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Towards an AI Literacy Framework for Maritime English Education: Integrating Language, Professional, and Digital-AI Competencies

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ABSTRACT

Generative artificial intelligence (GenAI) is increasingly influencing language education by providing opportunities for personalized practice, immediate feedback, and flexible access to learning resources. However, effective use of GenAI in Maritime English requires competencies beyond general language proficiency and basic technological skills. Maritime English involves specialized terminology, standardized communication, operational contexts, and professional requirements in which inaccurate or inappropriate AI-generated content may have practical consequences. This conceptual study develops an AI literacy framework for Maritime English education through a conceptual literature synthesis. The synthesis draws on literature published between 2020 and 2026, supplemented by earlier foundational works on AI literacy and English for Specific Purposes (ESP), as well as authoritative Maritime references, including IMO Standard Marine Communication Phrases and IMO Model Course 3.17. Sources were selected based on their relevance to AI literacy, generative AI in language education, ESP, learner autonomy, and Maritime English, with particular attention to their conceptual contributions and applicability to Maritime communication. The synthesis identifies digital-AI competence as the core AI literacy capability, supported by two contextual knowledge bases: language competence and professional Maritime competence. Language competence enables learners to evaluate AI-generated language, while professional Maritime competence supports the verification of terminology, operational relevance, and contextual appropriateness. Digital-AI competence enables critical and responsible interaction with AI systems, including prompt formulation, output evaluation, and information verification. The proposed framework provides a conceptual basis for integrating AI literacy into Maritime English education while maintaining linguistic and professional standards. Future empirical research is needed to operationalize and validate the framework among Maritime English learners, lecturers, and Maritime professionals.

Keywords: *AI Literacy; Maritime English; Generative AI*

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Abstract & Indexing

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INTRODUCTION

Generative artificial intelligence (GenAI) has rapidly become part of language education, changing how learners access explanations, practice language, generate texts, and receive immediate feedback. The emergence of large language model-based applications has expanded opportunities for learners to engage with English beyond formal classroom settings. Recent research has documented the potential of GenAI to support language learning through personalized assistance, writing support, conversational practice, feedback, and flexible access to learning resources (Kasneci et al., 2023; Kohnke et al., 2023; Law, 2024). Systematic reviews have also shown that research on GenAI in language education has grown substantially, although much of the existing literature remains concentrated on general English, academic writing, and conventional educational settings (Li et al., 2024, 2025; Lo et al., 2024).

The increasing availability of GenAI raises a broader question concerning the competencies learners need to use these technologies effectively, critically, and responsibly. In this study, AI literacy refers to the set of competencies that enables learners to understand and use AI, critically evaluate AI-generated outputs, interact effectively with AI systems, and make informed and ethical decisions about their use (Long & Magerko, 2020; Ng et al., 2021). Existing AI literacy frameworks emphasize competencies related to understanding AI, recognizing its capabilities and limitations, interacting with AI systems, evaluating AI outputs, creating with AI, and addressing ethical issues (Long & Magerko, 2020; Ng et al., 2021). These frameworks provide important foundations for understanding AI literacy in education. However, they are primarily designed as general AI literacy frameworks and do not explicitly specify how AI-generated language should be evaluated against specialized terminology, communication conventions, and professional standards within a particular occupational domain. Consequently, while existing frameworks provide a foundation for understanding AI literacy, they require contextualization when AI is used for specialized professional communication such as Maritime English.

This issue becomes particularly important in English for Specific Purposes (ESP), where language learning is closely connected to disciplinary and professional requirements. ESP differs from general English because learning activities are expected to reflect the communicative purposes, terminology, genres, and situations associated with particular fields (Basturkmen, 2010; Hutchinson & Waters, 1987). Consequently, the ability to use GenAI effectively in an ESP context cannot be evaluated solely according to general language proficiency or technological competence. Learners must also be able to determine whether AI-generated language corresponds to the conventions, terminology, communicative purposes, and professional requirements of their field. In this sense, AI literacy in ESP requires the integration of AI-related competencies with domain-specific language and professional knowledge.

This requirement is particularly significant in Maritime English. Maritime communication involves specialized terminology, standardized expressions, operational procedures, and communication practices associated with navigation, engineering, shipboard operations, and emergency situations. The International Maritime Organization (IMO) adopted the Standard Marine Communication Phrases (SMCP) through Resolution A.918(22) in 2001 to support clear and standardized communication in Maritime contexts (International Maritime Organization, 2001). The SMCP provides standardized expressions for routine, safety-related, and emergency communication and was developed to address language barriers and avoid misunderstandings that may contribute to accidents (International Maritime Organization, 2001). Research on Maritime bridge communication has also demonstrated distinctive linguistic characteristics of Maritime English and identified standardized communication behavior as an important benchmark for improving

communication effectiveness (John et al., 2017). Therefore, an AI-generated response that is grammatically acceptable in general English may not necessarily be appropriate for a particular Maritime situation.

The rapid development of GenAI creates both opportunities and challenges for Maritime English education. AI tools can potentially provide cadets with additional opportunities to practice professional vocabulary, construct Maritime dialogues, receive explanations, and simulate communicative situations that may be difficult to reproduce consistently in the classroom. Recent research has begun to examine the use of ChatGPT in Maritime English learning. For example, a study conducted at a Maritime polytechnic in Indonesia found that ChatGPT-assisted learning activities were associated with improvements in students' Maritime English speaking performance, including vocabulary use, grammatical accuracy, and fluency (Ratnaningsih, 2025). Such findings demonstrate the potential of GenAI to support language practice in Maritime education. However, improved learning outcomes do not necessarily establish whether learners can independently evaluate the accuracy, appropriateness, and professional validity of AI-generated Maritime English. Effective AI-supported learning therefore requires not only the ability to obtain AI-generated language but also the ability to judge and verify that language before it is applied in a professional context.

