

Integrating UNESCO AI Competences in Maritime English Teaching for Maritime Higher Education Students

Aliya Izet Begovic Yahya¹, Merry Lapasau², Syahfitri Purnama³, Oom Rohmah Syamsudin⁴, Abudlkarimu Yanda⁵

^{1*, 2, 3, 4} Universitas Indraprasta PGRI, Indonesia

⁵University of Dar es Salaam, Dar es Salaam, Tanzania

Corresponding author: begovicnskw@gmail.com

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ABSTRACT

Maritime English plays a pivotal role in ensuring safety and operational efficiency in global maritime communication, aligning with International Maritime Organization's (IMO) standardized linguistic framework. The emergence of Artificial Intelligence (AI) in higher education requires a pedagogical shift from conventional language instruction toward AI-integrated Maritime English learning. The unit of analysis in this study comprises empirical and conceptual research articles, while Scopus and SINTA serve as the primary databases for article retrieval. Additional supporting studies from DOAJ and conference proceedings were included only after relevance screening to broaden contextual coverage. Following a PRISMA-guided review, 48 articles published between 2017 and 2025 were screened, resulting in 22 eligible studies for thematic synthesis. The review critically identifies three major themes: (1) early adoption of AI-supported learning tools such as VR simulators, AI chatbots, and automated feedback systems; (2) limited pedagogical integration of AI competencies into Maritime English curricula; and (3) increasing awareness of ethical AI use in maritime education. The findings reveal that current implementation remains technologically oriented rather than pedagogically grounded, particularly in critical thinking, ethical reasoning, and AI-assisted communication competencies. This study contributes a conceptual framework that synthesizes UNESCO AI competencies with Maritime English pedagogy to support curriculum innovation in maritime higher education, particularly in Indonesia and comparable educational contexts.

Keywords: AI Competency Framework; Artificial Intelligence in Education; Digital Literacy, Maritime English; Maritime Higher Education

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INTRODUCTION

Maritime English is a fundamental competency in international shipping because it serves as the primary language for navigation, ship operations, and shipping safety. Trenkner emphasized that Maritime English has evolved into the lingua franca of global maritime communication, so that miscommunication can directly affect shipping safety. Maritime English functions as the primary language of communication within the international maritime community and plays a crucial role in supporting navigational safety and efficient maritime operations (Pritchard, 2003, 3). In addition, seafarers' English-language proficiency is closely correlated with operational efficiency and work coordination on ships (Pritchard, 2020). The International Maritime Organization also emphasizes that the use of Standard Marine Communication Phrases (SMCP) is necessary to prevent miscommunication at sea (IMO, 2020). Therefore, mastery of Maritime English is not only about linguistic competence but also about professionalism and occupational safety in the international maritime sector.

The development of digital technology has shifted the paradigm of Maritime English learning from a conventional approach to a technology-based one. Zhang explained that technology-enhanced learning can reconstruct English for Specific Purposes (ESP) teaching to be more interactive and contextual (Zhang, 2021: 5). The integration of information and communication technology in the maritime classroom has also been proven to increase students' motivation and understanding of shipping technical materials (Andrei, 2019: 118). On the other hand, Trenkner and Cole found that the blended learning approach provides greater flexibility for shipping cadets in learning maritime communication (Trenkner & Cole, 2018: 94). However, several studies show that the use of technology in Maritime English is still predominantly oriented towards learning media and has not been pedagogically integrated with the development of critical thinking competencies and technology-based decision-making.

The integration of artificial intelligence (AI) in higher education is getting more and more attention as AI is seen as an important part of the digital literacy of the future. UNESCO affirms that AI competencies for learners include critical thinking skills, creativity, ethical awareness, and social understanding of the use of smart technology (UNESCO, 2024). Holmes also stated that AI literacy is now an integral part of digital literacy in modern higher education (Holmes, 2023). In the context of maritime education, these competencies are needed to support communication skills, situational analysis, and technology-based decision-making in a shipping work environment (Holmes, 2022: 110). Nonetheless, most research still focuses on AI's technical aspects, such as simulators, chatbots, and automated evaluations, while the integration of AI competencies into Maritime English pedagogy is still largely understudied.

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Various studies show that AI has great potential in improving the effectiveness of Maritime English learning through simulation, adaptive learning, and immersive technology. Kim and Park found that AI-based simulators significantly improved cruise cadets' situational awareness and communication skills (Kim & Park, 2022). In addition, Xu explained that AI-based platforms can personalize Maritime English training to learners' needs and learning speed (Xu, 2019: 518). Sharma, Bhattacharya, and Sinha also show that AI-based chatbots are effectively used for COLREGs-based technical communication exercises in maritime education (Sharma et al., 2023: 238). However, the results of these studies show that the implementation of AI remains centered on the use of technology as an operational tool and has not been directed toward the development of AI-based ethical, evaluative, and communication competencies, as recommended by UNESCO.

From a pedagogical perspective, the integration of technology in ESP learning should not only emphasize the use of digital devices, but also the integration between technology, pedagogy, and learning content. Mishra and Koehler, through the TPACK concept, emphasized that the effectiveness of technology-based learning depends on a balanced integration of technological knowledge, pedagogy, and teaching materials (Mishra & Koehler, 2006). Li also stated that the integration of technology in ESP should be tailored to the professional needs and work context of learners (Li, 2021: 41). In maritime education, this need is closely related to the communication skills of international standards based on SMCP and the use of modern navigation technology (IMO, 2020). However, some studies show that, despite the rapid development of maritime technology, the Maritime English curriculum still tends to focus on terminology mastery and language accuracy rather than on developing digital communication competencies, AI literacy, and technology ethics.

Previous empirical research has also shown that shipping cadets still face difficulties in understanding technical terminology and pragmatic communication in Maritime English. Karatas found that students often experience obstacles in the contextual use of maritime terms in professional communication (Karatas, 2020: 63). Andriani's research shows the low mastery of technical vocabulary among Indonesian shipping cadets, especially in the context of ship operational communication (Andriani, 2021: 39). On the other hand, Prasetyo proves that the integration of multimedia and interactive technology can improve the understanding of maritime vocabulary more effectively (Prasetyo, 2022: 91). These findings show that there is a need to develop a more adaptive, interactive, and AI-based approach to Maritime English learning to support the professional communication skills of shipping students.

Although research on AI in maritime education continues to grow, the existing literature still shows significant conceptual and pedagogical gaps. Zhao stated that AI research in ESP remains fragmented and lacks a

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comprehensive integration model ([Zhao, 2022: 240](#)). Liu also asserts that most AI studies in language learning are still oriented towards the implementation of technology rather than the integration of AI competencies into curriculum design and specialized language pedagogy ([Liu, 2021: 105](#)). Thus, aspects that are still lacking in the current literature include the integration of UNESCO AI competencies, such as critical evaluation, ethical reasoning, and AI-mediated communication, into Maritime English learning. Based on these gaps, this study aims to synthesize the literature on integrating UNESCO AI competencies into Maritime English learning in shipping colleges, identify trends, challenges, and opportunities for their implementation, and propose a conceptual framework that connects AI competencies with ESP-based Maritime English pedagogy. Based on this description, this research is focused on the following three research questions: (1) what are the competencies of UNESCO AI that are relevant in Maritime English learning in shipping colleges; (2) how AI-based technologies are applied to support Maritime English learning; and (3) what pedagogical gaps are still found in the integration of AI in Maritime English learning based on international and national literature studies.

