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An Integrative Approach for Digitalization Challenges of the Future Maritime Specialists: A Case Study of the Lithuanian Maritime Academy

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ABSTRACT: Rapid changes in technologies and digitalization challenges caused by Industry 4.0 with the integration of the AI, machine learning algorithms, internet of things' technologies, introduction of maritime autonomous surface ships and the development of digital shipping and logistics processes require proper education and training of specialists working in maritime industry to ensure safety and security of people, oceans, goods and environment. The shipping and logistic processes and operations, including the decision-making processes, on the global scale and on the scale of whole-organisation ecosystems become more dependent on the manipulation of data from different unstructured open sources and private data sets, increased amount of data stream from sensorial systems. The specialists working with automated systems need competences to use and interpret special data, engineering and analysis algorithms, and skills in using modelling tools of optimised solutions in shipping and logistics. Educational institutions have to be ready to present effective solutions to educate quickly adaptable specialists able to meet volatile labour market needs able to meet digitalization challenges. The case study of the Lithuanian Maritime Academy (LMA) presented in the paper is based on the use of an integrative approach and work integrated learning with the aim of enabling the educational environment to develop proper competencies of the specialists of shipping and logistics information systems.

1 INTRODUCTION

Education and training of future professionals have recently been encountering a number of challenges: technological, societal, environmental, economic and other changes take place on a continuous basis with acceleration. That's why it can hardly be predicted what professions will be needed in the future and what kind of knowledge, skills, and attitudes have to be taught and learned. On the other hand, training and education require years from the initial idea to a fully developed and introduced study programme preparing required specialists; it means that education systems have to use a proactive approach and respond to the encountered changes quickly and effectively. However, despite all challenges, transportation and movement of goods and people never stop satisfying the needs of people. All the related support businesses and activities also take place on land and on oceans, yet in a changed situation when the concerns about safety and security significantly increase. The transport sector, including its part in maritime industries, is highly affected by the above mentioned rapid technological changes and especially by digitalization challenges [1], such as the introduction of maritime autonomous surface ships, the development of digital shipping and logistics processes on land, an enormously increasing amount of data accompanying all processes, etc. This require proper education and training of specialists for

maritime industries so that they are able to function effectively and to ensure safety and security both on land and at seas.

Educational institutions have to be ready to respond to recent changes and present effective solutions for the development of a future professionals with respective knowledge and practical skills enabling them to meet volatile labour market needs, with emphasis placed on the possibility of their quick adaptation to the rapid technological, digital, social, and other changes. One of the solutions aiming to meet future challenges was taken by the LMA when it undertook educating and training professionals of shipping and logistics information systems. Industry 4.0, a global strategic revolution of innovations and technologies, influences the demand for such specialists. This trend describes how new technologies and machine-learning algorithms can be used in different fields of national, regional, and worldwide industries. The development of 5G and 6G technologies influence the integration of the internet of things' technologies into shipping and logistic processes and operations on land and at sees. The said integration has changed technological, engineering, economic, and management processes of the whole-organization ecosystems because decision-making becomes more dependent on the analysis and manipulation of data from different unstructured open source and private data sets. Automated autonomous systems get rapidly integrated into the global supply chains, which means that the increasing data stream from sensorial systems creates the demand for the contemporary competencies of specialists working with automated systems in use and the interpretation of special data engineering and analysis algorithms as well as open-source accessible tools for modelling optimised solutions in shipping and logistics.

By way of answering to the questions: What kind of specialists will be needed in the future? What learning theory or approach can be suggested to solve the above-mentioned problems? - the LMA undertook preparing shipping and logistics information systems specialists through an approach of integrative learning and work integrated learning, thus enabling the educational environment to serve the purpose of developing proper competencies as a foundation for preparing the type of "individuals best suited to thrive along the edge of chaos" [7].