At the same time, GenAI systems can produce inaccurate, misleading, incomplete, or contextually inappropriate information (Bender et al., 2021; Kasneci et al., 2023). This concern is particularly relevant to Maritime communication because standardized communication is intended to reduce language barriers and misunderstandings in safety-related Maritime operations (International Maritime Organization, 2001). Evidence from Maritime accident and communication research has also shown that inadequate English-language competence and professional communication can contribute to misunderstandings in Maritime operations, including emergency situations (Mönnigmann & Čulić-Viskota, 2017). Accordingly, the issue is not simply whether GenAI can generate grammatically correct English, but whether learners can recognize when an AI-generated expression is linguistically or professionally inappropriate and verify it against authoritative Maritime standards before using it.

Recent research has increasingly connected artificial intelligence with Maritime English and Maritime education, including studies examining ChatGPT-assisted learning and the use of AI to support communication activities in Maritime English (Ratnaningsih, 2025; Ratnaningsih et al., 2025). These studies provide an important foundation for understanding the emerging role of GenAI in Maritime education. Nevertheless, existing AI literacy frameworks generally describe competencies for understanding, using, evaluating, and ethically engaging with AI, whereas Maritime English research emphasizes professional communication, terminology, standardized phraseology, and operational contexts (John et al., 2017; Long & Magerko, 2020; Ng et al., 2021). Existing studies therefore do not yet provide a sufficiently explicit conceptual explanation of how these competencies interact when Maritime learners use GenAI to produce, evaluate, verify, and revise specialized English for professional communication. The research gap addressed in this study is consequently not the absence of research on AI or ChatGPT in Maritime English, but the lack of an integrated conceptual framework that connects general AI literacy with language competence and professional Maritime competence. Such a framework is particularly necessary because AI-generated language may be linguistically acceptable while remaining inappropriate for a specific Maritime communicative situation.

This issue is particularly relevant to Indonesian Maritime education, where Maritime higher education institutions prepare cadets for professional communication in an internationally regulated and

multilingual industry. Indonesian Maritime students are increasingly exposed to AI-supported learning technologies while simultaneously being expected to develop the Maritime English competencies required for professional practice. Recent Indonesian research demonstrates that AI and ChatGPT are already being explored as tools for Maritime English learning and communication activities in Maritime higher education (Ratnaningsih, 2025; Ratnaningsih et al., 2025). However, the increasing availability of these tools also creates a pedagogical need to ensure that cadets do not equate AI-generated language with professionally valid Maritime communication. A framework that connects AI use with language accuracy, Maritime professional knowledge, and verification against established standards is therefore particularly relevant to Indonesian Maritime education and may provide a useful basis for curriculum development in Maritime higher education institutions.

To address this conceptual gap, this article proposes a framework for AI literacy in Maritime English education that integrates three interrelated dimensions: language competence, professional Maritime competence, and digital-AI competence. Language competence concerns the ability to understand and produce appropriate Maritime English. Professional Maritime competence concerns the ability to interpret language in relation to operational situations, Maritime procedures, terminology, and standardized communication requirements. Digital-AI competence concerns the ability to formulate appropriate prompts, understand AI limitations, evaluate AI-generated outputs, verify information against authoritative sources, and revise or reject inappropriate outputs. The proposed framework therefore extends general AI literacy models by introducing professional and domain-specific validation as an explicit requirement for AI use in Maritime English (Long & Magerko, 2020; Ng et al., 2021).

The proposed framework is not intended to replace existing AI literacy models but to contextualize and extend them for a specialized professional domain. General AI literacy frameworks provide the foundation for understanding AI, evaluating its outputs, and considering ethical issues, while Maritime English standards and research establish the linguistic and professional requirements for Maritime communication (International Maritime Organization, 2001; John et al., 2017; Long & Magerko, 2020; Ng et al., 2021). The contribution of the present study lies in bringing these strands together by positioning AI literacy as an integrated competence in which AI-generated language must be evaluated not only for linguistic quality but also for professional appropriateness and consistency with Maritime communication standards.

Accordingly, this article has two specific objectives. First, it aims to identify the major competencies required for the effective and responsible use of GenAI in Maritime English learning, particularly in relation to language competence, professional Maritime competence, and digital-AI competence. Second, it aims to develop a conceptual framework explaining how these competencies interact when learners generate, evaluate, verify, and revise AI-supported Maritime English communication. In line with these objectives, the study addresses two questions: what competencies constitute AI literacy in the context of Maritime English education, and how can language competence, professional Maritime competence, and digital-AI competence be integrated into a framework for responsible and contextually appropriate use of GenAI in Maritime English learning? The proposed framework is intended to provide a conceptual basis for curriculum development, classroom practice, and assessment design in Maritime English education, while also establishing a foundation for future empirical research to validate the framework across different Maritime education contexts.

METHODS OF RESEARCH

This study employed a conceptual literature review and theory-synthesis approach to develop a framework for AI literacy in Maritime English education. As a non-empirical conceptual study, the research focused on synthesizing established concepts and adapting them to a specific professional and educational context rather than collecting primary data from human participants. The methodological design followed the principles of conceptual research, particularly the use of a clearly defined research design, explicit identification of the theoretical concepts used, and systematic explanation of how these concepts were synthesized into a conceptual model (Jaakkola, 2020). The study did not involve surveys, interviews, experiments, participant recruitment, or the collection of primary human-subject data.

