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Setting Sail for Success: A Survey-Based Analysis of COLREGs Proficiency Through Self-E-Learning, Classroom Instruction, And Simulation Training

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ABSTRACT

This study examines the obstacles that maritime students at the Universiti Malaysia Terengganu (UMT) encounter when attempting to understand the Convention on the International Regulations for Preventing Collisions at Sea (COLREGs). Given the crucial role of COLREGs in ensuring maritime safety, aspiring seafarers must have a comprehensive understanding of these regulations. However, the learning process is susceptible to various influencing factors, including self-e-learning, classroom teaching, and simulator training. To investigate these challenges, this study employed a quantitative approach, using a structured questionnaire to gather data from a representative sample of UMT maritime students. The collected quantitative data aimed to elucidate students' experiences with self-e-learning, classroom teaching, and simulator training, along with their perceived grasp of COLREGs. The objective of this study was to explain the factors that impede or facilitate the effective learning of COLREGs among maritime students in Malaysia. This knowledge holds significant value for maritime educators, curriculum developers, and policymakers, offering insights into enhancing the quality of maritime education and training programs. By addressing the challenges identified in this study, the UMT and other maritime institutions can better prepare their students for careers at sea, contributing to improved maritime safety and professionalism.

1. Introduction.

The Convention on the International Regulations for Preventing Collisions in the Sea, widely known as COLREGs, is a keystone in maritime safety and navigation. Initiated by the International Maritime Organization (IMO), COLREGs are a set of universally recognized rules and principles designed to govern the conduct of vessels at sea, with the main objective of preventing collisions Ivanišević et al. (2019). These regulations lay down a framework for safe navigation, communication, and right-of-way between vessels of all types and sizes, ensuring that the vast network of global maritime traffic operates smoothly and securely Louro et al. (2015).

COLREGs serve as legal mandates for seafarers and represent a commitment to safeguard human lives, property, and the marine environment. Their application is pivotal in maintaining order in the world's oceans' dynamic and often congested waters, enabling vessels to navigate precisely and avoid potentially catastrophic accidents. Internationally changing the realm of international shipping, COLREGs continue to serve as essential navigational tools, directing seafarers towards safer journeys and upholding the vitality of the maritime sector. COLREGs are comprehensive rules that govern vessel navigation, communication, and situational awareness. The effectiveness of maritime education in imparting this knowledge is crucial to maritime safety. Recent advancements in educational tech-

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nology have introduced self-e-learning platforms into maritime curricula, allowing students to engage in independent learning beyond the traditional classroom settings.

Maritime education provides students with the necessary skills and knowledge to navigate the complex world of maritime law Mallam et al. (2019). One important rule that they learn is the International Regulations for Preventing Collisions at Sea (COLREGs). How well students grasp COLREGs can be influenced by how they are taught Classroom teaching remains a fundamental component of maritime education, offering structured instruction and opportunities for interactions with instructors and peers. Additionally, simulator training provides students with realistic environments to apply COLREGs in practical scenarios. Assessing the roles of these variables-self-e-learning, classroom teaching, and simulator training-in the learning process is essential for optimizing maritime education programs.

The primary objective of this study was to examine the difficulties encountered by maritime students in acquiring knowledge of COLREGs. Specifically, this study explores the influence of e-learning, traditional classroom instruction, and simulationbased training on learning COLREGs. By understanding these challenges, educators and policymakers can develop practical solutions to improve the learning experience and enhance the competency of maritime students in adhering to COLREG rules. This study was designed to achieve four distinct objectives. First, it aimed to evaluate the extent of maritime students' engagement with self-e-learning platforms for COLREGs, shedding light on the efficiency of digital learning tools in this context. Second, this study seeks to assess the effectiveness of traditional classroom teaching methods in conveying the principles and concepts of COLREGs to maritime students. Third, it examines the challenges that these students encounter in learning COLREGs, providing insights into potential hurdles in their educational journey. Lastly, this research aims to determine the relationship between self-e-learning and classroom teaching, exploring how these two modes of instruction intersect and influence the overall learning experience regarding COLREGs for maritime students.