METHOD

The SLR approach was chosen because it enables researchers to systematically identify, evaluate, and synthesize the results of previous research in a transparent manner. Snyder explained that a literature review is a method that can be used to build a conceptual foundation and identify open research gaps ([Snyder, 2019: 334](#)). In addition, Creswell emphasized that literature review not only serves as a theoretical review, but also as a basis for building a conceptual framework for research ([Creswell, 2014: 27](#)). In this study, the SLR method was used to connect the UNESCO AI Competency Framework with ESP (English for Specific Purposes) based Maritime English learning practices in maritime education. This research approach adopts the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) model to ensure transparency, procedural traceability, and reproducibility of research results ([Page et al., 2021: 2](#)).

Research data sources were obtained from articles from Scopus-indexed international journals, SINTA-indexed national journals, and international conference proceedings relevant to the research topic. The selection of resources was intended to provide a global and local perspective on the integration of AI into Maritime English learning. Booth, Sutton, and Papaioannou emphasized that the quality of literature review is largely determined by the accuracy of the source selection process used ([Booth et al., 2016: 95](#)). Therefore, only academic articles that have gone through a peer-review process and have direct relevance to Maritime English, learning technologies, or AI competencies are included in the analysis. The literature search strategy was conducted using a combination of keywords and Boolean operators across the Scopus, Google Scholar, Garuda, and DOAJ databases.

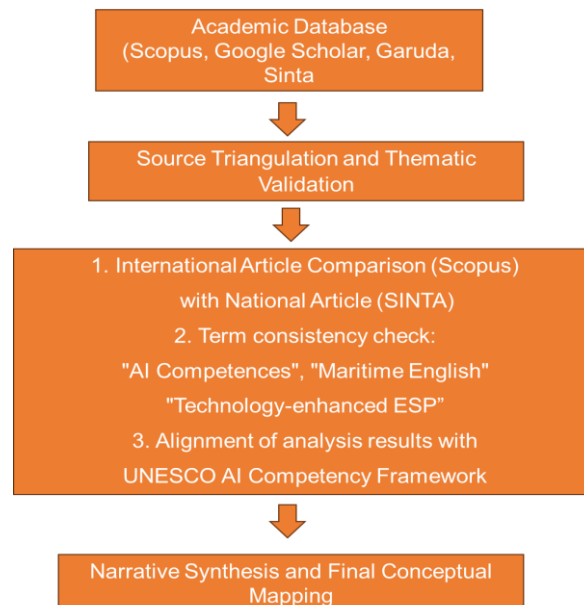
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The Boolean search strings used are: ("Maritime English" OR "English for Maritime Purposes") AND ("Artificial Intelligence" OR AI OR chatbot OR "virtual reality") AND (education OR pedagogy OR curriculum). The use of this search strategy aims to increase transparency and enable replication of the research by other researchers.

The research stage begins with the identification of problems and the formulation of research questions focused on the relevance of UNESCO's AI competencies, the application of AI technology in Maritime English learning, as well as pedagogical gaps that are still found in the previous literature. Creswell explained that the formulation of research questions is the core of research design because it determines the direction of data collection and analysis (Creswell, 2018: 74). Furthermore, the article search process was carried out systematically in the January-March 2026 period using Scopus, SINTA, Google Scholar, and Garuda databases. The articles were then selected based on the set inclusion and exclusion criteria. Inclusion criteria include: (1) English or Indonesian articles; (2) issued in the range of 2017–2025; (3) discuss Maritime English, AI integration, learning technology, or UNESCO AI competencies; and (4) have gone through a peer-review process. Meanwhile, the exclusion criteria include: (1) non-academic articles; (2) reports without full text; (3) duplicate articles; and (4) AI research that is not related to maritime education. These criteria are determined to maintain the research's focus and ensure the quality of the sources analyzed (Machi & McEvoy, 2016: 59).

Figure 1:
Article's collection flowchart



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Inclusion criteria include English/Indonesian articles published between 2017 and 2024 that focus on Maritime English or the integration of AI/technology in ESP. On the other hand, articles that do not undergo peer review or are only in the form of non-academic reports are published ([Andrei, 2019](#); [Wang, 2020](#); [Lyu & Li, 2022](#)). According to Machi & McEvoy (2016), the determination of inclusion and exclusion is important to maintain the focus of the research ([Machi & McEvoy, 2016](#)). Only quality academic sources are further analyzed. This process ensures that the analysis results reflect the current, reliable conditions of the existing literature.

The article selection process followed the PRISMA guidelines and involved two independent researchers to improve the reliability of data selection. At the identification stage, 48 articles were found from various databases. After removing duplicate articles, the number is reduced to 41. The screening stage was carried out by examining titles and abstracts, resulting in 34 articles considered relevant to the research topic. Furthermore, the eligibility stage was conducted by reading the full text of each article and evaluating its suitability for the research focus, resulting in 27 eligible articles. In the final stage, 22 articles were selected as the main sources for analysis. The discrepancy between the selection results of researchers was resolved through discussion until a mutual agreement was reached. Using more than one researcher in the selection process aims to increase the consistency and validity of the literature review results.

Data analysis was conducted using content analysis and thematic synthesis. Krippendorff explained that content analysis is a systematic method for identifying patterns, themes, and meanings in a text ([Krippendorff, 2018: 24](#)). In the initial stage, the entire article is thoroughly read to understand the research context. Furthermore, the open coding process involves marking the main concepts related to the integration of AI into Maritime English. The coding results were then grouped into several main themes, namely: (1) the role of Maritime English in maritime safety; (2) the application of AI and learning technology; (3) UNESCO AI competence; (4) pedagogical implementation; and (5) learning outcomes. This approach is used to reduce the tendency toward descriptive reporting and to strengthen critical synthesis across studies.

To increase transparency in the analysis, this study uses a coding framework consisting of four main variables: AI technology type, UNESCO AI competence, pedagogical implementation, and learning outcomes. The "AI Tool Type" variable includes the use of VR, chatbots, LMS, and automated feedback. The "UNESCO Competency" variables include critical thinking, AI ethics, creativity, and digital literacy. The "Pedagogical Use" variable includes simulation, communication, and learning assessment, while the "Learning Outcome" variable includes students' language skills, learning engagement, and digital literacy. Two researchers conducted the coding process independently, then compared the results to ensure data categorization consistency. Discrepancies in the coding process are resolved

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through discussion and re-examination of the source articles until a mutual agreement is reached. This step is carried out to improve the reliability and validity of the analysis of research data.