2 FUTURE PROFESSIONALS

There is no doubt that future professionals have to be suited to adapt to the continually changing environment. That means that to prepare students for an unknown future is to help them to learn to deal with uncertainties, take risks, confront dilemmas, embrace complexity, recognise the limitations of their own knowledge, and maintain health and wellness. Although educators cannot reduce the uncertainty about the future, they can help students develop the tools to learn how to adapt and live in uncertain times [2, 4]. Learning for an unknown future means making decisions in situ, without all of the information at hand [2]. It is difficult to foresee what kinds of skills and competences will be needed in the future. Reich [14] predicts that technical and behavioural competences will be needed, Levy and Murnane [13] highlight the need for higher-order cognitive skills and interpersonal competences, while Mindell [14] points out that the entire nature of the workers' population able to operate all types of systems will be changed. Gardner [7] identifies the consequences of the development of technologies on employment:

- unemployment of people who lost their jobs can last for an undetermined period of time, depending on how quickly new jobs will be developed; to illustrate this, the example of replacement of taxi drivers by Uber can be provided;
- creation of new jobs is an unpredictable process because of two factors: time (the timing of job destruction does not match the timing of job creation) and location (new jobs can be created in a different location from the dismantled job);
- some professions will disappear due to technological development, especially the professions related to the performance of routine and operational tasks which can be done automatically.

As mentioned in the WMU Report (2019) Transport 2040: Automation, Technology and Employment – The Future of Work [21], workforce in shipping will need training and reskilling. Special attention should be paid to the digital skills, their combination with the maritime skills, and the understanding of port operations. The tasks of maritime professionals are anticipated to increasingly transform into digital ones, especially in operation monitoring and system management, and to reduce operational work. Digital skills can be divided into three domains: 1) data fluency and the ability to interpret and analyse large amounts of data; 2) digital operation of equipment, such as ships, cranes, and winches; and 3) software engineering of fundamental programmes and systems. Education and training will have to be adapted in order to equip seafarers with the new skills required [21]. In major areas of port operations, in the context of automation, digital skills can be categorised as applied to the functioning of: the terminal operation, including the waterway ship scheduling service; the foreland transport service, including railway and road transport service connected to the port; the hinterland transport service, including railway and road transport service connected to the port; and warehouses related to the port [21].

According to the Future of Jobs report [20], the changes in the demand for, and composition of, skills indicate a shift toward "soft" skills (see Fig. 1). It can be anticipated that proper education and training of "human/soft" skills will have to be provided to all kinds of specialists, including engineers, managers, and professionals of information technologies. Emphasising the introduction of transferable/generic competences into study programmes can develop "Soft" skills. Transferable/generic competences are important in the context of lifelong learning, regardless of the field of studies. They can be divided into three main groups [16]:

- instrumental competences (competences that function as means or tools for obtaining a given

end), such as critical thinking, problem-solving, decision-making, oral communication, writing skills, etc.;
- interpersonal competences (different capacities that enable people to interact well with others), such as teamwork, self-motivation, conflict management, etc.;
- systemic competences (skills and abilities concerned with the comprehension of an entire set or system), such as creativity, innovation, project management, leadership, etc.

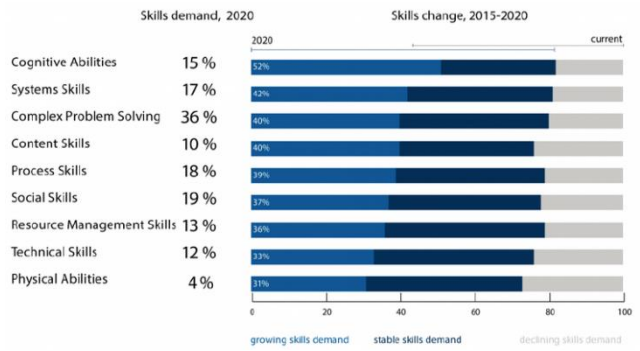

Figure 1. Change in the skills demand and composition [20].

To conclude, future professionals will need special technical, digital, and soft skills in order to effectively function in a rapidly changing environment. However, the question: What kind of theory or approach can be applied to the training of such professionals? - is not easy to answer. A possible answer to this question can be the introduction of an integrative approach and work integrated learning (WIL) into the education and training systems.

