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Future of maritime education and training: blending hard and soft skills

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ABSTRACT

The 21st century endeavour bring new challenges for the maritime industry. The challenges facing the professionals within the industry are multifaceted and complex due to globalization, cross-cultural interrelationships, and technological change that are permeating the maritime industry. The aim of this article is to contribute to better understanding the problem of developing the future maritime industry professional, filling the existing gap between education and training programmes, while integrating the 21st century professional skills. The contents of a comprehensive education and training programme shall be proposed within a knowledge triangle encompassing academia, the industry and relevant authority or regulatory institutions, so all interested parties' "voices" will be considered. Besides raising awareness for the educational and training challenges ahead, more effective teaching methods are suggested in order to meet the needs, particularly supporting double loop learning, together with a pragmatic proposal for a realistic programme at master's level. The proposed programme is based on the EU MarLEM project, which aims towards the development of the 21st century maritime industry professional, focusing on logistics, engineering and management contents.

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1 Introduction

Globalization has been the main driver in the world system since the end of the twentieth century, and the maritime industry has been playing a significant role in it for centuries.

The first wave of globalization was done by the Portuguese, *the world's first naval superpower* [1]. This was the result of Prince Henry's decision to build up Portugal´s expertise in navigation and shipbuilding, with a focus on establishing the country as a sea-based trading nation. Even if it was a great achievement for the technology and resources of the fifteen century, it is not fully comparable with the current second wave of globalization, which truly reaches all corners of the world. Globalization is about interconnecting people; hence the core subject is communication, whatever form it takes, remote or face-to-face, using ICT or physical transportation.

This means a considerable amount of intercultural relationships are at play which raises cultural gaps responsible for attrition and conflicts, besides the specific technicalities involved. This demands the harness of a considerable amount of soft, or core, skills, beyond the traditional maritime and shipping technology. It is fair to mention that seamen always were relatively ahead of other professionals when it comes to intercultural communication and people leadership, because the international communication they were forced at by means of related professions, together with the sea harsh environment, where cooperation and team cohesion put challenges typically more demanding than the ones most "land" professions would demand.

Managers and leaders are recognized, not because of the amount of knowledge they have gained in the school, but because of their ability to learn and present solutions to the problems they face. Education has changed little in the last two centuries; it continues to be mainly based on

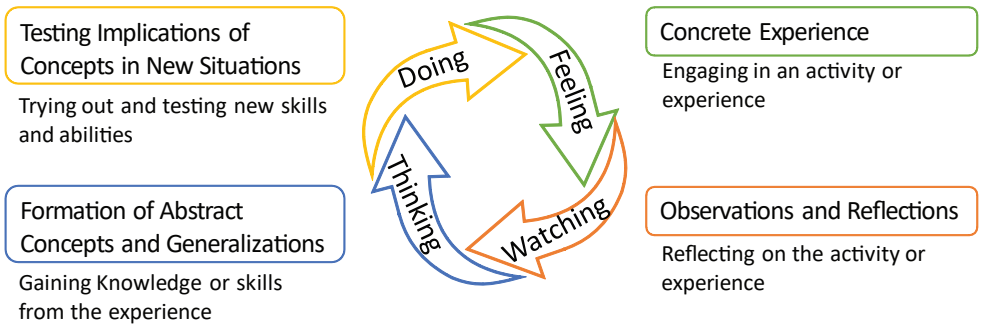


Figure 1 Kolb's Experiential Learning Model

Source: Adapted from Kolb [14]

the transfer of technical knowledge through expository techniques. Students continue to be evaluated in terms of their ability to repeat the teachings transmitted rather than providing them with the tools to prepare them for the uncertainty of their future professional life, and the decisions they have to make under a VUCA context, characterized by being Volatile, Uncertain, Chaotic, and with Ambiguity.

In face of a fast pace changing world, by providing education based solely on technical knowledge, we risk that most of this knowledge will be already obsolete when it has to be put into practice. To train the maritime industry professionals of tomorrow, it will be necessary to complement the basic technical knowledge with people skills, in order to enable them to develop a critical reasoning capability, of constant adaptation and improvement, select the relevant information from the endless sources of available data and have the ability to lifelong learn as part of society.

