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Mapping Research Trends in Maritime Education and Training: A Bibliometric Analysis

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Abstract
This study aims to analyze current research trends in Maritime Education and Training (MET) and to identify key gaps that warrant further investigation. As the maritime industry undergoes rapid technological and regulatory transformation, there is an increasing need for adaptive and effective educational practices. A bibliometric analysis was conducted using VOSviewer to map and visualize scholarly output on MET published between 2020 and 2024. The analysis examined 471 documents indexed in Scopus that were relevant to the term "Maritime Education and Training." The study explored connections between keywords, citation behaviors, and thematic clusters to map the intellectual composition of the discipline. The findings reveal that dominant research themes include "education," "STCW," "marine industry," "blended learning," and "learning system," indicating a strong emphasis on regulatory compliance and digital learning models. However, critical areas such as active learning methods, simulation-based training, and cyber security remain underrepresented in the existing literature. These gaps indicate that, although foundational elements of MET are well-developed, innovative pedagogical strategies and emerging digital threats remain largely excluded from current maritime curricula. The study highlights the need for future research to explore interactive and technology-enhanced learning approaches that can improve student engagement and operational preparedness.

Keywords: Maritime Education and Training, Seafarer Training, Bibliometric Analysis

Introduction

Maritime education and training (MET) play a pivotal role in shaping the competencies of future seafarers and maritime professionals. As the maritime industry continues to evolve with technological advancements and regulatory changes, the need for a robust educational framework becomes increasingly crucial (Türkistanli, 2024). MET encompasses a wide range of programs, from basic safety training to advanced navigational skills, ensuring that individuals are well-prepared to meet the demands of the industry. According to the International Maritime Organization (IMO), the quality of maritime education directly impacts maritime safety and environmental protection, highlighting its significance in the broader context of global trade and environmental stewardship (Kayisoglu et al., 2023). Moreover, the maritime sector is characterized by its unique challenges, such as the need for compliance with international regulations and the ability to operate sophisticated maritime technologies. For instance, the implementation of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) has set a global benchmark for maritime training (Manuel, 2017). This convention emphasizes the importance of standardized training and assessment, which is essential for maintaining safety and efficiency at sea. Consequently, MET programs must continuously adapt to incorporate these regulatory changes, ensuring that graduates possess the requisite skills and knowledge to navigate the complexities of modern maritime operations.

MET is essential for fostering a culture of safety within the maritime industry. Islam et al., (2018) research indicates that human error remains a leading cause of maritime accidents, underscoring the need for comprehensive training programs that emphasize safety protocols and risk management. Integrating safety training into the curriculum enables MET institutions to equip students with the skills necessary to identify and mitigate potential hazards. Therefore, enhancing the quality of MET can lead to improved safety outcomes and a reduction in maritime incidents. As technological advancements continue to transform the maritime industry, MET increasingly adopt innovative approaches to skill development (Barrie & Galadev, 2020). A leading trend involves the integration of digital technologies into MET programs. Maritime institutions now leverage e-learning platforms and virtual simulations to offer students flexible, accessible, and immersive learning experiences. These tools not only support remote instruction but also replicate real-world scenarios, enabling students to develop practical skills in a controlled environment. Bridge simulators allow trainees to engage with complex navigation challenges without exposing them to the risks of actual sea voyages.

Although MET play a vital role in the industry, researchers have yet to conduct a comprehensive bibliographic analysis that captures the field's current state. A bibliometric approach is essential to understanding the evolution and trajectory of research on MET in recent years, identifying dominant themes, revealing patterns of scholarly collaboration, and highlighting underexplored areas that warrant further investigation (Türkistanli, 2024). Most existing studies concentrate on specific components of MET such as curriculum design or instructional methods without offering a holistic perspective for example Dachev & Panov, (2017) and Bogusławski et al., (2022). This fragmented approach limits educators' and policymakers' capacity to make well-informed decisions about the future of maritime training programs (H. Li et al., 2020). In response, several scholars have called for a systematic review of the existing literature. For example, Renganayagalu et al., (2022) emphasizes the importance of examining the evolving landscape of maritime training, particularly in the context of technological innovation and shifting regulatory frameworks. Conducting a thorough bibliographic analysis allows researchers to uncover key trends, identify research gaps, and highlight emerging challenges, thereby contributing to the advancement of maritime education.
Furthermore, the integration of emerging technologies—such as simulation tools and e-learning platforms—has significantly reshaped traditional MET practices. A comprehensive bibliographic study can clarify how maritime institutions are adopting these innovations and evaluate their effects on educational outcomes. Ghosh (2017) contends that effectively implementing technology in MET enhances the quality of instruction and strengthens trainees' competencies, thereby narrowing the skills gap in the maritime workforce. Examining the reach and impact of these technological advancements offers critical insights for stakeholders aiming to modernize training systems and align them more closely with evolving industry requirements.