3 AN INTEGRATIVE APPROACH AND WORK INTEGRATED LEARNING

The traditional theories and approaches to learning, such as behaviourism, cognitivism, connectivism, constructivism, problem-based learning, blended learning, etc., applied solely one by one to the education and training of future professionals, can hardly meet the recent challenges to the full extent. The approach to be used is to combine different perspectives and approaches in a flexible way in a specific context-oriented environment. The authors of the paper believe the most appropriate one to be an integrative learning approach combined with work integrated learning. An integrative approach to learning can be understood as an approach to education that allows students to understand and apply the inter- and intra-disciplinary connections between different educational experiences not only in learning, but also in the real-world context. It is the tool enabling students to use all their learning experiences of different levels of complexity in all domains of learning, such as cognitive, affective, and psychomotor (i.e. from the lower level of the cognitive domain of learning, i.e. remembering, to the highest one, i.e. creating, etc.), across the curriculum and co-curriculum: from establishing simple connections between ideas to using and transferring comprehensive learning to new, complex situations in educational institutions and outside them [2, 8]. Integrative learning enables students to understand the world as a whole real system instead of just having a number of unconnected ideas and facts which are not related to their future professional life [9].

According to Torlind [19], integrative learning experiences are activities that lead to the acquisition of disciplinary knowledge as well as personal and interpersonal skills and the product, process, and system building skills; that comes in many varieties: "connecting skills and knowledge from multiple sources and experiences; applying skills and practices in various settings; utilizing diverse and even contradictory points of view; and understanding issues and positions contextually" [19]. Integrative learning involves bringing together traditionally separate subjects so that students can grasp a more authentic understanding and make connections between academic knowledge and practice. In engineering education, an integrative approach allows to mix elements of an innovative and entrepreneurial spirit with scientific values into a socially oriented combination, which is supported by cultural understanding and includes scientific, technical, social, and environmental dimensions of engineering in "one comprehensive form of education" [10].

Work integrated learning can be understood as inseparable part on an integrative learning approach, mostly focused on the development of students' abilities to integrate their learning through a combination of academic and work-related activities. It involves all possible educational activities from the academic learning of a subject to its practical application in the workplace. Fullan and Scott [6] suggest educating people to be able to "learn to do and do to learn" by focusing on deep learning and real-world problem solution at personal, social, local, and global levels. Their idea is to integrate thinking, learning, and doing through implementing WIL in order to prepare a person able to live with uncertainty within a global context [5]. To be effective in the 21st century, specialists need to have an interpersonal and cognitive capacity to identify problems in the volatile world and the ability to design effective responses and solutions. This idea is based on Kolb's [12] experiential learning theory, highlighting the experience as a main source of productive learning at the other level of an unpredictable and rapidly changing world.

Higher Education Quality Council of Ontario [18] describes three different types of WIL:

1 1.Systemic training at the workplace as a central piece of learning (i.e., apprenticeships);
2 2.Structured work experience as familiarisation with the world of work within an education programme (i.e., field studies, professional practices, internships, placement, practicums, etc.)
3 3.Institutional partnership as post-secondary education achieving industry and community goals (i.e., service learning).

The theoretical framework of integrative learning, understood as a learning approach allowing students to understand and apply the inter- and intra-disciplinary connections between different educational experiences in the academic, real-world, and cultural contexts, and work integrated learning,

focused on the development of students' abilities to integrate their learning through a combination of academic and work-related activities, has been applied at the LMA in the study programme of Shipping and Logistics Information Systems (SLIS).

4 CASE STUDY OF THE LITHUANIAN MARITIME ACADEMY

The trends in the development of digital shipping and logistics processes suggest that the global supply chain is evolving and leading to qualitative changes in the skills and competencies of specialists employed in the maritime transport sector. Although the need for a human in automated global supply chain systems and processes is not completely ruled out, there is no doubt that the number of the staff directly participating in some processes will decrease, while the remotely-based jobs will be in demand [11]. In addition, such types of competencies as data collecting and processing, data engineering and data analysis, programing and modelling as well as research methodology in the field of business processes will be required. All these competencies could be called digital competencies working in the era of automated processes.