This paper is composed of four sections. Besides this introduction where the context is laid out, some relevant background information is presented in section two on the subject of learning and maritime education. Section two also brings the concepts of single loop and double loop learning, and discusses types of more effective learning methodologies. Section three introduces the MarLEM case, an EU funded project aimed at building a new education programme for the maritime industry professional of the 21st century, which is related to logistics, engineering and management. The fostering of this programme argues on the need for an adequate level of integration of the relevant education matters, as opposed to just a set of unrelated, however relevant, courses. It suggests a modern curriculum for a master level degree with a focus on Maritime Logistics, Engineering and Management. Finally, in section four some conclusions are summarized.

2 Background

2.1 The learning process

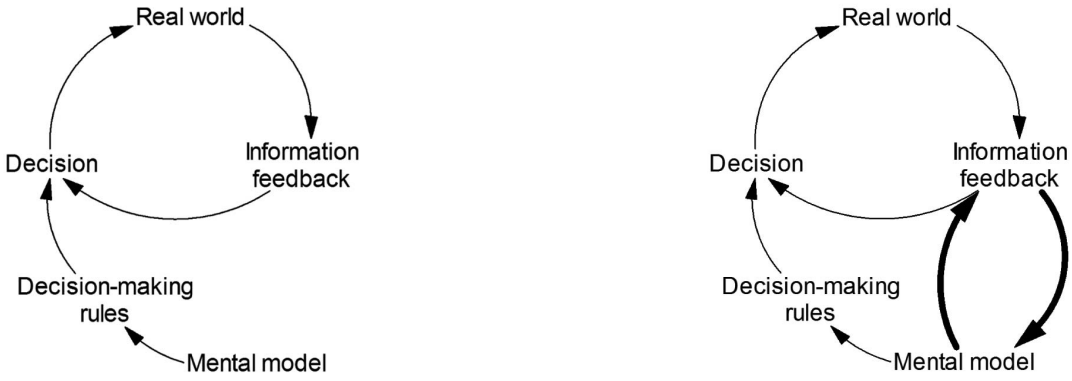
A process is a set of activities that develops in several sequential and cyclical steps which contribute, as a whole, to a common result. Learning does not have a single definition that applies to all domains of knowledge. Generically speaking, it can be said that it refers to the evolution of a knowledge system by the integration of new knowledge and information, generating change in its behaviour or properties [3]. Regarding the learning cycle, it has its origins in the 1950s and consists of three stages: Exploration, Concept Development and Expansion [18; 19].

To be effective, the learning process, although specific to each individual, shall follow a set of basic stages. David Kolb [14] Experiential Learning Model, composed of four stages, suggests the experiences are translated into concepts through a reflection process (Figure 1). In turn, these concepts are tested and integrate knowledge and the possibility of new experiences, restarting the cycle all over. The implementation of this model based on experimentalism assumes the need to consider the specificities of each individual or organization, while considering the existence of different perspectives.

Double loop learning

In addition to teaching problem solving, the learning process, must also foster critical thinking. The maritime professionals of tomorrow shall have a critical thinking attitude, acquired through learning from mistakes, where they are able to question the established procedures, in order to foster innovation and process optimization. Reformulating the thought process, Chris Argyris [2] proposes the double Learning loop, which adds a cycle related with the development of critical thinking in face of the instituted procedures.

The Figure 2a illustrates the single loop learning process, where one's mental model defines some decision rules, that triggers actions into the real world, which followed by feedback will provide an indication about the 'quality' of our decisions and further action whether adjusting such decisions. Conversely, if feedback is used to change one´s mental model, by changing beliefs, one will consequently be changing the decision-making rules, which originates a different set of decisions when facing problems or issues that need addressing (Figure 2b).



(a) Single loop (b) Double loop

Figure 2 Learning loop

Source: Authors

Considering the important role socializing plays in organizational knowledge creation socializing, it is beneficial to integrate these knowledge development processes as part of the teaching methodology [13]. In order for the higher education learning processes to be adjusted to the real needs of society, it needs for the academic knowledge to be complemented by the experience of skilled professionals and best practices of authorities, a cooperation that gives rise to a *Knowledge Triangle*.

