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Immersive Technologies in Maritime Language Training: Updating the Linguistic-Technological Component for the Digital Era

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Abstract

This paper examines a systemic approach to enhancing foreign language communicative competence among maritime navigation and ship handling specialists by integrating digital tools into vocational education and training (VET). The study highlights the growing need for seafarers to combine technical expertise with advanced English proficiency supported by immersive technologies and flexible learning formats.

The proposed model incorporates English for Specific Purposes (ESP), including Maritime and Business English, into a digitally enhanced training framework. It leverages virtual and augmented reality, AI-assisted environments, and collaborative international online learning to foster both language development and operational readiness. The approach is aligned with lifelong learning principles and supports rapid upskilling and reskilling in line with Industry 4.0 requirements.

Key components include ESP-based courses tailored to operational, managerial, and leadership competencies, delivered through blended and online formats on the MOODLE platform. These contribute to both initial training and continuing professional development.

Findings underscore the pedagogical value of immersive technologies in improving digital fluency, promoting autonomous learning, and fostering entrepreneurial thinking. The model provides a scalable framework that enhances communicative resilience in dynamic maritime contexts and may inform broader innovation strategies in maritime VET systems.

JEL Classification: I21, I23, O33, J24

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1. Introduction

The increasing complexity of the maritime sector, driven by globalization and rapid technological change, has significantly intensified the demand for specialized training systems that combine technical expertise with advanced communication skills. Competence in English, particularly within professional maritime contexts, plays a critical role in ensuring operational safety, effective leadership, and compliance with international standards. However, traditional methods of instruction often fall short in fostering context-driven communicative competence or in responding to the evolving needs of the digital era (Bocanegra-Valle). In response to these challenges, this study proposes a systemic revision of the linguistic-technological component in maritime professional education through the integration of immersive technologies – namely, virtual reality (VR), augmented reality (AR), and AI-powered language learning tools. The proposed model aims to enhance digital fluency, strengthen communicative resilience, and cultivate entrepreneurial capabilities within a lifelong learning framework. It seeks to integrate English for Specific Purposes (ESP) and Business English into maritime training through immersive environments, thereby addressing both communicative and technological proficiency as complementary competencies. The central objectives of this research are threefold: first, to present a pedagogical model that incorporates immersive tools for teaching ESP and Business English in maritime contexts; second, to detail the design and implementation of this model through modular course structures and digital platforms; and third, to evaluate its effectiveness in improving learners' communicative competence, digital skill acquisition, and readiness for innovation-driven vocational education and training (VET).

2. Theoretical Framework

This study is grounded in three interrelated domains: language education for specific purposes, immersive technology-enhanced learning, and the broader context of digital transformation within competency-based VET.

English for Specific Purposes (ESP) and Business English have long been integral to maritime education, where context-specific communication skills are essential. ESP frameworks emphasize functional language use aligned with authentic professional tasks, such as bridge command communication, emergency response protocols, cargo documentation, and intercultural negotiation. Business English extends this foundation by focusing on leadership communication and administrative interaction – competencies increasingly expected of managerial-level maritime professionals (Bocanegra-Valle).

The incorporation of immersive and AI-powered technologies into language education presents new opportunities for situated learning. VR and AR enable learners to engage in realistic simulations, fostering spatial awareness and contextual language use (Parmaxi and Zaphiris; Godwin-Jones). Meanwhile, AI-driven tools – such as natural language processing (NLP) chatbots and automated feedback systems – offer adaptive instruction, real-time error correction, and personalized learning pathways (Zawacki-Richter et al.). These technologies collectively support learner autonomy and accelerate the acquisition of

applied communication skills.

Finally, the digital transformation of VET entails not only a shift in content but also in pedagogical orientation. Competency-based education prioritizes demonstrable outcomes and skill transferability. By embedding immersive technologies into maritime language instruction, educators can promote higher learner engagement, improve knowledge retention, and align training with broader goals of upskilling, reskilling, and entrepreneurial readiness (Mulder). This theoretical foundation provides the basis for the development and analysis of the integrated model proposed in this study.

3. Methodology

This study employed a mixed-methods approach combining design-based research (DBR), pilot implementation, and both quantitative and qualitative evaluation techniques. The research was carried out over two academic semesters at a Ukrainian higher education institution specializing in maritime studies.

The participants in the study included 120 students enrolled in junior bachelor, bachelor, and master's level programs, along with 10 language instructors and course developers. All participants were engaged in the Navigation and Ship Handling specialization, which demands high-level linguistic and operational competence in English within international and high-risk contexts.