In the context of online learning, the structure of an online curriculum is mostly automated Khan (2009), granting students greater autonomy in determining the timing, manner, and selection of the content and activities in which they participate Milligan and Littlejohn (2014). Students need to monitor and adapt their behavior and activities to a particular learning environment because of this adaptability Zimmerman (2000). According to Demir and Yurdugül (2015), students understand their learning responsibility, which is intrinsic rather than reliant on external factors, such as teachers. Self-directed learners tend to actively participate in various learning processes, including information acquisition, strategic planning, and critical evaluation of learning activities. According to Freeman et al. (2014); Yilmaz (2016), the implementation of active learning methodologies has the potential to enhance student engagement, facilitate the learning process, and ultimately improve academic achievement Geng et al. (2019). Classroom teaching is pivotal for the effective learning of COLREGs among maritime students. It provides a structured environment in which students can receive guidance, interact with the subject matter, and practice their skills. To provide high-quality classroom teaching services, teachers play a vital role in guiding students throughout the learning process, aiming to achieve cognitive, affective, and psychomotor development Tacman (2011). To achieve this, teachers must establish an appropriate teaching environment that aligns with their solid foundation.

Existing literature on the teaching-learning process underscores the importance of combining various abilities and responsibilities. This includes planning, implementation, and assessment Beam III (1992); Brophy (1984). Educators play a crucial role in ensuring successful teaching and learning experiences. They shape every aspect of the process, from establishing a conducive learning environment to conducting meaningful assessments. Consequently, the qualifications and excellence of teachers have a profound impact on the overall success of this learning process.

Simulation-based training plays a crucial role in achieving educational goals related to the assessment and management of real-world situations. The utilization of simulation-based training has progressively become an integral part of educational programs with a focus on improving the application of acquired knowledge and skills in practical settings Hustad et al. (2019). This study aimed to investigate students' experiences with simulation-based training and their perceptions of how effectively they can apply what they have learned in real-life situations.

The remainder of this paper follows this structure, and the next section explains the theoretical foundations of the topic, establishes our hypotheses, and then proceeds to describe the materials and methodology employed in the study. Subsequently, the research presents its findings, engages in a discussion of these findings, and concludes with a summary of the study's outcomes.

2. Literature Review.

2.1. Theoretical Background.

The learning transfer theory is a widely accepted theory that explains how learning can be transferred from one context to another. According to this theory, learning transfer occurs when the knowledge, skills, and attitudes acquired in one context are applied to another Perkins et al. (1992). This theory suggests that the transfer of learning is influenced by several factors, including the similarity between the learning and transfer contexts, the degree of original learning, and the learner's motivation and ability to transfer learning. The study of maritime safety and navigation, particularly in the context of COLREGs, has long been a critical aspect of maritime education and training. The effectiveness of different learning methods in imparting the knowledge and skills required for COLREG compliance is paramount for enhancing maritime safety. This study draws upon Learning Transfer Theory, a well-established theoretical framework in education and training, to investigate how different modes of instruction impact the transfer of knowledge and

skills from the learning environment to practical application in real-world maritime scenarios.

Learning Transfer Theory suggests that the successful application of learned knowledge and skills in real?life situations is contingent on the alignment of the learning context, methods, and instructional design with the demands of the target environment. This theory suggests that the efficacy of self-paced e-learning, traditional classroom teaching, and immersive simulation training in facilitating the understanding and application of COLREGs can be understood through their ability to promote the transfer of learning. The theory emphasizes factors such as the relevance of learning content, engagement level, and opportunities for practice and feedback as critical determinants of successful learning transfer. Furthermore, selecting these three modes of instruction for investigation is grounded in their prevalent use in the maritime industry. Self-paced e-learning has become increasingly popular because of its flexibility, whereas classroom teaching remains a traditional but valuable approach. Simulation training offers a dynamic experiential learning environment that simulates real-life scenarios. This study examines how these distinct modes of instruction align with the principles of Learning Transfer Theory, and how they influence seafarers' comprehension and application of COLREGs.

