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Education as a Maritime Safety Improvement Factor

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ABSTRACT

The prevention of incidents and accidents at sea requires adequate education and technical training that gives professionals suitable competences and skills. Because sea is a hostile environment to humans, specific skills are needed for working and living on-board. Accelerated technical and societal developments create increased uncertainty regarding the skills needed by tomorrow's professionals. The present study aims to contribute to the discussion around the reformulation of teaching of management, logistics and engineering within the maritime industry at higher education level, to meet the referred needs of professionals and authorities in this sector. Education and training must contribute to the development of the needed competences and skills, through adequate syllabuses and using adequate teaching methodologies and techniques, complemented by suitable technologies.

Keywords: Teaching methodologies, Logistics, Maritime education and training (MET), Maritime security, Seafarers' competences

INTRODUCTION

Fires, floods, collisions or groundings affecting ships and other maritime infrastructures are examples of **maritime accidents**, causing human casualties, facilities damage, or environmental and social harm. Considering the scope of this paper, a maritime accident relates to any maritime casualty or incident, as per the IMO definitions (IMO, 2008). Generally, accidents are a result of human error, material failure or natural causes. According to different academic studies and technical reports, human error is the main cause of maritime accidents (e.g., EMSA (2021) or Sánchez-Beaskoetxea et al. (2021)).

The speed of technological and societal evolution is increasing, pressing professionals to continuously update themselves in terms of technical knowledge and skills to address new problems. Education should prepare professionals to address current problems and technologies, but also foresee potential solutions for problems and technologies that do not yet exist. Naturally a question emerges: Given the uncertainty of the future, which sort of contents and competences should education provide? It is commonly agreed that education and training contribute to adequate professional performance and to accident prevention, by improving technical and soft skills which help

to deal with unplanned situations involving the human factor (Bielić et al., 2017; Yildiz et al., 2021; Ahn et al., 2021).

A significant number of educational institutions aim to provide high quality education to their students. Considering quality as fitness for purpose, it will be necessary to know the needs of the target industry in order to select the most suitable syllabuses and methodologies to transfer the knowledge.

During the last decades, teaching relied heavily on the expository method for this transfer of knowledge and on repetition to assess students learning. However, nowadays is recognized that this is not the method that provides better learning outcomes (Dale, 1946). As identified by Kolb (1976), the model of experimental learning, together with observation and experimentation, generates a process of reflection that allows knowledge abstraction and generalization, resulting in better knowledge creation and new skills development. In approaching disruptive dynamic processes, observing and testing the surrounding environment is not enough to create knowledge for tomorrow; critical thinking must be used to anticipate problems and new situations. By applying a double learning cycle to the organizational environment, Argyris (1977) draw attention for the need to update the basic mental models according to the information collected from the real world.

One effect of globalization is that no entity or organization survives in isolation. Therefore, knowledge emerges from an active interaction of academia, practitioners and authorities. The *Lisbon Strategy for 2000-2010*, adopted by the European Council, advised for the need of universities, as educational entities with a strong character of innovation and research, to participate actively in the economic development alongside with environmental and social protection (Rodriguez et al., 2010). Considering the speed of evolution in most industries and society in general, the process of knowledge creation and dissemination must continuously adapt to the needs envisaged for tomorrow's society, rather than focusing just on today's problems (McGee, 2012). Therefore, a question arises for educators who prepare contents in their daily lives: what to teach young people today so that they are prepared for tomorrow? Although the future is unknown, some clues exist.

The present paper aims to contribute to the discussion around the reformulation of higher education teaching of management, logistics and engineering in the maritime industry, in order to meet the future needs of its professionals.

COMPETENCES FOR THE FUTURE

The educational system must be able to adapt and respond to the challenges of tomorrow. The identification of the necessary competences and skills to be taught has been sustained and led by academia. A few examples can be referred: (1) Dunne, Bennett and Carré (1997), who studied the acquisition and development of key competences in higher education to meet the needs of the "knowledge society"; (2) Reinstein and Bayou (1997), who dealt with the teaching of accounting, highlighting the relevance of critical thinking; (3) Elmore (2000), criticized the inability of the American educational system and its leaders to respond to new demands; (4) Bordage, Foley and Goldyn (2000), identified the desirable competences

and skills for future health care directors; (5) Urciuoli (2016) established an implementation roadmap for port security education and training, defining three levels of requirements: strategic, operational and legal. Drawing a parallel with the creation of a graduate program based on the "Knowledge Triangle", it can be said that: the accumulated knowledge within academia defines the strategic requirements and; the experience and needs felt by the industry would define the operational requirements; the inclusion of legal requirements will be ensured by the industry related authorities; (6) OECD (2019), in its conceptual framework for learning, named as *Learning Compass 2030*, draws attention to the importance of human skills in addition to technical skills, both based on social values and respect for the environment.

