Factors Impacting Curricula in Maritime Simulator-based Education

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Abstract: The nature of the competencies that maritime students require to work successfully in the industry has undergone significant changes, which require higher education providers to adapt. The International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers (STCW) was adopted by the International Maritime Organization. The STCW Code includes both guidance and constraints for the maritime education and training (MET) curriculum, which may lead to wide variability in implementation. However, a curriculum is influenced by many factors, including regulatory, social and cultural factors. This study examines the impact of such factors on curricula in MET using a concept map based on relevant literature that illustrates the relationships between these factors. The findings highlight significant concepts and ideas for developing an effective, comprehensive and coherent MET curriculum to ensure that students acquire the necessary skills for this safety-critical industry.

Keywords: Maritime education and training; simulator education; curriculum.

1. Introduction

The evolution of technology and automation has a significant impact on maritime education. Numerous studies in maritime higher education have aimed to understand how educational practices can be improved to facilitate effective learning (De Oliveira et al., 2022; Nazir & Hjelmervik, 2017; Scanlan et al., 2022; Sellberg, 2016; Sharma et al., 2018).

There is a significant amount of ongoing debate surrounding what teaching should look like, what should be emphasised, what the curriculum is and how it can be better structured to meet students' needs (Behar-Horenstein & Niu, 2011; Biggs, 1996; Light, Calkins, & Cox, 2009; Moore, 2005; O'Connor, 2022; Oliver & Hyun, 2011; Ramsden, 2003). In terms of what is taught, the curriculum is frequently taken for granted and thought to be easily transferable into new forms (O'Connor, 2022). In most domains, higher education curricula transform in response to changing technologies, policies and economies. Therefore, there is a need for further studies to explore the curriculum in maritime simulator-based education.

This study presents a curriculum concept map to provide a broader understanding of a curriculum to facilitate its sustainable, comprehensive, engaging and effective. . The following section provides information about maritime education and training (MET) as well as curricula definitions to unpack factors that impact maritime simulator-based education.

2. Background

MET offers career opportunities at sea and on land in the maritime sector. After fulfilling their required sailing time, graduates may start employment as deck officers on various types of vessels. Teaching at the university level ensures seafarers' competency and qualifications in accordance with the International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers (STCW), which was adopted by the International Maritime Organization (IMO) in 1978 and entered into force in 1984 (IMO, 1978). The STCW Convention stipulates standards for seafarers' training, certification and watchkeeping. In addition, the Code includes specific recommendations on the training and certification requirements for different types of seafarers (e.g., deck officers, engineering officers) and ratings, which provide guidance whilst also placing restrictions on the MET curriculum.

'Curriculum' is a term that is used with several meanings and different definitions. The *curriculum* is classically defined as the foundation for the teaching-learning process, including instructional strategies, teaching methods, learning resources, lesson plans, evaluation and assessment, staff development and the reconstruction of the human experience within and outside of the school (Duncan & Frymier, 1967; Johnson Jr, 1967; Krug, 1957). Others incorrectly understand a curriculum as simply a basic lesson plan, despite it being more complex and multifaceted than a mere list or series of lessons. Many other factors affect student learning within and outside of the classroom. Therefore, understanding how these factors interact is crucial for any educator.

Table 1 provides relevant selected curricula definitions from the literature to provide a comprehensive understanding of curricula and their impacting factors.

Table 1 Curricula definitions.

Curricula	Definitions
Assessed	Measured through formal and informal assessments, which provide information on student learning and achievement, as well as feedback to teachers on the effectiveness of their instructional strategies (Kelly, 2009).
Co-curricular	Activities aligned with the curriculum and learning objectives that are designed to enhance the student experience (Kuh, 2001).
Extracurricular	Activities that are conducted under the auspices of the school but occur outside of classroom time and are not part of the curriculum. These activities do not involve a grade or academic credit, and student participation is optional (Bartkus et al., 2012).
Prescribed	At a system level, the competent authority prescribes the curriculum, which lays down what has to be learned at each stage of education (Barrett, 2020).
Received	Learned by students based on their experiences, backgrounds and interpretations of classroom instruction (Wiles & Bondi, 1984).
Self-directed	The process of taking control of and responsibility for one's own learning, which can occur in various contexts, including formal education, workplace training and personal development (Caffarella & Daffron, 2013).
Societal curricula	The knowledge and values that individuals acquire from various socialising agents, such as family, peer groups, neighbourhoods and mass media(Cortes, 1979).
Supplemental	Resources that support the curriculum textbooks, software and other media (Glatthorn & Jailall, 2000).
Taught	What is taught in the classroom, including the teacher's interpretation of the written curriculum, the teaching methods used and the learning experiences provided to students (Wiles & Bondi, 1984).
Programme curricula	Embodied in approved state and district guides. Explicitly documented, including syllabi, textbooks and other instructional materials. These guide what teachers teach in the classroom (Glatthorn, Boschee, & Whitehead, 2016).

