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How Maritime Education System Shapes Students' Professional Mindset: Mediated by Learning Environment and Self-Directed Learning

Juliandri Hasnur [1]*, Syafni Yelvi Siska [1], M. Kurniawan [1]
[1] *Politeknik Pelayaran Sumatera Barat, Indonesia*

juliandrihasnur@gmail.com*

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ABSTRACT

The problem motivating this study is the limited empirical evidence concerning the mechanisms through which the Maritime Education System shapes students' professional mindset via the Learning Environment and Self-Directed Learning. This study aims to examine the effect of the Maritime Education System on the formation of students' professional mindset, with particular attention to the mediating roles of the Learning Environment and Self-Directed Learning. A quantitative approach was employed using Structural Equation Modeling based on Partial Least Squares (SEM-PLS) with bootstrap procedures to assess path significance. Results show that the Maritime Education System has a direct, positive, and statistically significant effect on students' professional mindset (O = 0.793; $p < 0.001$) and significantly influences the Learning Environment (O = 0.762; $p < 0.001$) and Self-Directed Learning (O = 0.717; $p < 0.001$); both the Learning Environment (O = 0.507; $p < 0.001$) and Self-Directed Learning (O = 0.268; $p < 0.001$) contribute positively to students' professional mindset. Specific indirect effects X–M1–Y (O = 0.387; $p < 0.001$) and X–M2–Y (O = 0.192; $p < 0.001$) were also significant, indicating partial mediation with a larger mediating contribution through the learning environment. Accordingly, future research is recommended to adopt longitudinal designs and test moderators such as internship experience and other contextual variables to strengthen empirical evidence and inform maritime education policy.

Keywords: Learning Environment, Maritime Education System, Self-Directed Learning, Students' Proffesional Mindset

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INTRODUCTION

Professional mindset is a key asset for students in the maritime field because it determines safety attitudes, work ethics, and operational readiness in the inherently high-risk shipboard environment (Baum-talmor & Kitada, 2022). Students who possess a professional mindset tend to comply with safety procedures, initiate improvements, and adapt more readily to new technologies and regulations (Phanphichit & Bartusevičienė, 2025). In Indonesia, cultivating a professional mindset is critically important given rising international standards and increasing national industry demands, which necessitate that professional attitudes be fostered beginning at higher education (Garay-rondero & Issa-zadeh, 2025). This study focuses on students as the primary subjects of professional mindset formation within formal maritime education, with a case study of Politeknik Pelayaran Sumatera Barat as a representative polytechnic institutions that directly supplies labor to the maritime sector (Abduh et al., 2022).

The development of students' professional mindset is not determined by a single factor but by the interaction between internal dispositions and the educational contexts they experience (Hasnur & Yatno, 2025). From the personal perspective, self-directed learning (SDL) influences initiative, self-regulation, and reflective capacity, all of which strengthen a professional orientation (Duin et al., 2023). From the pedagogical perspective, a conducive learning environment provides authentic experiences, quality feedback, and practical opportunities that replicate real working conditions (Back et al., 2023). Meanwhile, the maritime education system (MES) determines curriculum content, practical facilities such as simulators and training vessels, and assessment policies that shape students' exposure to professional experiences (Morariu et al., 2025). Recent literature indicates that these three domains; education system, learning environment, and individual learning capacity, are intertwined in affecting maritime education outcomes (Wahl & Hybertsen, 2025).

A theoretically and practically relevant maritime education system should integrate international competency standards, competency-based approaches, and adaptation to technological developments so that graduates are prepared for industry demands (Belabyad et al., 2026). Curriculum relevance to industry needs, integration of simulation and training-vessel practice, and institutional quality-assurance mechanisms are crucial components shaping professional learning experiences (Mashartanto et al., 2024). Moreover, curricular transformation responsive to phenomena such as automation and sustainability requires stakeholder collaboration to ensure graduate competency alignment (Fan & Yang, 2023). Therefore, strengthening the MES involves not only updating academic content but also improving practical learning processes that have direct implications for professional mindset formation (Hasnur et al., 2025); multi-country reports reinforce the need for systemic MES renewal to raise graduate employability (Yanti et al., 2025).