In Europe, the implementation of the Knowledge Triangle is already underway. The *Lisbon Strategy* 2000-2010, adopted by the European Council in 2000, aims at the stimulation of economic growth, employment and social cohesion across Europe, through modernisation and greater intervention by universities, reinforcing the three vertices of the knowledge triangle: Education, Research and Innovation. Despite some critics, which suggest some failure in implement this strategy, it had the merit of highlighting the importance of education, innovation and research as a means of fostering social cohesion and economic growth.

At times when human civilization is challenged across several domains, the task of implementing the knowledge triangle and fostering innovation, cannot be the task of a sole entity. In order to be able to develop the vertices of the knowledge triangle it is necessary to involve various entities from society in a collaborative way, comprising the state, universities and the industry at large [4]. Therefore, in order to achieve this modernisation goals, it will be necessary for the society at large, and for each industry in particular, to be able to define what knowledge and expertise tomorrow's professionals must develop in order to fulfil their goals.

2.2 21st century skills

Society evolves at a speed never seen before, so the education system must be able to adapt and respond to what will be the future challenges of current students. The academy and other relevant institutions have not remained crystallized. For instance, Bordage, Foley and Goldyn [6], identified desirable skills and attributes for future educational programmes of health care Directors; Reinstein and Bayou [29] argue that the teaching of accounting must adapt to the new reality, giving their students requirements to think critically. Elmore [11] criticises the inability of the American education system and its leaders to respond to new requirements. Dunne, Bennett and Carré [10] study Acquisition and Development of core Skills in Higher Education and Employment address the needs of the knowledge society; or OECD [24] understanding of the importance of social-capital, future needs and identifying the future path for 21st century education.

In order to standardize concepts, it is important to differentiate between competence, knowledge and skills. According to ISO 21001:2018 [12] standard, knowledge refers to "facts, information, principles or understanding acquired through experience, research or education"; for its part, Skills are understood as a "set of know-how that allows a person to master an activity and succeed in accomplishing a task" and; competence the "ability to apply knowledge and skills to achieve intended results". In general terms, knowledge is associate with possession of theoretical content, skills with acquirements of related practical activities and competence with the faculty to apply the two previous concepts.

A future conceptual learning framework, according to *OECD Learning Compass 2030* [24], must be sustained in core foundations and give the opportunity for students to implement transformative competencies in order to contribute to shape a better future. To influence their own lives and the world around them, students should be able to grow and exercise their agency and co-agency in a social context. Students' knowledge acquisition embraces theoretical concepts and ideas in addition to practical understanding grounded on the experience of having done

certain tasks. To use the knowledge in a responsible way and achieve the intended goals, students must have the cognitive, social and practical skills that give them the capability to carry out processes. To implement the knowledge and skills in the *right way*, the individuals must have a set of attitudes and values that allow them to evaluate risks and rewards and take socially responsible decisions, which contribute to build more inclusive, fair and sustainable economies and societies. To complete the OECD learning framework, students must enter an anticipation-action-reflection cycle; an iterative learning process where they continuously improve their thinking and act intentionally and responsibly. The learning process implies more than just gaining knowledge and skills, it involves the use of knowledge, skills, attitudes and values in a range of specific contexts to meet complex requirements. This article highlights the importance of social Skills, seen as a set of values for building a sustainable and ethical society, in conjunction with technical Skills.

2.3 Higher education challenges

A broad taking of university education is traditionally based on critical readings and discussions, fostering critical thinking and analytical capacity, leaving to vocational training the more task-oriented cognitive skills and solving of specific problems. Throughout the University long history, periods of stability have been the guarantors of knowledge, while times of change have been triggering the engine of innovation, which helps rethinking of society and identification of future paths [25].

The implementation of the knowledge triangle will imply the change of teaching contents and methods, as well as the rethinking of the university governance system as a whole. The assessment of the reforms will be made not only in terms of how the new system will be implemented, but also in terms of its contribution to society and the training of tomorrow's professionals [15]. In this change process, teachers are a key element and face important challenges, due to the constant need to update knowledge, to implement different methodologies in teaching or to respond to a higher level of demand and scrutiny over their activity.

The university must take the lead in this process, becoming an organization that is able not only to solve the immediate problems, but mainly implementing an internal critical process of rethinking its structure, teaching contents and used methodologies, that is, managing to implement a double loop Learning. In order for this process to be effective, it must listen to the surroundings interested parties, specifically professionals and authorities, creating a collaborative network which will allow the adaptation of the teaching to the real-world needs of the current and future society (Figure 3).