A variety of digital tools and platforms were integrated to support instruction and assessment. The modular courses were delivered via the Moodle Learning Management System (LMS), allowing structured access to content and tracking of learner progress. Immersive elements included virtual reality (VR) scenarios that simulated bridge command operations and distress communication, enabling students to practice situational dialogue under realistic conditions. Augmented reality (AR) applications were used to reinforce vocabulary acquisition related to cargo handling and navigational terminology, promoting contextualized learning through mobile interaction.

Artificial intelligence (AI) tools were embedded to further enhance the learning process. NLP-powered chatbots simulated maritime radio communication, enabling learners to engage in interactive dialogues and receive immediate feedback. Additionally, speech recognition technologies were applied to monitor pronunciation accuracy and adherence to standardized phraseology protocols, crucial for international communication in the maritime sector.

The evaluation strategy comprised several components. Language proficiency was assessed through pre- and post-testing based on ESP criteria tailored to the maritime context. Learners' digital fluency and sense of autonomy were measured using structured surveys and self-assessment tools. Finally, expert evaluations were conducted to analyze student performance during immersive simulations, focusing on their communicative efficiency, accuracy, and adaptability in professional scenarios.

This methodological framework not only ensured robust data collection and analysis but also aligned with the principles of learner-centered and competency-based education, supporting the integration of digital transformation into language training for the maritime profession.

4. Model Description

The proposed linguistic-technological component of the training model is organized into three interconnected learning pathways, each targeting a specific dimension of language competence relevant to the maritime domain. These pathways are designed to function in parallel, offering a comprehensive and modular structure that supports both technical communication and transversal skills development

within digitally mediated environments.

The first pathway, **Core ESP Modules**, focuses on foundational maritime English and context-specific language use. Instruction covers essential maritime vocabulary and standardized communication protocols, aligned with International Maritime Organization (IMO) conventions. Learners engage in contextual dialogues simulating real-world scenarios such as collision avoidance, port coordination, and cargo operations. Grammar instruction is functional and task-based, emphasizing its application in professional writing tasks such as logbook entries, incident reports, and safety documentation.

The second pathway addresses **Business Maritime Communication**, responding to the growing need for administrative and intercultural communication skills among officers and managerial-level personnel. Modules include training in email and report writing, formal negotiation strategies, and language used in meetings and decision-making contexts. A particular emphasis is placed on clarity, precision, and diplomacy – skills that are critical in multicultural maritime operations.

The third pathway includes **Transversal Competency Modules**, which target soft skills and leadership capabilities within multilingual and high-pressure operational environments. These modules comprise topics such as *Leadership and Team Dynamics, Mastering Communication in Emergencies, and Cultural Awareness and Non-Verbal Communication*. These areas are integrated with language instruction to reinforce the communicative behaviors expected in diverse and multinational crews.

Each of the three pathways is enhanced through the integration of immersive simulations, artificial intelligence-driven feedback mechanisms, and digital assessment tools. VR and AR environments simulate operational contexts that require real-time decision-making and communication under stress, while AI tools provide personalized correction and performance analytics. Assessments are embedded throughout the modules and adapted to measure both linguistic accuracy and functional application in professional maritime scenarios.

This model is designed to ensure that learners not only acquire technical terminology and communicative structures but also develop the digital literacy, leadership awareness, and intercultural competence necessary for success in the global maritime industry.

5. Results

The implementation of the immersive, linguistically integrated model yielded notable improvements across both language proficiency and digital competence. Quantitative data collected through pre- and post-testing indicated a significant enhancement in students' functional maritime English. On average, learners demonstrated a 22% increase in performance scores, particularly in areas related to operational communication and adherence to Standard Marine Communication Phrases (SMCP). Additionally, fluency in shipboard dialogues improved measurably, with learners displaying greater ease in executing context-specific communicative tasks such as collision avoidance exchanges and distress coordination protocols.

In terms of digital competence, post-intervention surveys revealed that 87% of students reported increased confidence in using digital tools for language learning. Learners also expressed a heightened sense of autonomy and motivation while engaging with self-paced modules, particularly those involving AI chatbots and VR-based scenarios. These findings suggest that the integration of adaptive and immersive technologies fostered not only linguistic gains but also a more active and self-regulated approach to learning.

Qualitative feedback gathered through focus group discussions and instructor reflections further supports these outcomes. Students consistently highlighted the realism and professional relevance of the simulations, noting that they felt more prepared to communicate in actual maritime environments.

Instructors observed improved classroom engagement, higher retention of technical vocabulary, and more spontaneous use of English in group tasks. Particularly noteworthy was the positive reception of the Business Maritime Communication modules among master's level students, many of whom are preparing for officer-level responsibilities. These learners reported that the formal writing and leadership communication tasks aligned closely with the communicative demands they anticipate in their future roles.

Taken together, the findings demonstrate the efficacy of the integrated model in enhancing both technical language skills and digital readiness, reinforcing its relevance for innovation-driven maritime vocational education.