In summary, this study aimed to provide valuable insights into maritime education and training. By utilizing the perspective of Learning Transfer Theory to examine self-e-learning, traditional classroom instruction, and simulation training, our goal was to shed light on the factors that either facilitate or hinder the successful transfer of COLREG knowledge and skills. The implications of this study extend to the development of more effective training programs, improved safety measures at sea, and the protection of human lives and maritime assets. Understanding how different instructional methods impact learning transfer in the context of COLREG compliance can offer guidance to educational institutions, maritime entities, and policymakers on optimizing their training approaches and improving maritime safety standards.

2.2. Hypothesis Development.

2.2.1. Self-E-Learning and Understanding of COLREGs.

Self-e-learning involves electronic media to deliver educational content to learners who are not physically present in traditional classroom settings Elfaki et al. (2019). This type is more like self-paced learning, where you learn with your availability and ease. In addition, this type can be accessed by students with an Internet connection from anywhere. Self-e-learning is effective for improving learners? knowledge and skills in various fields. The learning transfer theory suggests that self-e-learning can effectively transfer learning to new contexts, as learners can apply the knowledge and skills they have acquired in a self-paced, flexible learning environment to real-world situations Clark and Mayer (2023). Previous studies have underscored the importance of e-learning in maritime education Elfaki et al. (2019); Clark and Mayer (2023). The popularity of e-learning platforms has increased in tandem with technological improvements that facilitate the delivery of instructional content. Research indicates that e-learning can offer adaptable learning possibilities, enabling students to access course materials at their preferred speed and convenience. Nevertheless, there have been concerns over the efficacy of e-learning in intricate subjects such as COLREGs. The absence of direct interpersonal communication and practical instruction may impede students' capacities to grasp and implement regulatory principles in practical situations.

Self-e-learning is a self-directed and self-paced form in which learners control their learning process. Self-e-learning can effectively promote the transfer of learning because it allows learners to take responsibility for their learning and apply their knowledge to different contexts Pedersen et al. (2020). A study at Universiti Malaysia Terengganu by Kassar (2016) found that self-e-learning successfully promoted the transfer of learning of COLREGs, allowing learners to take responsibility for their learning and apply their knowledge in different contexts. According to another study, self-paced online education is an efficient method for facilitating the transfer of marine English learning because it enables students to take responsibility for their education and use what they have learned in various settings Navale (n.d.). Based on the above discussion, we hypothesize the following. **Hypothesis 1:** There is a significant relationship between self-e-learning and understanding of COLREGs

2.2.2. Classroom Teaching and Learning of COLREGs.

Classroom teaching is a conventional mode of education characterized by direct, in-person engagement between educators and students in a tangible classroom environment Spaulding (2010). This form of education is frequently organized and adheres to a predetermined syllabus, wherein educators provide lectures and facilitate conversations to facilitate learners' acquisition of knowledge and skills. Classroom teaching can effectively promote learning transfer when designed to promote active learning and engagement Beam III (1992). Research has consistently demonstrated the efficacy of classroom education in enhancing learners? knowledge and abilities across diverse domains Spaulding (2010). The learning transfer hypothesis postulates that structured teacher-led instruction can facilitate the transfer of knowledge and abilities from the classroom to real world contexts. This approach enables learners to effectively use the knowledge and skills acquired in diverse settings. Active learning strategies, such as group work, problem? based learning, and case studies, can help students apply their knowledge to different contexts Beam III (1992). A study by the United States Coast Guard found that classroom teaching effectively promoted the transfer of learning in COLREGs, as it allowed learners to engage in active learning strategies and apply their knowledge in different contexts Beam III (1992). Another study found that classroom teaching was effective in promoting the transfer of learning of maritime English, as it allowed learners to engage in active learning strategies and apply their knowledge in different contexts Spaulding (2010). Based on the above discussion, we hypothesize the following. **Hypothesis 2:** There is a significant relationship between classroom teaching and learning in COLREGs.