The literature search was conducted systematically using a Boolean Search String designed to identify research relevant to the topics of Maritime English, artificial intelligence (AI), and maritime education. The search strings used are:

("Maritime English" OR "English for Maritime Purposes") AND ("Artificial Intelligence" OR AI OR chatbot OR "virtual reality") AND (education OR pedagogy OR curriculum)

The use of Boolean OR operators expands the search scope by including a range of terms with similar or interrelated meanings. For example, the terms Maritime English and English for Maritime Purposes are used interchangeably in various publications, so both need to be included to avoid missing relevant research. Similarly, the terms Artificial Intelligence, AI, chatbots, and virtual reality are used to capture the various forms of artificial intelligence-based technology currently applied in the field of education.

Meanwhile, the AND operator is used to narrow the search results to only display articles that address the three main aspects of the research: Maritime English, AI technology, and the context of education or curriculum. This strategy was chosen to ensure that the articles found are directly related to the research focus and provide relevant empirical and conceptual evidence.

This study established several inclusion criteria to ensure the quality and relevance of the literature used. First, the selected article must have been published during the 2017–2025 period. The time frame was chosen because the development of artificial intelligence technology in education accelerated significantly during that period, so that longer research could no longer reflect current conditions and technological developments. Second, the source must be a reputable journal article that has undergone peer review or a scientific conference proceedings. These criteria are applied to ensure the academic validity, credibility of the methodology, and reliability of the findings reported in each study. Third, the article should focus on Maritime English, the integration of AI into learning, or UNESCO AI competencies. This criterion was established because the main objective of the research was to explore how AI technology can support the teaching and learning of Maritime English in accordance with UNESCO's recommended competency framework. Fourth, the article must be written in English. The selection of English was made because most relevant, high-quality international publications in the field of maritime education and artificial intelligence are published in the language, thereby enabling access to a wider global research base.

In addition to the inclusion criteria, this study applies several exclusion criteria to avoid including sources that are less relevant or less academically accountable. First, sources that do not undergo peer review are

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excluded from the study because experts in the relevant field have not validated their scientific quality. This is important to maintain the integrity and reliability of the literature review results. Second, research on Artificial Intelligence in general, unrelated to maritime education or Maritime English, was not included in the analysis. While the research may be relevant to AI, it does not fit into the specific focus of this study. Third, duplicate articles from other sources are removed to avoid double-counting and ensure each study is analyzed only once. In addition, articles whose full texts cannot be accessed are excluded because limited access can hinder methodological evaluation, data analysis, and the interpretation of research results as a whole.

The literature identification and selection process was carried out in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. This approach is used to increase transparency, consistency, and accountability in the process of selecting articles to be analyzed. At the initial identification stage, 48 articles were obtained from various scientific databases that matched the predetermined search keywords. After checking articles with the same title, author, and publication information, several duplicates were found, reducing the total to 40.

The next stage is the screening process based on titles and abstracts. At this stage, articles that are not relevant to the research focus are eliminated, leaving 34 eligible for further review. Next, an eligibility assessment was carried out on the full text of the article. This process aims to ensure that each article meets all inclusion criteria and is not excluded under the set exclusion criteria. The evaluation results showed that 27 articles were eligible for the in-depth assessment. In the final stage, an analysis of the quality and relevance of the research was conducted, resulting in the selection of 22 articles that met all methodological and substantive requirements for inclusion in the systematic study. The twenty-two articles then served as the basis for the literature synthesis on the integration of artificial intelligence into Maritime English learning and its relationship to UNESCO's AI competence. This text has been prepared in an academic style that is appropriate for the Methodology → Search Strategy, Inclusion and Exclusion Criteria, and PRISMA Flow Description sections in Scopus/Q1 articles or international proceedings.

Table 1:
Coding Framework

Variable	Category	Indicator
AI Tool Type	Technology	VR, chatbot, LMS, automated feedback
UNESCO Competency	Cognitive	critical thinking, ethics, creativity

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Pedagogical Use	Implementation	assessment, communication, simulation
Learning Outcome	Result	language proficiency, digital literacy

Two researchers independently coded the articles. Discrepancies were resolved through discussion to ensure coding consistency.

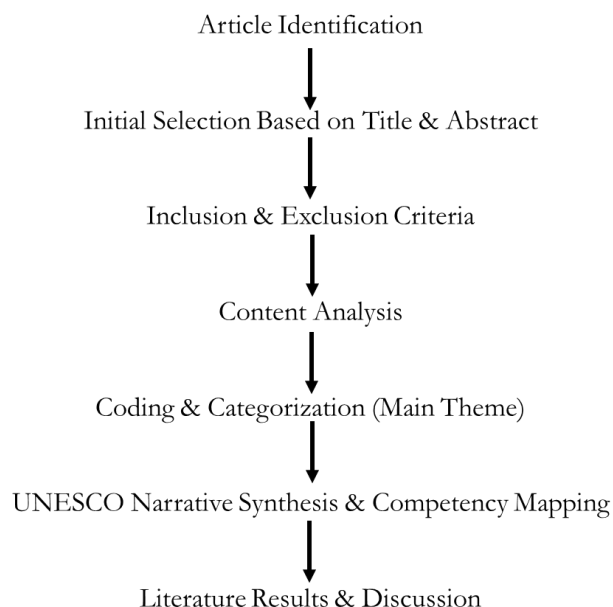
In addition to using thematic analysis, this study also applies source triangulation by comparing international and national research results from various databases. Triangulation is carried out through three stages, namely: (1) comparing the tendency of findings from international journals with the local context in national journals; (2) examine the consistency of the use of concepts such as "AI competencies" and "Maritime English" in various studies; and (3) matching research findings with UNESCO's AI competency framework as a global reference. This triangulation process aims to reduce the bias of a single perspective and strengthen the validity of the interpretation of research results. Thus, the results of the study are not only descriptive but also reveal the main patterns, contradictions, and tendencies in the integration of AI into Maritime English learning.

The analyzed data is then mapped using the PRISMA diagram to show the number of articles at each stage of selection, from identification and screening to feasibility and the final article analyzed. Page and colleagues affirm that the PRISMA diagram is important to increase transparency in systematic studies and make it easier for readers to understand the literature selection process (Page et al., 2021: 5). Therefore, this study presents a detailed flow diagram of PRISMA so that the research procedure can be replicated in different contexts. In addition, data synthesis was carried out using a descriptive-narrative approach to connect UNESCO's AI competency theory with Maritime English learning practices and maritime education technologies. Booth et al. explain that synthesizing the literature enables researchers to generate new conceptual contributions from existing studies (Booth et al., 2016: 187). The final result of this study is a conceptual map of the integration of UNESCO AI competencies into Maritime English learning in shipping colleges.

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Figure 2:
Research Process Flowchart (Adapted from the PRISMA model).



