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The effect of blended and traditional learning on students' entrepreneurial learning outcomes: A quasi-experimental study

Nazarwin Nazarwin [1,*], Yunia Wardi [1], Rino Rino [1], Abror Abror [1], Riki Wanda Putra [1], Deby Tri Mario [2]

[1]*Faculty of Economics and Business, Universitas Negeri Padang, Padang, Indonesia*
[2]*Faculty of Health Sciences, Universitas Teuku Umar, Meulaboh, Indonesia*

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ABSTRACT

This study aims to analyze the effectiveness of blended learning compared with traditional learning in improving students' entrepreneurial learning outcomes in maritime vocational education. The study employed a quasi-experimental design with a nonequivalent control group, involving 50 students divided into a blended learning group (n = 25) and a traditional learning group (n = 25). Instruction was conducted over one semester in 16 sessions, each consisting of 2 credits (2 × 50 minutes). The results showed that both groups experienced significant improvements in learning outcomes, but the improvement was greater in the blended learning group. The blended learning group showed a very large effect size (d = 5.094), while the traditional learning group had an effect size of 3.011. A comparison of posttest scores also revealed a significant difference between the blended learning and traditional learning groups (t = 12.290; p = 0.001; d = 3.478). Furthermore, students' perceptions of blended learning were very positive, with 82.40% of students falling into the "very good" category. These findings provide empirical evidence that blended learning may be more effective than traditional methods in entrepreneurship education, particularly in the context of maritime vocational education.

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1. Introduction

Nowadays, information and communication technology has advanced rapidly, leading to significant transformations in teaching practices at the university level. One form of these advances is e-learning, a learning approach that uses the internet, gadgets, and software to support the teaching process (Aboagye et al., 2021; Moore et al., 2011). Many scholars have reported the widespread adoption of e-learning in education. Generally, it is not intended as a replacement, but serves as both an alternative to and a complement to conventional face-to-face learning (Alajmi et al., 2020). Previous studies on e-learning generally compare e-learning with its traditional counterpart, investigate their impact, and explore the advantages and limitations of each approach (González-Gómez et al., 2016; Northey et al., 2015; Ryan et al., 2016; Wang, 2010).

Although e-learning has been reported to potentially improve student learning outcomes (Jose and Jose, 2022), its effectiveness compared to conventional learning remains a subject of debate. Some studies reveal that students still prefer face-to-face learning because it allows for direct communication, fosters more intense interpersonal interaction, and uses conventional learning resources that are considered easier to understand (Paechter and Maier, 2010). These limitations have led to the emergence of the blended learning approach, which integrates online and face-to-face learning into a single, systematic, and structured instructional design. This approach is believed to bridge the gap between online and traditional learning while optimizing the use of technology in higher education.

Blended learning has various implementation models, such as flexible, distributed, decentralized, and hybrid (Leidl et al., 2020). Instructors tend to adopt this approach because it is considered capable of enhancing students' learning experiences and promoting more student-centered learning. In this context, blended learning is seen as having the potential to foster greater learning autonomy compared to traditional learning. However, students' readiness to accept and adapt to blended learning

* Corresponding Author.
Email Address: erwinnazar15@gmail.com (N. Nazarwin)
https://doi.org/10.21833/ijaas.2026.10.019
Corresponding author's ORCID profile:
https://orcid.org/0009-0005-2056-457X
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remains a crucial issue. According to Adams et al. (2018), students' readiness is a determining factor in the successful implementation of blended learning in higher education. This readiness consists of technological skills, motivation to learn, and attitudes toward the use of e-learning and blended learning.

Although the literature on e-learning and blended learning continues to grow, the available findings are still inconsistent, especially regarding the advantages of blended learning over face-to-face instruction. Some studies report improvements in learning outcomes and student engagement, while others indicate no significant differences. Ellison and Wu (2008), for example, found no significant difference in students' writing skills between using blogs and conventional paper-based writing methods. Other studies reveal that students often face challenges in adapting when transitioning from face-to-face learning to online learning, particularly at institutions with limited technological infrastructure and low computer literacy (Panyajamorn et al., 2018). On the other hand, Al-Azawei et al. (2017) reported that variations in students' psychological conditions do not always have a significant effect on their level of satisfaction with e-learning. These varied findings suggest that the advantages of blended learning cannot be viewed as an automatic consequence of technology use, but are likely related to pedagogical design, student readiness, the quality of digital content, institutional support, and course characteristics. This context becomes particularly important when blended learning is applied to specific subject areas, such as entrepreneurship education, where learning outcomes may cover not only knowledge but also skills, attitudes, and entrepreneurial intentions.