3. Methodology

Guiding curriculum development is crucial because some curricula may not accurately capture the nuances and complexities of the subject matter, thereby leading to the oversimplification or exclusion of important concepts. A concept map is designed to depict significant connections between concepts in the shape of propositions (Novak & Gowin, 1984). Novak and Cañas (2008) defined concept maps as graphical tools for organising and representing knowledge. It aligns with the cognitive constructivist perpective, emphasizing how learners actively construct knowledge by connecting new information to existing frameworks. Concept mapping also embodies Ausubel's theory of meaningful learning, wherein interpreting, connecting and integrating new knowledge into existing frameworks enhances comprehension (Sexton, 2020). A concept map can structure a research project, reduce qualitative data, analyse the themes and interrelationships within a study, and present findings. Relationships are depicted by unidirectional or bidirectional arrows between concepts, with connecting words or phrases that form a meaningful statement (Moon et al., 2011). Creating a concept map requires generating, organising and refining ideas and concepts to produce a comprehensible and meaningful representation of the subject matter.

In the present study, we embarked on a systematic journey to construct a concept map that would aid us in the curriculum development process. Therefore, the key concepts were first identified through a literature review and engaging in in-depth discussions with experts within the maritime education domain. This helped to determine areas of overlap, knowledge gaps, and potential areas for additional exploration. These concepts were then connected with lines and arrows to illustrate their relationships. A box represents each concept, and the links between the boxes indicate the nature of the concepts' relationship. In this case, the curricula concept map was created to identify the key concepts and ideas that can be considered for use in curriculum development. Furthermore, this concept map align with Biggs' pedagogical principle of constructive alignment, a framework that ensures teaching methods, activities, and assessments are in harmony with the intended learning outcomes (Biggs, 1996). Integrating concept mapping into our study aligns with established educational theories and provides a pedagogically robust method for curriculum development, fostering improved knowledge organization. This map can be used to ensure that the curriculum development is comprehensive, coherent and centred on the most essential concepts.

4. Results and Discussion

It is essential to have a well-structured and comprehensive curriculum that directs teaching and learning processes. Curriculum development should consider some essential distinctions, such as inside-outside, subject-object, nature-culture, human-non-human, theory-practice and changes in time (Edwards, 2011). In this study, the concept map was divided into two parts, which are represented by the background being two shades of grey in Fig. 1. The top half focuses on factors outside of a student's control (university- or education system-related), whilst the lower half emphasises factors within a student's control. Since this study focuses on student-centred learning, it is essential to note that the received curricula are displayed at the centre of the concept map. Student-centred learning is an instructional method that places the student at the centre of the learning process. As such, the teacher serves as a facilitator rather than a mere transmitter of knowledge.

