SMART EDUCATIONAL TECHNOLOGIES AS A FACTOR OF SMART SHIPPING DEVELOPMENT

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المستخلص

تواجه الجامعات البحرية الحاجة إلى إعادة التفكير وإعادة هيكلة تجربة التعلم لتوفير مستوى التعليم الذي يتناسب مع تحديات وفرص صناعة الشحن البحري. إحدى الطرق لتحقيق هذا الهدف هي التطبيق الواسع للتقنيات التعليمية الذكية في العملية التعليمية. يُعتبر التعليم من المجالات التي جلبت فيها تكنولوجيا المعلومات العديد من التغييرات، ويُظهر التحول الواضح من الوسائل التعليمية التقليدية إلى البيئة التعليمية المتكاملة باستخدام التقنيات الذكية، قدرة هذه التقنيات على توفير متخصصين ذكيين للعمل في صناعة الشحن الذكي.

تتناول هذه الورقة الجوانب المتعلقة بالتحول الذكي في التعليم البحري وتستعرض القضايا الرئيسية المرتبطة بتطبيق تقنيات الواقع الافتراضي والمعزز في العملية التعليمية، بالإضافة إلى المقترحات بشأن استخدامها بشكل فعال. يتم النظر في العلاقة بين التقنيات التعليمية الذكية والبيئات المهنية في الأنظمة التعليمية المتكاملة البحرية. كما يتم تحديد وتوضيح شروط تنظيم التعلم الغامر ومعايير كفاءته. تُظهر الورقة أن تأثير الغمر يتحقق من خلال التكرار في بيئات تحاكي الأنشطة المهنية الحقيقية. كما يُحدد أن قضية تطوير التعليم الذكي مرتبطة ليس فقط بتطوير التقنيات، ولكن أيضًا بتشكيل جودة التعليم الذي تم اختراع هذه التقنيات من أجله، حيث تظل هذه التقنيات وسيلة وليست هدفًا.

تتناول هذه الورقة تقنيات التعليم الذكي على ثلاثة مستويات، بما في ذلك: عملية التعليم، وإدارتها، والبيئة التي يتم فيها تنفيذها. ويُؤكد على أن تقنيات التعليم الذكي هي عامل رئيسي في تطوير الشحن الذكي. كما يتم عرض نموذج نظام تعلم يجمع بين مزايا النظام التعليمي التقليدي وإمكانات بيئة التعليم المتكاملة. تثبت الورقة أن مفهوم التعليم البحري الذكي، الذي يشمل المرونة، واستخدام عدد كبير من المصادر، وتنوع المحاكيات المستخدمة، هو أحد الاتجاهات الواعدة سواء في التعليم البحري أو في تطوير الشحن الذكي في المستقبل.

الكلمات المفتاحية: التدريب والبيئات المهنية، النظام المتكامل، التعليم البحري، التعليم الذكي، الشحن الذكي.

Abstract

Maritime universities face the need to rethink and restructure the learning experience to provide the level of education, corresponding to the challenges and opportunities of the Maritime industry. One of the ways of achieving the goal is wide implementation of smart educational technologies in educational process. Education is considered as the area in which information technology has brought much changes and an evident shifting from the traditional educational means to the ergatic educational environment by smart technologies use is capable to provide smart shipping industry with smart specialists to work in it.

The offered paper deals with the aspects of intellectualization of Maritime education and shows the main issues associated with the implementation of virtual and argumented reality technologies in educational process and proposals on their efficient use. The correlation between the smart educational technologies and the professional environments in the maritime ergatic systems is considered. The conditions for the organization of immersive learning and criteria of its efficiency are defined and grounded. It is shown that the effect of immersiveness is achieved by repeated immersion under certain conditions that simulate real professional activity. It is determined that the issue of the smart education development is connected not only with the development of technologies, but also with the formation of the education quality, for which these technologies are invented, but still they serve as a means and not goals.

This paper considers smart educational technologies at three levels, including: the process of education, its management, and the environment in which they are effected. It is emphasized that smart educational technologies are the significant factor of Smart shipping development.

A learning system model, combining the advantages of the traditional learning system with the capabilities of the ergatic educational environment resources is offered. The paper proves that the concept of smart maritime education, involving flexibility, the use of a large number of sources, the diversity of used simulators, etc. is one of the promising tendencies both for Maritime education and further smart shipping development.

Keywords: training and professional environments, ergatic system, maritime education, smart education, smart shipping.