The emphasis on social values and environmental preservation is essential for the quality of education, as stated in the *Sustainable Development Goals* (SDGs) of the *United Nations 2030 Agenda* (UN, 2015). Education should ensure equal opportunities for all human beings and promote sustainability, through the teaching of social values such as lifestyle, human rights, gender equality, culture of peace and non-government violence, global citizenship, enhancement of cultural diversity and environmental preservation. Rather than merely acquiring knowledge and skills, the learning process involves the use of knowledge, competences, skills, attitudes and values to meet complex requirements within a variety of specific contexts (OECD, 2019). The acquisition of knowledge covers theoretical concepts and ideas, as well as practical understanding based on the experience acquired during the execution of tasks. To use knowledge in a responsible way and achieve the intended goals, students must have the cognitive, social and practical skills that give them the ability to perform tasks. They must also develop a set of attitudes and values that enable them to assess risks and rewards and, take socially responsible decisions, contributing to the building of a more inclusive future, fair and sustainable economies and societies. Students should be given the opportunity to implement transformative skills to contribute to the development of a better future. On the students' side, they must engage in an iterative learning process, a cycle of anticipation-action-reflection, where they continuously improve their thinking and act in an intentional and responsible way. Educational institutions and educators should thus promote the sustainable behavior of future professionals, transferring knowledge and implementing specific and environmentally friendly standards across their educational activities (Čulin et al., 2019).

To make the learning process effective while meeting the needs of the real world, collaboration between stakeholders and, the blend of contents and methodologies integrating the development of technical and human skills is essential (Rao, 2014). Different methodologies, techniques and tools to support education are available, and the adequacy of each one being assessed according to the intended goals. Each technique or method should be used according to the objectives, contents and characteristics of the players. The teaching known as "traditional", based on the exposition of accumulated knowledge, should not be considered incorrect or discarded. However, it can

be complemented by different methodologies and techniques, thus enhancing the process of acquiring knowledge by students.

EDUCATION IN THE MARITIME INDUSTRY

In addition to the homogeneity created by globalization and international norms, the specificities of particular industries, such as the maritime industry, should be taken into account. This industry is characterized by its complexity, multidisciplinary nature and teamwork under adverse conditions. Maritime Education and Training (MET) must consider its specific characteristics (Praetorius & Kataria, 2016). In the past, the MET was based on knowledge gained from experience and on-the-job training. With the increasing complexity of tasks and social valorization of education, higher education gained gradual relevance in this industry (Čampara et al., 2017). Currently, it is discussed what will be the ideal balance between academic education and vocational training for the maritime industry and what competences and skills the professionals of the XXI century must have. At first sight the importance of social skills in parallel with technical competences seem to dictate the future (Manuel, 2017).

Technological development across the fields of simulation, virtual reality or distance learning can make the learning process more efficient. Authors Sellberg and Viktorelius (2020) analyzed and compared theories and methods for studying cognition and learning by using maritime training simulators. Mallam et al. (2019) analyzed the importance of simulation using emerging technologies, such as virtual, augmented and mixed reality, for the development of maritime related skills. Correia et al (2020) describes the design and creation of an interactive environment for the training of maritime rescue teams, using virtual reality. Chiotoroiu et al. (2005), studied the implementation of distance learning technologies, and concluded that, at certain stages and in combination with other formats of education, distance learning is suitable for maritime education, making it possible to return education and training to the on-board format.