Data Triangulation

To increase the credibility and consistency of the findings, this study applies [data triangulation](#) at the literature collection and analysis stage. Triangulation is carried out by comparing and verifying information obtained from various data sources, namely the Scopus database, SINTA, the Directory of Open Access Journals (DOAJ), and international proceedings relevant to the research topic. The use of multiple data sources aims to reduce source bias and ensure that the findings do not come from a single database. The triangulation process is carried out through three stages. First, article identification is performed independently in each database using predefined keywords. Second, search results from various databases are compared to identify similarities and differences in the information found. Third, articles that meet the inclusion criteria are analyzed comparatively to ensure consistency in findings regarding UNESCO's AI competencies, Maritime English learning support technologies, and their impact on learning outcomes. Through this triangulation process, researchers can increase the validity of the results of literature synthesis while strengthening the reliability of the resulting interpretations. This approach is in line with [Creswell's \(2018\)](#) recommendations, which state that triangulation is an important strategy to increase trustworthiness in qualitative research and literature review studies.

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Figure 3:
Data Triangulation Process



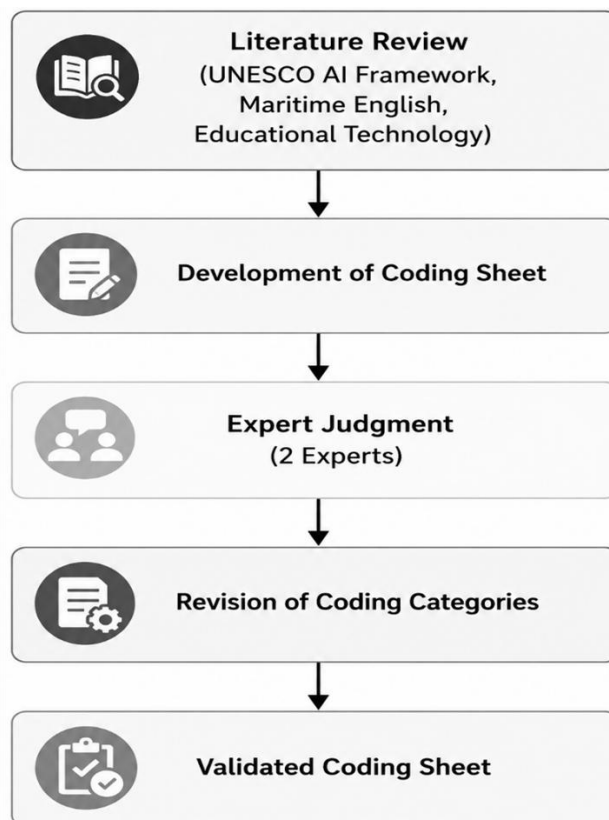
Validity of Coding Instruments

The main instrument in this study is a coding sheet used to identify and group information from the analyzed articles. The coding sheet is prepared based on UNESCO's AI competency framework (2024), the concept of Maritime English, and the learning technology categories found in the literature. To ensure the instrument's validity, an expert judgment process was conducted involving two experts with competence in research methodology and educational technology. Experts were asked to examine the suitability of coding categories, clarity of operational definitions, and relevance of indicators to the research objectives. Expert input is used to revise and refine the coding sheet before it is used in the analysis. This validation process aims to ensure that each coding category accurately and consistently represents the measured concepts. Thus, the instrument used has sufficient *content validity* to support the data analysis process.

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Figure 4:
Coding Sheet Validity Process



Coding Reliability

To ensure coding consistency, this study uses an inter-rater reliability procedure. After the coding sheet is valid, two coders independently encode the selected article sample. The coding results are then compared to identify the level of compatibility between the coder. Reliability was evaluated using an inter-rater agreement approach. If there is a difference in the coding results, discussions continue until agreement is reached on the categories used. This process aims to minimize the subjectivity of researchers and improve data interpretation consistency. The application of coding reliability is essential in content analysis-based research and literature reviews because it helps ensure that the classification process is carried out systematically and can be replicated by other researchers. Thus, the study's results have greater reliability and can be scientifically accounted for.

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Figure 5:
Process Reliability Coding



FINDINGS AND DISCUSSION

This section presents the results of a literature review on integrating UNESCO AI competencies into Maritime English learning in shipping colleges. The analysis was carried out on selected articles that had undergone a PRISMA-based selection process and were analyzed using content analysis and thematic synthesis. The research focuses on three main aspects: the relevance of UNESCO's AI competencies in Maritime English learning; the application of AI-based technology in maritime education; and the pedagogical gaps that persist in its implementation. In addition, the discussion is directed at identifying patterns, contradictions, and trends arising from previous studies to produce a more critical and comprehensive synthesis. Thus, this section not only describes the findings of previous research but also provides a conceptual interpretation regarding the opportunities and challenges of AI integration in ESP-based Maritime English learning in shipping colleges.

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Identification of Relevant AI (UNESCO) Competencies for Shipping Students in the Context of Maritime English

The results of the literature review indicate that the artificial intelligence (AI) competencies developed by UNESCO (2024) are highly relevant to Maritime English learning. This relevance arises because the modern shipping world not only demands the ability to speak English as a tool of international communication, but also to utilize digital technology, think critically in decision-making, and interact effectively with AI-based systems increasingly used in ship operations. Therefore, UNESCO's AI competencies can be seen as a framework that supports the development of maritime communication capabilities aligned with the needs of the global shipping industry.

As shown in Table 2, the first competency, namely Digital Literacy and Ethics, plays a crucial role in preparing shipping cadets to face an increasingly digitized maritime work environment. Currently, various navigation and communication systems for ships, such as the Electronic Chart Display and Information System (ECDIS), Global Maritime Distress and Safety System (GMDSS), electronic logbooks, and various shipboard electronic documents, require seafarers to understand, interpret, and communicate information presented digitally. In the context of learning Maritime English, digital literacy is not only about using technology but also about understanding terms, instructions, and technical information conveyed through digital systems. In addition, the ethical aspect is becoming increasingly important because AI-based technology is also linked to data security, professional responsibility, and compliance with international regulations. The findings of [Ratnaningsih et al. \(2024\)](#) indicate that AI-based learning media can increase student involvement in maritime communication activities, while UNESCO (2024) emphasizes that digital literacy must always be accompanied by ethical awareness in the use of technology.

The second competency, namely Critical Thinking, is closely related to the ability to analyze and make decisions, which are the main demands of the seafarer profession. In ship operations, communication serves not only to convey information but also to understand the situation, assess risks, and determine appropriate actions, especially in emergencies. Therefore, learning Maritime English should develop critical thinking skills through activities that require analysis, such as studying ship accident reports, maritime incident case studies, emergency communication simulations, and discussions on safety procedures. These activities allow cadets to understand communication context in greater depth, rather than just memorizing maritime terminology. Research by [Riyanto et al. \(2024\)](#) shows that the competency-based learning approach can improve the analytical and professional abilities of maritime students. Thus, integrating critical thinking competencies into Maritime English instruction can strengthen communication skills and support more effective decision-making in a maritime work environment.