2.2.3. Simulator Training and Learning of COLREGs.

Simulation training is an instructional approach that uses simulated settings to afford learners practical and experiential opportunities in secure and regulated contexts. This form of learning is frequently employed in domains in which real-world instruction is deemed excessively hazardous or costly, such as aviation, medical, and military training Cachia et al. (2015); Pedersen et al. (2020). Simulation training has been identified as an effective method for enhancing learners' knowledge and skills across several domains. According to the learning transfer hypothesis, simulation training can transfer the information and skills gained to novel contexts. This learning is achieved by enabling learners to apply their learned abilities within a simulated environment, thereby enhancing their ability to navigate real world circumstances effectively Vagale et al. (2022). Simulation training can effectively promote the transfer of learning because it allows learners to practice their skills in a safe and controlled environment Gonin et al. (1993). "A study by the United States Coast Guard discovered that simulator training effectively facilitates the transfer of COLREGs learning. Because it enables learners to practice their skills in a safe and controlled environment and apply their knowledge in various circumstances." Beam III (1992). Another study found that simulator training effectively promoted the transfer of learning of autonomous navigation systems, as it allowed learners to practice their skills and knowledge in a simulated environment Pedersen et al. (2020). Based on the above discussion, we hypothesize the following. **Hypothesis 3:** A significant relationship exists between simulation training and COLREG learning.

3. Research Methodology.

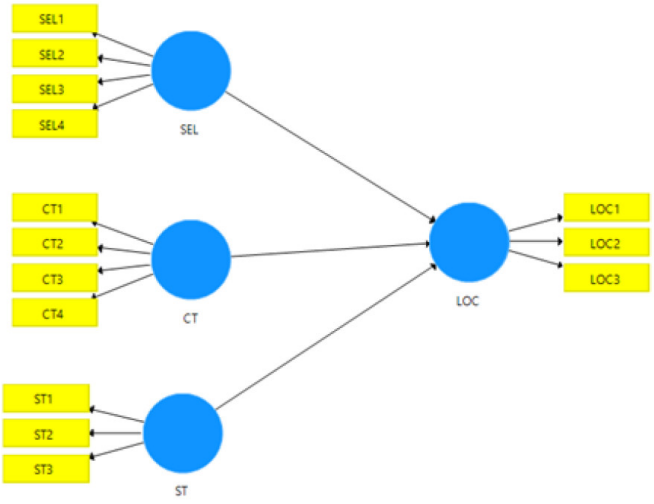
3.1. Conceptual Framework.

The study's conceptual framework is based on the Learning Transfer Theory, which provides the theoretical basis for examining the effects of self-e-learning, classroom teaching, and simulation training on acquiring COLREG knowledge among maritime students at the Universiti Maritime Malaysia (UMT). According to the Learning Transfer Theory, learning experiences can be evaluated by assessing how knowledge, skills, and competencies obtained in a particular context, such as the educational environment, can be successfully applied and transferred to real world practical situations. Within the realm of maritime education, this framework provides an opportunity to examine the impact of various instructional methods such as self?directed online learning, conventional classroom teaching, and simulation training on the acquisition, retention, and practical application of the International Regulations for Preventing Collisions at Sea (COLREGs). Through survey-based analysis, this study offers valuable insights into the effectiveness of these instructional approaches and their influence on maritime students' capacity to navigate and comply with crucial international standards concerning safe navigation at sea.

3.2. Research Instrument.

The research instrument employed in this study was a comprehensive survey questionnaire consisting of two distinct parts.

Figure 1: Theoratical Framework.



Source: Authors.

The first segment of the questionnaire was designed to capture essential demographic information from participants and provide valuable insights into their background characteristics. The second part included variables such as e-learning, which was measured using four items adapted from Elfaki et al. (2019); classroom teaching, measured using four items adapted from Keshavarz et al. (2022); and simulation training, measured using three items adapted from the study Cachia et al. (2015). The dependent variable Learning of COLREGs was measured using 3-items adapted from Louro et al. (2015). The self-administered questionnaire served as this study's primary data collection tool and was distributed among students enrolled in the Maritime Faculty who had completed simulation training as part of their curriculum. This questionnaire was constructed to measure students' perceptions, experiences, and learning outcomes in maritime education, with a specific focus on the effectiveness of simulation training. The questionnaire was structured to capture valuable insights into various facets, including their attitudes toward simulation training, the extent to which it enhanced their understanding of COLREGs, and their preferences for different modes of maritime instruction such as e-learning and classroom teaching. Using a self-administered approach, respondents could candidly express their opinions and provide self-assessments, ensuring that the collected data reflected their individual experiences and perspectives. This instrument, meticulously tailored to the research objectives, played a pivotal role in gathering essential information to improve our understanding of the impact of simulation training on maritime education within the context of COLREGs.