This research introduces a novel approach by framing MET within a multidisciplinary context. Instead of limiting the analysis to pedagogical or technical dimensions, the study incorporates perspectives from educational theory, technology studies, labor economics, and policy analysis. This broader analytical scope fosters a more integrated understanding of the diverse factors influencing MET practices and outcomes. Employing a multidisciplinary framework allows the research to identify underlying structural trends and generate more nuanced, context-sensitive recommendations for advancing maritime education in today's complex and rapidly evolving global landscape.

Materials And Methods

This study adopts a bibliographic research methodology to systematically examine existing literature on Maritime Education and Training from a multidisciplinary perspective. Bibliographic research involves the systematic collection, analysis, and synthesis of information from existing publications and documents (Pranckutė, 2021). Relevant academic sources were identified through a comprehensive search of major databases, specifically Scopus (Visser et al., 2021). The search strategy employed keywords such as "maritime education and training," "simulation," "e-learning," and "skills development," combined using Boolean operators. The review focused on peer-reviewed journal articles, conference proceedings, and academic books published between 2020 and 2024. Studies were included if the content addressed core

aspects of MET particularly those involving technological integration, curriculum development, or policy and excluded if lacking academic rigor, written in languages other than English, or unrelated to the scope of education and training. VOSviewer was utilized to perform bibliometric mapping and to visualize relationships among key themes, authors, and institutions within the selected literature (Arruda et al., 2022; van Eck & Waltman, 2017). The software facilitated the identification of citation patterns, co-authorship networks, and keyword co-occurrences, offering insights into the intellectual structure of the field (Bukar et al., 2023).

Result

This study analyzed documents indexed in Scopus between 2020 and 2024 and identified a total of 471 publications related to "Maritime Education and Training." These 471 documents were examined across several aspects, including the publishers with the highest number of publications on this topic, documents by affiliation, documents by country, documents by type, and documents by subject area. Following this initial bibliographic analysis, the data were further examined using VOSviewer software. The following section presents the findings related to the publishers that contributed the most publications.

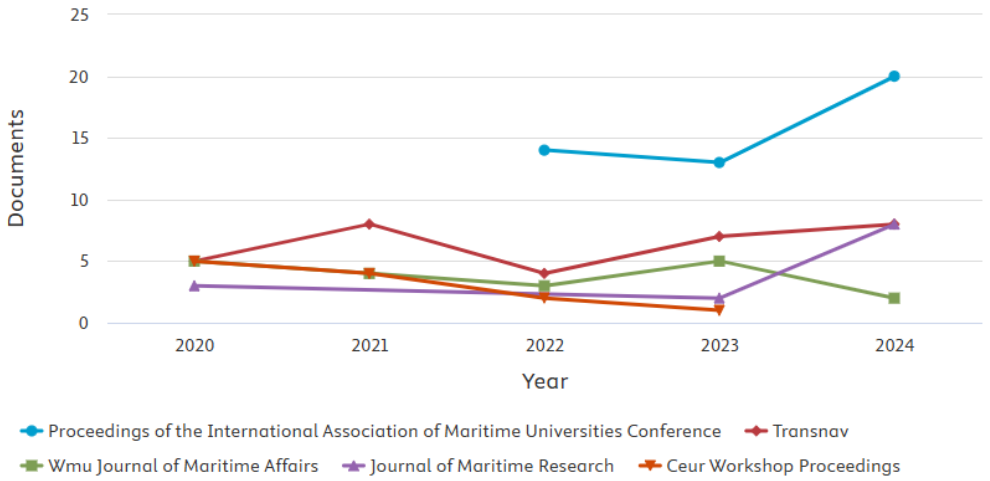

Figure 1. Documents per Year by Source

Source: www.scopus.com

As shown in Figure 1, the majority of documents were published in the Proceedings of the International Association of Maritime Universities Conference, followed by TransNav, WMU Journal of Maritime Affairs, and the Journal of Maritime Research. These publishers are recognized as leading sources in the field of Maritime Education and Training. The data may serve as key references for future research related to this domain. Furthermore, the study also analyzed documents by affiliation, as illustrated in Figure 2.