The learning environment, in both pedagogical and facility terms, acts as a mediating context that determines the extent to which students internalize professional values (Kurniawan et al., 2025). The concept of learning environment encompasses teaching methods, the quality of instructor–student interactions, availability of practical facilities (simulators, laboratories, training vessels), and an academic climate that encourages reflective discussion and problem-based learning (Johansen, 2023). Empirical evidence shows that supportive environments that enable immersive technologies, simulation-based practice, and student-centered approaches can enhance maritime students' cognitive, affective, and psychomotor skills (Jongbloed et al., 2024). Consequently, improving the learning environment has the potential to amplify the effect of the education system on professional mindset by enhancing practical experience and meaningful feedback (Sellberg & Giskeødegård, 2025).

Self-directed learning (SDL) reflects students' internal capacity to plan, manage, and evaluate their own learning, thereby becoming lifelong learning agents (Almomani et al., 2023). In the maritime education context, SDL enables students to proactively seek technical resources, practice practical skills independently, and tailor learning to safety requirements and operational demands aboard ships (Christopoulos & Stylios, 2024). Students with high SDL are better able to exploit simulation facilities, learn from field experiences, and apply critical reflection that shapes professional attitudes and ethical responsibility (Kong & Roh, 2024). Higher education literature identifies SDL as a driver of adaptability to new technologies and the dynamic competency requirements of the maritime industry (Adarkwah, 2025); accordingly, measuring SDL's contribution to professional mindset is essential to understand how individual capacity complements systemic interventions.

Several prior studies have examined the impact of curricular and technological aspects on maritime competencies and the role of the learning environment in enhancing practical outcomes; however, research that simultaneously integrates the influences of the education system, the learning environment, and self-directed learning (SDL) on professional mindset remains limited (Munim et al., 2025). For example, studies on competency-based curriculum development and technology integration emphasize improvements to the educational structure but pay insufficient attention to intermediary psychological mechanisms, such as self-directed learning, that shape professional attitudes (Ghosh & Emad, 2025). Cross-national reports provide policy recommendations for maritime education systems (MES), yet empirical studies testing the mediating roles of the learning environment and SDL within the context of Indonesian polytechnic institutions are relatively scarce (Suyatmo et al., 2025). This gap creates an urgent need for research that examines both the direct and indirect pathways from the maritime education system to professional mindset through these two mediators (Shi et al., 2024). The novelty of the present study lies in its comprehensive approach, which tests a double-mediation effect in a case-study context at maritime training institutions in Indonesia.

The general objective of this study is to analyze how the Maritime Education System shapes students' professional mindset with Learning Environment and Self-Directed Learning as mediators, specifically among students at maritime polytechnics in Indonesia. More specifically, the study aims to: (1) test the direct effect of the Maritime Education System on Students' Professional Mindset; (2) test the effect of the Maritime Education System on Learning Environment and Self-Directed Learning; (3) test the effects of Learning Environment and Self-Directed Learning on Students' Professional Mindset; and (4) evaluate the mediating roles of Learning Environment and Self-Directed Learning in the relationship between the Maritime Education System and Students' Professional Mindset. To address these objectives, the study tests hypotheses H1 through H7 as the empirical framework of the research:

Hypothesis 1 (H1): The maritime education system has a positive effect on students' professional mindset

Hypothesis 2 (H2): The maritime education system has a positive effect on the learning environment

Hypothesis 3 (H3): The maritime education system has a positive effect on self-directed learning

Hypothesis 4 (H4): The learning environment has a positive effect on students' professional mindset

Hypothesis 5 (H5): Self-directed learning has a positive effect on students' professional mindset

Hypothesis 6 (H6): The maritime education system has a positive effect on students' professional mindset with the learning environment as a mediator

Hypothesis 7 (H7): The maritime education system has a positive effect on students' professional mindset with self-directed learning as a mediator

METHOD

This study employs a quantitative causal-comparative design with path analysis based on Partial Least Squares Structural Equation Modeling (PLS-SEM) (Hair & Alamer, 2022). The purpose of the analysis is to examine the effect of the maritime education system on students' professional mindset and to assess the roles of the learning environment and self-directed learning in mediating the influence of these exogenous variables on the endogenous variable.