3.3. Participants and setting.

The study population comprised final year male and female undergraduate students enrolled in the Maritime Faculty at Uni-

versiti Malaysia Terengganu, Malaysia. Quantitative data were collected through a structured questionnaire administered to a sample of maritime students (both present and past) at UMT. The questionnaire assessed students' experiences with self-elearning, classroom teaching, and simulator training, as well as their perceived understanding of COLREGs. The population of interest for this study comprised students enrolled in various sessions at the University Malaysia Terengganu (UMT) undertaking maritime education programs. Owing to the unavailability of a population frame, convenience sampling was employed. Convenience sampling was chosen, as it allowed for data collection from students who voluntarily participated and filled out the questionnaire in the study. The questionnaire was distributed to the students via Google Forms; hence, the population frame was unknown. Approximately 150 responses were received from students across different sessions, and these respondents constituted the sample for this study. The unit of analysis for the current study is the individual, that is, students of the maritime faculty.

3.4. Data collection and sample selection.

This study utilizes a cross-sectional survey methodology to investigate the effects of self-directed e-learning, traditional classroom teaching, and simulation training on acquiring knowledge regarding the International Regulations for Preventing Collisions at Sea (COLREGs). The researchers built a questionnaire using simple questions that originated from and were amended from previous studies. Comprehensive information regarding

each variable item is provided in the Appendix. Participants' responses for most issues were collected using a five-point Likert Scale, with one representing "strongly disagree" and five representing "strongly agree." The participants in this study were chosen from the student population of the Faculty of Maritime at Universiti Malaysia Terengganu, Malaysia. This study employed a non-probability sampling technique because of the unavailability of information regarding the size of the population. The researchers used a convenience sampling strategy to obtain data from participants. Moreover, stable factor structure (SFS) criteria were employed to determine the appropriate sample size. According to the SFS criteria, to obtain reliable findings, it is necessary to have a sample size of 100 to 200 or a responder variable ratio of 1 to 2 MacCallum et al. (1999). Therefore, the present study established 150 respondents as the sample size for the data analysis. A convenience sampling method was used for data collection from the respondents, and their responses were promptly documented through questionnaires. The sample size was sufficient to ensure that the findings were representative of the target population.

3.5. Statistical methods.

The present work utilized the Structural Equation Modelling (SEM) technique to examine the proposed associations among many components, including SEL, CT, ST, and LOC. The Structural Equation Modelling (SEM) technique is a sophisticated multivariate statistical analysis approach that integrates multiple regression and factor analysis. Consequently, it is widely regarded as a more suitable tool for examining structural relationships that involve both seen indicators and underlying latent variables. This study utilized the partial least squares structural equation model (PLS?SEM), deemed suitable for the exploratory character of the objectives and the intricate specification of the model. Additionally, this study utilized measurement and structural models within the structural equation modeling (SEM) framework to examine specific research aims. The measurement model demonstrates the reliability and validity of each latent construct, whereas the structural model calculates the links among many latent variables inside the model Sarstedt et al. (2021).

4. Data Analysis and Results.

The present study examined the possibility of common method bias in the collected data before conducting extensive data analysis. PLS-SEM analysis was utilized as a multivariate analytical technique to examine and accomplish the research objectives. Smart-PLS 3 was employed to conduct two-stage analytical methods in partial least squares structural equation Modelling (PLS-SEM). The measurement model was estimated to evaluate the constructs' validity and reliability, whereas the structural models were analyzed to evaluate the hypothesized links among the specific variables inside the model.