To make learning effective and applicable to the real world, collaboration between interested parties within the knowledge triangle and the combination of content and methodologies that integrate the development of hard and soft skills is essential [28]. Education institutions and educators should promote future professionals' sustainability behaviour, by transferring knowledge and implementing concrete environmentally friendly standards in their educational activity [9].

Urciuoli [33] establishes a roadmap for implementing the harmonisation of education and training related to security in ports, defining three levels of requirements: strategic, operational and legal. Drawing a parallel with the foundation of a post-graduate program based on the Knowledge Triangle, it can be said that the knowledge accumulated within the academia defines the strategic requirements of a course and the knowledge and needs felt by the industry, together with the operational requirements. Moreover, the need to include the legal requirements will be ensured by the interaction with the adequate authorities.

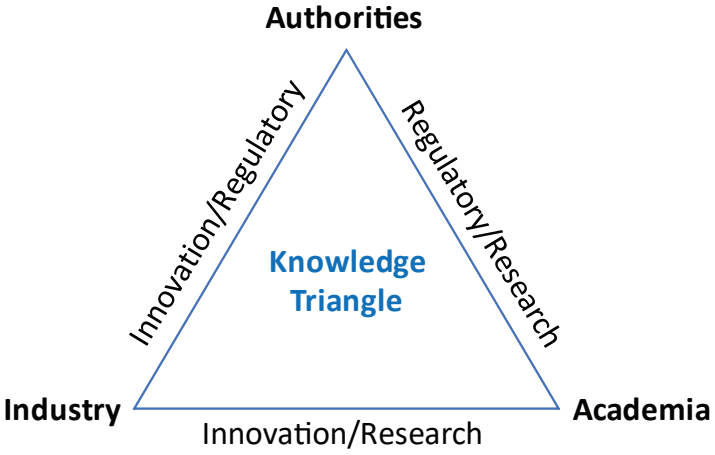


Figure 3 Knowledge Triangle implementation

Source: Adapted from MarLEM [20]

In addition to the needs of industry and authorities, teaching must meet the students' motivations and expectations. According to Pallis and Ng [26], the main reasons why students enrol in maritime higher education courses are because they are practice-oriented and have an above-average employment perspective. In choosing a programme, the decisive factor is its reputation, being such understood in terms of the skills is provides, the timeliness of the information provided and the qualification its faculty. The use of different teaching methods, which contribute to the transmission of Skills related to the professional activity, are associated with the perception of the faculty qualifications.

2.4 Strengthening the learning experience

The literature points towards the abandoning of a teaching approach that boils down to the transmission of concepts based solely on theoretical knowledge. 21st century education is intended to educate men and women who, in addition to theoretical concepts, have a solid moral and ethical background in relation to living in society and preserving the environment, which integrate theoretical knowledge with practical knowledge and that can, in an autonomous and innovative way, develop a logical reasoning capable of identifying new solutions to past and future problems. Instead of automated repeaters of concepts, society needs human beings capable of questioning the world that surrounds them and, based on moral and social values, being able to identify different ways to solve the questions that arise [23].

The traditional expository methods, however widespread, may not be that effective, especially for experienced students and once people achieve an adequate level of reasoning ability; features that are desirable for the 21st century maritime leaders and professionals. This section suggests two teaching and learning methods that may be more effective in the education of mature students and experienced professionals – the case method, long tested within some specific circles and, the use of simulators. Moreover, these methods may foster the change of beliefs, and as such promote desirable paradigm shifts.

2.4.1 The case method as an example of a more effective learning method

With its origin at Harvard Business School, in early twentieth century, the case method as a teaching method for general management is based on the Socratic approach to learning, where directed questioning and reflection, as opposed to expository methods, are the main learning mechanism. It started together with the teaching of general management, which later became known as Business Policy, where the situations were complex and holistic enough to demands other approaches beyond expository teaching methods [5]. The Socratic method allows for deeper reflection alongside more vivid sessions which strengthens knowledge retain, critical thinking skills development and improved problem solving together with decision-making capabilities.

