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DETERMINANTS OF MARITIME ENGLISH PROFICIENCY IN VOCATIONAL HIGHER EDUCATION: THE ROLES OF SELF-DIRECTED LEARNING, SIMULATION-BASED TRAINING, AND EDUCATIONAL CULTURE

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ABSTRACT

Maritime English is a critical competence in vocational maritime education because it supports safe communication, operational performance, and global employability. However, empirical evidence regarding the combined influence of self-directed learning, simulation-based training, and educational culture on Maritime English proficiency remains limited. This study investigated the effects of self-directed learning and simulation-based training on Maritime English proficiency, as well as the moderating role of educational culture among students at Politeknik Ilmu Pelayaran Semarang. Using an explanatory quantitative design, data were collected from 444 students through a five-point Likert-scale questionnaire and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The findings reveal that self-directed learning and simulation-based training significantly improve Maritime English proficiency, with simulation-based training emerging as the strongest predictor. Educational culture also demonstrates a significant direct contribution to Maritime English proficiency. However, educational culture does not significantly moderate the relationships between self-directed learning, simulation-based training, and Maritime English proficiency. These findings highlight the importance of contextual simulation practices and autonomous learning development in strengthening Maritime English competence within vocational maritime education. The study contributes to vocational language education literature by integrating learner autonomy, simulation-based learning, and institutional culture within a single predictive model.

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INTRODUCTION

Vocational Higher Education (VHE) has a strategic role in preparing a skilled workforce whose competencies are aligned with industry demands, particularly in practice-oriented fields such as maritime education (Suyatmo et al., 2025). Unlike general higher

education, VHE is expected not only to transmit knowledge but also to ensure that students can demonstrate work-ready competence in authentic professional settings (Hasnur et al., 2026). In the maritime sector, this expectation is especially important because seafarers must operate safely, communicate accurately, and respond effectively to dynamic shipboard situations (Yin et al., 2025). Therefore, identifying the learning factors that contribute to vocational maritime competence remains an important research priority.

Within this context, Maritime English has become one of the most critical competencies for maritime students (Mashartanto et al., 2024). English is the principal language of international shipping, and standardized maritime communication, including Standard Marine Communication Phrases (SMCP), is essential for safety, operational efficiency, and cross-national employability (Siska et al., 2025). For cadets and vocational maritime students, Maritime English proficiency is not merely an academic achievement but a professional requirement that supports onboard communication, emergency response, and international career mobility (Abduh et al., 2022). Consequently, improving Maritime English competence is a central task for maritime vocational institutions.

Politeknik Ilmu Pelayaran (PIP) Semarang provides a relevant context for examining Maritime English proficiency because the institution emphasizes practice-based learning, simulator use, and professional maritime preparation (Oktavinanda et al., 2020). Learning resources at PIP Semarang include laboratories, simulators, and operational training environments designed to approximate authentic shipboard conditions (Kurniawan et al., 2025). However, the availability of facilities alone does not necessarily guarantee optimal learning outcomes. Students' competence development is also influenced by how learners manage their own learning process, how instructional activities are designed, and how the institutional environment supports academic and professional development (Siska et al., 2024). Therefore, Maritime English proficiency should be understood not only as the result of classroom instruction but also as the outcome of interactions among learner characteristics, instructional practices, and institutional culture.

One important factor associated with competence development in vocational education is self-directed learning (SDL). Self-directed learning refers to students' ability to independently identify learning needs, set learning goals, select strategies, monitor progress, and evaluate learning outcomes (Ma & Winther, 2025). In vocational higher education, SDL is particularly relevant because students are expected to continuously strengthen both theoretical understanding and practical competence beyond formal classroom activities (Jackson, 2025). In the context of Maritime English, students with strong SDL are more likely to independently practice maritime vocabulary, review communication procedures, seek additional English exposure, and reflect on their communication performance (Vlachopoulos & Makri, 2024). SDL theory further suggests that learners who actively regulate their learning process tend to achieve stronger academic and skill-based outcomes because they engage more consistently with learning materials and practice opportunities (Namaziandost et al., 2024). Accordingly, SDL is theoretically expected to contribute positively to Maritime English proficiency.