4.1. Common Method Bias.

The primary objective of this study was to evaluate the common method bias using the collinearity test recommended by Kock (2017). The issue of common method bias commonly occurs because of the measuring method used in studies linked to structural equation modeling (SEM). It is worth noting that the choice of instrument can affect the responses obtained, leading to shared variation among indicators. In this context, a stochastic variable was constructed and subjected to regression analysis using the latent variables to evaluate the coefficients of complete collinearity. The findings presented in Table 1 indicate that all collinearity variance inflation factors (VIFs) are below the established threshold level of 3.3 Kock (2017). Therefore, this finding proves that the common method bias does not affect the model.

4.2. Measurement Model.

This study employed a bootstrap technique to estimate the factor loadings and determine their significance in analyzing the measurement model. All latent variables were conceptualized as multi-item structures within reflective models. The objective was to assess the constructs that exhibited robust internal consistency and were mutually associated. This study evaluated the loadings of indicators and examined their internal consistency to establish the reliability of the constructs. The factor loadings and results of the internal consistency tests are listed in Table 1. The results showed that all items had satisfactory outer loadings, ranging from 0.682 to 0.992. The calculated outer loadings for all items were determined to be above the threshold level of 0.5, indicating the reliability of the items Byrne (2001).

Table 1: Measurement Model Results.

Constructs	Items	Indicator reliability Outer loadings> 0.5	Internal consistency Composite reliability> 0.6	Convergent validity AVE> 0.5	Full collinearity VIFs VIF> 3.3
Self E–learning	SEL1	0.878	0.898	0.689	1.967
	SEL2	0.765			
	SEL3	0.881			
	SEL4	0.792			
classroom teaching	CT1	0.809	0.850	0.587	1.971
	CT2	0.812			
	CT3	0.754			
	CT4	0.682			
Simulation training	ST1	0.992	0.992	0.975	1.417
	ST2	0.978			
	ST3	0.992			
Learning of COLREGs	LOC1	0.811	0.924	0.803	1.886
	LOC2	0.939			
	LOC3	0.934			

Source: Authors.

Subsequently, a Composite Reliability (CR) test was administered to evaluate the item?s internal consistency. The findings in table 1 indicate that the composite reliability (CR) values for all constructs fall within the range of 0.850-0.992. These values surpass the minimum threshold level of 0.6, as recommended in previous research Hair et al. (2011). Therefore, the findings of the measurement model demonstrate that all constructs possess sufficient reliability to be used in the analysis of the structural model.

Furthermore, the present study examined the discriminant validity of the model, which pertains to the degree to which the items accurately predict their respective concepts or effectively differentiate between constructs. In academic research, the evaluation of discriminant reliability typically involves computing correlations between constructs that may share common measures. The primary objective of discriminant validity testing is to ascertain whether the items used in a study unintentionally analyze a different construct than anticipated. The Heterotrait-monotrait ratio of correlation (HTMT) technique was primarily employed to evaluate discriminant validity Ramayah et al. (2018). The HTMT ratio was computed by dividing between-trait correlations by within-trait correlations Hair et al. (2017).

According to a previous study, HTMT levels below 1, specifically 0.9 and 0.85, are deemed acceptable in certain research circumstances Henseler et al. (2015). The results shown in Table 2 indicate that none of the components exhibit an HTMT value greater than 0.9, thereby providing evidence of discriminant validity within the measuring model. In summary, this study's measurement model findings indicate that both the constructs' reliability and validity standards have been met. As a result, the data were considered appropriate for further analysis to examine the hypothesized correlations in the structural model.

Table 2: HTMT Results.

	CT	*LOC*	*SEL*	*ST*
CT				
LOC	0.774			
SEL	0.762	0.676		
ST	0.454	0.468	0.562	

Source: Authors.