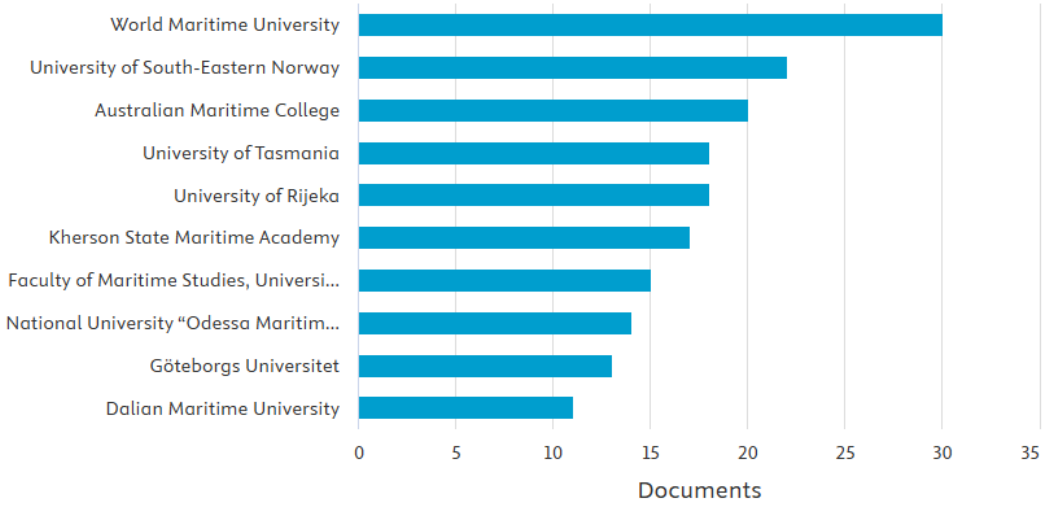

Figure 2. Documents by Affiliation

Source: www.scopus.com

The findings presented in Figure 2 indicate that the World Maritime University has produced the highest number of documents, totaling 30 publications. The university is widely recognized as a research-intensive institution that has significantly contributed to the development of knowledge in the field of Maritime Education and Training. In addition, the University of South-Eastern Norway has produced 22 documents, while the Australian Maritime College has published 20 documents. These institutions have become key reference points for research on Maritime Education and Training. Numerous other institutions have also contributed scholarly work in this field, offering valuable sources for future studies and supporting further academic exploration. Another aspect of the analysis includes documents by country, as illustrated in Figure 3.

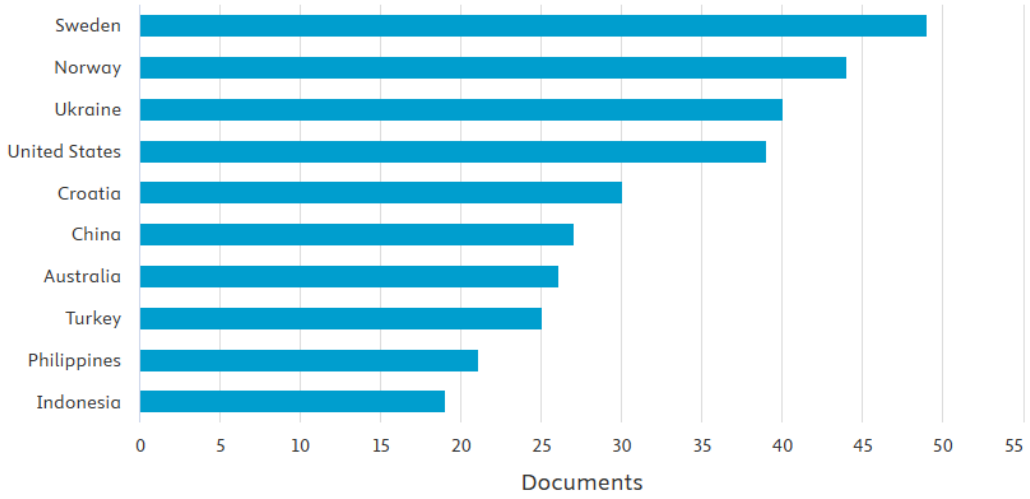

Figure 3. Documents by Country

Source: www.scopus.com

Figure 3 illustrates the distribution of documents by country indexed in Scopus, highlighting Sweden, Norway, and Ukraine as the leading contributors to research on Maritime Education and Training. These countries are widely recognized as primary references in the development of educational frameworks and training programs aimed at enhancing the competencies of crew members and maritime personnel on board ships. With a strong focus on academic output and practical application, each country has demonstrated the capacity to serve as a pioneer in shaping international standards and best practices in maritime education. The results of the analysis by document type are presented in Figure 4.