Another important determinant is simulation-based training (SBT), which has become a central instructional approach in maritime education. Simulation-based training recreates professional situations through scenario-based tasks, operational role-play, and controlled practice environments that resemble real maritime operations (Bolierakis et al., 2023). In maritime education, simulation is particularly valuable because it allows students to practice communication and operational procedures safely while experiencing realistic shipboard conditions (Sellberg et al., 2021). From the perspective of experiential learning, competence is strengthened when learners actively engage in authentic activities, apply knowledge in practice, and improve performance through reflection and feedback (Phanphichit &

Bartusevičienė, 2025). In Maritime English learning, simulation-based activities enable students to use English in practical contexts such as bridge communication, navigation coordination, watchkeeping instructions, and emergency response situations (Vinh et al., 2025). Unlike purely theoretical instruction, simulation encourages learners to integrate vocabulary mastery, comprehension, pronunciation, and response accuracy simultaneously. Therefore, simulation-based training is expected to have a substantial positive effect on Maritime English proficiency.

In addition to learner autonomy and instructional practice, educational culture also plays an important role in vocational learning environments. Educational culture refers to the institutional values, norms, practices, and expectations that shape the learning climate and influence student behavior (Lindström et al., 2025). In vocational higher education, educational culture affects how students perceive learning responsibilities, how lecturers organize instruction, and how institutions reinforce professionalism, discipline, and academic engagement (Ankareddy et al., 2025). A supportive educational culture may encourage students to become more active, collaborative, and committed to competence development (Sadam & Mamun, 2024). In Maritime English learning, educational culture is especially important because language competence develops not only through individual effort but also through institutional environments that encourage communication practice, professional standards, and continuous improvement (Yu et al., 2025). When educational culture supports practice-oriented learning and academic seriousness, students are more likely to engage meaningfully in Maritime English activities (Khan et al., 2026). Consequently, educational culture may directly contribute to Maritime English proficiency.

Beyond its direct influence, educational culture may also function as a moderating variable. A moderating variable affects the strength or direction of the relationship between independent and dependent variables (Bai et al., 2025). In this study, educational culture is expected to shape the extent to which self-directed learning and simulation-based training contribute to Maritime English proficiency. Students' autonomous learning behaviors may become more effective when institutional culture supports independent study, reflective learning, and academic responsibility (Bauer et al., 2025). Similarly, simulation-based training may produce stronger outcomes when educational culture reinforces active participation, professional seriousness, and constructive feedback during learning activities (Wallace, 2023). Conversely, weak or inconsistent educational culture may reduce the effectiveness of SDL and simulation practices. Therefore, educational culture is theoretically appropriate not only as a direct predictor but also as a moderating variable within the proposed model (Núnez-Regueiro et al., 2025). For this reason, the fourth and fifth hypotheses examine whether educational culture moderates the relationship between SDL and Maritime English, and between simulation-based training and Maritime English.

Previous studies have investigated self-directed learning, simulation-based training, and educational culture in relation to student competence; however, these variables have generally been examined separately or within non-maritime contexts (Hemmler & Ifenthaler, 2024). Empirical studies integrating self-directed learning and simulation-based training within a single predictive model remain limited, particularly when educational culture is positioned as a moderating variable (Wahl & Hybertsen, 2025). More specifically, there is still insufficient evidence regarding whether educational culture strengthens or weakens the influence of learner autonomy and simulation-based learning on Maritime English proficiency in vocational maritime education (Held & Mejeh, 2024). This gap is important because maritime vocational education requires an integrated explanation that captures the interaction among learner characteristics, instructional strategies, and institutional context.

Based on the theoretical and empirical considerations above, this study examines the effects of self-directed learning and simulation-based training on Maritime English

proficiency among students at PIP Semarang and investigates the moderating role of educational culture. Conceptually, this study contributes to vocational education research by integrating learner autonomy, simulation-based learning, and institutional culture within a single predictive framework in maritime vocational education. Practically, the findings are expected to provide evidence for strengthening Maritime English instruction through improved autonomous learning practices, more effective simulation design, and a supportive educational culture. Accordingly, this study proposes the following hypotheses: (H1) self-directed learning has a positive and significant effect on Maritime English proficiency; (H2) simulation-based training has a positive and significant effect on Maritime English proficiency; (H3) educational culture has a positive and significant effect on Maritime English proficiency; (H4) educational culture moderates the relationship between self-directed learning and Maritime English proficiency; and (H5) educational culture moderates the relationship between simulation-based training and Maritime English proficiency.