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The third competency, AI-enhanced Communication, reflects the increasing use of AI to support communication and learning processes. The development of AI-based chatbots, virtual reality (VR), augmented reality (AR), and digital simulators has opened new opportunities for more interactive, contextualized teaching of Maritime English. The technology allows cadets to practice maritime communication in conditions that resemble real conditions on board without being directly in the operational environment. Through AI-based chatbots, students can practice having repeated conversations with quick, personalized feedback. Meanwhile, VR technology allows students to practice using Maritime English in realistic navigational scenarios, ship bridge communication, and safety procedures. [Miyusov et al. \(2024\)](#) explain that immersive learning technology has great potential to improve the quality of maritime education, while [Sharma et al. \(2023\)](#) show that AI-based chatbots can enhance the effectiveness of maritime communication training. Therefore, AI-assisted communication competencies not only improve language skills but also strengthen confidence, situational awareness, and cadets' readiness to communicate in a multicultural shipping environment.

Overall, the analysis shows that UNESCO's AI competencies not only serve as a set of technological capabilities but also directly contribute to the development of the communication, cognitive, and professional competencies needed by aspiring seafarers. The integration of Digital Literacy and Ethics, Critical Thinking, and AI-enhanced Communication competencies into the Maritime English curriculum can bridge the gap between traditional language learning and the demands of digital transformation in the maritime sector. Thus, learning Maritime English in the digital era should no longer be seen solely as language training, but as a multidimensional learning process that prepares cadets to communicate effectively, think critically, and utilize AI technology responsibly in a global shipping environment.

Table 2:
UNESCO AI Competency Mapping in the Maritime English Context

UNESCO AI Competency (2024)	Relevance to Maritime English	Practical Implementation in Maritime English Learning	Supporting References
Digital Literacy & Ethics	Understanding ECDIS, GMDSS, and electronic ship documents	Analysis of electronic navigation messages, digital reporting exercises, cybersecurity awareness tasks	UNESCO (2024); Ratnaningsih et al. (2024)

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Critical Thinking	Analysis of maritime incidents and emergency communication	Accident report analysis, bridge simulation discussions, case-based learning	UNESCO (2024); Riyanto et al. (2024)
AI-enhanced Communication	AI-supported international communication practice	Chatbot conversations, VR communication simulations, AI feedback systems	UNESCO (2024); Miyusov et al. (2024); Sharma et al. (2023)

These findings suggest that UNESCO's most dominant AI competency in the context of Maritime English is at the Apply level, indicating that most research continues to focus on AI technology as a learning and communication tool. Meanwhile, competencies at the Create level, such as the development of AI-based learning systems or intelligent maritime simulation design, are still relatively limited. This condition indicates that there are future research opportunities to develop a Maritime English learning model that not only leverages AI as a user but also encourages cadets to participate in the design and evaluation of AI technology relevant to the needs of the modern shipping industry.

Technology/Tools Used or Potentially Supporting AI Competence in Maritime English Teaching

The results of the literature review show that various digital and artificial intelligence-based technologies have been used or potentially used to support the development of UNESCO AI competencies in Maritime English learning. These technologies not only serve as learning media but also as a means to improve communication skills, problem-solving, digital literacy, and cadets' readiness to face an increasingly digitized maritime work environment. Table 3 presents the four main groups of technologies most often found in the literature: Virtual Reality (VR), Augmented Reality (AR), AI Chatbots, and Gamification and Learning Management Systems (LMS).

Table 3:
Supporting Technologies in Maritime English Teaching

Technology/Tools	Functions in Maritime English	UNESCO AI Competency Supported	Reference
Virtual Reality (VR)	Simulation of emergency communication,	Digital Literacy, Critical Thinking	Lyu & Li (2022); Lin & Zhang (2025)

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		navigation, and evacuation		
Augmented Reality (AR)	Virtual ship tour & technical instruction training	Digital Literacy, Human-centred Learning	Riananda et al. (2025)	
Chatbot AI	COLREGs & Maritime English-based conversation practice	AI-enhanced Communication	Sharma et al. (2023); Hristova (2024)	
Gamification & LMS	Increase motivation for digital-based learning & evaluation	Digital Literacy, Self-directed Learning	Dayana et al. (2025); Suhartini & Meilinasari (2024)	

Virtual Reality (VR) is the most discussed technology in research related to maritime education. This technology allows students to practice using Maritime English in a simulated environment that resembles real conditions on board. Through VR, cadets can practice emergency communication, navigation, evacuation procedures, and crew coordination in realistic situations without incurring actual operational risks. [Lyu and Li \(2022\)](#) show that integrating VR into Maritime English learning can increase student engagement in technical communication activities, while [Lin and Zhang \(2025\)](#) confirm that VR-based simulations are highly effective for safety training and emergency response. In addition to improving language skills, VR use also contributes to the development of UNESCO's competencies in digital literacy, problem-solving, and decision-making in complex situations.

Augmented Reality (AR) offers a different approach to learning by incorporating virtual objects into a real environment. In the context of Maritime English, AR technology can be used to introduce different parts of ships, navigation equipment, safety systems, and operational procedures through interactive visualization. [Riananda et al. \(2025\)](#) show that AR-based virtual ship tours can improve students' understanding of maritime terminology by allowing them to see objects directly while learning English technical terms. This approach is very helpful in connecting language concepts with the actual operational context. In addition to supporting understanding of technical vocabulary, AR also strengthens digital literacy and experiential learning competencies, which are important parts of UNESCO's AI competencies.

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AI Chatbot is one of the innovations with great potential for learning Maritime English because it can provide flexible, personalized, and continuous communication exercises. AI-based chatbots can simulate conversations among ship officers, crew members, and port authorities, mirroring common communication scenarios in the shipping world. [Sharma et al. \(2023\)](#) showed that chatbots designed for training COLREGs improved participants' understanding of shipping rules and strengthened technical communication skills. [Hristova \(2024\)](#) also explained that chatbots allow students to receive feedback directly without waiting for an instructor's evaluation. Thus, the use of chatbots not only improves language skills but also supports AI-enhanced communication competencies, self-learning, and adaptation to the increasingly prevalent intelligent technologies used in the maritime sector.

Gamification technology **and Learning Management System (LMS)** play an important role in improving learning motivation, student engagement, and the effectiveness of learning evaluations. Through a gamification approach, the Maritime English learning process can be packaged as challenges, simulations, point systems, and awards that encourage active student participation. [Dayana et al. \(2025\)](#) found that integrating game elements into technology-based learning can significantly increase student motivation and engagement. Meanwhile, the LMS enables more systematic, measurable management of learning materials and assessments, as well as the monitoring of student development. The combination of gamification and an LMS supports the development of digital literacy competencies, self-learning skills, and the ability to use technology for professional purposes, which are part of UNESCO's AI competencies.

Overall, the analysis shows that each technology makes a different but complementary contribution to the development of Maritime English competencies. Virtual and Augmented Reality focus more on contextual learning and immersive experiences; AI Chatbots support adaptive and personalized communication; and Gamification and LMS help increase motivation, engagement, and the effectiveness of the learning process. The integration of these technologies shows that the development of AI competencies in maritime education is not only about mastering the technology itself, but also about effectively using it to support communication, safety, and professionalism in a global shipping environment.