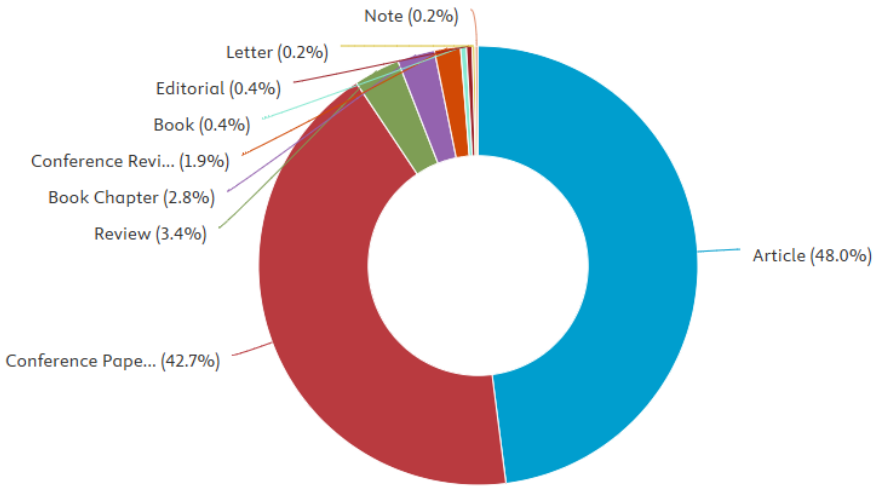

Figure 4. Documents by Tipe

Source: www.scopus.com

Based on Figure 4, it can be seen that the majority of documents on the topic of Maritime Education and Training were published as journal articles (48%), followed by conference papers (42.7%), with a smaller portion appearing in other forms of publication. This finding indicates a strong emphasis on disseminating research through peer-reviewed academic channels, while also highlighting the relevance of conference platforms for presenting ongoing studies, emerging issues, and collaborative discussions within the maritime education community. The distribution suggests a balanced approach between formal academic dissemination and active engagement in professional and scholarly forums. Figure 5 presents the analysis of documents based on subject area.