Additionally, the concept boxes have a dotted background pattern to indicate the rate of their evolution over time. Fewer dotted boxes indicate more extended development periods, whilst more concentrated dotted boxes indicate more frequent or rapid changes over time. Additionally, the connecting arrows and lines are labelled to demonstrate the relationships between the concepts.
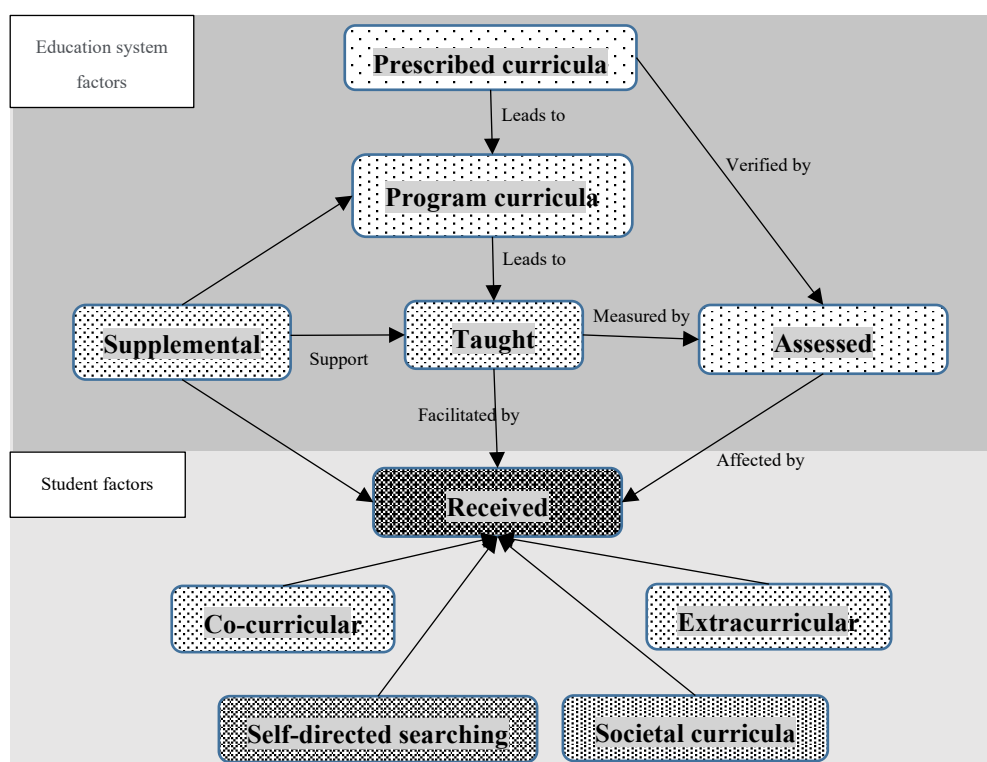

Fig. 1 Student-centred maritime simulator-based education curriculum concept map.

Prescribed curriculum refers to the subjects, knowledge and competencies mandated or suggested by regulatory bodies. The IMO is the regulatory body for MET since the STCW Convention specifies the minimum

criteria for seafarers' training, certification and watchkeeping. In addition, the STCW Code provides a complete framework for institutions and teachers to build lesson plans, design assessments and apply teaching practices. Furthermore, national regulatory authorities in both the maritime and education also have influence on the MET.

Programme curriculum refers to a programme that institutions design following the requirements and standards established by the IMO, the state's relevant authorities and the needs of the industry. It is a set of educational objectives, content and instructional resources formed and documented by educational institutions or authorities and mandated to direct classroom instruction. It typically includes study plans, materials and guides. Additionally, incorporating simulator-based training within the program curriculum is closely related to the institutional approaches. Key determinants include the which simulator types to use, the allocated hours in simulators, and the number of simulator instructors. Overall, a programme's curriculum offers a structure for the delivery of maritime education and guarantees that students obtain a thorough and consistent education that fulfils the criteria of the industry and its regulatory authorities. Therefore, it is essential to regularly examine the curriculum and identify parts that may no longer be relevant or need to be updated. The quality and effectiveness of maritime education programs depend on students receiving a well-rounded, practical, and industry-relevant learning experience.

Taught curriculum is delivered to students by the instructor in a classroom environment. It is strongly affected by the programme curriculum but may differ due to factors such as the teacher's interpretation and instruction (teaching style), students' needs, and available materials. These are interdependent and essential components for taught curricula. The process of translating the prescribed curriculum into the taught curriculum is crucial. Moreover, the reasons why there may be a difference between the prescribed and taught curricula should be well understood. To bridge the gap between the prescribed and taught curricula, teacher training, enhanced collaboration amongst educational stakeholders and the adoption of new learning techniques should be considered. Additionally, the focus of instruction should be shifted from the teacher to the student, with the teacher providing guidance and support to help students take responsibility for their own learning, set their own learning goals and actively participate in the learning process.

Supplemental curriculum is an additional set of educational materials or programmes and can include intangible concepts such as a learning environment's culture, values and norms. In this case, the maritime culture may not be expressly included but influences teaching. Likewise, the maritime culture and community influence students' attitudes, values and behaviours.

Received curriculum is closely related to the implementation of student-centred learning. Adopting student-centred learning in higher education will likely increase the alignment between the taught and received curricula, thereby resulting in a more effective learning environment for students. This strategy empowers students to take responsibility for their education and acquire the skills and self-assurance necessary to become lifelong learners in a complex, ever-changing world (O'Connor, 2022). In MET, received curriculum refers to the knowledge, skills and competencies that students actually learn and internalise through their own experiences, interactions and interpretations of classroom instruction, which may differ from the taught curriculum due to students' varied learning styles, prior knowledge, personal perspectives, motivations, engagements with classroom instruction, practical training, real-world situations and societal factors.