RESEARCH METHOD

Research Design

This study employed an explanatory quantitative research design with a cross-sectional survey approach (Lukito et al., 2025). The design was intended to test the hypothesized relationships among self-directed learning, simulation-based training, educational culture, and Maritime English proficiency among PIP Semarang students. Rather than comparing groups, this study focused on examining the predictive and explanatory power of the independent variables, including the moderating effect of educational culture, on the endogenous construct.

Partial Least Squares Structural Equation Modeling (PLS-SEM) was used as the analytical approach because it is suitable for prediction-oriented research involving multiple latent constructs, direct effects, and moderating effects within a single framework (Guenther et al., 2023). PLS-SEM is widely applied in explanatory and exploratory studies that seek to estimate complex relationships simultaneously while accommodating fewer distributional restrictions than covariance-based SEM. In addition, the method enables the simultaneous evaluation of measurement and structural models, allowing the assessment of construct validity, reliability, and hypothesized relationships in an integrated manner.

Population and Sample

The population of this study consisted of 634 Batch LXII students at Politeknik Ilmu Pelayaran (PIP) Semarang in the 2025/2026 academic year from three study programs: Nautical, Technical, and Maritime Transportation and Port Management (TALK). To ensure proportional representation across the study programs, proportionate quota sampling was applied (Futri et al., 2022).

Prior to the main study, a pilot test involving 190 students was conducted to evaluate item clarity, content validity, and preliminary reliability. Although the pilot respondents were drawn from the same population, they were excluded from the final sample and were not included in the main hypothesis testing.

The final sample consisted of 444 students who provided valid responses for analysis. Data were collected using an online questionnaire administered through Google Forms and distributed via official academic communication channels and class coordinators (Kunselman, 2024). To minimize duplicate participation, the questionnaire was configured as a single-response survey and monitored throughout the data collection process. Response entries were further screened to identify potential duplicates based on respondent identity and submission records. Only complete and unique responses were retained for analysis. Before

being exported to SmartPLS 3, the dataset was examined for completeness, consistency, and response validity to ensure data quality and analytical accuracy (Singh & Sagar, 2021).

Instruments

The research instrument was a closed-ended questionnaire using a five-point Likert scale (1 = Strongly disagree to 5 = Strongly agree) (Marar et al., 2023). This scale was selected because it is widely used in educational and behavioral research, is easy for respondents to understand, and provides sufficient response variability for analyzing perceptions and self-reported learning conditions in a vocational student population. Each construct was operationalized based on an extensive literature review and adapted to the context of PIP Semarang. The questionnaire consisted of 20 items, with five indicators for each construct. SDL was defined as students' ability to plan, regulate, monitor, and evaluate their own learning process independently. SBT was defined as the extent to which simulation activities provide realistic, structured, and supportive learning experiences that connect theory with practice. ME was defined as students' perceived competence in using English for maritime communication, including oral, listening, written, and technical communication skills. EC was defined as the institutional learning climate reflected in norms, values, support systems, instructional practices, and communication culture that shape learning behavior.

To improve construct clarity, each indicator was translated into a specific questionnaire item aligned with the conceptual definition of the variable. The items were validated through a pilot test and refined before the main survey. The questionnaire blueprint is presented in Table 1.

Table 1
Pilot test questionnaire

No.	Variable	Operational Definition	Indicator	Code	Item
1	Self-Directed Learning (X1) (Dogham et al., 2022; Almomani et al., 2023)	Students' capacity to initiate, organize, monitor, and evaluate their own learning independently	Motivation & learning initiative	SDL1	I actively look for additional ways to improve my Maritime English.
			Learning planning & organization	SDL2	I set a learning plan before studying Maritime English.
			Learning strategies & methods	SDL3	I use appropriate strategies to understand Maritime English materials.
			Monitoring & self-evaluation in learning	SDL4	I evaluate my own progress in learning Maritime English.
			Management of learning resources and technology	SDL5	I use books, digital media, or online resources to support my learning.
2	Simulation-Based Training (X2) (Su & Zeng, 2023; Christopoulos & Stylios, 2024)	Learning through realistic simulator-based activities that connect theory with maritime practice	Alignment of simulation and scenario design with learning objectives	SBT1	The simulation activities match the Maritime English learning objectives.
			Quality of instruction and post-simulation feedback	SBT2	The lecturer gives clear guidance and feedback after simulation activities.
			Linkage between theory and practice / ability to transfer simulation tasks to real tasks	SBT3	Simulation training helps me apply Maritime English in real maritime situations.
			Comfort and confidence when using the simulator	SBT4	I feel comfortable and confident during simulation-based learning.
			Learning outcomes:	SBT5	Simulation training improves

