of problem-solving involves finding solutions to complex or challenging problems. It is an essential skill applied in various settings, including the workplace, daily life, and educational institutions. According to Schunk (2012), problem-solving is the culmination of a person's endeavors to achieve an objective without a solution. Likewise, Cinar (2019) noted that it is one of the most significant cognitive processes that regularly occur throughout learning.

However, the marine transportation students experienced difficulties with problem-solving related to trim, stability, and stress computation during cargo operations. Based on the initial interviews with former students who took this subject, they mentioned that it's hard to do the computations alone. Hence, the researchers aim to help marine transportation students improve their performance in Advanced Trim, Stability, and Stress (SEAM 6) by introducing a novel learning method.

Collaborative learning initiatives can include systematic evaluations of implementation challenges, helping identify practical solutions and best practices for broader adoption in maritime education. Hence, expanding peer-based learning models to other courses and academic disciplines allows researchers to explore their adaptability and affect in varied educational environments, potentially establishing them as a universally beneficial pedagogical strategy.

Thus, this study aims to assess whether peer-based learning is an effective method for enhancing the problem-solving performance of students in marine transportation. Specifically, it sought to answer the following subsidiary questions: [1] What is students' performance in traditional and peer-based learning? [2] Is there a significant difference between traditional and peer-based learning? [3] Does the peer-based learning method of problem-solving significantly affect the performance of marine transformation students? and [4] What program training/workshop may be proposed based on the result of the study?

Hypotheses of the Study

There is no significant difference in the problem-solving performance of marine transportation students using traditional and peer-based learning.

The Peer-based learning method has no significant effect on the problem-solving performance of students in marine transportation.

Literature Review

The study is grounded in the experiential learning model, which was developed by David A. Kolb and Ron Fry in the early 1970s, building on the ideas and theories of John Dewey, Jean Piaget, Kurt Lewin, and others to create a paradigm for learning experiences (Pinasti, 2023). According to Rahmi (2024), experiential learning is a method of education in which experience is transformed into knowledge and understanding. Kolb asserts that learning is a continuous, interrelated process with four major stages. This approach to education is holistic since it incorporates aspects of constructivism, behaviorism, and cognitivism.

Peer-based learning

The transmission model, which places teachers at the top of the classroom hierarchy, is no longer the foundation of teaching theories; instead, the transactional model, in which students learn in groups and pairs with the assistance of their peers (Jeyasala, 2016). Similarly, students should be able to learn to prepare the next generation. If learning is motivated by interests, it will be maximized. Students should be given the opportunity to take charge of their own education. Innovative learning techniques and self-regulated learning behaviors are crucial for fostering enhanced engagement and achieving lifelong success (Kanchana, 2019).

Murphy et al. (2024) note that creating an environment that facilitates the optimal delivery of the material is challenging, as the instructor must manage both the new mode of content delivery and any social or behavioral issues that may arise in the classroom. Since traditional classroom instruction involves a continuous process within the same walls and boards, it will become monotonous or boring over time. Giving students more options for studying encourages them to take greater responsibility for their education (Kanchana, 2019).

Peer-based learning is a cooperative educational approach where one or more peers, such as students, guide the group's (or class's) learning. Peer-to-peer learning has enhanced learning outcomes, allowing students to practice lifelong skills such as teamwork and communication (Murphy et al., 2024). The peer support group approach, as described by Kumar et al. (2018) and Janmohamed et al. (2020), is a popular community-based tool for educating rural women about nutrition relevant to their specific area and enhancing their ability to adopt healthier eating habits. The size, makeup, methods, and focus areas of peer groups vary. People with similar situations—in health and nutrition programming, typically women of reproductive age—gather in these groups to share stories, access resources, and build social networks, knowledge, and skills. The fundamental idea is peer-to-peer education to spread health-related attitudes and information, including social support (Pieterse et al., 2020).