Several concepts that occur outside of the school environment but are within students' control are presented in the second part of the concept map.

Co-curricular refers to activities designed to supplement a school's programme curriculum. These activities are outside of the regular programme curriculum but remain an integral part of the educational experience. Co-curricular activities in maritime education aim to improve students' personal and social development and academic abilities. In addition, they provide practical experiences that enable students to apply what they have learned in the classroom.

Extracurricular refers to activities that are organised outside of the regular programme curriculum and aim to develop students' maritime skills and knowledge. These activities aim to enhance students' personal and social development, as well as their academic skills, by providing hands-on experiences that complement the programme curriculum. Examples of such activities include participating in a maritime club or joining a sailing or rowing team. Students can develop leadership, teamwork and personal growth skills whilst gaining practical maritime knowledge through these activities.

Self-directed learning entails the learner assuming responsibility for their own learning process. This emphasises the role of the learner in establishing their own learning objectives, selecting appropriate learning

activities and evaluating their own progress. However, biases can arise when students encounter information that is misleading, outdated or influenced by personal beliefs. To avoid this, students should consider the accuracy and reliability of the information they meet with scepticism. This may involve examining multiple sources, consulting with professionals and utilising credible training programmes and resources.

Societal curricula shape students' attitudes, values and beliefs, which can significantly impact their academic and personal development. This type of learning occurs due to students' interactions with their environment and people, both within and outside of the university environment. Societal curricula are frequently unconscious or implicit and may be influenced by university culture, social norms, educators and other adults' personal beliefs and biases. In this case, interactions involve maritime industry workers, regulators, maritime forums, shipping companies and even students from other maritime institutions.

Simulator education is foundational to MET institutions achieving many of the goals set out within the STCW Code, with multiple concepts within the map containing simulator usage. Since the IMO prescribes the use of simulators, METs design simulator use into their curricula and actively teach with them. Furthermore, simulators are used for assessments and supplementary material delivery. From the student perspective, simulators provide an engaging student experience and enable co-curricular activities.

The concept map illustrated in Fig. 1 is a valuable tool that can be used to enhance maritime simulator-based education. It can help educators organise and structure their knowledge, identify gaps in their understanding and establish connections between different concepts. By using the concept map as a reference, MET institutions can ensure that their curricula are comprehensive, coherent and aligned with the requirements of the STCW Code and the maritime industry. Utilising the concept map can also facilitate collaboration among the stakeholders involved in curriculum development, such as faculty members, industry experts and regulatory bodies. By sharing a collective understanding of the key concepts and objectives, these parties can work together to develop curricula that meet the needs of all stakeholders.

In conclusion, the concept map illustrated in Fig. 1 is a useful tool for enhancing maritime simulator-based education. Thus, it would be worthwhile to continue developing this concept map as a guide and educational development resource. The Centre of Excellence in Maritime Simulator Training and Assessment (COAST) consortium aims to develop a guidance document on curriculum synergies, which can later be disseminated at the international level to other professions using simulator training. It is planned to use the concept map as a tool to identify commonalities and differences in maritime institutions in Norway and develop strategies to address any gaps and best practices in the curriculum. It can facilitate collaboration among stakeholders and help identify areas where simulation-based training can be particularly effective.

5. Conclusion

To prepare students for the challenges of the 21st century, educators must accept the need for flexibility and adaptability in educational systems. This requires changes to curriculum and traditional pedagogical approaches with an emphasis on success in today's rapidly changing world. It is critical to define factors, stakeholders and objectives in detail when making decisions about curriculum development.

This study proposed a curricula concept map to identify the key concepts and provide valuable insights and recommendations that can be used to enhance the quality of not only to MET simulation education but also as a model that can be compared and used by other industries.

Future studies should aim to evaluate the effectiveness of the curricula concept map in guiding the development of maritime simulator-based education curricula. Exploring the impacts of curricula developed through the use of this concept map can provide valuable insights into the effectiveness of this approach. Furthermore, by continuing to build upon this study's findings, educators can better guide curriculum development to ensure comprehensive, coherent and effective learning experiences for students. This can ensure that students acquire the knowledge, skills and competence necessary to succeed in their careers.

Acknowledgements

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