			technical and non-technical skills		both my communication and practical skills.
3	Maritime English (Y) (Yashnikova, 2022; Jurkovic, 2022)	Students' perceived competence in using English for maritime communication and task performance	Oral ability (spoken communication)	ME1	I can speak Maritime English clearly in classroom or simulator activities.
			Listening comprehension	ME2	I can understand instructions in Maritime English.
			Written ability (writing/reporting)	ME3	I can write simple Maritime English reports or notes.
			Technical vocabulary / SMCP terminology	ME4	I understand common maritime terms and SMCP expressions.
			Practical readiness / task-based ability	ME5	I am ready to use Maritime English in operational situations.
4	Educational Culture (M) (Ripatti-torniainen & Stevanovic, 2023; Purnomo et al., 2024)	The institutional learning climate that supports autonomy, discipline, communication, and professional learning	Learning norms and values (autonomy, collaboration, academic)	EC1	My campus encourages discipline and responsibility in learning.
			Teaching and assessment practices (learner-centered, debriefing, feedback)	EC2	Lecturers use learning practices that support active participation and feedback.
			Organizational & infrastructural support (LMS, laboratories & simulators)	EC3	The campus provides adequate facilities to support learning activities.
			Technology and innovation culture (virtual reality, digital learning, simulators)	EC4	The campus supports the use of technology in learning.
			Social interaction & culture of open communication	EC5	Students and lecturers communicate openly and constructively in the learning process.

Data Analysis

This study employed path analysis based on Partial Least Squares Structural Equation Modeling (PLS-SEM) (Hair & Alamer, 2022). Data analysis was conducted in two stages. The first stage involved pilot testing the instrument using SPSS 24.0 to assess item validity and reliability. Item validity was determined using the Product-Moment correlation with a significance level of 0.05, while internal consistency reliability was evaluated using Cronbach's Alpha with a minimum acceptable value of 0.70. The second stage analyzed the main survey data using Partial Least Squares Structural Equation Modeling (PLS-SEM) in SmartPLS 3, selected for its suitability in estimating complex predictive models involving multiple latent constructs, direct effects, and moderation effects.

The PLS-SEM analysis followed a measurement model and structural model evaluation. The measurement model was assessed through outer loadings, Cronbach's Alpha, rho_A, Composite Reliability, Average Variance Extracted (AVE), and discriminant validity using the Fornell–Larcker criterion. The structural model was examined through collinearity diagnostics, R-square, f-square, and bootstrapping to obtain t-statistics and p-values for hypothesis testing. The moderation effects of educational culture were tested through interaction terms within the PLS framework. All hypotheses were evaluated at a 0.05 significance level, and the results were interpreted as explanatory-predictive associations based on cross-sectional data.

RESEARCH FINDINGS AND DISCUSSION

Research Findings

The instrument pilot test was conducted with 190 respondents who were not included in the main study sample; therefore, the critical r value for the Product-Moment correlation at $\alpha = 0.05$ with $n = 190$ ($df = n - 2$) is 0.1424. The validity criterion was that an item's correlation coefficient (r_calculated) must be greater than or equal to r_table (r_calculated ≥ r_table) at $\alpha = 0.05$ to be declared valid. The reliability criterion was Cronbach's Alpha ≥ 0.70 for all questionnaire items to be considered reliable. Validity and reliability tests were performed using SPSS 24.0. The validity and reliability results are presented in Table 2.