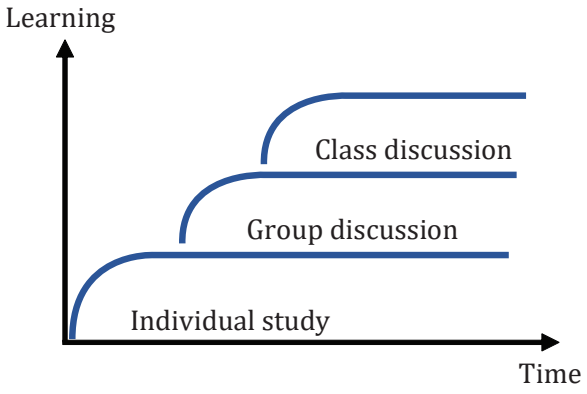


Figure 4 Every stage in the Case Method increments learning

Source: Mauffette-Leenders, Erskine & Leenders [21]

Learning with cases has traditionally three stages: the individual study; the small group discussion; and the class discussion (Figure 4). Every stage increments knowledge during the learning experience. By allowing for decision making in a safe, controlled environment, the case method allows for the double loop learning to be at play, hence strengthening effective learning.

As compared to expository methods, the case method allows for a more effective critical thinking skills development. In fact, it is a sort of management 'simulation' under safe conditions, while benefiting from diverse knowledge backgrounds and analysis.

2.4.2 Use of "management flight simulators" to harness complex problems

> *"The capacity of the human mind for formulating and solving complex problems is very small compared with the size of the problem whose solution is required for objectively rational behaviour in the real world or even for a reasonable approximation to such objective rationality."*
>
> In Simon [32, p.198]

According to Senge [31], Systems Thinking is the ultimate subject to master if one wants to develop a truly holistic view of the world, and the due management of any dynamics system, where complexity is the norm. In his famous book, *The Fifth Discipline*, he argues that for the effective learning organization to accomplish its *raison d'être*, people shall master several disciplines.

Mastering systems thinking techniques, however, is a necessary condition but not sufficient *per si*. To master the complexity that arise within dynamics complex systems as the ones found within the maritime and logistics industry, one needs to develop the ability to translate causal

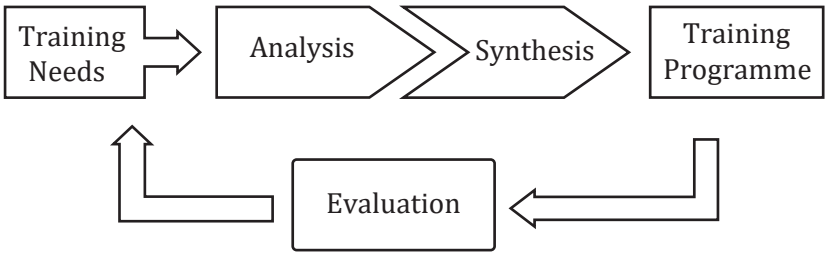


Figure 5 A robust programme design

Source: Authors

diagrams into systems simulators, where problems are mathematically modelled, in order to learn by testing and observing the feedback of such testing. There are problems which cannot be solved by analytical solutions, hence a way of dealing with these problem typologies, usually under the category of complex problems, is by modelling and simulation.

To learn and understand complex systems it is fundamental for cause and effect to be close in space and time, otherwise learning will be difficult at least. In order to perform simulation using mathematical models, the calculations of the model's equations are performed repeatedly in order to imitate the passage of time. If such calculations were carried out manually, these simulations would have an enormous cost. In the sixteen century, years were spent running numerical simulations for the creation of Nautical Tables, but the great importance of navigation for commerce and naval power showed that it was a well-spent effort. Fortunately, in the last sixty years computer simulation has replaced traditional simulation with hand calculations.

Simulators have long been used for training, ranging from navigation simulators, flight simulators, to all kind of operations management simulators, across a great variety of industries and subjects. Simulation allows students to harness the complexity behind complex problems, as would be the case of managing maritime supply chains, as they allow for the participants to immediately watch the results of their experiments, by changing input variables into the simulator modelling the problem of interest.

The process of feedback obtained when faced with simulations allow students to change their mental models accordingly and developing the sort of critical thinking that minimize unintended consequences improving their decision-making and due actions once in the field. Hence the use of simulation-based training constitutes one kind of double loop learning.