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). The questionnaire comprised four latent constructs: Maritime Education System (MES) (5 indicators), Students' Professional Mindset (SPM) (5 indicators), Learning Environment (LE) (5 indicators), and Self-Directed Learning (SDL) (5 indicators), for a total of 20 items. Items were developed based on a literature review and theories relevant to each variable and were adapted to the context of students at Politeknik Pelayaran Sumatera Barat. The questionnaire blueprint is presented in Table 1.

Table 1. Research Questionnaire

No.	Variable	Indicator	Code
1	Maritime Education System (MES) (Karahalil et al., 2025)	Curriculum relevance to maritime industry demands (up-to-date; competency-focused)	MES1
		Frequency and quality of simulator/bridge/shipboard training	MES2
		Quality of instructors/practical trainers (competence, industry experience)	MES3
		Practical facilities and infrastructure (simulators, laboratories, training vessels)	MES4
		Assessment and feedback systems (practice & theory)	MES5
2	Students' Professional Mindset	Belief that maritime skills can be improved through effort (growth belief)	SPM1

	(SPM) (Türkistanli, 2023)	Resilience in the face of training failures/errors (learning from error)	SPM2
		Commitment to safety and professional standards (safety culture)	SPM3
		Orientation toward continuous improvement	SPM4
		Motivation to pursue a career in the maritime industry (career orientation)	SPM5
3	Learning Environment (LE) (Farooqi et al., 2020; Wójcik et al., 2023)	Perceptions of instruction (clarity of material; teaching methods)	LE1
		Perceptions of instructors (competence; support)	LE2
		Academic self-perceptions (self-confidence; preparedness)	LE3
		Perceptions of atmosphere/environment (facilities; learning comfort)	LE4
		Social perceptions (peer support; welfare)	LE5
4	Self-Directed Learning (SDL) (Arianpoor et al., 2025)	Learning motivation and initiative (proactiveness in seeking resources)	SDL1
		Planning and time-management for learning	SDL2
		Self-monitoring / evaluation of learning progress	SDL3
		Ability to locate and evaluate learning resources (digital literacy)	SDL4
		Learning persistence and responsibility	SDL5

Source: Research Instrument (2026)

The study population comprised students of Politeknik Pelayaran Sumatera Barat for the 2025/2026 academic year. The sample consisted of 368 students from the Nautical Studies and Marine Transportation and Nautical Technology programs, selected via total sampling (Cash et al., 2022). For the instrument pilot test, 68 respondents drawn from the total population were used to assess content validity, initial reliability, and to refine items. The remaining 300 students served as the main sample for the study.

Data were collected using a structured questionnaire survey administered online (Google Forms) during the data collection period specified by the researchers (Kunselman, 2024). Respondents received information on the study's objectives, confidentiality assurances, and provided informed consent (Singh & Sagar, 2021). Data collection continued until the predetermined sample size was reached (n = 300), after which the dataset was imported into SmartPLS 3 for analysis.

RESULT AND DISCUSSION

The research instrument was piloted with 68 respondents who were not included in the main study sample. The critical value of the Pearson Product–Moment correlation coefficient at a significance level of $\alpha = 0.05$ for $n = 68$ ($df = n - 2$) is 0.2387. The validity criterion required that the correlation coefficient for each item (r_calculated) be greater than or equal to the critical r (r_calculated ≥ r_critical) at $\alpha = 0.05$; items meeting this condition were considered valid. The reliability criterion stipulated that Cronbach's Alpha ≥ 0.70, in which case all questionnaire items were considered reliable. Validity and reliability tests were performed using SPSS 24.0. The results of these tests are presented in Table 2.

Table 2. Results of Instrument Validity & Reliability Tests

No	Variable	Indicator	r-calculated	Validity	Cronbach's Alpha	Reliability
1	Maritime Education System (MES)	MES1	0.868	Valid	0.961	Reliable
		MES2	0.685	Valid	0.963	Reliable
		MES3	0.679	Valid	0.963	Reliable
		MES4	0.442	Valid	0.967	Reliable
		MES5	0.862	Valid	0.961	Reliable