Table 2
Instrument validity & reliability results

No.	Variable	Indicator	r-item	Validity	Cronbach's Alpha	Reliability
1	Self-Directed Learning (X1)	SDL1	0.673	Valid	0.947	Reliable
		SDL2	0.613	Valid	0.948	Reliable
		SDL3	0.619	Valid	0.948	Reliable
		SDL4	0.539	Valid	0.949	Reliable
		SDL5	0.735	Valid	0.946	Reliable
2	Simulation-Based Training (X2)	SBT1	0.725	Valid	0.946	Reliable
		SBT2	0.758	Valid	0.946	Reliable
		SBT3	0.716	Valid	0.946	Reliable
		SBT4	0.680	Valid	0.947	Reliable
		SBT5	0.719	Valid	0.946	Reliable
3	Maritime English (Y)	ME1	0.695	Valid	0.946	Reliable
		ME2	0.700	Valid	0.946	Reliable
		ME3	0.613	Valid	0.948	Reliable
		ME4	0.753	Valid	0.946	Reliable
		ME5	0.717	Valid	0.946	Reliable
4	Educational Culture (M)	EC1	0.527	Valid	0.949	Reliable
		EC2	0.662	Valid	0.947	Reliable
		EC3	0.722	Valid	0.946	Reliable
		EC4	0.743	Valid	0.946	Reliable
		EC5	0.705	Valid	0.946	Reliable

As shown in Table 2, all instrument items yielded r values ≥ 0.1424, indicating that all items are valid at $\alpha = 0.05$. Cronbach's Alpha coefficients for each construct were also very satisfactory (≥ 0.946), indicating high internal consistency and that the instrument may be considered reliable. Accordingly, the instrument was deemed suitable for main data collection and subsequent SEM-PLS analysis.

Demographic distributions of respondents by gender, study program, and competence level are presented in Table 3.

Table 3
Respondents demography

Characteristics	Category	Frequency (n)	Percentage (%)
Gender	Male	339	76,35
	Female	105	23,65
Study Program	Nautical	164	36,94
	Technical	176	39,64
	Maritime Transportation & Port Management	104	23,42
Competence level	D-IV (ANT III)	164	36,94

	D-IV (ATT III)	176	39,64
	D-IV	104	23,42
Total		**444**	**100**

Before testing the structural model, the PLS algorithm was run to examine outer loadings. Outer loadings indicate how strongly each indicator reflects its latent construct and thus serve as an initial check of indicator reliability and convergent validity. Indicators with high loadings are interpreted as effectively measuring the intended construct. A common threshold for loadings is 0.50–0.70. Outer loadings are presented in Table 4.

Table 4
Outer loading result

Indicator	Self-Directed Learning (X1)	Simulation-Based Training (X2)	Maritime English (Y)	Educational Culture (M)
SDL1	0.847			
SDL2	0.809			
SDL3	0.805			
SDL4	0.732			
SDL5	0.851			
SBT1		0.862		
SBT2		0.868		
SBT3		0.810		
SBT4		0.812		
SBT5		0.836		
ME1			0.881	
ME2			0.765	
ME3			0.826	
ME4			0.841	
ME5			0.831	
EC1				0.705
EC2				0.759
EC3				0.835
EC4				0.820
EC5				0.823

Table 4 shows that all indicators exhibit high outer loading values, ranging from 0.705 to 0.881, thus exceeding the common threshold (0.50–0.70), with most loadings above 0.70. In detail, each item strongly reflects its respective latent construct. These results indicate adequate indicator reliability and provide initial support for convergent validity of the four constructs.

Therefore, no indicators were eliminated at this stage, and the analysis proceeded to compute Composite Reliability and Average Variance Extracted (AVE) for further verification. The results are reported in Table 5.

Table 5
Reliability and validity results

Variabel	Cronbach's Alpha	Rho_A	Composite Reliability	Average Variance Extracted (AVE)
SDL (X1)	0.868	0.871	0.905	0.656
SBT (X2)	0.894	0.896	0.922	0.702
Moderating Effect 1	0.984	1.000	0.985	0.730
Moderating Effect 2	0.990	1.000	0.990	0.801
ME (Y)	0.887	0.893	0.917	0.688
EC (M)	0.850	0.867	0.892	0.624

As shown in Table 5, all constructs display Cronbach's Alpha and rho_A values above 0.70, indicating good internal consistency. Composite Reliability for all constructs ranges from 0.892 to 0.990, well above the 0.70 threshold, satisfying composite reliability requirements. AVE values for all constructs exceed 0.50 (range 0.624–0.801), confirming convergent validity of indicators for their latent constructs.