Integration of AI and UNESCO Competencies in Maritime English Teaching

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Table 4:
Integration of AI in Maritime English Teaching

Integration Aspects	Impact on Students	Reference
AI-based Blended Learning	Learning flexibility & improved understanding of ESP AI-based assessment can improve the validity and reliability of language testing by providing consistent automated feedback	Andiansyah et al. (2024) Alghamdi (2022)
AI for Communication Strategy	Improve maritime communication skills	Ratnaningsih, Munir, & Anam (2024)
Gamification & Simulation	Increase motivation and engagement	Dayana et al. (2025); Suhartini & Meilinasari (2024)

Table 5:
Selected studies (brief mapping to UNESCO AI competences & level)

No	Author(s) & Year	Country	UNESCO AI Competence(s) Applied (dimension)	Level (Understand / Apply / Create)
1	Alghamdi (2022)	Saudi Arabia	AI techniques & applications — automated assessment / feedback; Data literacy.	Apply
2	Andiansyah, Yuliasri, Widhiyanto & Wahyuni (2024)	Indonesia	Human-centred mindset; AI techniques (blended learning/platform use).	Apply
3	Andrei (2019)	Romania	AI techniques & applications; Human-centred use of ICT for ESP.	Understand
4	Andriani (2021)	Indonesia	Human-centred mindset; Digital literacy for vocabulary learning.	Understand
5	Aprillina, Abimanto & Oktavia (2024)	Indonesia	AI techniques & applications (mobile/flash apps for testing); Assessment literacy.	Apply
6	Begovic Yahya, Dewanti & Sulistyaningrum (2023)	Indonesia	Human-centred mindset; AI techniques integration in syllabus design.	Apply
7	Booth, Sutton & Papaioannou (2016) (method book)	UK/International	(Methodological support) — supports ethical synthesis & system design thinking.	Understand
8	Chen (2019)	China	AI techniques & applications; Human-centred simulation for SMCP training.	Apply

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9	Colabianchi, Antonelli & d'Onofrio (2022)	Italy	AI techniques & applications — chatbots; AI system design aspects for training tools.	Create
10	Cole & Trenkner (2017)	International (WMU)	Human-centred mindset; Communication competence (SMCP) — foundation for ethical AI use.	Understand
11	Creswell (2014) (book)	USA	(Methodological) informs review design and ethics in research syntheses.	Understand
12	Creswell (2018) (book)	USA	(Methodological) supports applied review procedures and validity concerns.	Understand
13	Cui (2008)	China	Human-centred mindset; Technology-enhanced constructivist pedagogy (pre-AI era but relevant).	Understand
14	Dayana, Angraini, Suhartini & Yahya (2025)	Indonesia	AI techniques & applications; Human-centred gamification to increase engagement.	Apply
15	Diahyleva (2025)	Ukraine / Int'l	AI techniques (online tools) & Human-centred adoption in Maritime English.	Apply
16	Durlik (2024)	Poland	AI techniques & applications; Ethics of AI for maritime operations.	Apply
17	Dwivedi et al. (2021)	UK / Global	AI techniques & applications; System design & ethical/policy implications (metaverse).	Understand–Apply
18	Gucma et al. (2025)	Poland	Human-centred interaction; AI techniques in VR; user welfare (simulator sickness).	Apply
19	Holmes (2022)	UK	Ethics of AI; curriculum integration; human-centred ethical literacy.	Understand–Apply
20	Holmes (2023)	UK	Human-centred mindset; AI literacy as part of digital literacy (student competencies).	Understand
21	Hristova (2024)	International/Regional	AI techniques (chatbots) for maritime edu; human interaction design considerations.	Apply
22	Huang, L. (2022)	China	Human-centred mindset; AI-assisted language learning to increase engagement.	Apply
23	Huang, X. (2024)	China	Pedagogical scaffolding; Human-centred tech integration for Maritime English.	Understand
24	International Maritime Organization (IMO, 2020)	International	Not an AI paper — normative communication (SMCP) essential background for AI application (ethics & human-centred).	Understand
25	Juan, Wang & Li (2025)	China / Int'l	AI techniques & applications in maritime engineering — informs system design for edu tools.	Apply–Create

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26	Karatas (2020)	Turkey	Human-centred issues: learner difficulties with terminologies; informs AI instructional needs.	Understand
27	Karimi, Ahrari & Yilmaz (2024)	Turkey	AI-based adaptive instructional systems — AI techniques & applications; system design.	Apply–Create
28	Katuuk et al. (2025)	Indonesia	Human-centred competence; technology-mediated strategies for communication skills.	Apply
29	Kim & Park (2022)	South Korea	AI-powered simulation — AI techniques; situational awareness & system design.	Apply
30	Krippendorff (2018) (book)	USA/International	(Method) Content analysis methodology — supports ethical and rigorous synthesis.	Understand
31	Li (2021)	China	Needs-based approach to tech integration in ESP — Human-centred alignment.	Understand–Apply
32	Liao (2021)	Taiwan / China	Motivation & tech-enhanced learning — human-centred considerations for AI adoption.	Understand
33	Lin & Zhang (2025)	China	VR for firefighting/evacuation — AI techniques & human-centred safety training design.	Apply
34	Liu (2021)	China	Review of AI in ESP — AI techniques & application models; ethics considerations.	Understand–Apply
35	Lyu & Li (2022)	China	SPOC + VR blended ESP — AI techniques; human-centred immersive learning.	Apply
36	Machi & McEvoy (2016) (book)	USA	(Method) Stepwise literature review guidance — supports transparent synthesis (PRISMA).	Understand
37	Makransky, Terkildsen & Mayer (2022)	Denmark	VR presence vs learning — human-centred evaluation of immersive tools (ethics/UX).	Understand–Apply
38	Mishra & Koehler (2006)	USA	TPACK framework — pedagogical+tech+content knowledge; underpins curriculum design with AI.	Understand–Apply
39	Miyusov, Nikolaieva & Smolets (2024)	Eastern Europe	Future perspectives on immersive learning — AI techniques & system design directions.	Understand–Apply
40	Muczyński, Kowalski & Nowak (2025)	Poland	VR simulator sickness comparative study — human-centred welfare & system design considerations.	Apply

Based on the mapping results in Table 4 and Table 5, it can be seen that the integration of artificial intelligence (AI) in Maritime English learning has evolved from simply using supporting technology to being part of a

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pedagogical strategy that supports the development of 21st century competencies. These findings show that AI is not only used to improve the effectiveness of language learning but also to build competencies aligned with the AI Competency Framework for Students developed by UNESCO (2024). In general, the integration of AI into Maritime English learning contributes to greater learning flexibility, improved quality of maritime communication, increased student engagement, and greater adaptability to an increasingly digitized maritime work environment.

The first aspect that stands out is the implementation of **AI-based Blended Learning**. Table 4 shows that blended learning supported by AI technology has a positive impact on learning flexibility and understanding of English for Specific Purposes (ESP) materials in the maritime sector. However, these findings have broader implications than ease of access to learning. In the context of shipping education, blended learning allows cadets to access maritime communication materials, technical terminology, and simulation-based exercises on an ongoing basis outside of the classroom. In addition, AI-based scoring systems can provide automated feedback that is faster, more consistent, and more objective than conventional evaluations. [Alghamdi's findings \(2022\)](#) show that AI-assisted assessment has the potential to enhance the validity and reliability of language evaluation by enabling a more systematic analysis of student performance. Thus, AI integration not only supports the learning process but also strengthens the quality of assessment in Maritime English learning.