In entrepreneurial education, researchers use a variety of indicators, such as business knowledge and skills, entrepreneurial attitudes, and entrepreneurial intention. Dobson and Muhammad (2022) also showed that entrepreneurship education can influence students' entrepreneurial intentions. The diversity of these indicators suggests that entrepreneurial learning outcomes are a multidimensional construct; therefore, comparisons of the effectiveness of learning models must consider clearly defined learning outcome indicators aligned with the learning objectives.

Although research on blended learning and entrepreneurship education has attracted a growing interest, empirical evidence regarding the effectiveness of blended learning in vocational education, particularly maritime vocational education in Indonesia, remains limited. This is significant because vocational education typically requires a connection between knowledge mastery, analytical skills, and the application of concepts in professional contexts. Previous research has demonstrated the potential of blended learning to improve learning outcomes in various higher education contexts (González-Gómez et al., 2016). However, they mostly focus on general theoretical courses or technology-based learning in a broad sense. Therefore, more specific empirical evidence on how blended learning can be implemented in entrepreneurship education is still needed, especially within the maritime vocational education setting.

The potential of blended learning to support learning outcomes can be further understood from the perspectives of constructivism and self-directed learning to explain the mechanisms by which blended learning enhances student learning outcomes. Constructivism views learning as an active process involving students' experiences, interactions, and engagement in constructing knowledge. In blended learning, this principle is realized by combining face-to-face instruction and technology-based activities (Adigun et al., 2025). Meanwhile, self-directed learning emphasizes students' ability to independently direct, manage, and take responsibility for their own learning process, which can be supported by the availability of learning resources and technology-based communication. These perspectives provide a foundation for the idea that blended learning can create active, flexible learning experiences that foster student autonomy, thereby potentially improving learning outcomes in entrepreneurship.

Based on this review, this study aims to analyze the impact of blended and traditional learning approaches on entrepreneurship learning outcomes among students in maritime vocational education. This study is expected to provide an empirical contribution to enrich the literature on blended learning in vocational education and serve as a basis for developing more effective entrepreneurship learning strategies in higher education institutions.

The research hypotheses are formulated as follows: (a) There is a significant improvement in the entrepreneurship learning outcomes of students in the blended learning group after completing the course compared to their initial abilities; (b) There is a significant improvement in the entrepreneurship learning outcomes of students in the traditional learning group after completing the course, compared to their initial abilities; (c) There is a significant difference in entrepreneurship learning outcomes between students in the blended learning and traditional learning groups after one semester of instruction; and (d) Students in the blended learning group demonstrate a high level of positive response to e-learning as an online learning medium.

2. Literature review

2.1. Blended learning

This section begins by defining what blended learning really means. This concept is often described as an educational approach characterized by a combination of face-to-face and online learning processes to make the learning experience more flexible and effective. This approach allows students to access course material through various

complementary learning modes. Hence, the learning process can be potentially more engaging and effective (Anthony et al., 2022).

Recent studies often associate blended learning with student psychological and academic domains. Han (2025), for example, found a positive relationship between blended learning and student engagement, academic motivation, and student learning outcomes. These findings suggest that combining online and face-to-face learning can create a more interactive learning experience that encourages greater engagement.

However, findings of the above studies should be treated carefully because current empirical evidence is not entirely consistent. Previous scholars believe that the advantages of blended learning cannot be viewed as an automatic consequence of technology use. Ellison and Wu (2008), for example, found no significant difference in students' writing skills between using blogs and conventional paper-based writing methods. Similarly, various studies indicate that students may face difficulties adapting to an online learning environment, particularly when they have limited access to technological infrastructure, limited digital literacy, or a lack of readiness to learn (Panyajamorn et al., 2018). Thus, differences in research findings are likely related not only to the choice between online and face-to-face learning but also to how online components are designed, integrated, and utilized in the pedagogical process.

A critical review by Anthony et al. (2022) showed that blended learning is often affected by several factors, such as technology, institutional readiness, and pedagogical strategies. It is generally characterized by flexibility. Müller and Mildenberger (2021) showed that partially replacing face-to-face time with online learning can provide flexibility without compromising learning quality. However, this flexibility may yield different benefits if students do not yet possess adequate self-regulated learning skills. Anthonysamy et al. (2020) demonstrated that self-regulation is important in determining student success in adopting blended learning environments.