2	Students' Professional Mindset (SPM)	SPM1	0.847	Valid	0.961	Reliable
		SPM2	0.817	Valid	0.962	Reliable
		SPM3	0.834	Valid	0.961	Reliable
		SPM4	0.703	Valid	0.963	Reliable
		SPM5	0.735	Valid	0.962	Reliable
3	Learning Environment (LE)	LE1	0.804	Valid	0.962	Reliable
		LE2	0.812	Valid	0.961	Reliable
		LE3	0.740	Valid	0.962	Reliable
		LE4	0.886	Valid	0.961	Reliable
		LE5	0.848	Valid	0.962	Reliable
4	Self-Directed Learning (SDL)	SDL1	0.545	Valid	0.965	Reliable
		SDL2	0.667	Valid	0.963	Reliable
		SDL3	0.830	Valid	0.961	Reliable
		SDL4	0.778	Valid	0.962	Reliable
		SDL5	0.723	Valid	0.963	Reliable

Source: SPSS Analysis (2026)

Based on Table 2, all indicators across the four constructs met the validity criterion, with r-calculated values ranging from 0.442 to 0.868; therefore, every item can be categorized as valid. In addition, the very high Cronbach's Alpha values for each construct (α ≥ 0.961) indicate excellent internal consistency and instrument reliability. Accordingly, the research instrument is suitable for use in the main data collection and subsequent analysis using SEM–PLS. The respondents' demographic distribution is presented by gender, cohort (batch), study program, semester, and competence level. Frequency and percentage details for each category are provided in Table 3.

Table 3. Respondents Demography

Characteristics	Category	Frequency (n)	Percentage (%)
Gender	Male	255	85
	Female	43	15
Batch	VII	60	20
	IX	103	34,33
	X	137	45,67
Study Program	Nautical	95	31,67
	Technology Nautical	70	23,33
	Sea Transportation	135	45
Semester	2nd	137	45,67
	4th	103	34,33
	6th	20	6,67
	8th	40	13,33
Competence level	ANT III (D-III)	95	31,67
	ATT III (D-III)	70	23,33
	D-IV	135	45
TOTAL		300	100

Source: Respondent Data 2026

Based on the sample distribution, the majority of respondents were male (255; 85%), while females accounted for 43 respondents (15%). Respondents were concentrated in cohort X (137; 45.67%) and the Sea Transportation study program (135; 45%). The largest share of respondents were in the 2nd semester (137; 45.67%), followed by the 4th semester (103; 34.33%). Regarding competence level, the largest proportion was D-IV (135; 45%), followed by ANT III (95; 31.67%) and ATT III (70; 23.33%). Overall, the sample encompassed variation in cohort, study program, semester, and competence level.

Prior to testing the structural model, the PLS algorithm was run and outer loadings were inspected. Outer loadings indicate how strongly each indicator reflects its latent construct and thus provide an initial check on indicator reliability and convergent validity. In practice, indicators with higher loadings are taken to measure the intended construct well, loadings are expected to meet common thresholds (generally 0.50–0.70) (Sukhov et al., 2023). The outer loading values are reported in Table 4.

Table 4. Outer Loading Result

Indicator	Maritime Education System (X)	Students' Professional Mindset (Y)	Learning Environment (M1)	Self-Directed Learning (M2)
MES1	0.753			
MES2	0.742			
MES3	0.753			
MES4	0.771			
MES5	0.821			
SPM1		0.810		
SPM2		0.837		
SPM3		0.779		
SPM4		0.742		
SPM5		0.813		
LE1			0.834	
LE2			0.713	
LE3			0.763	
LE4			0.780	
LE5			0.794	
SDL1				0.699
SDL2				0.724
SDL3				0.812
SDL4				0.772
SDL5				0.810

Source: SEM-PLS Result Analysis

As shown in Table 4, all indicator outer loadings exceeded the common threshold range of 0.50–0.70. The majority of indicators exhibited loadings greater than 0.70, indicating good indicator reliability and initial evidence of convergent validity for their respective constructs. Therefore, at the outer-loading examination stage no indicators required elimination, and analysis could proceed to calculate AVE, composite reliability, and to test the structural model. Composite reliability and AVE values are reported in Table 5.

Table 5. Reliability & Validity Result

Variable	Cronbach's Alpha	Rho_A	Composite Reliability	Average Variance Extracted (AVE)
Learning Environment (M1)	0.837	0.847	0.884	0.605
Maritime Education System (X)	0.831	0.855	0.878	0.591
Self-Directed Learning (M2)	0.825	0.849	0.875	0.585
Students' Professional Mindset (Y)	0.856	0.858	0.897	0.635

Source: SEM-PLS Result Analysis

Table 5 shows that all constructs demonstrated good internal consistency: Cronbach's Alpha ranged from 0.825 to 0.856, rho_A from 0.847 to 0.858, and Composite Reliability from 0.875 to 0.897. The AVE values for each construct exceeded the 0.50 threshold (0.585–0.635), indicating that convergent validity was satisfied. In addition, Common Method Bias (CMB) was assessed via collinearity diagnostics using VIF. If VIF < 5, CMB is unlikely (Islam, 2023), therefore, the present findings are unlikely to be driven by method effects.