The second aspect relates to **AI for Communication Strategy**, which is at the core of Maritime English learning. As the international working language in the shipping sector, Maritime English requires the ability to communicate accurately and clearly, in accordance with international maritime safety standards. The research by [Ratnaningsih, Munir, and Anam \(2024\)](#) shows that the use of AI in learning can significantly improve students' communication strategies. These findings are important because they show that AI can serve as a means of practicing adaptive, personalized communication through chatbots, conversation simulations, and AI-based learning platforms. From UNESCO's competency perspective, the use of AI for communication strategies not only supports language mastery but also develops critical thinking, problem-solving, and collaboration skills in cross-cultural communication situations common in international shipping environments.

The third aspect is the application of **Gamification and Simulation**, which have consistently been found to increase student motivation and engagement. The findings of [Dayana et al. \(2025\)](#) and [Suhartini and Meilinasari \(2024\)](#) indicate that elements of technology-based games and simulations can create a more engaging and contextually relevant learning

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experience. In the context of Maritime English, simulations allow cadets to practice English in situations that mimic real-life conditions on board, such as emergency communication, navigation, crew coordination, and interaction with port authorities. The increased motivation resulting from the gamification approach also has important implications for long-term learning success because it encourages active participation and independent learning. Therefore, gamification-based technology serves not only as a learning tool but also as a means to build more authentic and meaningful learning experiences.

Analysis of Table 5 shows that most of the research is on **the dimensions of AI Techniques and Applications** and **Human-Centred Mindset**. The dominance of these two dimensions indicates that the main focus of research is still on the use of AI technology to support the learning process and develop students' competencies. Most of the research has reached **the Apply** level, indicating that AI technology has been used in real-world learning activities, such as chatbots, virtual reality, adaptive learning systems, and digital learning platforms. However, the number of studies that reach the **Create** level is still relatively limited. Only a few studies explicitly develop new AI systems or design innovative learning platforms tailored to the needs of maritime education. These findings show that the Maritime English field still offers significant opportunities to develop more targeted, context-specific AI-based innovations for the shipping industry.

From a geographical perspective, the distribution of research highlights the broad contributions of various countries, especially those in Asia and Europe. The dominance of research from China, Indonesia, South Korea, Poland, and several other European countries shows that digital transformation in maritime education is a global issue of mutual concern. The diversity of research contexts enriches the understanding of how AI can be integrated into maritime language learning to meet each country's needs. In addition, the existence of normative documents such as [IMO \(2020\)](#) and UNESCO (2024) provides an important ethical and regulatory foundation, ensuring that the implementation of AI remains oriented towards safety, professionalism, and the needs of the main users of technology.

Another interesting finding is the combination of theoretical and practical approaches in the analyzed research. Some studies use conceptual frameworks such as TPACK ([Mishra & Koehler, 2006](#)), digital literacy, and AI literacy to explain the integration of technology in learning. Meanwhile, other research focuses more on practical implementation through learning experiments, media development, and user experience evaluation. The combination of the two approaches shows that the success of AI integration in Maritime English depends not only on the availability of technology but

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also on the appropriate pedagogical design and the user's readiness to use the technology effectively.

Overall, this study's results show that integrating AI into Maritime English learning has made a real contribution to improving learning quality, developing maritime communication competencies, and strengthening students' digital literacy. Nonetheless, further research is needed to develop more innovative AI systems, improve the ethical and sustainability dimensions of AI use, and evaluate the long-term impact on seafarers' professional competence. These findings strengthen the relevance of UNESCO's AI competency framework as a reference for developing the Maritime English curriculum to address the challenges of digital transformation in the global shipping sector.

1. PRISMA Analysis

The literature selection process in this study follows the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 to ensure transparency, consistency, and reproducibility of the literature review. An article search was carried out systematically across several databases, namely Scopus, SINTA, DOAJ, and international proceedings, using keywords related to Artificial Intelligence, UNESCO AI Competencies, Maritime English, English for Specific Purposes (ESP), and digital learning.

At the identification stage, 120 articles relevant to the research topic were identified. Furthermore, a screening process is carried out to eliminate duplicate articles and those that do not align with the research's focus. A total of 65 articles were excluded because they did not discuss the context of Maritime English, were not related to UNESCO's AI competence, or only discussed maritime technology without any connection to language education and learning.

Articles that pass the screening stage then enter the eligibility assessment stage through full-text review. At this stage, each article is evaluated against the set inclusion criteria, including relevance to Maritime English learning, discussion of AI-based technology, relevance to UNESCO's AI competence, publication quality, and the availability of complete manuscripts for analysis. Articles that do not meet these criteria are excluded from further analysis.

The final results of the selection process showed that 40 articles met all inclusion criteria and were used as the main data source in this study. The forty articles were then analyzed to identify the form of integration of UNESCO's AI competencies, the supporting technologies used in Maritime English learning, the impact on learning outcomes, and its implications for the development of maritime education in the era of digital transformation. To improve the reliability of the selection process and reference management,

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this study uses the Rayyan application for article screening and Zotero for citation management and reference documentation.

Figure 6:
Literature Selection Process Flow Based on PRISMA 2020 Principles

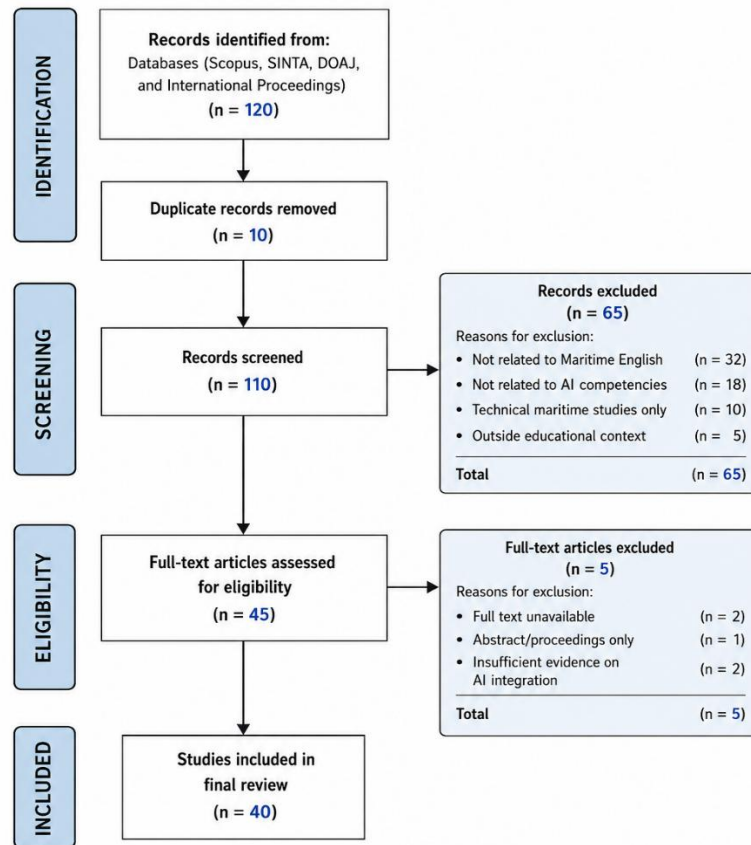


Figure 4 shows the article selection process based on the PRISMA 2020 framework. The diagram illustrates the number of articles identified, screened, evaluated for eligibility, excluded at each stage, as well as the number of articles that were eventually included in the study. The presentation of this information aims to provide a clear audit trail that allows the research process to be traced and replicated by other researchers.