In the case of the LMA, it can be seen that changes in the labour market influence changes in its study programmes and consequently programmes' learning outcomes [4, 17]. The Academy provides six different study programmes oriented to the maritime transport sector on foreland and hinterland: Marine Navigation, Marine Engineering, Marine Electrical and Electronic Engineering - for Seafarer Training; Maritime Logistics Technologies, Port and Shipping Management, and Port and Shipping Finances – for shore side. Digitalization of maritime transport operations and processes lead to certain consequences, and one of them can be explained in the context of the relationship of education and the labour market. Changes related to Industry 4.0 are taking place in all areas of the maritime transport sector, and they strongly influence the labour market requirements for sufficient digital competencies and a wide range of interdisciplinary skills. The LMA has responded to the said market challenges by developing a new study programme meeting the labour market needs. A new study programme Shipping and Logistics Information Systems (SLIS) was prepared for the development of digital technical, specific, and soft skills of specialists employed in the maritime transport sector with the perspective to partial changes in other study programmes by adapting them to the digitalization in the global supply chain. The SLIS study programme is aimed to develop the combination of the skills and competencies from different professional foreland and hinterland logistics areas to be able to solve global supply chain connectivity problems.

Another consequence of Industry 4.0 and global digitalization and automation is related to human recourses and communication in maritime organizations. Different digital competencies dependent on the profession, moreover, on the age of the staff as well as on their personal intelligence and interests, at maritime transport companies influence interrupted communication in the area of the IT implementation under the automation of business processes. Usually, the main problem is related to the ability of managers to understand IT specialists and capability of IT specialists to understand the tasks assigned by the managers. This problem can be explained by the difference between professional activities of IT and programming specialists, who concentrate on IT systems administration or coding, and professional activities of managers, who are mainly interested in business processes and company's profit maximization. Working together, they could find optimal solutions, however they usually fail to understand each other's concerns. Therefore, IT specialists-graduates from the new study programme can help to connect that interrupted communication channel in the organization because they will be familiar with the main business processes in shipping and logistics, including the basic elements of finance and management, and simultaneously they will boast competencies in the area of information and data analysis technologies. Given all that, the SLIS study programme is a unique interdisciplinary study programme in the area of the science of informatics in Lithuania.

As shown in figure 2, the LMA recently provides seven study programs and prepares specialists for different functional areas of the global supply chain: the shipping market, the shipping services market, the shipbuilding and repair market, port navigation services, port logistics services, including port logistics, stevedoring, and forwarding, moreover, ship brokering, warehousing, custom brokering services, and the hinterland transportation market, including all the hinterland logistics services.

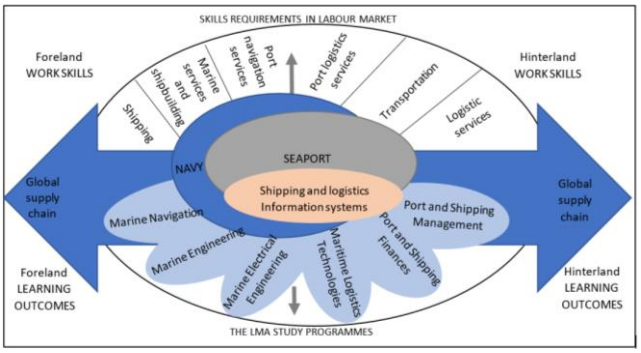

Figure 2. Integrative learning functions of the SLIS study programme at the LMA

Digitalization is a continuously changing process in all of those areas, where sensorial systems create a big amount of specialised digital data which together with a billion bits of public data forms huge data sets used for different business and technical purposes. In addition, the need to be able to analyse and use the huge amount of digital data means important changes for important maritime sectors. One of them is the Navy sector, because the similar changes in technologies take place in the Navy fleet, supply logistics technologies, and radio communication. However, differently from merchant maritime sectors, Navy radio communication is based on special

STANAG [1] standards, which are affected by the changes in radio communication technologies. So, the continuous changes of technologies and standards in the Navy cause a need for corresponding skills. All those reasons increase the Navy interests to educate their specialists at LMA SLIS study programme since it creates a unique educational ecosystem of the whole maritime transport sector (Fig. 2).

It is important to note that the maritime transport sector is a part of the national transport system and economy as well as global. By clearly defining the tasks and objectives of the national and global transport system and requirements to the specialists working in it, the market-oriented learning outcomes were defined as shown in figure 3.

The involvement of different stakeholders into the development of learning outcomes in ensured by the programme's approval by the steering committee which consist of stakeholders from various areas from the industry relevant to the study programme content. Those conditions create opportunities for the implementation of work integrated learning in all the three work integrated learning dimensions, which are part of an integrated approach to learning methodologies.