1- Introduction

Currently, technological advancements, including automation, have made transportation of people and goods more complex and sophisticated. We undoubtedly understand that automation and technological advances present not only challenges, but also opportunities for different branches of the economy. At the same time the effects of automation and new technologies are understood as not inevitable. They are a result of grounded policy choice. Representatives of business, employers and workers have the power to make digital technology a tool for positive change and they prefer to use them as this decision offers new opportunities.

Maritime transport provides a vital service both to the national economy and the global community. Innovation and technology have always been part of its development and have

enabled maritime transport to become a mechanism for constant improvement. Implementation of new technologies, increasing level of automation and the compulsory use of various navigation systems influence the quality of sea industry. However, every new invention changes the nature of work and constantly requires new skill sets of seafarers, that requires time, efforts and money.

2- Smart ports and shipping as a factor of its further development

"Smart port" is a relatively new concept, meaning the ergatic system, taking advantages of technological advancements, namely: Artificial Intelligence, Cloud Computing, Blockchain, Internet of Things, Big Data and Physical Internet. All mentioned is developed and implemented with aim to enhance competiveness, reduce environmental impact, increase productivity, reduce maintenance and operating costs, create safe labour conditions and so on.

Automation and new technologies are introduced progressively in all transport sectors. In maritime transport changes occur not so quickly due to the necessity to be agreed according to the international guidelines and regulations. However, owing to a strong economic benefit is expected, highly automated transport solutions are implemented at the regional level and governed by national legislation or bilateral agreements among adjacent countries.

We live in a period that is characterized by the integration of artificial intelligence and higher degrees of automation and autonomy into the industry. It was always so, but now it is characterized by greater rapid pace of technological developments. As a result, a number of issues in relation to the implications are discussed and solved by different stakeholders and specialists at national and global levels. Much efforts are made by governments, businessmen, shipping companies and researches, to develop navigation support technologies to improve safety and efficiency of ship operations (Makashina, 2016, Makashina, et al. 2021, Makashina and Marichev, 2021 and Makashina, 2022).

No one is arguing that the activity of modern navigators and ship engineers is more cognitive in nature, consisting in analyzing data on the functioning of the systems used in navigation, their understanding, interpretation, operational control of automation, analysis and management of systems, and making complex, responsible solutions (Loginovsky, 2019 and Gilmartin and O'Connor, 2019). Despite the complexity of the implemented information technologies in the sea industry, the prerogative of solving the tasks is the responsibility of a human operator.

All mentioned issues are closely connected with maritime education, which main task is to prepare smart specialists able to serve this complicated sea industry. Maritime universities face the need to modernize and restructure the educational technologies in educational process. Training a specialist for work in one of the most complex ergatic systems, requires great attention to smart training, including immersive environments that allow to simulate future professional conditions and form professional skills that in future can be transferred to real activities. Maritime universities face the challenge of providing the highest possible level of education, corresponding to the

challenges and opportunities of the modern Maritime industry. One way of achieving a high level of education for marine professionals is wide implementation of smart technologies.

3- Smart educational technologies

The level of professional knowledge in much depends on the effectiveness of the educational process, which contributes to the formation of the competencies demanded by employers from graduate of Maritime Universities. Education is considered as the area in which information technology has brought much changes and an evident shifting from the traditional educational means to the ergatic educational environment by smart technologies use is capable to provide smart shipping industry with smart specialists to work in it.

We consider the ergatic educational environment as a set of conditions for the performance of educational activities, where the main relationships are the relationship “man-machine”, in our case, “man-simulator”. The conditions for this activity can be divided into external (components of the educational environment) and internal (the educational process itself). The specified set of conditions is created directly by educational actions and is used to realize them.

It should be kept in mind that the ergatic educational environment does not appear, exist and function on its own, and only its competent construction will help determine the result of the educational process. When creating an ergatic educational environment, it is important to rely on an understanding of its complex structure, the interrelationships of its components and their purpose (Sergeev, 2010). At the same time, the main and only purpose of the components is precisely to provide opportunities for educational activities, so its structure and its content are determined by the purpose and objectives of the educational process.