Table 6. Collinearity Statistics (VIF)

Indicator	VIF X	VIF Y	VIF M1	VIF M2
MES1	1.832			
MES2	1.938			
MES3	1.764			
MES4	1.527			
MES5	1.903			
SPM1		1.852		
SPM2		2.271		
SPM3		1.843		
SPM4		1.591		
SPM5		1.940		
LE1			2.068	
LE2			1.583	
LE3			1.686	
LE4			1.697	
LE5			1.730	
SDL1				1.573
SDL2				1.628
SDL3				1.892
SDL4				1.703
SDL5				1.630

Source: SEM-PLS Result Analysis

Table 6 indicates that all indicator VIF values ranged from 1.527 to 2.271, well below the critical threshold of 5 (Shela et al., 2023). This suggests the absence of excessive multicollinearity among indicators and supports the conclusion that Common Method Bias is unlikely. Consequently, the collinearity test supports continuation of the structural model analysis and hypothesis testing without further correction for CMB. Then, an inner-model analysis was then conducted by inspecting R-Square (R^2) to evaluate whether the structural relationships provide meaningful explanatory power and to compare or assess model improvement. R-Square values are reported in Table 7.

Table 7. R-Square Result

	R Square	R Square Adjusted
Learning Environment (M1)	0.581	0.579
Self-Directed Learning (M2)	0.514	0.512
Students' Professional Mindset (Y)	0.840	0.839

Source: SEM-PLS Result Analysis

Table 7 shows that the model explains 58.1% of the variance in Learning Environment and 51.4% of the variance in Self-Directed Learning, indicating moderate explanatory power for these mediators. Students' Professional Mindset has a very high R^2 of 84.0% (adjusted R^2 = 0.839), implying that the exogenous variables, including the Maritime Education System and the mediators, collectively account for most of the variance in respondents' professional mindset. The minimal difference between R^2 and adjusted R^2 suggests no substantial overfitting, and thus the structural model demonstrates strong predictive capability and is suitable for path analysis and mediation testing (Guenther et al., 2023). Furthermore, the F-Square values are presented in Table 8.

Table 8. F-Square Result

Variable	Learning Environment (M1)	Maritime Education System (X)	Self-Directed Learning (M2)	Students' Professional Mindset (Y)
Learning Environment (M1)				0.459
Maritime Education	1.386		1.058	0.111

System (X)				
Self-Directed Learning (M2)				0.149
Students' Professional Mindset (Y)				

Source: SEM-PLS Result Analysis

Using Cohen's guidelines (small = 0.02; medium = 0.15; large = 0.35) (Lutfi et al., 2024), Table 8 indicates that the Maritime Education System (MES) exerts a very large effect on Learning Environment (f^2 = 1.386) and on Self-Directed Learning (f^2 = 1.058), demonstrating the dominant role of the education system in shaping both mediators. Learning Environment has a large effect on Students' Professional Mindset (f^2 = 0.459), whereas Self-Directed Learning shows an effect approaching the medium category on mindset (f^2 = 0.149). The direct effect of MES on mindset is small-to-moderate (f^2 = 0.111). Overall, effect-size results confirm that MES primarily influences professional mindset indirectly via the mediators (LE and SDL), while LE also plays a significant role in explaining variance in mindset. Then, the predictive relevance (Q^2) can be seen in Table 9.