2.5 An integrated view

Designing a world-class curriculum for any education programme for the 21st century maritime leader and professional, demands at least two broad stages. A first stage where analysis is done, followed by a second stage where synthesis is accomplished, desirably with an adequate level of integration and harmony. A robust programme design comprises two stages, analysis and synthesis, as shown in Figure 5.

In doing the analysis stage one has to be conscious that, perhaps more important than bringing in subjects about well-known techniques, is to bring new ways of thinking that will better prepare students to face the problems that are not common yet. This demands a solid technical body of knowledge related to the substantive domain, together with a diversified set of soft skills, that will allow future graduates to be better prepared in facing new situations and complex problems.

Such body of knowledge and the desirable critical thinking will hardly be developed if only traditional expository teaching methods are used. Hence, more effective methods aimed at developing such skills, such as the two mentioned above, shall be part of the learning experience. For maximum effect, several other methods exist that may also be considered, as for instance, gamification methods, role play and field work.

2.6 The specificity of maritime education and training

Due to the specificities of the maritime industry, namely its complexity and multidisciplinary profile, professional training and preparation to perform in such endeavour requires special attention [27]. In the past, Maritime Education and Training (MET) relied on the knowledge acquired through experience and on-the-job training. Following the societal trend in general and considering professions characterized by a strong technical complexity, university level of education has gradually established its importance, especially regarding coordination and leadership [7]. Currently, it is discussed what would be the optimal level of blend between university education and vocational training for the maritime industry and which skills professionals should own to perform in the 21st century. The importance of social skills in parallel with techniques seem to dictate the future path of the MET, however it will be dependent on what will be the direction of societal trends and the evolution of relevant technologies [17].

The MET can be seen as a system that includes: (1) organizational aspects, related to its structuring and organization, such as the implementation of a quality system, the number of students per teacher, faculty qualifications or technologies used; (2) operational features relating to teaching methodologies (what to teach and how to teach).

With regard to content, in the context of teaching, these should include a mix of basic knowledge (e.g. languages, mathematics, physics or informatics), human attitudes and relationships (e.g. logics, ethics and leadership) together with technical and vocational (e.g. port authority, personnel; port economy and management; port technology and Logistics support) [22]. To teach the contents, the classroom expository method should be complemented by other methods that foster students' reasoning and active participation, taking advantage of the available technologies.

In order to cope with the constant evolution of business requests, including the maritime ones, education cannot be closed within itself. The integration of maritime transports into complex supply chains and technological developments require personnel with more than professional experience or technical knowledge. Therefore, management skills, as interpersonal relationship skills, leadership, organizational organisational behaviour and decision-making skills have become key competences [26].

The volume of published articles suggests that there is a growing interest of the academy in studying the subject, analysing different methods of training and teaching. Sellberg and Viktorelius [30] are examples of authors who review and compare theories and methods for studying cognition and learning in simulator-based maritime training. Another example could be Mallam, Nazir and Renganayagalu [16] who analyse the importance of simulation, using emerging Immersive Technologies, such as virtual reality, augmented reality and mixed reality, for the for development of seaman competencies. Chiotoroiu and Dinu [8], studying the implementation of distance simulation learning technology, conclude that, in certain stages and combine with other educations forms, distance learning is appropriate for maritime education, putting back education on board.

3 Methods and the MarLEM Case

The EU project MarLEM's objectives are to create a permanent platform of collaboration between industry, university and interface entities, within a multinational cooperation endeavour involving countries from Atlantic side, to Mediterranean up to the British islands, to develop a Knowledge Triangle Network and to design, structure and develop a Master degree programme in the field of logistics engineering and management, applied to the maritime and port industry and related activities. To achieve this goal, a skills match shall be conducted between the real needs of professionals (requirements) and the OECD 21st Century Skills, as well as the identification of innovative teaching methodologies that fosters the learning process improvement [20].

3.1 A suggested maritime logistics programme

Having done an extensive and pragmatic research, several subjects came as key when designing such a program aimed at simultaneously developing logistics, engineering and management competences for the 21st century maritime leaders and professionals. A possible taxonomy could group such subjects in three main categories: management and logistics skills, regulatory and compliance skills, and people skills.