Discussion

Research Question 1: The Relevance of UNESCO AI Competencies in Maritime English Learning

The study's results show that UNESCO's AI competencies are highly relevant to Maritime English learning in shipping colleges. Competencies such as digital literacy, critical thinking, technology-based communication, creativity, and ethical awareness are no longer seen as additional skills but have become

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an integral part of seafarers' professional competence in the digital age. These findings indicate that the increasingly digitized maritime work environment demands a redefinition of the learning objectives of Maritime English from mere language mastery to the development of communication competencies supported by intelligent technology.

Theoretically, this finding expands the concept of Maritime English, which has been rooted in the English for Specific Purposes (ESP) approach. The traditional ESP approach generally focuses on mastery of technical terminology, linguistic accuracy, and operational communication skills. However, the results show that the demands of the modern maritime industry require integrating new competencies, including the ability to evaluate AI-generated information, understand the ethical implications of technology use, and communicate effectively in an increasingly digitized work environment. Thus, UNESCO's AI competency can be seen as an extension of maritime communicative competency, which has been the foundation of shipping education.

In addition, this study reveals that most AI implementation in Maritime English learning is still focused on digital literacy and the use of learning technology. In contrast, dimensions related to AI ethics, awareness of algorithmic bias, and critical evaluation of AI output are still relatively neglected. This condition indicates a gap between the use of technology and the development of deeper competencies. If this situation continues, there is a risk that learners will become users of the technology without the ability to evaluate its validity, reliability, and ethical consequences. Therefore, the integration of UNESCO's AI competencies needs to be carried out thoroughly so that Maritime English learning not only produces linguistically competent graduates but also enables graduates to adapt critically to the development of maritime technology.

Research Question 2: Application of AI Technology in Maritime English Learning

The study's findings show that various AI-based technologies, such as virtual reality (VR), augmented reality (AR), chatbots, and AI-based learning management systems (LMS), have been used to create a learning experience that is more contextual and closer to real on-board conditions. The existence of this technology shows a paradigm shift from instructor-centered learning to more interactive, personalized, and experiential-based learning.

From a pedagogical perspective, the effectiveness of such technology lies not only in its ability to simulate maritime work environments but also in its capacity to bridge the gap between theory and practice. VR-based simulations, for example, allow cadets to practice maritime communication in complex situations without facing actual operational risks. This is in line

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with experiential learning theory, which emphasizes the importance of hands-on experience in building a deeper, more sustainable understanding.

However, the study also found that most AI implementations remain oriented toward improving the technical efficiency of learning. Many institutions are leveraging AI for operational simulations, automated feedback, or communication exercises, but have not optimally integrated those technologies to develop critical thinking, decision-making, and ethical reflection skills. These findings show a tendency toward a technology-centered approach rather than a learner-centered one. In TPACK's perspective, the success of technology integration is determined not only by the availability of technology but also by the ability to connect technology, pedagogy, and learning content in a balanced way. Therefore, the existence of AI technology should not be seen as an end in itself, but rather as a means to achieve broader, more meaningful learning goals.

Research Question 3: Pedagogical Gaps in AI Integration in Maritime English

This study identifies that the main challenge of integrating AI into Maritime English learning does not lie solely in technological limitations but also in pedagogical aspects and human resource readiness. Many institutions have begun adopting AI technology, but lecturers' capacity to design AI-based learning remains diverse. This condition shows that digital transformation in maritime education is a more complex problem than simply procuring technological devices.

These findings reinforce the view that the success of educational transformation is not determined by technology alone, but by institutions' ability to build a learning culture that is adaptive to change. When lecturers lack adequate AI competencies, technology can be used in a limited way as a technical tool, without producing significant improvements in learning quality. Therefore, investment in lecturer competency development is a strategic factor that is as important as investment in technology infrastructure.

This research also shows that the Maritime English curriculum remains dominated by an orientation toward linguistic accuracy and mastery of technical terminology. While these aspects remain important, a too-narrow focus can reduce graduates' readiness to face a maritime work environment increasingly influenced by automation and artificial intelligence. Therefore, the curriculum needs to be expanded to include evaluative competencies, data literacy, AI ethics, and technology-based decision-making as part of learning outcomes.

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Conceptually, this study offers a new contribution by linking UNESCO's AI competencies with ESP-based Maritime English pedagogy. In contrast to previous research that focused more on technology adoption, this study suggests that AI should be positioned as a catalyst for pedagogical transformation that supports the simultaneous development of language competence, professional communication, and digital responsibility. This perspective broadens understanding of AI's role in maritime education and provides a theoretical basis for developing Maritime English learning models that are better adapted to the needs of the maritime industry of the future.

Practically, the findings of this study indicate the need for curriculum development, lecturer training, and learning systems that explicitly integrate UNESCO's AI competencies. The move is important to ensure that graduates of shipping colleges are not only able to meet international communication standards but also ready to work in an increasingly digitized maritime ecosystem supported by artificial intelligence technology. Thus, the integration of AI into Maritime English must be understood as a pedagogical transformation aimed at developing future competencies, rather than merely adopting learning technologies.

CONCLUSION

This research shows that integrating UNESCO AI competencies into Maritime English learning has strategic relevance for maritime higher education in the era of maritime digital transformation. Competencies such as digital literacy, critical thinking, technology-based communication, creativity, and AI ethics support the strengthening of cadets' international communication skills in line with IMO and STCW standards. Various AI technologies, including VR, AR, chatbots, gamification, and automated feedback systems, have also been shown to improve learning engagement and effectiveness. Theoretically, this study extends the study of AI integration in maritime education by offering a conceptual framework that connects UNESCO's AI competencies with ESP-based Maritime English pedagogy. AI is not only positioned as a technological tool but also as a pedagogical support that helps develop professional communication, digital responsibility, and cadets' readiness to face an intelligent technology-based maritime work environment. This study has limitations: it uses only English and Indonesian literature and a systematic literature review approach, so the results remain conceptual and have not empirically tested the implementation of UNESCO's AI competencies. Therefore, further research is recommended to use an empirical approach to test the effectiveness of UNESCO's AI competency-based Maritime English curriculum, particularly in the context of maritime education in Southeast Asia and Indonesia.

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