Arguably, blended learning is a potential approach, but the literature indicates that its effectiveness is contextual. This approach can be beneficial when the online and face-to-face components are pedagogically designed and complementary. However, its benefits may weaken when technology is used solely as a medium for distributing course materials without involving meaningful learning activities. Student individual factors, the quality of instructional design, institutional support, and course characteristics need to be considered when comparing blended learning with fully face-to-face learning.

Thus, although there is a body of evidence supporting blended learning, the extent to which these advantages apply in the context of specific courses and different educational environments is still not well established. These limitations are particularly relevant in vocational education, especially in entrepreneurship courses that require not only conceptual mastery but also the ability to analyze opportunities and apply concepts in business situations.

2.2. Traditional learning

Traditional learning is an approach long used in higher education and generally focuses on face-to-face interaction between instructors and students in the classroom. In this approach, the learning process may involve lectures, class discussions, and direct instruction (Xu and Xu, 2020). This learning model provides opportunities for instructors and students to interact directly during the learning process.

Several studies indicate that traditional learning positively contributes to students' academic achievement, particularly in environments that emphasize direct interaction and instructor feedback (Seaba, 2021). The physical learning environment is essential as it also influences the dynamics of interaction, student participation, and learning effectiveness (Papaioannou et al., 2023). When given an appropriate learning environment, Xu and Xu (2020) demonstrated that face-to-face learning fosters social interaction, collaboration, and hands-on learning experiences.

Nevertheless, the literature does not support the conclusion that traditional learning is always inferior or superior to technology-based learning. Vallée et al. (2020), for example, showed that blended learning has certain advantages in medical education, while traditional learning continues to play a role in supporting conceptual understanding. This suggests that the effectiveness of a learning approach may depend on the characteristics of the material, pedagogical strategies, the quality of interactions, and learners' needs.

Traditional learning should not be positioned merely as an approach opposed to technology, but rather as a point of comparison that possesses its own pedagogical strengths. Face-to-face interaction allows instructors to provide immediate explanations and feedback, while its limitations include relatively lower flexibility in scheduling and access to digital learning resources. Therefore, a comparison of blended and traditional learning must consider not only the presence of technology but also the quality of the learning experience produced by each approach.

2.3. Student entrepreneurship learning outcomes

Entrepreneurship learning outcomes are among the key indicators for evaluating the effectiveness of entrepreneurship education in higher education institutions. These learning outcomes not only encompass students' cognitive achievements but also the development of entrepreneurial skills and attitudes, as well as the ability to identify and capitalize on business opportunities in a dynamic economic environment (Ayandibu, 2025).

Recent studies indicate that entrepreneurship education can foster competencies such as creativity,

problem-solving, innovation, and the ability to recognize business opportunities (Ayandibu, 2025; Bauman and Lucy, 2021). The learning outcomes can be measured through various indicators, including entrepreneurial knowledge, business skills, innovation capabilities, and entrepreneurial attitudes. To support entrepreneurial learning experiences, scholars encourage the use of simulation games, a sustainability approach, and digital technology (Kotla and Bosman, 2023).

Although entrepreneurship education fosters multiple domains, the definitions and indicators of its learning outcomes are overly diverse, posing challenges in comparing findings across studies. Some studies emphasize cognitive achievements, while others use entrepreneurial intention, practical skills, or business projects as primary indicators. These differences can lead to seemingly inconsistent research results even when the learning approaches are the same. Thus, the effectiveness of a learning model must be assessed based on the type of learning outcomes measured, not merely on whether the model uses technology or not.

In this study, learning outcomes are emphasized as achievements that can be measured through tests to assess understanding of entrepreneurial concepts, the ability to analyze business opportunities, and the application of entrepreneurial concepts. This focus provides a clearer conceptual boundary than using broader entrepreneurship indicators such as entrepreneurial intent or practical competencies. Therefore, there is still room to test whether the advantages of blended learning reported across various fields of study also apply when entrepreneurship learning outcomes are measured specifically through cognitive and applied outcomes in the context of vocational education.

3. Research methods

3.1. Design

This study employed a quasi-experimental design with the nonequivalent control group. Two previously formed entrepreneurship classes were assigned to experimental and control groups without individual randomization. The experimental group received a blended-learning treatment, while the control group received a fully face-to-face treatment. A pretest and posttest were given before the treatment was administered. The learning model was treated as the independent variable, while entrepreneurship learning outcomes served as the dependent variable. This research design is summarized in Table 1.