Table 9. Construct Cross-validated Redundancy

	Q^2 (=1-SSE/SSO)
Learning Environment (M1)	0.337
Self-Directed Learning (M2)	0.275
Students' Professional Mindset (Y)	0.519

Source: SEM-PLS Result Analysis

All endogenous constructs yielded $Q^2 > 0$ (Learning Environment = 0.337; Self-Directed Learning = 0.275; Students' Professional Mindset = 0.519), indicating predictive relevance of the model according to the Stone–Geisser criterion (Prakash et al., 2024). With interpretative benchmarks (Q^2 = 0.02 small; = 0.15 medium; = 0.35 large), Students' Professional Mindset demonstrates large predictive relevance, while Learning Environment and Self-Directed Learning show medium-to-large relevance. Therefore, the structural model possesses adequate predictive power for the endogenous variables and is appropriate for subsequent path analysis and predictive applications. The next recommended step is to assess discriminant validity prior to evaluating the structural model and testing hypotheses. The results of Fornell-Larcker is displayed in Table 10.

Table 10. Fornell-Larcker Result

Variable	Learning Environment (M1)	Maritime Education System (X)	Self-Directed Learning (M2)	Students' Professional Mindset (Y)
Learning Environment (M1)	0.778			
Maritime Education System (X)		0.769		
Self-Directed Learning (M2)			0.765	
Students' Professional Mindset (Y)				0.697

Source: SEM-PLS Result Analysis

The Fornell–Larcker matrix indicates adequate values, and discriminant validity can therefore be regarded as satisfied. Technically, discriminant validity is met when each construct's diagonal value is greater than its correlations with the other constructs (Kante & Michel, 2023). The path model clearly represents the hypothesized structure and displays statistical evidence supporting the proposed theoretical relationships. Figure 1 presents this research path model.

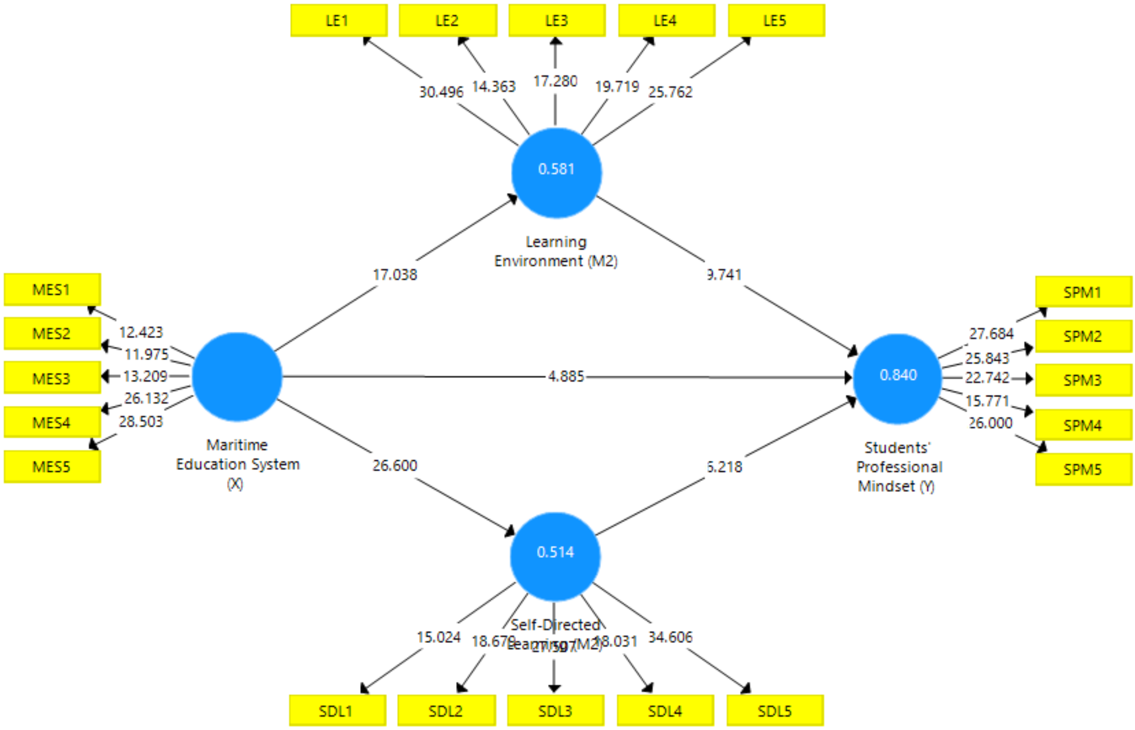

Figure 1. Path Model

Figure 1 shows that the Maritime Education System has direct positive influences on both Learning Environment and Self-Directed Learning, and that both constructs also have direct paths to Students' Professional Mindset, indicating partial mediation. The magnitude of path coefficients suggests strong effects for X on M2 and X on M1, while both mediators (M1 and M2) contribute positively to Y, with M2's contribution being relatively more prominent. Overall, the path-model results support the proposed theoretical structure. To determine statistical significance of these relationships, t-statistics or p-values from the bootstrap must be examined. Table 11 presents the hypothesis testing results.