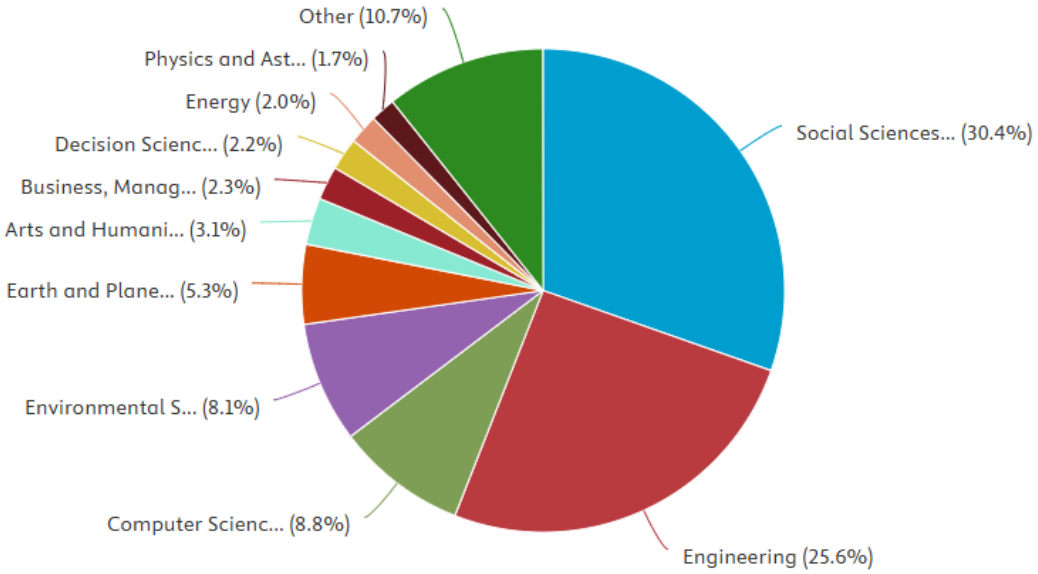

Figure 5. Documents Based on Subject Area
Source: www.scopus.com

Based on Figure 5, it can be observed that the subject areas associated with Maritime Education and Training are predominantly within Social Sciences (30.4%), followed by Engineering (25.6%), and Computer Science (8.8%). This finding indicates that Maritime Education and Training is not solely focused on engineering aspects related to ship operations or technical systems, but also encompasses broader interdisciplinary fields. The prominence of social sciences suggests a strong interest in educational methodologies, human resource development, leadership, safety culture, and socio-behavioral factors within the maritime context. This multidisciplinary orientation reflects the evolving nature of maritime education, which requires not only technical competence but also soft skills, digital literacy, and an understanding of complex social dynamics on board and within maritime institutions. In Figure 6, the analysis using VOSviewer is extended to examine the network of research topics related to Maritime Education and Training.

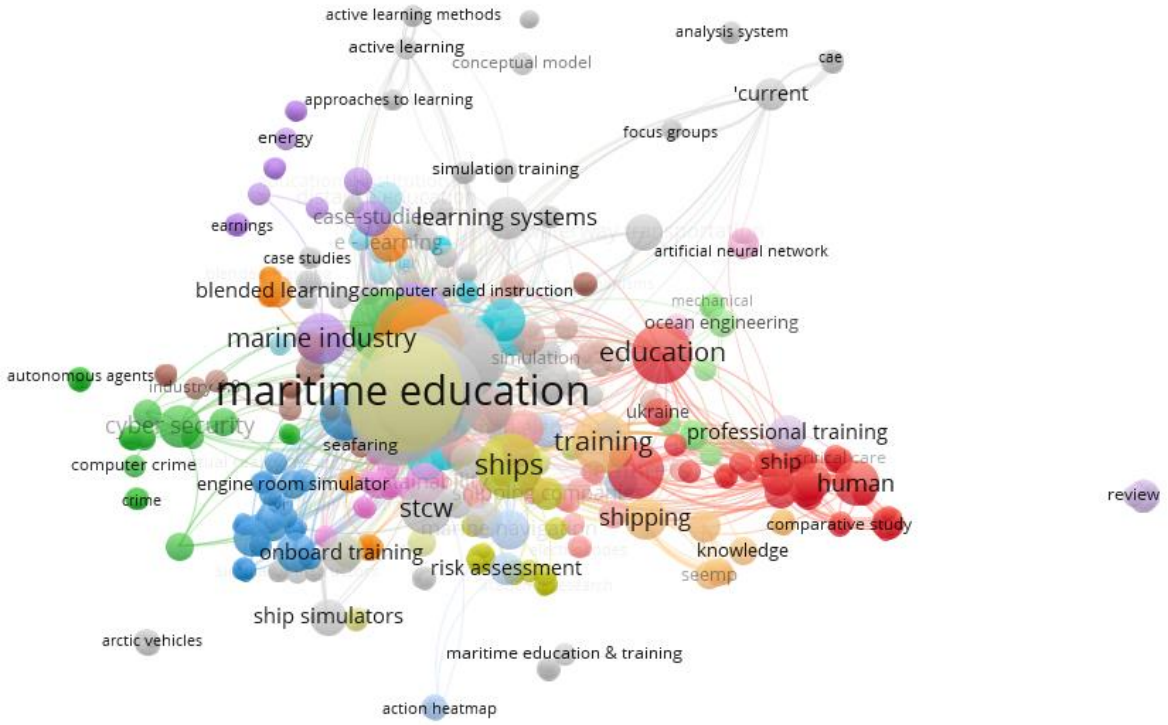

Figure 6. VOSViewer Result

The results of the analysis using VOSviewer indicate that there has been a significant amount of research on the topic of maritime education, particularly associated with keywords such as “education,” “STCW,” “marine industry,” “blended learning,” “learning system,” “ships,” and “human.” This suggests that these themes have become central focuses in previous studies and have received considerable attention within the academic community. However, the data analysis also shows that research related to “active learning methods” or “active learning” remains limited. This indicates that participatory and interactive learning approaches have not been extensively explored in the context of maritime education, thus presenting a potential research gap in enhancing the effectiveness of teaching and learning processes. In addition, there appears to be further opportunity for research on “ship simulator” or “simulation training,” suggesting that simulation technology as a training tool has not been fully utilized in the existing academic literature. Further exploration is needed to support the development of practical competencies among maritime cadets. Another research opportunity lies in the topic of “cyber security,” which can be integrated with maritime education. This highlights that digital security aspects in the maritime sector have not yet received adequate scholarly attention, despite their growing relevance in the era of increasing digitalization in the maritime industry.