Addressing this issue, the European Union MarLEM project, identified the main skills that maritime professionals should have in the future, concerning the areas of management, logistics and engineering, by listening to industry professionals, authorities and academia. Different requirements have been found relevant, such as: (1) The existence of a comprehensive but at the same time specialized technical expertise, to enable the operation and maintenance of existing equipment or equipment still to be created; (2) A deep knowledge of information and communications technologies (ICT) as a way for addressing the industry's rapid technological change and digitization; (3) The development of social and human skills that allow flexibility to work as a team and address new challenges; (4) The development of critical thinking and decision making abilities in order to address unknown situations. Based on the identified requirements, a master program in Maritime Management and Logistics (MML) was developed. The program is intended for current or future professionals with functions and responsibilities in the fields of

management, logistics and engineering, across several activities related to the sea (MarLEM, 2019; Água et al., 2020).

TEACHING METHODS AND TECHNIQUES

To achieve the desired competences within the context of the MML program, in addition to the syllabus previously identified by the authors in (Água et al., 2020), the use of different teaching methods and techniques will be relevant. By teaching methods, one shall consider a coherent set of actions organized by teachers, aimed at facilitating the learning by students. Teaching techniques are the tools, strategies or procedures that make it possible to operationalize, or put into practice, the teaching methods.

Different methods exist, from teacher-based ones such as exposure or demonstration to students-based, such as interrogative or active/generative approaches. Different techniques and different levels of technology may be used for each method. The selection of a specific method, technique or technology to be implemented is dependent on the involved stakeholders, context and selected objectives (Ganyaupfu, 2013). Some student-based teaching techniques, with the potential to be applied to higher education in the maritime sector, are the following:

(1) Case study method - Application of the Socratic method to the analysis of specific cases linked to the subject of the course, giving students skills related to critical thinking or adaptation to new situations.

(2) Role-play - Transports students for a theatrical setting where a situation close to reality is simulated, and where each participant has a role to act. This method promotes the development of decision making, teamwork or adaptability to new situations.

(3) Simulation - Scenarios are created where students are invited to enter and develop a set of activities. The use of technologies such as virtual reality or augmented reality make it possible to create a more realistic and interactive environment. One of the great advantages of simulation is to allow error in the operation of equipment, without negative consequences. Promotes autonomy and decision-making competences, together with leadership skills.

(4) Gamification - Games that allow the interaction between students in simulated situations. The use of technology can bring an added motivational factor to students, making games more appealing and realistic. It fosters analytical capacity, autonomy or decision making. Gaming may also increase students' engagement, by appealing to competitive personalities.

(5) Practical group or individual work - Has the advantage of the possibility to be carried out asynchronously outside the classroom. When carried out individually, it fosters research capacity, data analysis, critical thinking or autonomy; when performed in a group, it also enables the development of leadership and teamwork capabilities.

In addition to the skills these techniques are able to develop, the possibility of being developed in an asynchronous way or at distance, may be an added value for trainee students within the context of work or students working across the maritime industry.

DISCUSSION AND CONCLUSION

Education, both in terms of syllabuses and methodologies, must follow technological and social developments. Only this way, will it be possible to assign to today's students - tomorrow's professionals - the competences that will allow them to respond to the future challenges of each industry.

The education of professionals in the maritime sector, whether intended for working on land or at sea, due to the peculiarities of their functions and the environment in which they are carried out, should consider their specificities. In addition to academic contents, the choice of the most suitable teaching methodologies is an important factor in the creation of human and social competences.

In addition to the singularities associated with each sector of activity and its technical requirements, there are competences that are transversal to the whole society and that education should promote, such as: critical thinking, acting in respect of social values and environmental preservation, the ability to take decisions, an integrated systems view of processes or the ability to lead and work as a team.

The technological evolution when applied to teaching has opened new opportunities, leveraging the application of different methodologies and techniques. Virtual reality, augmented reality or other forms of simulation with heavy use of technology, promote a higher level of student motivation and greater flexibility in the teaching formats and delivery, contributing to a better prepared workforce and less human factors' problems.

Only with high quality education and training, which meets the needs of professionals and authorities in the industries for which they are intended, enable students to develop the competences and skills required by tomorrow's real world. This will have a positive impact on tomorrow's professionals, improving their technical performance and their social skills as citizens. Within the maritime sector, one of the possible consequences will be the existence of a more technically better prepared and efficient maritime industry as well as socially competent, thus better prepared to prevent and face accidents.

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