The next recommended step is to assess discriminant validity before evaluating the structural model and testing hypotheses. Discriminant validity results (Fornell–Larcker criterion) are shown in Table 6.

Table 6
Fornell-Larcker result

	Simulation-Based Training (X2)	**Maritime English (Y)**	**Self-Directed Learning (X1)**	**Educational Culture (M)**
SBT (X2)	0.838			
ME (Y)		0.830		
SDL (X1)			0.810	
EC (M)				0.790

Table 6 reports the square root of AVE (Fornell–Larcker criterion) on the diagonal for SBT, ME, SDL, and EC as 0.838, 0.830, 0.810, and 0.790, respectively. These diagonal values exceed the corresponding off-diagonal inter-construct correlations, indicating that each construct is more strongly associated with its own indicators than with other constructs. Thus, the Fornell–Larcker discriminant validity criterion is satisfied for all four constructs.

Next, the inner model was evaluated by examining the R-Square (R^2) values to assess the explanatory power of the structural relationships and the model's predictive capability. The R-Square results are presented in Table 7.

Table 7
R-Square result

	R Square	**R Square Adjusted**
Maritime English (Y)	0.856	0.855

The R-Square indicates that the structural model explains 85.6% of the variance in Maritime English ability (Y). This figure denotes very strong explanatory power, suggesting that the exogenous variables (Self-Directed Learning, Simulation-Based Training, and the moderating role of Educational Culture) collectively contribute substantially to differences in students' Maritime English performance. The F-Square values are presented in Table 8.

Table 8
F-Square result

	Maritime English (Y)
Simulation-Based Training (X2)	0.540
Educational Culture (M)	0.051
Self-Directed Learning (X1)	0.024

Referring to common f^2 interpretation thresholds (0.02 small; 0.15 medium; 0.35 large), X2's effect on Maritime English is classified as very large, whereas EC and SDL exhibit only small individual effects. Practically, SBT is the dominant contributor to variation in Y, while EC and SDL have relatively limited direct contributions, although both remain relevant in the contexts of interaction/moderation and statistical significance. The path model clearly represents the hypothesized structure and shows statistical evidence supporting the proposed theoretical relationships. Figure 1 displays the research path model.