Peer interaction can enhance students' motivation and interest, helping them explore different ideas in depth and improve their learning outcomes (Qureshi et al., 2023). Similarly, the findings of Woodward and Pattinson (2023) suggest that, although thematically directed peer learning is not commonly observed, certain students participate in peer learning more frequently than others across various themes and contexts. assistance on understanding topic literature is the most powerful content-based theme of two-way peer-learning; assistance on business environment characteristics, such as economics, is the weakest. Based on reports, group assessment work and in-class activities are the best environments for peer learning. Therefore, increasing the use of in-class activities that call for peer and collaborative learning is the primary teaching proposal. More open investigations of student peer interaction, where students can identify noteworthy in-class experiences and occurrences, are among the primary suggestions for additional research.

Korhonen et al. (2027) state that rich pedagogies would include practice-focused, collaborative, and inquiry-based approaches that build on the critical and reflective foundations established in the first phase and draw from the educational legacy of social constructivism. In the study by Abdelhamid and Stower (2022), it was found that students employed the Feynman style to create videos explaining concepts, and they could offer helpful criticism of each other's videos. Also, the instructor moderates the content and gives students digital badges as rewards for their participation and interactions. Their contributions to the study include a novel framework based on activity and incentive theories that promote students' learning, engagement, and motivation. Additionally, the study's results, as reported by Auer et al. (2024), suggest that peer groups addressed the information, interpersonal assistance, and observable changes in the lives of some members. The experiences that the participants shared were largely pleasant, encouraging behavior modification, and maintaiing involvement. They emphasized interactive facilitation, group dynamics, and community recognition as factors that enhance the motivation and trustworthiness of group facilitators. More experiential learning to promote involvement and increased family engagement could enhance implementation. Localizing group activities can help address factors that influence behavior change and make them more pertinent to the needs of participants. According to Suyatna and Suana's (2014) study, when diversified learning is not employed, teachers struggle to adapt to their students' diverse learning styles, which in turn reduces their problem-solving capacity. Additionally, the study findings of Sari et al. (2021) demonstrated that the problem-based learning model significantly improved students' scientific writing and problem-solving abilities, and that students' scientific writing abilities were also significantly impacted by problem-based learning and problem-solving abilities.

Furthermore, the findings of Klang et al. (2021), showed that the intervention had a significant impact on students' performance in both general and geometry problem-solving. On the chosen tests of mathematical problem-solving, the children who scored higher on friendships and social acceptance on the pre-test also performed better. Therefore, in diverse classes, the cooperative learning technique may improve students' ability to solve mathematical problems, but friendships and social acceptance may also significantly influence students' performance.

Problem-solving

The term' problem-solving skills' describes the capacity to recognize difficulties, evaluate circumstances, devise potential solutions, and implement those solutions to overcome barriers. These abilities include logical reasoning, critical thinking, creativity, and decision-making. Individuals and organizations that possess strong problem-solving abilities are better equipped to handle challenging situations, adapt to changing conditions, and achieve their objectives efficiently. Because it fosters innovation, yields improved results, and promotes ongoing development, effective problem-solving is highly regarded in both academic and professional settings.

Problem-solving abilities can be significantly enhanced when students engage in structured learning processes that guide them

through critical thinking and the development of solutions. Nayazik (2017) and Widiawati et al. (2018) underscore that problem-solving is a fundamental element of the curriculum and warrants intentional emphasis during instruction. Cultivating these abilities not only promotes active learning, but also encourages students to generate thoughtful responses—even when questions are presented in varying formats. Moreover, strong problem-solving skills empower students to effectively overcome the obstacles they encounter during their learning journey. In this context, Sari et al. (2021) highlight that problem-based learning plays a vital role in fostering higher-order thinking, expanding knowledge, and cultivating independence and self-confidence as students confront and resolve challenges.

Moreover, learning in the twenty-first century emphasizes the development of problem-solving skills. To elaborate on the difficulties, a higher level of education requires a deeper understanding of a more systematic concept. One of the basic cognitive functions is the ability to solve problems. To find answers or concepts, higher-order thinking is required. Additionally, problem-solving skills motivate students to apply higher-order thinking abilities, enabling them to make connections between facts and existing concepts to generate multiple solutions for addressing problems (Armanda et al., 2021). The efficiency of problem-solving is influenced by higher-order cognitive abilities (Yurniwati & Soleh, 2020).