3.2. Participants

The study was conducted in the Maritime Transportation Program at the West Sumatra Maritime Polytechnic, Indonesia. The institution has implemented e-learning since 2018 by providing digital learning materials, videos, online discussions, quizzes, and online assignment submissions. A total of 50 students enrolled in an entrepreneurship course were invited as participants. They came from two intact classes: 25 students in the blended learning group and 25 in the traditional learning group. The classes had been assigned by the institution prior to the study; therefore, individual randomization was not performed. All participants were officially enrolled in the same course and semester and attended classes according to their respective groups.

Table 1: Research design

Group	Pretest	Treatment	Posttest
Experiment	O_1	X_1	O_2
Control	O_3	X_2	O_4

O_1 and O_3 are pretest results for entrepreneurship learning; O_2 and O_4 are posttest results for entrepreneurship learning; X_1 is blended learning; X_2 is traditional learning (full face-to-face)

The use of pre-existing classes has the potential to introduce selection bias and pose a threat to internal validity. To minimize this threat, both groups followed the same learning outcomes and material, were taught by the same instructor, and used the same measurement instruments. A pretest was also administered before the intervention to identify possible differences in baseline abilities between the groups. Prior to data collection, ethical approval was obtained from the Polytechnic's ethics committee under the number: 7577/P35.3/PG/2025.

3.3. Procedure

The study was conducted over one academic semester in accordance with the institution's academic calendar. The course consisted of 16 sessions, with each session lasting 2 credits (2 × 50 minutes). Thus, the duration of the intervention adhered to the official structure of the entrepreneurship course and did not extend beyond the lecture period of the research semester.

In the initial stage, two existing classes were designated as the experimental group and the control group. Before the intervention was administered, all participants took a pretest on entrepreneurship learning outcomes to assess their initial abilities. The pretest scores were used to evaluate the equivalence of initial abilities between the experimental and control groups.

After that, the experimental group participated in entrepreneurship learning using a blended learning approach that combined face-to-face learning with online learning via the institution's e-learning platform. Online learning activities included the provision of digital learning materials, instructional videos, online discussions, quizzes, and online assignment submissions. These online activities supplemented and enriched face-to-face learning. Thus, blended learning did not entirely replace face-to-face interactions between instructors and students.

On the other hand, the control group participated in traditional entrepreneurship instruction through fully in-person learning without the use of e-learning as part of the instructional treatment. Both groups followed the same learning outcomes and course material; thus, the main difference between the two learning conditions lay in the use of online learning components in the blended learning group.

Both groups were taught by the same instructor. This was intended to minimize the potential influence of differences in the instructor's characteristics, experience, and teaching abilities on learning outcomes, so that differences in outcomes could be more reliably attributed to the compared learning approaches.

After all learning interventions were completed, both groups took a posttest to measure students' learning outcomes in entrepreneurship. The instrument used in the posttest was the same as that used for the pretest to ensure consistency in measurement. Additionally, the study collected data from the blended learning group, investigating their responses to e-learning. These data were collected using a questionnaire that has been examined for validity and reliability.

3.4. Instrument

Learning outcomes in entrepreneurship were measured using a test consisting of 20 multiple-choice items. The test was designed based on the learning outcomes of the entrepreneurship course and covered three main aspects: understanding entrepreneurial concepts, analyzing business opportunities, and applying entrepreneurial concepts. The overall specification of the test is illustrated in Table 2.

Before being used in the study, the instrument was reviewed through expert judgment to assess content validity, specifically the relevance of the items to the learning outcomes, the clarity of the question wording, the appropriateness of the material, and the representativeness of the indicators being measured. The instrument was validated using the Content Validity Index (CVI), yielding a value of 0.821. Furthermore, the internal consistency was tested using Cronbach's Alpha to ensure its level of reliability. The test yielded a coefficient of 0.903, indicating adequate internal reliability. When participants had completed the test, their learning achievement scores were classified into four categories: excellent (91–100), good (81–90), satisfactory (70–80), and inadequate (< 70).

Student responses to the use of e-learning were measured using a questionnaire consisting of 30 statements. The questionnaire covered five main aspects of e-learning: (1) knowledge, (2) content quality, (3) accessibility, (4) usefulness, and (5) satisfaction (Table 3).

Like the test instrument, the questionnaire underwent an expert judgment process to assess its relevance, clarity of wording, the alignment of each item's content with the construct being measured, and the representativeness of the aspects covered by the instrument. The content validity of the instrument was evaluated using the CVI, which was 0.896. Furthermore, the instrument's internal consistency was assessed using Cronbach's Alpha, with a coefficient of 0.810. This figure indicates adequate internal reliability.