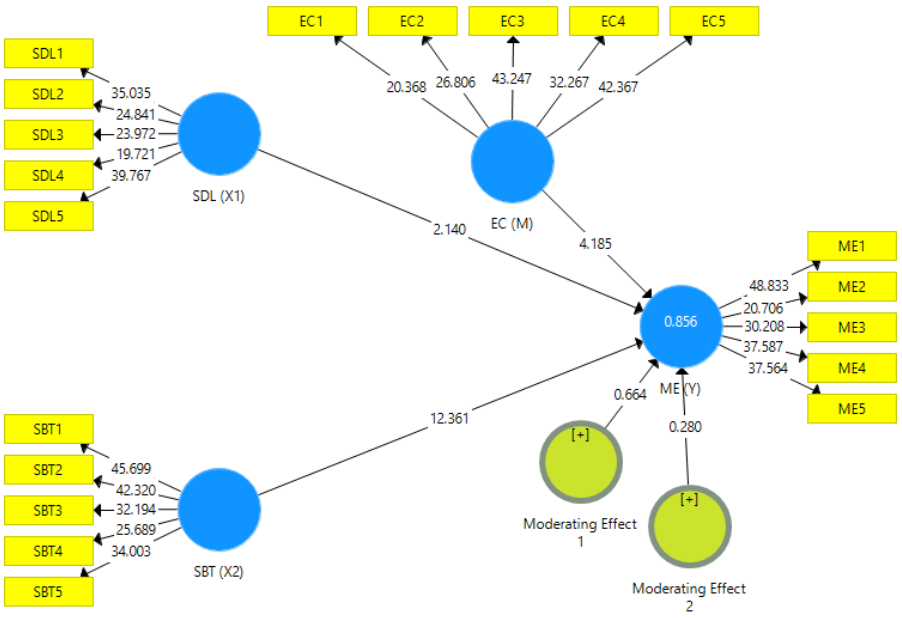

Figure 1. Research path model

The bootstrap plot indicates that t-statistics along the primary paths are sufficiently large; therefore, the three exogenous paths exceed the significance threshold ($t > 1.96$) and can be considered statistically significant. From the t values, Simulation-Based Training (SBT) appears to be the strongest influence on Maritime English ability, followed by Educational Culture and Self-Directed Learning. The large numbers reported for free-items/outer loadings (many > 19 and some > 30) also indicate that indicators consistently and significantly reflect their constructs. Conversely, the values for the displayed moderation effects (approximately 0.664 and 0.280) are relatively small and fall below the bootstrap significance threshold; thus, although positive, those moderating effects were not statistically significant and require cautious interpretation or further analysis. To determine statistical significance of the paths, t-statistics or p-values from the bootstrap should be consulted. Hypothesis testing results are presented in Table 9.

Table 9
Hypotheses testing

Hypothesis Formula	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
SDL – ME	0.121	0.131	0.056	2.140	0.033
SBT – ME	0.629	0.620	0.051	12.361	0.000
EC - ME	0.156	0.155	0.037	4.185	0.000
EC – SDL – ME	-0.035	-0.049	0.053	0.664	0.507
EC – SBT - ME	-0.015	0.000	0.052	0.280	0.780

Based on Table 9 and the significance criterion $\alpha = 0.05$ ($p < 0.05$), it can be concluded that Self-Directed Learning (SDL) has a positive and significant effect on Maritime English ability (coefficient = 0.121; t = 2.140; p = 0.033). Simulation-Based Training (SBT) shows a much stronger positive and significant effect on Maritime English ability (coefficient = 0.629; t = 12.361; $p < 0.001$), making it the dominant contributor. Educational Culture (EC) also has a positive and significant direct effect on Maritime English ability (coefficient = 0.156; t = 4.185; $p < 0.001$). However, moderation tests indicate that EC does not moderate the effect of SDL on ME (coefficient = −0.035; t = 0.664; p = 0.507) nor the effect of SBT on

ME (coefficient = −0.015; t = 0.280; p = 0.780). Thus, although educational culture exerts a direct effect, it does not strengthen or weaken the relationships between student learning disposition or simulation practice and Maritime English outcomes in this sample.

Discussion

The findings demonstrate that self-directed learning (SDL) positively and significantly influences Maritime English proficiency among PIP Semarang students, although the effect size is relatively small. This result indicates that students who actively regulate their learning process, independently practice maritime vocabulary, and seek additional language exposure tend to achieve better communicative competence (Zarestky et al., 2022). Reflective learning habits and self-evaluation activities may also support students in internalizing technical terminology and Standard Marine Communication Phrases (SMCP) required in maritime operations (Tyler et al., 2022). However, the relatively limited effect suggests that Maritime English proficiency is not determined solely by learner autonomy, but also by contextual and practice-oriented learning experiences commonly found in vocational maritime education (Siska et al., 2024). This finding supports previous studies reporting a positive relationship between SDL and language learning outcomes in higher education (Rahmasari et al., 2025). Nevertheless, the smaller effect observed in this study may reflect the strong emphasis on operational practice and contextual learning within maritime vocational education, where practical experience becomes equally important as individual learning readiness (Cattaneo et al., 2025). Therefore, strengthening SDL should be accompanied by learning environments that provide intensive communication practice and authentic maritime exposure.

Simulation-based training (SBT) emerged as the strongest predictor of Maritime English proficiency, showing a large and highly significant positive effect. This finding reinforces the importance of experiential and practice-oriented learning in maritime education (Jurkovi, 2022). Through simulation activities, students are exposed to realistic communication scenarios involving navigation coordination, emergency procedures, and watchkeeping communication, allowing them to apply language skills in authentic operational contexts. Such learning conditions encourage students to integrate vocabulary mastery, comprehension, pronunciation, and response accuracy simultaneously (Jongbloed et al., 2024). The strong effect of SBT also indicates that repetitive and contextual communication practice is more influential in improving Maritime English proficiency than dispositional factors alone (Munim et al., 2025). This result is consistent with previous studies emphasizing the effectiveness of simulation in improving both technical competence and professional communication skills (Lanza-postigo et al., 2024). The substantial contribution of SBT in this study may also reflect the availability of simulator facilities and intensive practical training at PIP Semarang. Consequently, improving the quality, frequency, and realism of simulation activities should become a priority strategy for strengthening Maritime English competence in vocational maritime institutions.