The specific requirements for the training and means of training specialists for sea industry are clearly defined by the International Convention on the Training and Certification of Seafarers and Watchkeeping as amended in 2010 (STCW) (IMO, 2011), which allows the use of simulators as a tool of training and assessing the competence of ship's crew members on an equal basis with ship's equipment. This made it possible to use simulators for various types of training in order to acquire skills in performing basic functions, and today their introduction into the educational process has become not only desirable, but also mandatory. Different types of simulators are used to train and verify the competence of marine specialists within the framework of the requirements of the above said convention. Their choice depends on the possibility of either fully or partially corresponding to the requirements of the Convention, in particular, replacing the internship on board a real ship. The widespread use of simulators in the educational process is explained, first of all, by the fact that simulators allow to reproduce the environment, including the water space, the coastline, piloting, towing, navigation moving ships, loading and unloading operations. A realistic representation of all weather conditions, the effects of visibility and illumination, procedures related to mooring, towing, search and rescue, and special operations turn the simulator into an effective training tool. The psychological readiness of marine specialists affects their ability to

withstand extreme external influences, respond quickly and competently to changes in the situation in order to work and to save.

Guiding with requirements of Code A, Section A-I/8 quality standards (IMO, 2011), we agree that smart maritime education is able to provide a sufficiently high level of students' competence, through the development of practice-oriented courses developed by the members of the virtual pedagogical community, working at maritime institutions.

Speaking about intellectualization of Maritime education it is necessary to mention the main issues associated with the implementation of virtual and argumented reality technologies (smart technologies) in educational process. Virtual trends in modern maritime education are becoming the norm, which leads to serious changes in the educational process, and affects all its participants: the organizers of the process, teachers and cadets, turning both knowledge and communication into virtual ones. Virtualization of the maritime educational space, which is determined by external and internal factors, including: development of the marine industry, unlimited access to information, international integration, globalization, national and conventional requirements to the level of marine experts training, growth of accidents in the Maritime transport sector, continuous development of technologies and their implementation on ships and in shore structures and others. Accounting these factors and specific conditions of implementation different types of simulators in maritime education allows design a productive educating process with elements of virtual learning. In light of mentioned, the conditions for the organization of immersive learning and criteria of its efficiency should be defined and grounded.

Immersive learning environment is in the field of view of many scientists and practitioners, and most of them consider this phenomenon as the ergatic learning environments (Makashina, 2016, Makashina, et al. 2021, Makashina and Marichev, 2021 and Makashina, 2022).
These environments are designed taking into account such principles of their organization as: self-organization, selectivity, immersion, presence, activity of a student, mutual orientation in the process of learning communication, physical immediacy and subjective (conscious) mediation, interactivity. As a rule, immersive environments are created with the help of simulators widely used in the learning process at maritime universities. To work effectively in the virtual educational space, the teacher/instructor must be competent both in the field of pedagogy and in the field of information technology.

Smart educational process means performing educational activities by means of advanced technologies, e.g. when the student is immersed in an environment formed by virtual reality technologies, which displays artificially created conditions, but at the same time this student is to solve purely professional tasks.

Considering the conditions for the design and operation of smart training it is important to mention that educational activities are carried out in the proposed conditions (territory, classroom and training center), where participants in educational activities and their means are located. Funds are

provided to both the teacher and the student, i.e. those who are the executor of the leading and decisive activity. The connections between the participants are mutual and the result of this interaction affects the correction of the learning immersive environment.

The conditions for organizing immersive learning environments include any means of educational activity: a fund of educational and other literature, equipment for laboratories and training classes visual aids, etc. Special attention is paid to normative documents (curricula, programs, textbooks), which are necessary for adjustment of the content of education, due to changes of the educational standards, improvement of production technologies, development of science and technology, changes in the needs of production, social order, etc.

The effect of immersiveness is achieved by repeated immersion under certain conditions that simulate real professional activity (Makashina, 2022 & Sergeev, 2010) . Opportunities of the virtual world with its powerful potential could be helpful for educators to make learning activity more interesting, creative and useful. In this connection not only appropriate software for maritime students and research from basic programs to the latest simulation software must be available, but methodical and pedagogical support must be continuously provided and updated.
We are absolutely sure that it is impossible to use only smart technologies as the only form of training, but wide smart technologies implementation is necessary and it allows provide flexibility of learning process in an interactive learning environment and personalization and adaptation of learning process.

The smart education concept involves the creation of an intellectual environment for the continuous development of students' competencies in the educational process. Smart learning is implemented based on technological innovations and the Internet, which provides cadets with the opportunity to obtain professional competencies based on a systematic vision and study the content of disciplines, taking into account the need for their continuous updating.

Now-days smart education is developed in three directions, which are closely interconnected, namely: the process of education, the management of the process, and the environment in which it is created and effected. Smart education must be managed, but at the same time it should provide flexibility of educational process taking into account internal and external factors influencing the marine education and possible risks associated with changes of these factors.
Among the main problems associated with the widespread implementation of smart education we distinguish: insufficient quality of electronic educational resources; the ineffectiveness of control methods and assessment; necessity of compliance with both national and international standards; intellectual property issues; automation of administrative tasks, compatibility of programs among different operating systems.