The literature identification process focused on four interconnected areas: AI literacy and generative artificial intelligence, language education and English for Specific Purposes (ESP), Maritime English and Maritime communication, and AI-supported learning in Maritime education. The literature search was conducted using [insert the academic databases or search platforms actually used]. The search strategy used combinations of keywords such as "AI literacy," "artificial intelligence literacy," "generative AI," "ChatGPT," "large language models," "AI in language education," "AI in ESP," "Maritime English," "Maritime education," "ChatGPT Maritime English," "AI Maritime education," "IMO Model Course 3.17," and "standard marine communication phrases." The literature search was supplemented by backward citation checking of relevant publications and consultation of authoritative International Maritime Organization (IMO) documents relevant to Maritime English and Maritime communication. The search focused primarily on literature published from 2020 to 2026 to capture the development of contemporary AI literacy and GenAI research, while earlier foundational publications were retained when they provided established theoretical or professional concepts necessary for framework development (Jaakkola, 2020; Long & Magerko, 2020; Ng et al., 2021).

The literature selection followed predefined inclusion and exclusion criteria. Sources were included when they addressed at least one of the conceptual areas relevant to the framework, namely AI literacy, generative AI in education or language learning, ESP, Maritime English, Maritime communication, or AI in Maritime education. Peer-reviewed journal articles, scholarly conference papers, established academic books, and authoritative Maritime publications were considered. Foundational publications published before 2020 were retained when they established important concepts in ESP, AI literacy, or Maritime communication. Sources were excluded when they focused exclusively on technical AI development without educational or literacy relevance, did not contribute to the conceptual domains of the study, or lacked sufficient scholarly or institutional credibility for supporting the framework. The final synthesis prioritized sources that contributed directly to the conceptual relationship between AI competence, language competence, and professional Maritime competence.

The conceptual analysis was conducted through a structured three-stage synthesis. In the first stage, the selected literature on AI literacy was examined to identify recurring competencies associated with understanding AI, using and interacting with AI systems, evaluating AI-generated outputs, recognizing AI limitations, and addressing ethical and responsible use. These competencies were primarily derived from established AI literacy frameworks and were treated as the initial conceptual pool for the digital-AI dimension (Long & Magerko, 2020; Ng et al., 2021). In the second stage, the identified AI literacy competencies were compared with the requirements of language learning and ESP. Particular attention was given to contextualized language use, disciplinary terminology, communicative purposes, genres, and

professional requirements in ESP (Basturkmen, 2010; Hutchinson & Waters, 1987). This comparison established that AI literacy for specialized language learning requires more than general technological interaction because learners must also judge whether AI-generated language is appropriate for the communicative and professional context.

In the third stage, the resulting concepts were mapped onto the specific requirements of Maritime English. The mapping considered specialized Maritime terminology, standardized Maritime communication, operational contexts, and professional communication requirements reflected in Maritime communication research and IMO standards (International Maritime Organization, 2001, 2015; John et al., 2017; Jurkovič, 2022). This stage was necessary because Maritime English represents a specialized form of professional communication in which linguistic appropriateness must be considered together with operational meaning and established Maritime communication practices. The mapping therefore connected general AI literacy competencies with the specific linguistic and professional requirements of Maritime communication.

The audit trail from literature to the proposed framework was maintained through a concept-mapping procedure. Each selected source was examined according to the principal concept it contributed, the educational or professional requirement associated with that concept, and its relevance to the three emerging domains. AI literacy literature contributed concepts related to understanding, using, evaluating, and ethically engaging with AI; ESP literature contributed concepts concerning contextualized language and professional communication; and Maritime English literature and IMO standards contributed concepts concerning Maritime terminology, standardized phraseology, operational context, and professional communication. The resulting conceptual relationships were compared across the literature rather than being assigned solely on the basis of individual sources. Table 1 presents representative examples of this mapping process.

The decision to formulate three domains was based on the conceptual convergence identified through the synthesis rather than on an arbitrary division of competencies. The first domain, language competence, emerged from the requirements of language learning and ESP, particularly the ability to understand and produce appropriate specialized language. The second domain, professional Maritime competence, emerged from Maritime English literature and Maritime standards emphasizing terminology, operational context, standardized communication, and professional requirements. The third domain, digital-AI competence, emerged from AI literacy literature emphasizing the ability to understand, interact with, evaluate, and use AI responsibly. These domains were retained as three distinct components because each represents a different source of competence while remaining necessary for effective AI-supported Maritime English use. Combining language and professional competence into one domain would obscure the distinction between linguistic accuracy and professional contextual appropriateness, while treating AI competence as part of either domain would fail to represent the distinctive skills required to interact critically with GenAI systems (Long & Magerko, 2020; Ng et al., 2021).

The resulting framework conceptualizes AI literacy in Maritime English as an integrated competence rather than as three independent skill sets. Language competence enables learners to formulate and evaluate Maritime English expressions; professional Maritime competence enables them to judge whether those expressions are appropriate for specific Maritime situations and consistent with professional standards; and digital-AI competence enables them to formulate prompts, recognize AI limitations, evaluate generated outputs, verify information against authoritative sources, and revise or reject inappropriate outputs. The

interaction of these three domains forms the basis of the proposed AI literacy framework for Maritime English education, as illustrated in Figure 1.