Table 2: Entrepreneurship learning outcomes test

Aspect	Indicator	Item
Understanding entrepreneurial concepts	Understand the basic concepts of entrepreneurship, identify the characteristics and principles of entrepreneurship, and explain concepts and terms related to entrepreneurship	7
Business opportunity analysis	Identify business opportunities, analyze market needs and business potential, and determine business opportunities based on existing conditions and available resources	7
The application of the concept of entrepreneurship	Apply entrepreneurial concepts in business situations, identify alternative solutions to business problems, and select appropriate actions or strategies for business development	6

Table 3: Student response questionnaire

Aspect	Indicator	Item
Knowledge of e-learning	Students' understanding of the e-learning use and function in the learning process	6
Quality of e-learning content	Students' perceptions of the quality, clarity, relevance, and presentation of digital learning materials	6
Accessibility of e-learning	Students' perceptions of how e-learning provides the ease with which students can access and use learning resources	6
Usefulness of e-learning	Students' perceptions of the benefits of e-learning in supporting the learning process and outcomes	6
Satisfaction after using e-learning	Student satisfaction with their e-learning experience in the learning process	6

The questionnaire used a four-point rating scale: very good (score 4), good (score 3), fair (score 2), and poor (score 1). This instrument was used to support the description of students' perceptions in the blended learning group regarding the use of e-learning after participating in the learning process, not as the primary measure of the treatment's effectiveness. The questionnaire data were analyzed descriptively by converting the obtained scores into percentages. Student response levels were classified into five categories: very good (81–100), good (61–80), fair (41–60), poor (21–40), and very poor (0–20).

3.5. Statistical analysis

Data analysis was conducted in three stages. Initially, descriptive statistics were used to describe the pretest and posttest scores for both groups, focusing on the minimum, maximum, mean, and standard deviation. Normality was tested using the Shapiro–Wilk test, and homogeneity of variances

was tested using Levene's test. To evaluate the equivalence of initial ability, the pretest scores of the blended-learning and traditional-learning groups were compared using an independent samples t-test. Furthermore, score changes from the pretest to the posttest in each group were analyzed using a paired-samples t-test. The comparison of posttest scores between the blended learning and traditional learning groups was analyzed using an independent-samples t-test. Finally, effect sizes were calculated using Cohen's d to complement the interpretation of statistical significance and to describe the magnitude of differences or changes in learning outcomes. Cohen's d values were interpreted as small (d = 0.2), moderate (d = 0.5), and large (d ≥ 0.8) effects. Student response data on e-learning were analyzed descriptively using percentages for each response category. All statistical analyses were conducted using SPSS version 26 with a significance level set at α = 0.05.

4. Results

4.1. Description of learning outcomes

Table 4 presents descriptive statistics for entrepreneurship learning outcomes in the blended learning and traditional groups. In the blended learning group, the mean pretest score was 66.80 (SD = 4.80). This number significantly increased to 88.48 (SD = 3.63) on the posttest. In the traditional learning group, the mean pretest score of 66.48 (SD = 4.57) increased to 77.60 (SD = 2.53) on the posttest. Fig. 1 shows that both groups experienced an improvement in learning outcomes. However, the improvement varies, with the blended learning group achieving greater gains than the traditional group.

4.2. Equality of students' initial abilities

To assess the equality of the students' baselines, this study conducted an independent-samples t-test on the pretest scores. The results identified no significant difference between the blended-learning and traditional groups (t = 0.241; p = 0.810). These results confirm that both groups had equivalent initial abilities prior to the learning intervention. Detailed statistics of this test are summarized in Table 5.

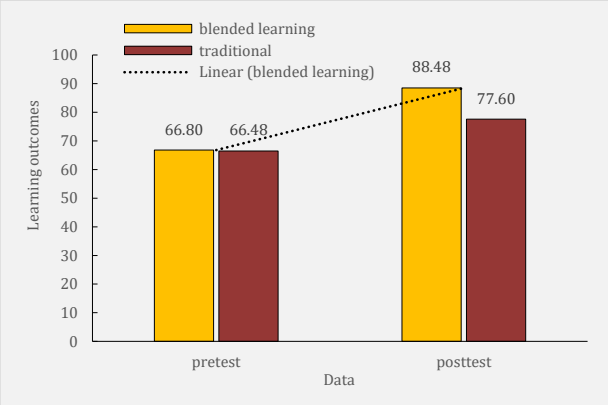


Fig. 1: Average pretest and posttest scores of both groups

Table 4: Description of learning outcomes with blended and traditional learning

Group	Data	n	Min	Max	M	SD
Blended learning	Pretest	25	60.00	75.00	66.80	4.80
	Posttest	25	80.00	94.00	88.48	3.63
Traditional	Pretest	25	60.00	76.00	66.48	4.57
	Posttest	25	73.00	82.00	77.60	2.53