One of the dimensions of the WIL methodology is institutional partnership. An analysis of the Navy and the merchant maritime transport sector relationships and educational issues can be described through institutional partnerships, as shown in figure 3. The Lithuanian Navy is part of the Lithuanian Armed Forces; however, they have different landscapes of activity: the Lithuanian Navy functions on the foreland, and the Lithuanian Armed Forces - on the hinterland. The mentioned differences influence the requirements for institutional partnerships between the Lithuanian Navy and the LMA in the foreland landscape (Fig. 3), because the main functions of the Navy are related to shipping and supply logistics. The Lithuanian Navy is tasked with a wide range of missions: the protection of national interests in territorial waters and the exclusive economic zone, explosive ordnance search and disposal operations, coordination of search and rescue operations, support of special operations, control and protection of the lines of communication, fisheries, and pollution control. As shown in figure 3, the partnership in the maritime transport sector-related education can be implemented by the partnership of the military sector (the Lithuanian Armed Forces and the Lithuanian Navy) and the sector of education (General Jonas Žemaitis Military Academy of Lithuania and the LMA), providing development of military and merchant maritime work skills.

Therefore, the Lithuanian Navy can be said to be part of the maritime transport sector, because they have their own specialised fleet and need to manage supply logistics for recourses used in the implementation of specialised Navy tasks. The Lithuanian Navy is influenced by digitalization, which is the consequence of the requirements for the development of digital and soft skills adopted by the military sector. To sum up, the new SLIS study programme can be applied for the development of the digital skills of specialists prepared for the Lithuanian Navy and for ensuring lifelong learning of merchant maritime specialists. Those are the main reasons for creating an environment for the WIL applied in the multi-sectorial partnership. An integrative approach and WIL can be explained, based on the LMA study programme SLIS and its interdisciplinary and multi-sectorial purposes: the SLIS study programme is an only study programme of that type in Lithuania, and all the learning objectives are based on the relevance of their application in the sector of logistics or in the context of partnerships in the military sector within the specialism of Navy Logistics through integrating the radio communication modules and the military maritime sector-applied courses in the General Jonas Žemaitis Military Academy of Lithuania.

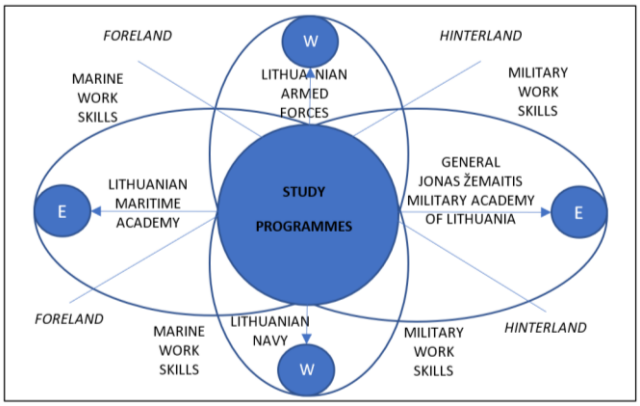

Figure 3. The LMA in the network of institutional partnerships for the WIL model implementation

In accordance within the law regulations in the Lithuanian sector of education, the professional bachelor study programmes have to ensure proper work-related training of graduates, however WIL approach can be rarely noticed. At LMA the organisation and structure of SLIS study programme is based on three main stages, each of following being broader in the context of practical training in simulators and companies. As shown in figure 4, at the beginning of the study programme, students come with a minimal basis of general, technical, and specific knowledge, which is developed at the initial stage of their studies through the implementation of systemic training (Fig. 4), accounting for 40% of the study programme credits. The integrative approach to learning including WIL in the mentioned study programme can be described by defining interdisciplinary and multi-scale skills of future graduates. Those skills, namely digital and soft skills, as it is presented in the framework of work integrated learning approach (see Fig. 4), are developed by implementing three main parts of study process, starting from the so-called input, as a provision of the basic knowledge; following by the processing, meaning education and training processes itself, and finalized by the output described by learning outcomes and trained skills in accordance with the digitalization requirements. As it was explained above, training the main and specific skills in the described study programme is not sufficient, so the special attention is paid to developing more important special skills, such as digital competencies and soft

[1] STANAG is NATO Standardization Agreements for procedures, systems and equipment components

skills. In the case of the SLIS study programme, special skills are related to the IT architecture, coding in Python, and statistics in R by applying them to specific shipping and logistics problem solution by means of data analysis. In the process of training the specialists of Lithuanian Navy, specific skills are related to the Navy main functions, processes, and international military tasks.