Table 11. Hypotheses Testing

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
Total Effects					
X – Y	0.793	0.796	0.034	23.434	0.000
X – M1	0.762	0.766	0.045	17.038	0.000
X – M2	0.717	0.722	0.027	26.600	0.000
M1 – Y	0.507	0.502	0.052	9.741	0.000
M2 – Y	0.268	0.268	0.043	6.218	0.000
Specific Effects					
X – M1 – Y	0.387	0.384	0.042	9.239	0.000
X – M2 - Y	0.192	0.194	0.033	5.829	0.000

Source: SEM-PLS Result Analysis

Bootstrap results indicate that all hypothesized paths are highly statistically significant (p = 0.000 and t-statistics well above 1.96); hence, the hypotheses are supported. Total-effect estimates show that the Maritime Education System strongly influences Students' Professional Mindset (O = 0.793), and exerts substantial effects on Learning Environment (O = 0.762) and Self-Directed Learning (O = 0.717). Both mediators also contribute positively to mindset (M1 → Y: O = 0.507; M2 → Y: O = 0.268). Specific indirect effects for X → M1 → Y (O = 0.387) and X → M2 → Y (O = 0.192) are both significant. Thus, the Maritime Education System affects Students' Professional Mindset both directly and indirectly via Learning Environment and Self-Directed

Learning, indicating partial mediation and providing empirical support for the theoretical model.

Hypothesis 1 (H1) posited a positive effect of Maritime Education System on Students' Professional Mindset, and the bootstrap results provide strong support (O = 0.793; t = 23.434; p = 0.000), indicating a substantial direct effect. This finding is consistent with prior studies showing that curriculum policy, instructional quality, and industry linkage within the maritime education system shape students' professional attitudes and career orientation (Dewan et al., 2024). Differences in effect magnitude compared to other studies may arise when field experience or internship factors are more dominant (Wicaksono et al., 2024). Institutional context (e.g., accreditation, training facilities) and cross-national sample variation can also explain disparities (Veltsin et al., 2025). Theoretically, this result reinforces the education system's role as a primary determinant of professional mindset formation among maritime students (Chen et al., 2025). Practically, strengthening curriculum components and industry synergy is recommended to enhance professional outcomes.

Hypothesis 2 (H2), that Maritime Education System positively affects Learning Environment, is also strongly supported (O = 0.762; t = 17.038; p = 0.000), indicating that policy and structural changes significantly impact learning-environment quality. This aligns with literature that frames the education system as a key source for shaping facilities, pedagogical practices, and academic culture supportive of learning (Nakashima et al., 2023). However, other studies emphasize the influence of local actors (faculty and administrators) and fiscal resources, which can attenuate or amplify this relation (Nazarwin et al., 2025); measurement differences (e.g., focusing on physical versus pedagogical aspects of the learning environment) may also yield varying effects (Rahman, 2023). The finding underscores the importance of institutional policies that prioritize the learning environment as part of maritime education reform (Altes et al., 2024). Practical implications include directed investment in training facilities, faculty development, and the design of work-relevant learning experiences.

Hypothesis 3 (H3) tested the effect of Maritime Education System on Self-Directed Learning and received strong empirical support (O = 0.717; t = 26.600; p = 0.000), indicating that educational structures and policies promote students' autonomous learning capabilities. This concurs with prior research showing that curricula granting autonomy, project-based tasks, and digital learning resources enhance self-directed learning tendencies (Novalia et al., 2025). Differences with other studies may occur where academic cultures do not support individual initiative or where an overly rigid curriculum limits opportunities for autonomy (Mo et al., 2025). Variability in SDL measurement (e.g., motivation scales versus learning-strategy scales) can also affect the estimated relationship (Ferdianto & Anindita, 2023). The result reinforces the argument that system reforms should include strategies to facilitate learner autonomy (e.g., PjBL and open educational resources) (Hamori, 2023). Policy wise, institutions must balance academic guidance with space for student initiative.