Discussion

The maritime industry is an essential component of global trade and transportation, necessitating a robust educational framework to prepare future professionals. Recent analyses using VOSviewer, a software tool for visualizing bibliometric networks, reveal significant trends in maritime education research. Key themes identified include “education,” “STCW” (Standards of Training, Certification, and Watchkeeping for Seafarers), “marine industry,” “blended learning,” “learning system,” “ships,” and “human.” This essay aims to explore these themes in-depth, while also highlighting the gaps in research related to active learning methods, simulation training, and cyber security within maritime education.

The prevalence of research surrounding the keywords mentioned above indicates a concentrated effort within the academic community to address the foundational aspects of maritime education. According to the International Maritime Organization (IMO), the STCW convention has set the benchmark for training and certification of seafarers globally, ensuring that maritime professionals meet international safety and competency standards (Ghosh, 2018). Nazir & Jungefeldt (2017) emphasizes that adherence to STCW is

crucial for maritime safety, thus making it a focal point in maritime education research. Furthermore, blended learning, which combines traditional classroom instruction with online learning, has gained traction in various educational sectors, including maritime studies. Shamsuddin & Kaur (2020) suggests that blended learning enhances student engagement and retention, making it an essential area of exploration for maritime education programs.

Despite the robust body of research surrounding these central themes, there remains a conspicuous gap in the literature concerning active learning methods. Active learning, characterized by participatory and interactive approaches, has been shown to enhance critical thinking and problem-solving skills among students (R. Li et al., 2023). In the context of maritime education, the limited exploration of active learning methods presents a significant opportunity for future research. For instance, Børte et al., (2023) illustrated that incorporating active learning strategies in higher education significantly improved practical competencies. Therefore, further investigation into these methods could lead to enhanced teaching and learning processes within maritime programs.

Another area ripe for exploration is the use of ship simulators and simulation training. Simulation technology has revolutionized various fields, including aviation and healthcare, by providing realistic training environments without the associated risks. However, in maritime education, the literature indicates that simulation training has not been extensively utilized (Dewan et al., 2023). Kim et al., (2021) demonstrated that maritime cadets who underwent simulation training showed a marked improvement in their navigational skills compared to those who received traditional instruction. This underscores the need for further research into integrating simulation technology into maritime curricula to better prepare cadets for real-world challenges.

Additionally, the increasing relevance of cyber security in the maritime sector cannot be overlooked. As the industry becomes more digitized, the risks associated with cyber threats grow exponentially (Afenyo & Caesar, 2023). Despite this, scholarly attention to cyber security within maritime education remains inadequate. Cyber attacks on maritime operations have increased in recent years, highlighting the urgent need for educational programs to incorporate cyber security training (Polatidis et al., 2018). Integrating this topic into maritime curricula could equip future professionals with the necessary skills to mitigate cyber risks, thus enhancing the overall security of maritime operations.

Conclusion

This research aimed to investigate key themes in Maritime Education and Training (MET) and to identify gaps that remain underexplored in the academic literature. The analysis confirmed that topics such as “education,” “STCW,” “marine industry,” “blended learning,” and “learning system” dominate recent MET research. These findings reflect a strong academic focus on foundational issues, particularly regulatory compliance and the integration of hybrid instructional models. STCW compliance continues to serve as a cornerstone in MET, reinforcing the global standardization of training and certification for maritime professionals. Blended learning has also emerged as a prominent area of interest, offering flexible and engaging educational models that align with evolving pedagogical demands. Despite these advancements, the study identified clear research gaps. Active learning methods remain significantly underrepresented, even though evidence from other disciplines supports their effectiveness in improving critical thinking and practical competence. Simulation training, another high-potential area, lacks sufficient exploration in maritime contexts, despite its proven benefits in enhancing real-world preparedness. Additionally, the critical issue of cyber security has not received adequate attention in MET literature, even as cyber threats become more frequent and sophisticated in maritime operations. Future research should address these gaps to modernize maritime curricula and ensure alignment with industry demands. Prioritizing active learning, simulation-based instruction, and cyber security education will better prepare cadets for the complex challenges of a digitized and globalized maritime environment.

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