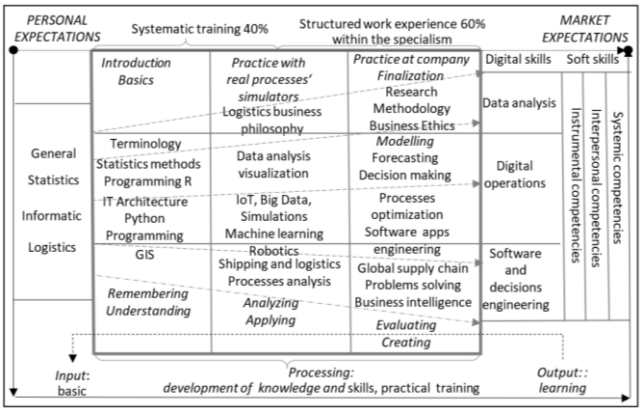

Figure 4. The framework of WIL approach of the SLIS study programme

All the courses of the study programme are divided into four blocks, such as general courses, informatics, statistics, and logistics, and, within the three years of studies, the focus shifts from lower-order cognitive skills, such as remembering and understanding to higher-order cognitive skills, such as evaluating and creating. Longer period of studies is devoted to the practical training in real time and real system simulators, and students are transferred from simulated reality to the real processes at the maritime sector companies. Such a structure of the study programme is oriented toward the training of practical skills in specific sectors, while the applied methods are oriented toward the development of "soft skills" through each content unit. Instrumental competencies are trained in each content unit through applying correct terminology and through learning to use specific coding software as well as specific and methodologically correct research and data analysis methods. Moreover, instrumental competencies are trained through the critical thinking education and systemic point of view in the analysis of the processes and operations in logistics and shipping. Another part of soft skills is interpersonal competencies: that type of soft skills is mastered through teamwork tasks, including sharing of responsibilities between the team members, improving leadership competencies, and participating in different roles during the training in simulators. One more part of soft skills, i.e., systemic competencies, are trained in the last stage of the studies, when students have to do experiments with real data and find optimal solutions as well as prepare software projects or decision projects for the optimisation and problem solution in the selected research fields by means of data analysis methods and technological innovations.

The developers of the SLIS study programme found out the fastest track to create a positive link between personal and market expectations through WIL by implementing as many dimensions as possible:

- systemic training for the basic operational knowledge and skill development, the major part of which are instrumental skills as part of the soft skills;
- structured work experience with the soft shifting from real time simulators to the real market processes, which partially belong to the instrumental and interpersonal competencies;
- institutional partnership for the training of special competencies in real-world processes and for the support of systemic competencies, trained over the entire duration of the study programme.

5 CONCLUSIONS

The theoretical framework of Integrative learning is understood as a learning approach allowing students to understand and apply the inter- and intra-disciplinary connections between different educational experiences in the academic, real-world, and cultural contexts for the purpose of preparing the type of "individuals best suited to thrive along the edge of chaos" [7]. Work integrated learning (WIL) is focused on the development of students' abilities to integrate their learning through a combination of academic and work-related activities; it can be approached by three different types: systemic training, structured work experience and institutional partnerships

The case study of the Lithuanian Maritime Academy demonstrates the application of the theoretical framework of integrative learning and work integrated learning in the study programme Shipping and Logistics Information Systems (SLIS) by being able to develop special technical, digital, and soft skills in order to effectively function in a rapidly changing environment. The SLIS study programme can be considered as a unique inter and intra-disciplinary study programme in the area of the science of informatics in Lithuania. All three different types of work integrated learning, such as systemic training, structured work experience and institutional partnerships are incorporated in SLIS study programme to ensure the positive link between personal and market expectations.

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