6. Discussion

The findings of this study affirm the pedagogical value of immersive technologies in English for Specific Purposes (ESP) education, particularly within the maritime domain. The integrated linguistic-technological model demonstrates that digital immersion facilitates rapid and contextualized skill acquisition, offering learners realistic environments in which to practice professional communication. These outcomes are closely aligned with international maritime standards, including the Standards of Training, Certification and Watchkeeping (STCW) and communication protocols set forth by the International Maritime Organization (IMO).

A key feature of the model is its use of artificial intelligence to personalize the learning process. AI-driven chatbots, speech recognition systems, and adaptive feedback mechanisms reduce the dependency on continuous teacher intervention while enabling students to engage in reflective, self-directed learning. This transformation from content-heavy instruction to performance-based learning is particularly suited to digital-native students as well as mid-career professionals engaged in lifelong learning trajectories.

The inclusion of Business English and leadership-oriented modules within the language training curriculum has also proven valuable. These components extend the functional focus of ESP by introducing transversal competencies such as negotiation, intercultural communication, and team leadership – skills increasingly essential for entrepreneurship, innovation, and managerial responsibility in contemporary maritime operations. The strong reception of these modules among master's level students suggests their relevance for officer-track training and broader career progression.

Despite these positive outcomes, several challenges remain. The integration of immersive technologies requires substantial technical resources, including VR/AR hardware, high-speed connectivity, and compatible learning platforms. Faculty development also emerges as a critical factor, as instructors must acquire both digital fluency and pedagogical strategies to effectively deliver and assess immersive learning. Furthermore, institutional variability in infrastructure poses barriers to the scalability and equitable adoption of such models, particularly in regions with limited access to educational technology.

Overall, the discussion highlights the transformative potential of immersive, AI-enhanced language education in maritime training while also emphasizing the systemic and logistical considerations necessary for sustainable implementation.

An important aspect of immersive learning is ensuring inclusiveness and accessibility for all learners. The proposed framework can be adapted to support students with different levels of digital literacy or specific learning needs by integrating multimodal access options, subtitles, alternative navigation tools, and adaptive feedback systems. Such design considerations promote equitable participation and align with the broader goal of providing high-quality, inclusive education in vocational training environments.

The outcomes of this study are consistent with the priorities outlined in the European Skills Agenda and initiatives advanced by the Skillman Alliance, which promote innovation-driven upskilling and reskilling

within Technical and Vocational Education and Training (TVET). The proposed model contributes to the strategic objectives of the Adriatic–Ionian region, where maritime transport remains a key economic and employment sector. By integrating immersive and AI-assisted tools into language training, this approach reinforces the EU's commitment to fostering digital readiness and lifelong learning for a sustainable and competitive maritime workforce.

7. Conclusions and Recommendations

This study concludes that the proposed model – based on the integration of immersive technologies into the linguistic-technological component of maritime professional education – effectively enhances both domain-specific language competence and learners' digital readiness. By aligning instructional design with real-world communicative contexts and leveraging tools such as virtual reality, augmented reality, and AI-driven applications, the model contributes meaningfully to addressing current skill gaps in maritime training.

The outcomes indicate that this approach not only improves students' functional command of maritime English but also promotes key transversal skills such as learner autonomy, critical thinking, and leadership communication. Furthermore, the modular and performance-oriented structure supports the goals of upskilling and lifelong learning within vocational education and training (VET) frameworks, which are increasingly emphasized in international policy discourse.

The following recommendations are proposed to further enhance the impact and scalability of this model:

1. *Wider Institutional Adoption*: Expansion of the model across other maritime higher education institutions is strongly recommended, particularly those aiming to modernize their language curricula in alignment with STCW and IMO standards.
2. *Faculty Development Investment*: Structured training programs for instructors should be prioritized to ensure they are equipped to effectively utilize immersive and AI-driven tools. This includes both technical proficiency and pedagogical integration.
3. *Policy and Curriculum Innovation:* Regional and national education authorities should consider embedding immersive language modules into VET policy strategies. This would ensure consistent access to innovative learning across institutions with varying capacities.

Finally, the model supports the principles of Education for a Just and Sustainable Transition by fostering communicative, digital, and ethical competencies that enable maritime professionals to operate responsibly within evolving technological and environmental contexts. Through the development of adaptable, sustainability-oriented skill sets, the framework contributes to building resilient human capital for the future of the maritime industry.

Overall, the proposed framework presents a scalable and transferable model that can inform broader innovation strategies within maritime education. Its successful implementation demonstrates the feasibility of integrating immersive learning technologies into ESP instruction, thereby advancing the digital transformation of vocational training systems on a systemic level.

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