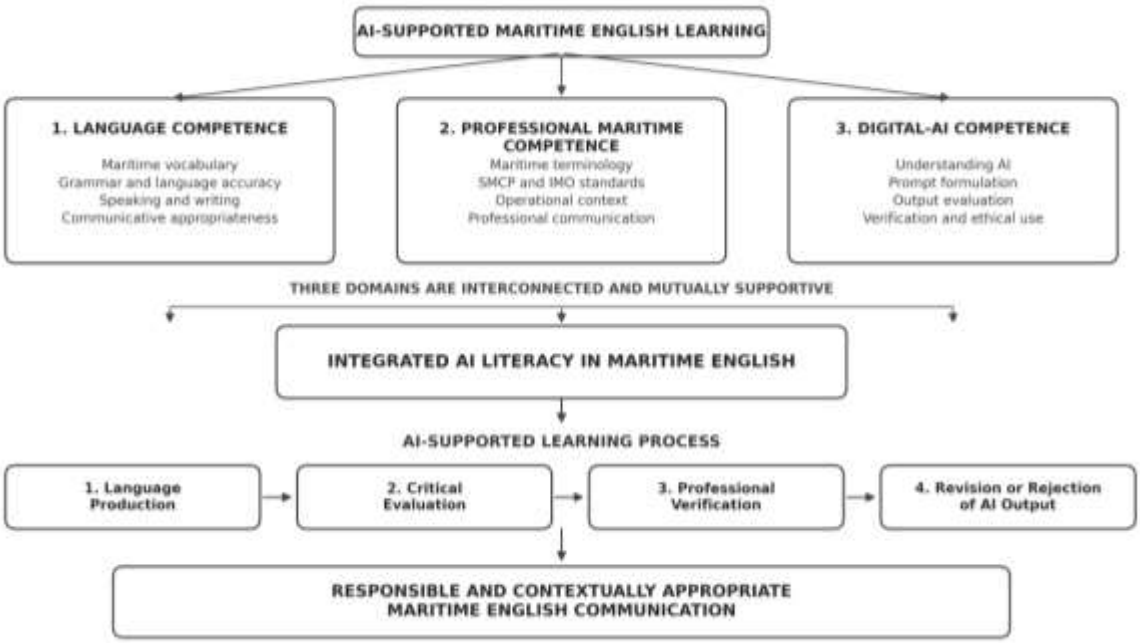


Figure 1. Proposed AI Literacy Framework for Maritime English Education
Source: *Processed by the author (2026)*

To make the conceptual synthesis transparent, Table 1 summarizes how representative sources contributed to the development of the proposed framework.

Table 1. Literature-to-Framework Conceptual Mapping

Source	Main concept extracted	Comparison / synthesis	Resulting domain
Long and Magerko (2020)	Understanding AI, interacting with AI, evaluating AI, recognizing limitations	Identified core competencies required for critical interaction with AI	Digital-AI competence
Ng et al. (2021)	Knowing and understanding AI; using and applying AI; evaluating and creating; ethical issues	Expanded the digital-AI competency pool to include evaluation and responsible use	Digital-AI competence
Basturkmen (2010)	ESP as context-specific and professionally oriented language education	Established the need for language competence to reflect disciplinary purposes	Language competence
Hutchinson and Waters (1987)	Learning-centered ESP and needs-based specialization	Supported the connection between language learning and specific professional contexts	Language competence
International Maritime Organization (2001)	Standardized Maritime communication and SMCP	Established the requirement to evaluate language against Maritime communication standards	Professional Maritime competence
International	General and Specialized	Provided the Maritime-specific	Language competence

Maritime Organization (2015)	Maritime English	educational foundation for specialized language competence	/ Professional Maritime competence
John et al. (2017)	Maritime communication and standardized phraseology	Demonstrated the importance of specialized Maritime communication practices	Professional Maritime competence
Jurkovič (2022)	Maritime English and professional Maritime communication	Reinforced the relationship between language and authentic Maritime communication	Professional Maritime competence
Ratnaningsih (2025)	ChatGPT-supported Maritime English learning	Provided recent evidence of GenAI application in Maritime English education	Digital-AI competence / Language competence

Source: Processed by the author (2026)

The three domains were subsequently integrated into the conceptual framework through a process of AI-supported language production, evaluation, professional verification, and revision. This process reflects the central argument of the study that AI literacy in Maritime English cannot be reduced to the ability to operate an AI application. Instead, competent use requires learners to combine linguistic knowledge, professional Maritime knowledge, and critical digital-AI skills when evaluating AI-generated communication.

Because the study is conceptual and does not involve a primary dataset, no statistical analysis or participant recruitment was undertaken. The study's contribution is the synthesis and contextualization of existing theoretical, educational, and Maritime knowledge into a domain-specific framework. The framework should subsequently be subjected to empirical validation through studies involving Maritime English learners, lecturers, and Maritime professionals. Future empirical research may examine the reliability and validity of the proposed competency indicators, compare AI literacy across Maritime study programmers, and test whether the framework can improve learners' ability to evaluate and appropriately use AI-generated Maritime English in authentic professional communication contexts.

RESULTS AND DISCUSSION

Results

Conceptual Structure of AI Literacy in Maritime English

The literature synthesis produced a context-specific framework for AI literacy in Maritime English education. The central finding is that effective use of generative artificial intelligence (GenAI) in Maritime English requires more than the ability to operate an AI system or evaluate its general outputs. Learners must also draw on linguistic knowledge and professional Maritime knowledge to determine whether AI-generated communication is accurate, meaningful, and appropriate for a particular Maritime situation. The proposed framework therefore distinguishes between digital-AI competence as the core AI literacy capability and language competence and professional Maritime competence as two contextual knowledge bases that support its application.