Likewise, Lu and Xie (2024) noted that the ability to solve problems is crucial for education, employment, and everyday living in our rapidly evolving society. Effective and meaningful learning is achieved through problem-solving, a fundamental strategy that encompasses cognitive processes and tactics such as creating and manipulating representations, analyzing data, identifying reasons, creating plans, and finding answers. Consequently, from elementary to university education, problem-solving skills are deemed crucial in numerous topic areas within formal educational environments. Numerous studies have been conducted on problem-solving, beginning with the examination of problem-solving exercises as both measured variables and treatment measures. It is typically conducted using mixed methodologies, experimental research, or occasionally a qualitative examination of the curriculum for problem-solving.

Methodology

Research Design

According to Matilla et al. (2021), experimental research is a scientific method used to investigate causal correlations between variables. An actual experimental design was used in the investigation. It is frequently used in assessments of educational programs when random assignment is not possible or practical (Gibbons & Herman, 2019). This entails assigning individuals to various groups at random and altering the independent variable to see the impact on the dependent variable. Researchers can determine causal correlations using these designs (Em, 2024). Experimental research is a scientific method used to investigate cause-and-effect connections between variables (Matilla et al., 2021). An actual experimental design was used in the investigation. It is frequently used in assessments of educational programs when random assignment is not possible or practical (Gibbons & Herman, 2019). Participants will be randomly assigned to different groups, and the independent variable will be manipulated in order to assess its effect on the dependent variable. These designs allow researchers to determine what causes what (Em, 2024).

In the study, one group of students was taught the subject (SEAM 6) using the traditional method while the other group implemented the peer-based learning method. After completing the lessons, an examination was given to both groups.

Respondents of the Study

The respondents of the study are 120 third-year Bachelor of Science in Marine Transportation (BSMT) students at the College of Maritime Education in Dr. Yanga's Colleges (Main Campus), Bocaue, Bulacan. The study will be utilizing the total sampling method. Total sampling is a method that involves selecting the same number of samples as the total population (Sugiyono, 2008, as cited in Susmadiana et al., 2021).

Instrument of the Study

The researchers utilized researcher-made problem-solving activities on Advanced Trim, Stability, and Stress (SEAM 6). The problem-solving activities were carefully reviewed and checked by experts in the field, including a faculty member from the College of Maritime Education at DYCI, who also served as a deck officer, a full-pledge professor at a university, and a researcher. Their feedback helped ensure that the activities were accurate, practical, and suitable for the students' learning needs. Results of the exam were quantified using the Likert scale as follows: (96-100, Outstanding; 91-95, Very Satisfactory; 86-90, Satisfactory; 81-85, Fair; 75-80, Needs Improvement).

Statistical Analysis

The study used an independent t-test to determine if there is a significant difference in the problem-solving performance of marine transportation students between the two groups. According to Akpan et al. (2023), using an independent t-test is crucial for evaluating the efficacy of interventions, instructional strategies, and educational policies, as it provides educators and researchers with evidence-based methods to enhance learning outcomes. On the other hand, regression analysis was utilized to determine the significant effect of peer-based learning on students' problem-solving performance. Regression analyasis is a statistical method for modeling and analyzing the connection between a single dependent variable and several independent variables. This process is widely used to examine the cause-and-effect relationship between variables, assess time series models, and create estimates and forecasts based on empirical data (Tyagi et al., 2022).

Result and Discussion

1. Students' Performance in Traditional and Peer-Based Learning

Marine transportation students in the traditional learning condition (M = 77.38, SD = 14.36) exhibited a median score of 75 with an interquartile range from 75 to 88. Scores spanned from a low outlier of 0 to a high of 95, indicating greater dispersion and the presence of at least one extreme low performer. In contrast, students in the peer-based condition (M = 90.73, SD = 11.69) achieved a median of 100 and a narrow IQR of 100–100, with scores ranging from 75 to 100. This pattern suggests not only higher central tendency under peer-based learning but also markedly reduced variability—most students achieved near-perfect scores when collaborating.