The study also reveals that educational culture has a positive and significant direct effect on Maritime English proficiency, although the effect size remains relatively moderate. This finding suggests that institutional values, academic norms, and professional expectations contribute to shaping students' learning attitudes and engagement (Riza et al., 2025). A supportive educational culture may encourage discipline, active participation, collaboration, and stronger commitment toward professional competence development (Veltsin et al., 2025). In maritime education, institutional environments that emphasize communication practice, professionalism, and continuous improvement may motivate students to participate more actively in Maritime English learning activities. However, compared with simulation-based training, educational culture functions more as a contextual support system rather than a direct instructional mechanism (Xiong, 2025). This result aligns with studies highlighting

the importance of organizational and academic culture in supporting educational outcomes (Ventista & Brown, 2023). Therefore, strengthening institutional support, faculty development, and practice-oriented academic policies remains important for enhancing students' language competence.

In contrast, the moderation analysis demonstrates that educational culture does not significantly moderate the relationships between self-directed learning, simulation-based training, and Maritime English proficiency. These findings indicate that the positive effects of SDL and SBT on Maritime English competence remain relatively stable regardless of variations in educational culture within the institutional context examined. One possible explanation is that educational culture at PIP Semarang may already be relatively homogeneous, limiting the variability necessary to detect interaction effects statistically (Choo et al., 2025). In addition, SDL may operate primarily as an internal learner characteristic that is less dependent on contextual reinforcement once autonomous learning habits have been established (Schweder et al., 2026). Similarly, the strong direct influence of simulation-based training may dominate the learning process, reducing the relative contribution of moderating effects (Mishra et al., 2023). These findings support studies suggesting that educational culture often functions more effectively as a direct contextual factor rather than as a moderator of instructional relationships (Assefa et al., 2025). Nevertheless, the non-significant moderation results indicate the need for further research involving institutions with more diverse cultural characteristics and different simulation practices to better understand the contextual conditions under which educational culture may strengthen learning outcomes.

This study highlights simulation-based training as the most influential factor in improving Maritime English proficiency among vocational maritime students, followed by educational culture and self-directed learning. The findings emphasize that effective Maritime English instruction requires not only learner autonomy but also authentic practice environments and supportive institutional conditions. Conceptually, the study contributes to vocational education literature by integrating learner autonomy, experiential learning, and institutional culture within a single predictive model in maritime education. Practically, the results suggest that maritime institutions should prioritize realistic simulation activities while simultaneously fostering autonomous learning habits and strengthening supportive academic cultures to improve students' professional communication competence.

CONCLUSION

This study concludes that self-directed learning, simulation-based training, and educational culture positively influence Maritime English proficiency among PIP Semarang students, with simulation-based training emerging as the most dominant predictor; however, educational culture was not found to moderate either relationship. These findings indicate that Maritime English development in vocational maritime education is driven primarily by authentic, contextual, and practice-oriented learning experiences, supported by students' independent learning capacity. Theoretically, this study enriches the literature on vocational maritime education by integrating self-directed learning, experiential learning, and institutional culture within a single empirical model, while also showing that educational culture functions more as a direct supporting factor than as a moderator. Practically, maritime institutions should prioritize realistic simulation activities, structured feedback, and systematic self-directed learning development, while fostering a disciplined and communicative academic culture. The study is limited by its cross-sectional design, quota sampling, and single-institution setting; therefore, future research should employ longitudinal, multi-campus, and mixed-method designs to improve the robustness and generalizability of the findings.

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INFORMED CONSENT STATEMENT
Participation in this study was voluntary. Prior to participation, all participants were provided with clear information regarding the study's objectives, procedures, potential risks, and anticipated benefits. Participants were assured of the confidentiality of their personal information and informed that all data collected would be used solely for research purposes. They were also informed of their right to withdraw from the study at any time without penalty. Informed consent was obtained from all participants prior to data collection.

DATA AVAILABILITY STATEMENT
The data generated and analyzed in this study are not publicly available because they contain information that could compromise participant privacy and confidentiality. Restricting public access ensures compliance with ethical research principles and applicable data protection regulations. Nevertheless, the dataset may be made available to qualified researchers upon reasonable request for verification or further analysis. Any such request will be reviewed on a case-by-case basis and will require prior approval from the appropriate institutional ethics authority.

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