This distinction is important for defining the construct. Existing AI literacy frameworks primarily emphasize understanding AI, interacting with AI systems, evaluating AI-generated information, and recognizing ethical and social implications (Long & Magerko, 2020; Ng et al., 2021). These competencies

describe the general capabilities required to engage critically with AI. However, they do not necessarily specify the disciplinary knowledge needed to evaluate AI outputs in a specialized professional environment. In Maritime English, the quality of an AI-generated response cannot be determined solely by its grammatical accuracy or apparent coherence. Its terminology, communicative purpose, and operational meaning must also be considered.

Accordingly, this study does not propose that language competence and professional Maritime competence are universal components of the definition of AI literacy. Rather, they are contextual knowledge requirements that enable learners to exercise AI literacy effectively in Maritime English. Digital-AI competence represents the ability to formulate prompts, understand AI limitations, evaluate generated outputs, verify information, and make informed decisions about whether to accept, revise, or reject an output. Language competence provides the linguistic basis for judging accuracy and communicative appropriateness, while professional Maritime competence provides the disciplinary basis for judging operational and professional suitability.

This conceptual distinction also addresses the potential overlap between language competence and professional Maritime competence. Maritime terminology and Standard Marine Communication Phrases (SMCP) are not exclusively linguistic or exclusively professional. They operate at the intersection of both. Their linguistic form must be understood, but their communicative function must also be interpreted within a specific Maritime situation. In the proposed framework, SMCP therefore functions as a professional communication standard through which linguistic accuracy and operational appropriateness can be evaluated together.

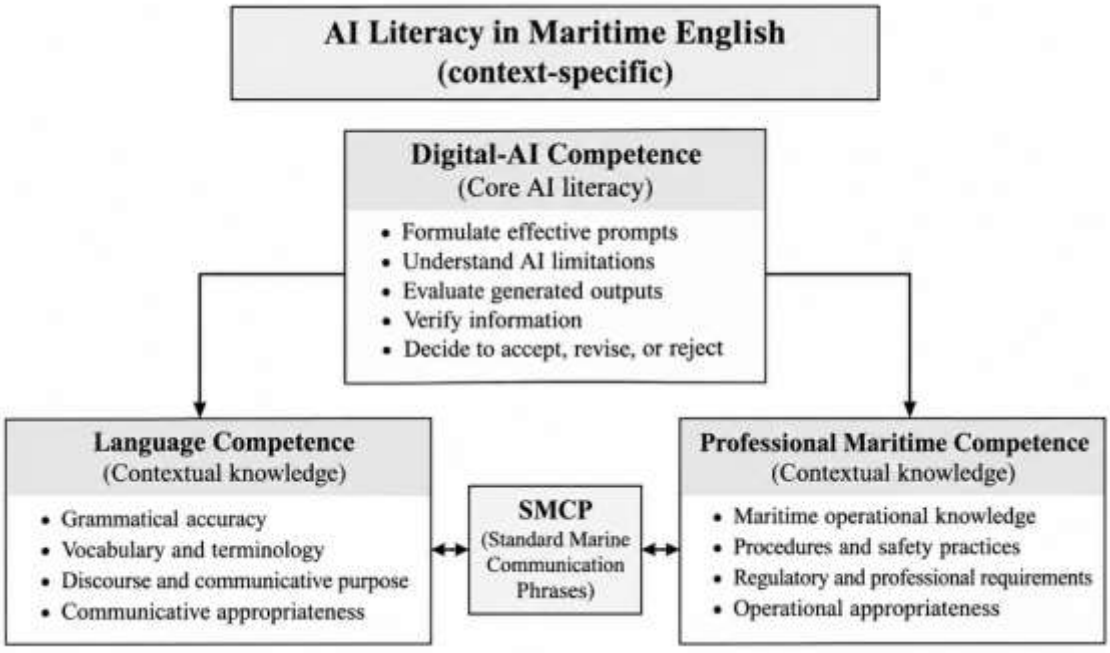


Figure 2. Contextual Structure of AI Literacy in Maritime English Education
Source: *Processed by the author (2026)*

Figure 2 illustrates the relationship between the core AI literacy capability and the two contextual knowledge bases. The model positions digital-AI competence at the centre of critical interaction with GenAI, supported by language competence and professional Maritime competence. The intersection between the two contextual knowledge bases is particularly important because Maritime communication standards, including SMCP, require both linguistic understanding and professional interpretation.

Positioning the Framework against Existing AI Literacy Models

The proposed framework builds on, rather than replaces, established AI literacy models. Existing models conceptualize AI literacy through competencies that enable individuals to understand and critically interact with AI systems, as well as to know and understand AI, use and apply AI, evaluate and create with AI, and consider ethical issues (Long & Magerko, 2020; Ng et al., 2021).

However, these perspectives differ in their emphasis. One adopts a competency-oriented approach that highlights human interaction with AI and the ability to recognize how AI systems operate, whereas the other provides a broader educational categorization connecting AI knowledge, application, evaluation, creation, and ethics (Long & Magerko, 2020; Ng et al., 2021). Although complementary, these approaches do not explicitly establish how learners should evaluate AI-generated communication against the linguistic and operational requirements of Maritime practice.

Research on ESP and Maritime English provides a different but necessary perspective. ESP emphasizes the relationship between language learning, communicative purposes, and the specific requirements of professional or academic contexts (Basturkmen, 2010; Hutchinson & Waters, 1987). Maritime communication research further demonstrates that communication at sea involves specialized terminology and standardized communication practices rather than general English proficiency alone (John et al., 2017; Jurkovič, 2022). These perspectives do not constitute AI literacy models; instead, they explain why general AI literacy competencies require contextual application in Maritime English.