Table 5: Summary of initial competency testing for students

Group	Source	t	df	p	MD	SED
Blended learning-traditional	Equal variances assumed	0.241	48.001	0.810	0.320	1.325
	Equal variances not assumed	0.241	47.876	0.810	0.320	1.325

Pretest data between groups; MD is mean difference; SED is standard error difference; p < 0.05

4.3. Testing data normality and homogeneity

The results of the normality test revealed that all pretest and posttest data were normally distributed (p > 0.05). In addition, the homogeneity test showed that the variances across groups were homogeneous (p > 0.05), meaning that the data meet the assumptions for parametric analysis (Table 6).

4.4. Improvement in intra-group learning outcomes

Table 7 presents the results of the paired-samples t-test, which showed a significant improvement in entrepreneurship learning outcomes in both groups. The blended learning group showed a highly significant improvement (t = 33.490; p = 0.001) with a very large effect size (d = 5.094). The traditional learning group also showed a significant improvement (t = 11.265; p = 0.001), but with a smaller effect size (d = 3.011).

4.5. Comparison of learning outcomes between groups

As shown in Table 8, a comparison of posttest scores between the two groups revealed a statistically significant difference (t = 12.290; p = 0.001). The blended learning group achieved a higher posttest score than the traditional group, with a mean difference of 10.880 points. A Cohen's d value of 3.478 indicates that the implementation of blended learning has a very large effect on students' entrepreneurship learning outcomes.

4.6. Student responses to the use of e-learning

The analysis of student responses regarding the use of e-learning in the blended learning group showed a very positive response (Table 9 and Fig. 2). All indicators (knowledge of e-learning, content quality, accessibility, usefulness, and satisfaction) showed positive responses, with more than 80.00%

of students rating them as "very good." This indicates a very high level of acceptance and a perception of significant benefits from blended learning.

5. Discussion

This study shows that blended learning yields a greater improvement in entrepreneurship learning outcomes compared to traditional learning. Both groups showed significant improvement from the pretest to the posttest, but the blended learning group exhibited a larger effect size (d = 5.094) than the traditional group (d = 3.011). A comparison of posttest scores also revealed a significant difference between the groups (t = 12.290; p = 0.001; d = 3.478). These results indicate that the superiority of blended learning is not merely statistical but also reflects a substantive difference in achievement among the study sample.

The superiority of blended learning in this study can be linked to the approaches' characteristics, which integrate face-to-face instruction with digital materials, instructional videos, online discussions, quizzes, and assignment submissions via e-learning. This combination provides students with the opportunity to access materials more flexibly, deepen their understanding, and gain learning experiences through various types of activities. These findings are consistent with research showing that blended learning can improve student learning outcomes, engagement, flexibility, and learning experiences (De Bruijn-Smolders and Prinsen, 2024; Müller and Mildenberger, 2021; Ryan et al., 2016).

Table 6: Summary of data normality and homogeneity testing

Group	Data	K-S[a]		S-W[b]		Levene[c]	
		df	p	df	p	Pretest	Posttest
Blended learning	Pretest	25	0.200	25	0.167	0.179	0.100
	Posttest	25	0.200	25	0.200		
Traditional	Pretest	25	0.185	25	0.153		
	Posttest	25	0.200	25	0.189		

a: Kolmogorov-Smirnov; b: Shapiro-Wilk; c: Homogeneity test; p < 0.05

Table 7: Summary of testing within the group

Group	n	Correlation		MD	SD	SEM	t	df	p	Cohen's d
		r	p							
Blended learning	25	0.739	0.001	21.680	3.236	0.647	33.490	24	0.001	5.094
Traditional	25	0.677	0.001	11.120	4.935	0.987	11.265	24	0.001	3.011

Intra-group pretest and posttest data; r is the correlation between pretest and posttest data; MD is mean difference; SEM is standard error mean; Effect size: Cohen's d = $(M_2 - M_1) / SD_{pooled.}$; p < 0.05

Table 8: Summary of intergroup testing

Group	Source	t	df	p	MD	SED	Cohen's d
Blended learning-traditional	Equal variances assumed	12.290	48.001	0.001	10.880	0.885	3.478
	Equal variances not assumed	12.290	42.894	0.001	10.880	0.885	