When speaking about the standard, quality is always meant. Quality is usually understood as the objective characteristics of the objects that appear in the aggregate of their properties. Under the "2010 Manila Amendments" to the Standards of Training, Certification and Watchkeeping for

Seafarers (STCW) Convention and Code, Quality Standard System (QSS) requirements require "in accordance with the provisions of section A-I/8 of the STCW Code, all training, assessment of competence, certification, including medical certification, endorsement and revalidation activities carried out by non-governmental agencies or entities under its authority are continuously monitored through a quality standards system to ensure achievement of defined objectives, including those concerning the qualifications and experience of instructors and assessors (IMO, 2011).

It is common understanding, that the quality of smart education of specialists is determined by the quality of educational programs and content; quality of potential of teaching personnel; quality of potential of the applicants; quality of educational technologies; quality of resource provision.
The structure of the material proposed for mastering in the virtual space must comply with certain rules, i.e. include: basic material that provides a presentation of the content of the educational subject; additional material related to the basic material by a clear navigation system and serving to expand and deepen basic knowledge; explanatory texts accompanying the key terms of the basic material, graphic images; control the component. Moreover, the main requirements include: multimedia, interactivity, attraction of symbolic information (text, hypertext), static realistic and synthesized visual series, sound series and dynamic video series.

We have allocated organizational and pedagogical conditions for the organization of smart training as follows:

- sequence of actions of students in accordance with traditional practical exercises;
- development of a model of training system for the organization of independent work of students;
- individualization of the learning process;
- the visibility and availability, including control of acquired knowledge;
- feedback that allows you to adjust the current educational process taking into account the current state of knowledge of the student.

Educational and methodical conditions of smart training functioning can be distinguished as following:

- due to preparation of a teacher/instructor to work in smart educational environment;
- development of pedagogical support;
- application of the most effective teaching methods;
- provision with modern technological means;
- regularly updated software for simulators;
- provision of teaching materials in electronic form etc.,

Moreover, the principles of the organization of the smart educational process can be formulated as the following:

- scientific content of information material (selection of the most important elements of knowledge) should be updated;

- provision of feedback must allow choose the most appropriate forms depending on the formed level of students' knowledge;
- feedback should be considered as the main condition of the educational process;
- cumulative effect is to be realized in the form of accumulation knowledge as a result of responses to test tasks and repeated reference to the theory;
- individualization of learning should be achieved.

Work in the smart educational environment involves adherence to certain methodological requirements for the creation of educational electronic materials:

- educational electronic material must meet the requirement of completeness of the content;
- educational electronic material should be built on the principle from simple to complex;
- pedagogical methods and technologies should be used in accordance with the specifics of each certain science and its corresponding discipline.

The software, used for smart educational process should provide:

- comfortable learning environment;
- availability of information material;
- dynamic feedback between the user and the training system;
- the possibility of returning to the wrong tasks and wrong answers;
- availability of reference material on the subject.

We hope that the pedagogical, technological and practical aspects of how smart education can potentially benefit Maritime education and its communities should be accounted while arranging educational process.

The processes of changes in the Maritime educational space occurs due to the strengthening of virtual trends arising in sea industry, so the concept of smart maritime education, involving flexibility, the use of a large number of sources, the diversity of used simulators, etc. is one of the promising tendencies both for Maritime education and further smart shipping development.

4- Conclusion

The challenges of automation, new technology and the future of work are some of the most important experience facing workers today. Transport workers should be equipped with the required knowledge, skills and expertise for the jobs of today and tomorrow. The Maritime ergatic technological systems is characterized by the rapid development and introduction of modern technologies into production and this demands specialists to work in it, due to the fact that in the shipping industry, the human element is recognized as the main source of risk for safe and efficient shipping. Functioning in the smart technological sphere like sea industry requires smart specialists, capable to overcome risks and difficulties while performing complicated professional functions both onboard and ashore. Smart specialists are result of smart education and in this connection responsibility of Maritime Universities is constantly increasing.

Despite the wide interest in the use of training complexes in the educational process, the task of choosing the optimal composition of training equipment for training of smart specialists continues to be relevant, due to the constant development of technology and the search for ways to achieve the quality of training. No matter how unique the simulator is, for its effective use, appropriate conditions in the educational environment should be created.

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