The conceptual contribution of the present framework lies in connecting these previously distinct areas. It retains the central AI literacy capabilities identified in existing models while specifying the linguistic and professional knowledge needed to evaluate AI-generated Maritime English. Thus, the framework is best understood as a contextualized application of AI literacy rather than an entirely new general definition of AI literacy.

Language Competence as a Basis for Evaluating AI-Generated Language

Language competence remains necessary in AI-supported Maritime English learning because learners must be able to interpret, evaluate, and revise generated language. It includes vocabulary, grammar, reading, writing, speaking, listening, and pragmatic awareness. These abilities support both the production of Maritime English and the evaluation of language generated by AI systems.

GenAI can provide opportunities for vocabulary practice, writing support, language feedback, and simulated communication. These applications are consistent with research on the use of conversational AI and GenAI in language education (Kohnke et al., 2023; Law, 2024). However, the availability of fluent generated language should not be interpreted as evidence of linguistic or contextual accuracy. A response may be grammatically well-formed while using an inappropriate expression, an imprecise technical term, or a communicative structure that does not fit the intended situation.

This distinction reveals an important limitation of evaluating AI-generated language through grammar alone. In general language learning, a grammatically correct sentence may be considered acceptable for its intended communicative purpose. In Maritime English, however, acceptability also depends on whether the expression conveys the required meaning clearly and conforms to the conventions of professional Maritime communication. Consequently, language competence in this framework is not simply the ability to produce correct English. It also involves the ability to recognize when apparently correct AI-generated language requires modification because of its specialized communicative purpose.

The framework therefore treats language competence as a contextual knowledge base for critical AI use. Learners need sufficient language knowledge to identify unclear expressions, incorrect vocabulary, inappropriate sentence structures, and possible ambiguity in generated communication. This interpretation also avoids assuming that access to AI automatically compensates for inadequate language proficiency.

Professional Maritime Competence and the Boundary of Contextual Knowledge

Professional Maritime competence provides the disciplinary knowledge required to evaluate whether AI-generated Maritime English is appropriate for Maritime situations. It includes knowledge of Maritime terminology, operational contexts, communication procedures, standardized phraseology, and professional responsibilities. Its role is different from that of digital-AI competence: professional Maritime competence does not primarily explain how to interact with AI, but enables learners to judge the professional validity of the information and expressions generated by AI.

This distinction is particularly relevant to SMCP. The IMO developed SMCP to standardize safety-related verbal communication between ships, between ships and shore, and among personnel on board. The phrases are intended to reduce language-related misunderstandings in Maritime communication (International Maritime Organization, 2001). Their use therefore involves more than selecting grammatically correct words. Learners must understand the purpose of a message, the relationship between participants, and the operational context in which the phrase is used.

SMCP also illustrates why language competence and professional Maritime competence should remain analytically distinguishable without being treated as completely separate in practice. Understanding the wording of a standardized phrase requires linguistic knowledge, whereas selecting and responding to the phrase appropriately requires professional and situational judgment. The same communication item can therefore contribute to both contextual knowledge bases. The framework recognizes this overlap as an intentional relationship rather than treating it as a reason to merge the two components.

Professional Maritime competence consequently functions as a contextual verification resource. It enables learners to compare AI-generated content with authoritative Maritime references, recognize expressions that do not reflect standardized communication practices, and identify information that requires confirmation by lecturers or qualified Maritime professionals. This is particularly important when learning activities involve navigation, shipboard operations, ship-shore communication, emergency communication, or engineering-related procedures.

An Illustrative Example of Critical AI Literacy Using SMCP

The relationship between the three components can be illustrated through a hypothetical learning activity involving an instruction related to vessel movement. The following example is illustrative and is not presented as the output of an empirical test of a particular AI system.

A learner asks a GenAI system to generate a short ship-to-ship communication dialogue about avoiding a vessel crossing the fairway. The system produces the following hypothetical response:

AI-generated draft:

"Okay, I will try to stay away from the channel."

Although the response is understandable in general English, the learner should not automatically accept it as an appropriate standardized Maritime response. The expression "try to stay away" does not reproduce the precise wording of the relevant SMCP response and may be less explicit about the action being communicated.

The learner then compares the draft with the SMCP example concerning an instruction not to cross the fairway. The standardized exchange includes the message marker and instruction "INSTRUCTION. Do not cross the fairway," followed by the response "I will not cross the fairway" (International Maritime Organization, 2001).

The evaluation involves three forms of judgment. First, language competence enables the learner to understand the difference between the generated expression and the standardized response. Second, professional Maritime competence enables the learner to recognize the communicative function of the instruction and the importance of using the relevant standardized phrase. Third, digital-AI competence enables the learner to identify the limitations of the generated response, compare it with the authoritative reference, and revise or reject the output.

The example demonstrates that an AI-generated sentence may be understandable without being the most appropriate expression for a standardized Maritime communication task. It also illustrates why AI literacy in Maritime English should involve verification against authoritative references rather than relying solely on the fluency or confidence of generated language. The example is intended to demonstrate the framework's application, not to establish the frequency or severity of errors produced by GenAI systems.

The AI Literacy Practice Cycle

The three components are operationalized through a recurring process of interaction with GenAI. The proposed cycle consists of four stages: prompt formulation, critical evaluation, verification against authoritative Maritime sources, and revision or rejection of the generated output. The cycle represents an instructional process through which learners apply digital-AI competence while drawing on their language and professional Maritime knowledge.