3.1.1 Management and maritime logistics skills

Operations management. It is necessary to provide a broad view of the main areas of operations management, including operations design, project management, decision making tools and sustainability.

Integrated logistics support. This knowledge field, closer to systems engineering, provides for an overall understanding of the maritime systems logistics, focused on ships, their lifecycle, activities and supporting needs.

Maritime business analysis. This subject introduces the fundamentals of the diverse business models that are common across the maritime logistics supply chain and the tools for financial analysis and evaluation.

Port operation. It is important for the maritime industry professional to understand the role of ports as logistical centres, identifying the different elements of the shipping industry and characterization of the main types of port terminals and conditions.

Technology and engineering. In the 21st century it is critical for the maritime industry professionals to master the application of the fundamental concepts about information and communication technologies. Extensive use of relevant examples from maritime logistics shall provide an adequate background on this subject.

3.1.2 Regulatory and compliance skills

Port administration. It is critical for the maritime industry professionals to be able to characterize the relevant Maritime Administration Authorities and entities, alongside their functions as global units as well as recognize the functionalities of a sea port and interactions with related authorities and services.

International maritime law. The 21st century maritime industry professional shall have an in-depth understanding of existing legal relationships in international maritime trade, main shipping documents, cargo claims or bills of lading and their repercussions on ports and ships activity.

3.1.3 People skills

Creativity and innovation. With increased competitiveness and sometimes harsh economic challenges, creativity and innovation skills development by means of the resolution of specific in-class problems, drawing from theoretical teaching and students' personal experience, compels students to develop their creativity aimed at obtaining more innovative solutions.

Personal and team leadership. In a technological world the human factor is as relevant as before, if not more. The maritime industry professionals shall familiarise themselves with a broad set of soft skills as for instance leadership, organizational behaviour and creativity models, which are relevant for the leader in the maritime logistics sector.

Critical thinking and problem solving. Central to any human endeavour is the ability to surpass obstacles, to solve problems, large and small. The debate of ideas and the interaction between teachers and students; the accomplishment of focused practical assignments as well as the use of the case method and simulators, promotes critical thinking and the ability to increasingly solve different problems that arise in their future life.

Decision making. 'Life is deciding' one could argue. The implementation of different teaching techniques, like the case method or simulators, helps to better understand real and theoretical problems, and how decisions about input variables influence outcomes within a cause-and-effect basis. A selected set of cases, related to the maritime industry, would foster the development of decision-making skills as a process.

Intercultural communication and negotiation. Globalization, as mentioned, brings new challenges into the human relationships sphere. This knowledge area is critical for the 21st century maritime industry professional. It shall cover subjects as for instance the development of intercultural negotiating skills, understanding the difference between simple or complex negotiation situations, involving two parties or multiple parties, relating different cultures, and understanding how power dynamics and influence may shape approaches to communication and negotiation across cultures.

4 Discussion/Conclusion

This article calls attention to the critical issue of developing the maritime industry professional for the 21st century. Taking the demands of globalization with its associated multicultural skills, the emerging technologies impacting the maritime industry and society, and people at the centre of such paradigm, new curriculums need to be developed to fill the gap.

Double loop learning seems more adequate to develop the 21st century maritime industry professionals, as there will be an increase in complexity due to the need for intercultural relationships, leadership and team management where the matrix form of organization and networks of business are the trend; together with new emerging technologies, and new regulations. All these features demand critical thinking, adaptation and a continuous improvement attitude. To be comprehensive enough, such programmes shall be developed within a knowledge triangle encompassing academia, the industry and relevant authority institutions, so all "voices" are considered.

The main contributions of this article are (1) the raise of awareness for the educational and training challenges ahead in what maritime industry concerns; (2) suggestions for more effective methods to meet the needs while aligning with students preferences, specifically supporting double loop learning, and (3) a proposal of a realistic programme at master's level that is aligned with the relevant literature for the field.

The proposed programme is based on EU MarLEM project, which is still in development and constitutes a first step towards the suitable development of the maritime education professional for the 21st century. Being a work in progress, it is not possible to evaluate the results yet. As lines for future research, it will be to detail the contents and methodologies best suited to teach maritime logistics, engineering and management.

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