Table 1. Descriptive Statistics for Exercise Scores by Learning Condition

Condition	n	M	SD	Median	IQR	Min	Max
Traditional (no collaboration)	40	77.38	14.36	75	75–88	0	95
Peer-based (collaboration)	40	90.73	11.69	100	100–100	75	100

Note. IQR = interquartile range.

Results suggest that peer-based learning produces significantly superior and more consistent outcomes than traditional methods. Although the traditional group exhibited a greater degree of variability and even extremely low scores, the peer group consistently achieved high results, albeit with a ceiling effect that restricted differentiation among the best performers. Overall, it seems that collaboration significantly improves problem-solving abilities; however, future evaluations may require a greater degree of difficulty to accurately capture individual distinctions at higher levels of achievement.

These findings reinforce that peer-based learning substantially elevates and harmonizes problem-solving performance: the traditional group's wider spread and lower central scores contrast with the peer group's consistently high outcomes. Klang et al. (2021) similarly demonstrated that the intervention had a substantial effect on the problem-solving abilities of students in both general and geometry. Students who scored higher on the pre-test in terms of social acceptability and friendships also performed better on the selected mathematical problem-solving tests. In diverse classes, the cooperative learning technique may enhance students' capacity to solve mathematical

problems; however, students' performance may also be substantially influenced by their social acceptance and friendships.

2. Difference of Performance between Traditional and Peer-Based Learning

An independent-samples t-test was conducted to compare exercise scores for marine transportation students in the traditional (no collaboration) and peer-based (collaborative) learning conditions. There was a significant difference in scores between the traditional condition (M = 77.38, SD = 14.36, n = 40) and the peer-based condition (M = 90.73, SD = 11.69, n = 40), t(78) = −4.56, p < .001, two-tailed. Cohen's d was calculated to be 1.02, indicating a large effect size.

Table 2. Independent Samples t-Test Results for Exercise Scores by Learning Condition

Outcome	t	df	p	Cohen's d
Exercise Score	−4.56	78	< .001	1.02

Note. t(78) = −4.56, p < .001, two-tailed; Cohen's d = 1.02.

The same t-test demonstrates a large effect of peer-based learning on exercise scores (Cohen's d = 1.02). Given p < .001 and a large effect size, the researchers reject Hypothesis 2. This provides strong evidence that the peer-based learning method has a meaningful and positive effect on students' problem-solving performance. These results suggest that peer-based learning significantly enhances problem-solving performance compared to traditional individual learning. The large effect size underscores the practical importance of collaborative methods for improving both proficiency and consistency in exercise outcomes among marine transportation students.

The t-test results demonstrate that peer-based learning yields substantially higher exercise scores than traditional individual learning, with a large effect size indicating both practical and statistical significance. This implies that collaboration significantly improves the problem-solving abilities of students, rendering it a more effective method for enhancing proficiency and guaranteeing more consistent outcomes among marine transportation students.

Likewise, the empirical data cited by Shyr et al. (2021) indicate that peer interaction is advantageous for the acquisition of mathematics. Additionally, empirical evidence supports the advantages of peer interaction in the context of mathematics education. It was subsequently discovered that mathematics learning was improved when peers provided explanations and posed queries to one another. Students are also able to reorganize their thinking and elucidate concepts through this process.

3. Effect of Peer-based Learning Method of Problem-Solving Towards the Performance of Marine Transportation Students

The finding that peer-based learning yields significantly higher and more consistent problem-solving performance has several important implications for the design and delivery of marine transportation curricula. First, incorporating structured collaborative exercises into existing courses may accelerate skill acquisition by allowing students to articulate reasoning strategies, receive immediate feedback from peers, and observe alternative approaches to complex stability and stress problems. Such interactions align with social constructivist theories, which posit that knowledge is co-constructed through dialogue and reflection (Vygotsky, 1978).