Table 9: Description of students' responses to the use of e-learning

Indicator	Classification									
	Very good	%	Good	%	Enough	%	Less	%	Very less	%
Average	20.60	82.40	4.40	17.60	0.00	0.00	0.00	0.00	0.00	0.00

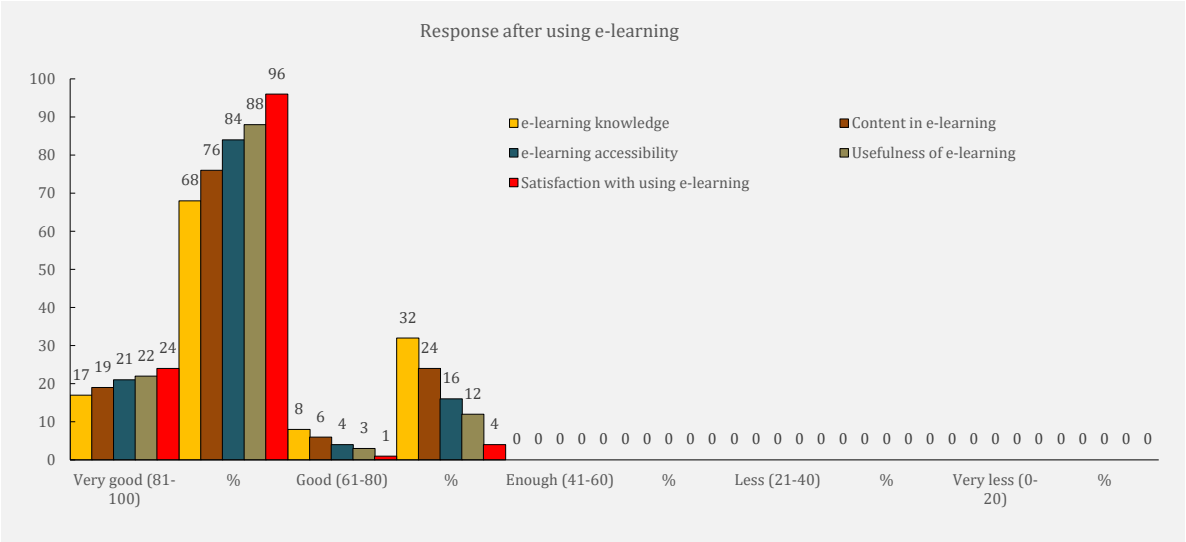


Fig. 2: Percentage of student responses regarding the use of e-learning

Blended learning is particularly relevant to entrepreneurship education because this course requires not only a mastery of concepts but also the ability to analyze opportunities and apply concepts in business situations. Digital materials and online activities can give students space to explore

information and complete assignments independently, while face-to-face learning allows instructors to provide explanations, feedback, and reinforcement of concepts. This integration supports the connection between conceptual understanding and the application of entrepreneurial knowledge. This aligns with Bauman and Lucy (2021), who emphasized the importance of creativity, problem-solving, and innovation in entrepreneurship education.

The relevance of blended learning is becoming increasingly evident in the context of maritime vocational education. Learning in the Maritime Transportation Study Program requires not only mastery of knowledge but also the ability to connect concepts with practical needs and professional contexts. In entrepreneurship education, students need to understand business concepts, identify business opportunities, analyze market conditions, and determine alternative courses of action (Ayandibu, 2025). Blended learning provides a space to combine conceptual learning through face-to-face instruction with more flexible digital activities. The effectiveness observed in this study can be understood through the alignment of this approach with learning needs that connect knowledge and applied skills.

Although research findings support the advantages of blended learning, previous findings have not been entirely consistent. Some studies report improvements in learning outcomes and student engagement through blended learning (Kang and Kim, 2021; Ryan et al., 2016), whereas Ellison and Wu (2008) found no significant difference between the use of blogs and conventional writing methods. These differences indicate that the effectiveness of blended learning is determined not solely by technology use but also by pedagogical design, student readiness, content quality, and institutional support (Anthony et al., 2022). The advantages of blended learning in this study are best understood as the result of integrating digital and face-to-face activities within a specific learning context.

The potential of blended learning as a learning approach is also supported by student responses, which indicate positive acceptance. On average, 82.40% of students rated the following aspects as "very good": knowledge of e-learning, content quality, accessibility, usefulness, and satisfaction. These findings support the view that students' readiness, acceptance, and ability to use technology are important factors in the success of e-learning-based instruction (Adams et al., 2018). Alenezi (2020) believed that the strength of blended learning stems from its materials and tools that support learning outcomes. Meanwhile, Asad et al. (2021) emphasized the flexibility and variety of learning opportunities offered by technology.