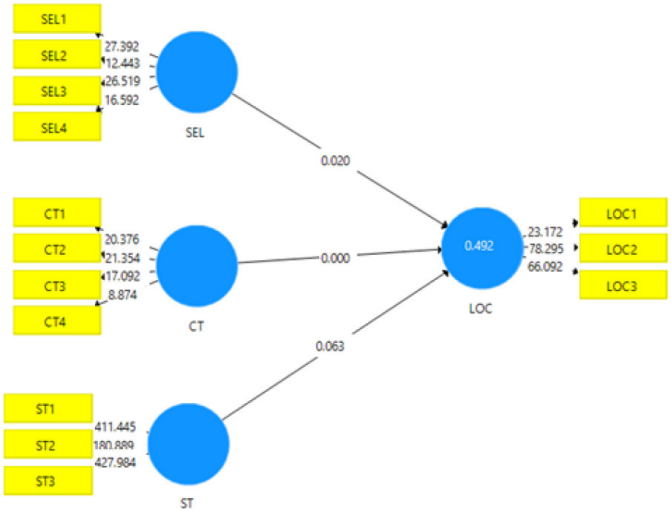
4.3. Structural Model.

In the next step, this study assessed the structural model to examine the hypothesized links to the research objectives. Collinearity is significant in the assessment of structural models. VIF values are commonly employed to identify collinearity issues in the model. According to the literature, the Variance Inflation Factor (VIF) values should be below the threshold levels of 3.3 or 5 Hair et al. (2017). The findings in Table 3 indicate that all Variance Inflation Factor (VIF) values fall below the established threshold of 3.3. This observation provides evidence that collinearity does not pose a concern within the context of this study.

Following the existing literature Ramayah et al. (2018), this study utilized a sample size of 5000 by implementing the bootstrapping technique in SmartPLS. Subsequently, other metrics, such as path coefficients and t-values, were computed to assess the statistical significance of the hypotheses. Table 3 shows that SEL is positively connected with LOC (= 0.224, $p < 0.020$). Therefore, the first hypothesis of this study is accepted. Similarly, at the 5% significance level, CT was found to have a highly significant and positive relationship with LOC (= 0.455, $p < 0.000$), thus supporting our second hypothesis. Therefore, our second hypothesis was also accepted, with a 5% confidence interval.

Lastly, ST had a non-significant effect on LOC (β = 0.142, p < 0.063). Therefore, the third hypothesis of this study was rejected. Therefore, we can argue that based on the available data, there is no such relationship between ST and LOC, but if we increase the confidence interval, we can say that this hypothesis could be accepted with a confidence interval of 10%. Furthermore, several scholars have criticized the utilization of pvalue criteria and recommended alternative approaches such as confidence intervals and impact size. Consequently, this study additionally presented F-squared values to consider the effect magnitude in the analysis. Cohen (2013) introduced threshold values of 0.35, 0.15, and 0.02, denoting significant, moderate, and negligible impacts, respectively. Based on the F-squared values presented in Table 3, it can be observed that Classroom Teaching (CT) has a moderate impact on the dependent variable LOC. Furthermore, the findings indicate that Self-E-Learning (SEL) and Simulation Training (ST) have a weak effect on the Learning of COLREGs (LOC).

Figure 2: Structural Model.



Source: Authors.

4.4. Discussion.

Table 1 shows the measurement model results of the surveybased analysis conducted among UMT University Maritime students to assess the impact of self-e-learning, classroom teaching, and simulation training on COLREG knowledge. The table provides information on the constructs and items' reliability, internal consistency, convergent validity, full collinearity VIFs, outer loadings, composite reliability, and AVE. The table shows that all constructs had good reliability and internal consistency, with Cronbach's alpha values ranging from 0.682 to 0.992. All constructs had good convergent validity, with all items having outer loadings greater than 0.5, and AVE values greater than 0.5. All constructs had VIF values less than 3.3, indicating no multicollinearity issues.

Table 2 presents the HTMT results of the survey-based analyses. The table shows the constructs' heterotrait-monotrait ratio of correlations (HTMT). The HTMT values were all less than 0.9, indicating good discriminant validity between the constructs. Table 3 presents the structural model results of the survey-based analyses. This table provides information on the beta coefficients, 95% confidence intervals, t-values, p-values, decisions, R-squared, F-squared, effect size, and VIF of the relationships between the constructs. The results show that classroom teaching and self-e-learning positively impact the learning of COLREGs among UMT Universiti Maritime students, whereas simulation training does not significantly impact them. The effect size of classroom teaching on the learning of COLREGs was moderate, whereas the effect size of self-e-learning on the learning of COLREGs was small. The VIF values were all less than two, indicating no multicollinearity issues. The beta coefficients of classroom teaching and self-e-learning were 0.455 and 0.224, respectively, indicating that classroom teaching had a stronger impact on learning COLREGs than self-elearning. The beta coefficient of simulation training was 0.142, which is insignificant, indicating that simulation training does not significantly impact the learning of COLREGs.