Second, the reduced variability in scores under the peer-based condition suggests that collaborative formats can help lower-performing students "catch up" by leveraging the knowledge and problem-solving heuristics of more proficient peers. This egalitarian effect may enhance overall cohort competence and reduce achievement gaps, a particularly valuable outcome in safety-critical fields such as marine transportation.

Third, because the peer-based method demonstrated both statistical and practical significance (d = 1.02), institutions should consider investing in faculty development workshops that train instructors to facilitate effective peer learning. Key workshop components might include: (a) designing clear problem-

solving roles within groups, (b) structuring peer-feedback prompts, and (c) monitoring group dynamics to ensure equitable participation.

Finally, curriculum committees could pilot a "Peer Collaborative Problem-Solving" module in capstone navigation or stability courses, assessing long-term retention and transfer to real-world simulation tasks. If sustained benefits are observed, accreditation bodies and industry partners may recognize peer-based learning as a best practice, thereby further embedding collaborative methods into marine training standards. These steps can help ensure that future officers not only master technical concepts but also develop the teamwork skills essential for safe and efficient vessel operations.

Similar to the study's findings of Sari et al. (2021), where it was illustrated that the problem-based learning model had a substantial impact on the scientific writing and problem-solving abilities of students, and that these abilities were significantly influenced by both the problem-based learning and problem-solving.

4. Proposed Workshop

Based on the demonstrable benefits of peer-based learning for problem-solving performance, the researchers propose a faculty-led "Collaborative Problem-Solving Workshop" designed to equip instructors with the skills and materials necessary to implement structured peer learning in marine transportation courses. The workshop would consist of the following components:

Workshop Overview and Learning Objectives

Main Objective. Enable instructors to design, facilitate, and assess peer-based problem-solving activities that maximize student engagement, consistency, and mastery of technical content.

Specific Objectives. By the end of the workshop, participants will be able to:

a) Articulate the theoretical foundations of peer learning (e.g., social constructivism).
b) Develop clear, role-based group tasks for stability and stress exercises.
c) Create peer-feedback prompts and rubrics aligned with course learning outcomes.
d) Monitor and scaffold group dynamics to ensure equitable participation.
e) Evaluate student performance using both quantitative (scores, variance) and qualitative (self-reflection, peer evaluation) measures.

2. Workshop Structure and Content

Table 2. Program Structure

Session	Duration	Content & Activities
I. Foundations of Peer Learning	1.5 hr	• Brief lecture on social constructivist theory • Review of study findings ($t(78)=-4.56$, $p<.001$; $d=1.02$) • Group discussion: benefits & challenges
II. Designing Collaborative Tasks	2 hr	• Hands-on small-group work to draft "Advance Trim Stability" problems with assigned roles (e.g., Analyst, Checker, Reporter) • Peer critique of task designs
III. Crafting Effective Feedback	1.5 hr	• Demonstration of feedback prompts and rubrics • Practice in pairs: using rubrics to deliver constructive feedback

3. Materials and Resources

1) **Instructor Guidebook.** Background theory, example tasks, rubrics, and troubleshooting tips.
2) **Slide Deck.** Ready-to-use presentations summarizing key concepts and data from the study.
3) **Template Package:**
   a) Problem-solving worksheets with role assignments
   b) Peer-feedback forms
   c) Self-reflection journals

4. Follow-Up and Evaluation

1) Two one-hour virtual check-ins at Weeks 2 and 6 to address implementation challenges.
2) Online forum for instructors to share experiences, materials, and student outcomes.
3) Collection of student score data (pre-/post-implementation), paired with qualitative reflections, to evaluate impact and refine the workshop in subsequent semesters.

Conclusions

The results of this study indicate that peer-based learning outperforms traditional solo techniques in helping students enhance their problem-solving abilities. In addition to enhancing overall performance, collaborative learning fosters consistency among students, indicating a deeper and more thorough comprehension of the subject matter. The evidence unequivocally demonstrates that collaborative tactics greatly improve academic performance for students in maritime transportation, despite the evaluation instrument's potential limits as indicated by the ceiling effect. Therefore, it is strongly recommended to utilize peer-based learning strategies to foster a deeper understanding and mastery of skills in this area.

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