Although student responses indicated very positive perceptions, the data were not statistically tested for their relationship with learning outcomes. Therefore, the 82.40% response rate cannot be interpreted as evidence that positive perceptions of e-learning directly lead to higher learning outcomes. The questionnaire in this study serves as supporting data to illustrate students' acceptance of e-learning, while the main analysis remains focused on comparing learning outcomes across groups.

Theoretically, these findings support the perspectives of constructivism and self-directed learning (Adigun et al., 2025), as blended learning provides students with the opportunity to build understanding through face-to-face interactions, digital resources, and self-directed learning activities. In entrepreneurship education, these characteristics are relevant because the learning process must link conceptual understanding with analysis and application in business contexts. Blended learning in this context is not merely a means of delivering digital content but a pedagogical approach that integrates various learning experiences.

In practical terms, these findings provide a foundation for maritime vocational education to develop blended learning in entrepreneurship education without eliminating the role of face-to-face learning. Implementation can focus on providing relevant digital content, instructional videos, online activities, and assignments that support the application of entrepreneurial concepts. Its development must still take into account student readiness, infrastructure quality, and instructors' digital pedagogical competencies (Anthony et al., 2022).

This study has several limitations. First, the sample consisted of only 50 students from two intact classes. Hence, generalizations to a broader population should be made with caution. Second, the absence of individual randomization raises the possibility of selection bias, although initial ability was assessed via a pretest. Third, the study was conducted in a single course at a single maritime vocational education institution. Fourth, learning motivation, interest in entrepreneurship, and learning environment characteristics were not fully controlled for. Fifth, students' responses to e-learning were analyzed only descriptively, and their relationship with learning outcomes was not tested. Future research could involve a more diverse sample and a wider range of institutions, control for relevant psychopedagogical variables, and examine the relationship between digital learning characteristics, student responses, and learning outcomes.

6. Conclusions

This study shows that blended learning is more effective than traditional learning in improving entrepreneurial learning outcomes among students in maritime vocational education. Both learning approaches resulted in improved learning outcomes, but the blended learning group demonstrated higher achievement. Student responses to e-learning were also rated "very good," indicating positive acceptance of digital learning components. These

findings demonstrate that integrating face-to-face learning and digital activities has strong potential to support entrepreneurship education, particularly when learning requires both conceptual mastery and the ability to analyze opportunities and apply concepts in a business context. In practice, the implementation of blended learning in maritime vocational education can be achieved by maintaining face-to-face learning as the primary component while utilizing e-learning for digital materials, instructional videos, online discussions, quizzes, and assignment submissions. Implementation must be accompanied by the development of digital content relevant to students' competency needs, ensuring students' readiness to use technology, and enhancing instructors' digital pedagogical competencies. Institutions also need to ensure the availability of infrastructure and technical support so that the online components can operate consistently. These recommendations are important to ensure that blended learning does not merely amount to the digitization of course materials but truly functions as a pedagogical strategy that supports the attainment of entrepreneurial competencies. Future research should involve a larger sample and a more diverse range of institutions to enhance the generalizability of the findings.

Subsequent studies could also incorporate psychopedagogical variables such as motivation, readiness for online learning, and acceptance of technology, and examine the relationship between these variables and learning outcomes. Further analysis could provide insights into the conditions under which blended learning is most effective for entrepreneurship education in vocational education.

List of abbreviations

α	Significance level
CVI	Content validity index
d	Cohen's d; effect size
df	Degrees of freedom
K-S	Kolmogorov–Smirnov test
Levene	Levene's test for homogeneity of variances
M	Mean
Max	Maximum
MD	Mean difference
Min	Minimum
n	Sample size
O1	Pretest result for the experimental group
O2	Posttest result for the experimental group
O3	Pretest result for the control group
O4	Posttest result for the control group
p	Probability value
r	Correlation coefficient
SD	Standard deviation
SDpooled	Pooled standard deviation
SED	Standard error difference
SEM	Standard error mean
S-W	Shapiro–Wilk test
SPSS	Statistical Package for the Social Sciences
t	t-statistic
X1	Blended learning treatment
X2	Traditional learning treatment

Compliance with ethical standards

Ethical considerations

This study has been approved by the Polytechnic's ethics committee under number: 7577/P35.3/PG/2025 and was conducted in accordance with the principles of research ethics, ensuring the rights, privacy, and confidentiality of all participants' data.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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