At the first stage, learners formulate prompts that specify the intended communicative situation, participant roles, language level, and relevant Maritime context. At the second stage, they examine the generated response for clarity, linguistic accuracy, relevance, and possible inconsistencies. At the third stage, they verify specialized terminology, standardized expressions, and operational information against authoritative references such as IMO SMCP, IMO Model Course 3.17, and relevant professional materials. At the final stage, learners decide whether the output should be accepted, revised, or rejected. When uncertainty remains, they should seek clarification from a lecturer or an appropriate professional source rather than treating the AI response as authoritative.

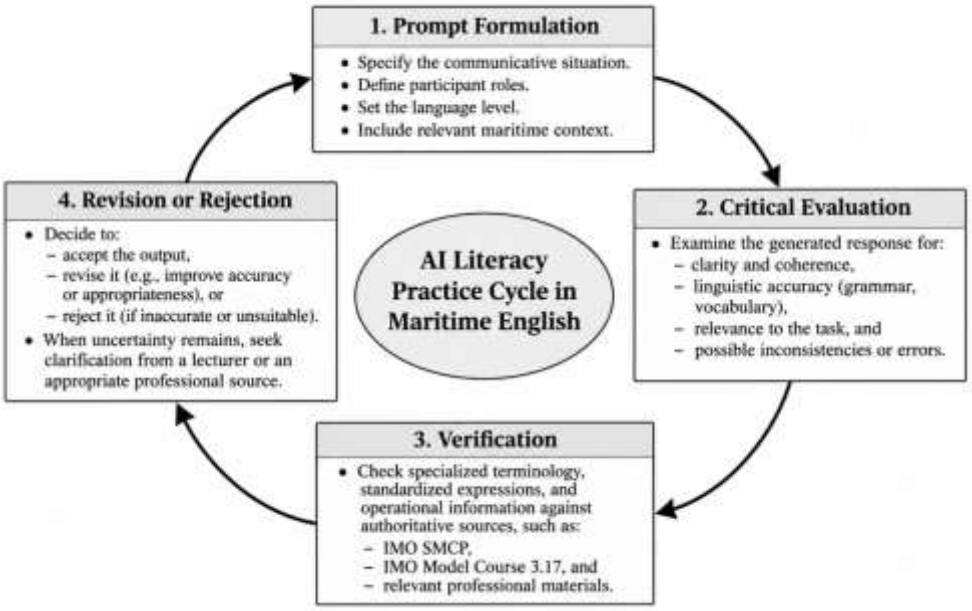


Figure 3. AI Literacy Practice Cycle in Maritime English Learning
Source: *Processed by the author (2026)*

This cycle distinguishes critical AI literacy from passive AI use. Learners are not simply expected to obtain a response from an AI system; they are expected to evaluate the response and take responsibility for the decision to use it. The cycle is iterative because an unsatisfactory response may require a revised prompt, further verification, or rejection of the generated content. The final communication product should therefore reflect the learner's linguistic judgment and professional understanding rather than merely reproduce the initial AI output.

Pedagogical Implications for Maritime English Education

The proposed framework can be integrated into existing Maritime English instruction rather than treated exclusively as a separate technology subject. The IMO Model Course 3.17 provides a relevant curricular reference because it distinguishes General Maritime English (GME) from Specialized Maritime English (SME). This structure offers opportunities to introduce AI literacy progressively: general language activities can develop learners' ability to formulate prompts and evaluate basic language outputs, while specialized activities can require verification of Maritime terminology, standardized phraseology, and professional communication (International Maritime Organization, 2015).

At the GME level, lecturers can use GenAI to support vocabulary development, grammar practice, reading comprehension, and basic speaking and writing activities. Assessment should not focus only on the quality of the AI-assisted final answer. Learners should also explain how they evaluated the generated language, identify any revisions they made, and demonstrate that they understand the final expression.

At the SME level, activities can be aligned with specialized Maritime communication, including SMCP, shipboard communication, ship-shore exchanges, navigational situations, and engineering-related communication. For example, learners can evaluate an AI-generated VTS dialogue, compare its message markers and phrases with SMCP, and justify whether the response should be accepted, revised, or rejected.

Such activities connect language learning with professional Maritime knowledge and critical AI use. They also provide a practical way to connect the framework with the communication competencies addressed in Maritime training and certification requirements under the STCW Convention, as amended (International Maritime Organization, 1978).

Assessment should consequently include both the final communication product and the reasoning process used to evaluate AI-generated content. A classroom assessment task may consider four dimensions: linguistic accuracy and clarity, professional Maritime appropriateness, quality of AI interaction and prompt formulation, and critical verification and justification of the final decision. This approach would allow lecturers to distinguish between learners who simply reproduce AI-generated responses and those who can independently evaluate and improve them. Assessment tasks should be adapted to the intended learning outcomes and the relevant course level.

Lecturers also require appropriate AI literacy to implement this approach. They need to understand the capabilities and limitations of GenAI, design tasks that require critical evaluation, identify when generated content must be checked against authoritative Maritime sources, and establish appropriate boundaries for AI use. Without lecturer preparation, AI-supported activities may become exercises in text generation rather than opportunities to develop critical and professional competence.

At the institutional level, Maritime education providers should establish guidance on acceptable AI use in teaching, learning, and assessment. Such guidance may address academic integrity, disclosure of AI assistance, data privacy, verification of technical and operational information, and lecturer responsibilities for reviewing AI-supported learning materials. AI-generated content should not replace official Maritime publications, approved training materials, or professional judgment, particularly in activities related to safety and operational procedures.