Hypothesis 4 (H4), that Learning Environment affects Students' Professional Mindset, was accepted (O = 0.507; t = 9.741; p = 0.000), indicating that learning-environment quality significantly shapes professional mindset. This finding is consistent with studies emphasizing the role of learning conditions, such as simulation practice, collaborative learning, and practical feedback, in forming professional attitudes and behavioral norms (Natori et al., 2025). Some studies, however, report that real-world work experience (internships) is a stronger predictor than academic environment, suggesting that academic environment and field experience are complementary (Barasa et al., 2025). Institutional resource and instructor competence variability across institutions may also account for differences. This finding implies that improving pedagogical practices and the quality of practical learning can effectively enhance student professionalism (Starup et al., 2024). Strengthening applied practice and an academic culture that fosters professional ethics is therefore important.

Hypothesis 5 (H5), that Self-Directed Learning positively influences Students' Professional Mindset, was significant though smaller in magnitude compared with the learning environment effect (O = 0.268; t = 6.218; p = 0.000). This aligns with literature showing that SDL promotes initiative, learning responsibility, and metacognitive skills that support professional attitudes (Nguyen et al., 2026). Studies reporting larger SDL effects often identify moderating factors such as institutional support, access to learning resources, or cultural differences in learning that influence SDL expression (Assefa et al., 2025). External influences like practical experience and industry mentoring may also reduce the relative contribution of SDL to mindset formation (Chea, 2024). Practically, the result highlights the importance of scaffolding SDL through academic supports and learning infrastructure to maximize its contribution to student professionalism (Beckers et al., 2022). Policy recommendations include integrating structured SDL strategies and tutor/mentor support.

Hypothesis 6 (H6) assessed the mediation of Learning Environment in the relationship between Maritime Education System and Students' Professional Mindset; the significant indirect effect (X → M1 → Y O = 0.387; t = 9.239; p = 0.000) indicates substantive partial mediation. This result is consistent with prior studies that identify the learning environment as an important mechanism through which educational policy and system design impact attitudinal and readiness outcomes (Dunmoye et al., 2025). Variations in mediation proportion across studies may depend on control variables such as internship experience or career services support. Methodological differences, construct operationalization, and sample characteristics may also explain discrepancies (Dempsey et al., 2025). The finding emphasizes that interventions should not only modify system structures but also explicitly shape the learning environment to effect mindset change (Shen et al., 2024). Practical implementations include practice-space design, competency-based curricula, and faculty capability development.

Hypothesis 7 (H7) tested whether Self-Directed Learning mediates the effect of Maritime Education System on Students' Professional Mindset and was also significant, although with a smaller mediation effect (X → M2 → Y O = 0.192; t = 5.829; p = 0.000). This suggests that SDL is a pathway through which the education system influences professional mindset, but its contribution is relatively limited compared with that of the learning environment (Yue et al., 2025). This finding accords with studies that find SDL to be a mediator, particularly in contexts where curricula allow learning autonomy; differences in effect size may be influenced by academic culture and resource availability (Wu, 2024). Some studies indicate that without institutional support (e.g., technology facilitation and mentoring), SDL's potential as a mediator is constrained (Schweder & Raufelder, 2024). The practical implication is that policy should combine SDL enhancement with improvements in the learning environment to ensure this mediation pathway meaningfully contributes to developing students' professional mindset (Huang & Rusdi, 2025).

CONCLUSION

In conclusion, this study demonstrates that the Maritime Education System significantly shapes Students' Professional Mindset both directly and indirectly through improvements in Learning Environment and Self-Directed Learning, with a larger mediating contribution from the learning environment. Both mediators exert positive influences on the formation of students' professional mindset. These findings underscore the importance of strengthening curriculum policy, enhancing the quality of practical learning, and providing facilities and support to foster autonomous learning as an integrated strategy to improve professional outcomes for maritime graduates. Practically, the results open opportunities for implementing competency-based curriculum redesign, faculty training programs, and integration of industry practice experience and digital learning resources to accelerate the transition from competence to workplace professionalism. For future research, a longitudinal approach is recommended, as well as exploration of potential moderators (e.g., internship experience, institutional culture) and testing of measurable educational interventions to produce more robust evidence suitable for informing sustainable maritime education policy.

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