Conclusions and Recommendations.

Conclusion.

In summary, our extensive study has not only yielded valuable insights but has also significantly advanced the understanding of the impact of various educational methods on COLREG knowledge among students at the University Malaysia Terengganu (UMT). The thorough data analysis conducted in this research revealed the crucial relationships between self-e-learning, traditional classroom teaching, and their influence on the acquisition of COLREG knowledge. These findings underscore the importance of adopting a comprehensive and adaptable approach to maritime education that considers UMT the diverse learning preferences of UMT students.

The positive correlation between self-e-learning and COLREG knowledge emphasizes the potential benefits of incorporating technology-driven, self-directed learning modules into the maritime curriculum. The association between traditional classroom teaching and enhanced COLREG knowledge highlights the significance of conventional teaching methods. Consequently, a blended approach that seamlessly integrates both digital and traditional pedagogies has emerged as the optimal strategy for fostering a comprehensive understanding of COLREGs among UMT students. However, the notable rejection of the hypothesis concerning simulation training warrants careful reflection and critical revaluation of current simulation programs. This highlights the necessity of refining and optimizing the design and implementation of simulation training to ensure its efficacy in enhancing COLREG knowledge. The findings not only contribute to the academic discourse on maritime education but also provide practical implications for educators, curriculum developers, and policymakers involved in shaping the future of maritime training programs.

This study highlights the ever-changing nature of effective maritime education and emphasizes the need for a flexible curriculum that utilizes a variety of teaching methodologies. Going

Table 3: Structural Model Results.

Relationship	Beta	95% Confidence Interval	T–Value	p–Value	Decision	R–Sq	F–Sq	Effect Size	VIF
SEL – > LOC	0.224	[0.046;0.423]	2.342	0.020	Accepted		0.050	Small	1.983
CT – > LOC	0.455	[0.255;0.622]	4.884	0.000	Accepted	0.492	0.236	Moderate	1.723
ST – > LOC	0.142	[-0.008;0.301]	1.863	0.063	Rejected		0.029	Small	1.383

Source: Authors.

forward, it is essential to adopt a responsive and sensitive approach to maritime education to adequately prepare UMT students to meet the demands and responsibilities of their future maritime careers. The implications of this research extend beyond the boundaries of the UMT, providing a theoretical foundation for global maritime education. Our study highlights the importance of customizing instructional methods to accommodate individual learning styles and underscores the critical role of technology in contemporary maritime education. These findings and conclusions can serve as a basis for enhancing the quality and accessibility of maritime education worldwide.

Recommendation.

Based on the findings of our study, we offer the following recommendations for maritime educational institutions, policy makers, and educators.

- Curriculum Revision: Institutions should consider revising their curricula to include a balanced mix of self-elearning and classroom teaching methods. This approach ensures the comprehensive acquisition of COLREG knowledge.
- Investment in E-Learning: Maritime organizations should allocate resources to developing and maintaining high-quality e-learning platforms and materials tailored to maritime education, making them accessible to all students.
- Quality Assurance: Institutions should establish mechanisms for ongoing teacher training and evaluation to maintain high teaching standards in the classroom.
- Simulation Program Review: Maritime institutions should critically evaluate their simulation training programs and make necessary adjustments to enhance their effectiveness in teaching COLREGs.
- Innovation Recognition: Institutions should recognize and incentivize innovative teaching methods that combine various instructional approaches to improve COLREGs' knowledge of COLREGs.
- Quality Monitoring: Establish a system for continuous monitoring and evaluation of instructional methods to ensure their effectiveness over time.
- International Collaboration: Explore opportunities for international collaboration in maritime education and share best practices and resources to enhance educational outcomes.

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