Conceptual Contribution and Directions for Future Research

The main contribution of this study is the contextualization of AI literacy for Maritime English education by distinguishing the core capability to interact critically with AI from the linguistic and professional knowledge required to evaluate AI-generated communication. This distinction provides a more precise conceptual basis than treating all relevant competencies as equivalent domains of AI literacy.

The framework also establishes a relationship between AI literacy and professional language education. Existing AI literacy models explain the general competencies required to understand, use, and evaluate AI systems (Long & Magerko, 2020; Ng et al., 2021). ESP and Maritime English research explain why specialized communication requires attention to language, disciplinary purposes, and professional context (Basturkmen, 2010; Hutchinson & Waters, 1987; John et al., 2017; Jurkovič, 2022). The proposed framework connects these perspectives by showing how contextual knowledge supports the critical evaluation of AI-generated Maritime English.

Nevertheless, the framework remains conceptual and has not yet been empirically validated. Future research should examine whether the proposed distinction between core AI literacy and contextual knowledge is meaningful for Maritime English learners, lecturers, and Maritime professionals. Instrument development should distinguish digital-AI competence from language and professional Maritime knowledge rather than automatically treating all indicators as one undifferentiated AI literacy scale. Empirical studies may also investigate whether learners can reliably identify inappropriate AI-generated

Maritime expressions, verify them against authoritative references, and justify decisions to accept, revise, or reject generated outputs.

Further research should examine lecturer AI literacy, the integration of the framework into GME and SME curricula, and the development of assessment rubrics for AI-supported Maritime English tasks. These investigations would provide evidence regarding the framework's conceptual validity, practical relevance, and suitability for different Maritime education programmers.

CONCLUSION

This study proposes a context-specific framework for AI literacy in Maritime English education and clarifies the distinction between core AI literacy capabilities and the contextual knowledge required to apply them. In response to the first research objective, the framework identifies digital-AI competence as the core component of AI literacy, encompassing the ability to formulate prompts, understand AI limitations, critically evaluate generated outputs, verify information, and make informed decisions about whether to accept, revise, or reject AI-generated content. Language competence and professional Maritime competence are identified as two contextual knowledge bases rather than universal components of AI literacy. The former enables learners to assess linguistic accuracy and communicative appropriateness, while the latter supports judgments about operational relevance, professional suitability, and safety.

Regarding the second research objective, these components are integrated through the application of digital-AI competence to AI-generated Maritime English, informed by both linguistic and professional Maritime knowledge. Standard Marine Communication Phrases (SMCP) provide an important connection between the two contextual knowledge bases because their appropriate use requires both linguistic understanding and awareness of their operational communicative functions. This integration is reflected in the proposed AI literacy practice cycle, which involves prompt formulation, critical evaluation, verification against authoritative Maritime references, and revision or rejection of generated outputs. Thus, the framework emphasizes that the educational value of GenAI depends not simply on generating responses but on learners' ability to evaluate and take responsibility for their use.

The framework has practical implications for Maritime English curriculum development, assessment, and lecturer preparation. Curriculum designers can incorporate AI literacy activities into existing Maritime English topics and align them with the communicative and professional requirements addressed in IMO Model Course 3.17. Assessment should evaluate not only the final language product but also learners' prompting decisions, evaluation processes, verification of terminology and standardized expressions, and justification for accepting or rejecting AI-generated responses. Lecturers, in turn, need sufficient AI literacy to guide students in identifying limitations, checking outputs against authoritative Maritime sources, and maintaining appropriate professional and safety standards. These implications suggest that institutional guidance on responsible AI use should accompany classroom integration.

Several limitations should be acknowledged. First, the framework was developed through a conceptual literature synthesis rather than a systematic literature review; therefore, the selection and coverage of relevant literature may not be exhaustive. Second, the synthesis relies on second-order evidence and previously published studies rather than original empirical data on how Maritime English learners or lecturers interact with GenAI. Third, the proposed relationships among the framework components have

not yet been evaluated through expert validation or empirical testing. Consequently, the framework should be regarded as a conceptual proposal rather than a validated measurement model.

Future research should proceed in three directions. First, the proposed competencies and their indicators should be operationalized into an assessment instrument and evaluated through expert review, pilot testing, and psychometric validation. Second, empirical studies should investigate lecturers' and learners' perceptions, practices, and challenges in using GenAI in Maritime English education. Third, comparative studies across Nautical Studies, Ship Engineering, and other Maritime-related programmers could examine whether the contextual knowledge requirements and applications of AI literacy differ across professional specializations. These investigations would provide evidence for refining the framework and determining its applicability across different Maritime education settings.

AUTHOR CONTRIBUTIONS

Yuniar Ayu Hafita contributed to the conceptualization of the study, literature analysis, development of the proposed AI literacy framework, and preparation of the initial manuscript. Ryan Puby Sumarta contributed to the literature review, analysis of relevant literature, and substantive revision of the manuscript. Agus Sulistiono contributed to the review of the Maritime English and Maritime professional communication aspects and provided substantive input to the manuscript. Sunarlia Limbong contributed to the critical review of the conceptual framework and revision of the manuscript. Fadel Muhammad contributed to the review and refinement of the manuscript, particularly regarding its relevance to Maritime English education. All authors participated in the discussion and review of the manuscript, approved the final version, and are responsible for the integrity and accuracy of the work.

CONFLICT OF INTEREST

The authors declare that there are no financial or non-financial conflicts of interest that could have influenced the conceptualization, preparation, or publication of this article.

ARTIFICIAL INTELLIGENCE (AI) USE STATEMENT

The authors declare that no artificial intelligence (AI) technology was used in the research process or in the preparation of this article.

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