Survey on innovative web-based teaching/learning methods and smart technologies applied in the educational process in maritime higher education

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Abstract: *The development of smart technologies in recent years has had a significant impact on the maritime industry as well, allowing the improvement of operational efficiency, the increase of safety, the reduction of costs, and environmental impact. A particularly important element is the alignment of maritime higher education with technological evolution through the continuous improvement of study programs and their continuous correlation with the current requirements of the labor market in the maritime industry. The article presents the results of the evaluative research study on innovative web-based teaching and learning methods and intelligent technologies applied to students from the master's programs of the "Mircea cel Batran" Naval Academy. The study has three directions and the results provide the guidelines for improving the educational process in the maritime higher education institutions, to approach technological evolution, and to provide students with the skills and knowledge needed to use smart technologies within the maritime industry.*

Keywords: Innovative web-based teaching/learning methods, Intelligent teaching/learning technologies, Maritime Higher Education.

1. Introduction

Smart technologies are constantly evolving and developing, improving operational efficiency, increasing safety, reducing costs and environmental impact. Economic and industrial competition in the maritime field requires the implementation of intelligent technologies at the company level and the preparation of human capital for their use.

The article presents a scientific research study, regarding the perception of students from the master programs of the "Mircea cel Bătrân" Naval Academy (MBNA) regarding the implementation of innovative methods, the use of tools based on intelligent technologies to improve the education process, and the perception regarding how to involvement of the maritime industry in the training of students. The study was carried out within the project "Romanian-Norwegian Strategic Cooperation in Maritime Higher Education for the Improvement of

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Human Capital and the Knowledge Base in the Field of Marine Intelligent Technologies", financed by the SEE Grants program 2014-2021 (Marintech, 2021).

The innovative methods and tools, based on ICT and web technology (simulation, web communication platforms, dedicated software, videos, etc.) were largely implemented within MBNA, with the transition of education from the classical system to the online one, during Covid-19 (Avram & Coșofreț, 2020). During this period, the university's web platform was the main teaching/learning/assessment tool, allowing students to remotely access teaching resources, participate in online courses and assessments, and communicate with each other and with teachers (Dumbraveanu & Peca, 2022).

Simulation learning is an increasingly used method in naval higher education. It allows the learner to access a virtual environment similar to the real one, being able to simulate real processes within the maritime industry, with the help of smart technologies such as Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR) (DNV, 2021).

Another innovative method under study is learning by inquiry. This method uses both innovative teaching/learning methods (TLM) and tools and especially intelligent technologies, such as collection, analysis, and database modeling technologies (machine learning, intelligent sensors, data provision websites, specialized modeling software, etc.), robotics technologies, and autonomous marine vehicles, etc. This method is successfully implemented within the Norwegian University of Science and Technology (NTNU) at the level of bachelor's, master's, and doctoral studies. The results of applying this method are highlighted by increasing the research level of the university and by increasing the involvement of companies in the education process (Wu, et al., 2023). In the implementation of this method, the university has an important role in attracting students to these projects and by identifying companies to participate in research programs, by proposing research topics, supervising and participating in the research stages, and also by financing them. Correspondingly, with a view to involving beneficiaries from the industry in the education process is the development of a web platform, through which communication is carried out between actors in the labor market and the university environment (teachers, students). Through this platform, the beneficiaries contribute to the updating of the curriculum, the implementation of new technologies, propose research topics, request students to carry out cadetship practice, etc. Such a platform is developed at the level of MBNA and NTNU, within the Marintech project (Virtual Learning Platform, 2022).

2. Research method

The target group of the research is the first-year students of the master's programs: "Oceanography and Hydrography" (O&H) and "Naval Electrome-chanical Systems" (NES). For the analysis of respondents' answers, the evaluative

and cross-sectional research method was chosen. The opinion poll was chosen as the data collection method, the polling technique being the electronic poll. The survey tool used for data collection was the anonymous questionnaire, made with the help of the Google Forms program. The data collection period was: 17.03-03.04.2023. The study participant sample of 48 students is representative of the target group population (52 students), with an admitted error of +/- 5% and a confidence level of 95%; (Pomohaci & Pârlea, 2008). The stratification of the collected data was carried out on two categories of respondents, namely on the two master's study programs.

The percentage participation of students on the two layers is 24% from O&H and 76% from NES. Statistical techniques for measuring the intensity of students' perception were used for data analysis: mean and standard deviation (data variability within the sample of respondents) and minimum and maximum Likert scales (Cardinal & Aitken, 2013). Four degrees of intensity measurement on the Likert scale were used in the study: Not at all-1, To a small extent-2, To a moderate extent-3 and, To a great extent-4. To compare the responses of the two categories of respondents in the study, the methods of simple ANOVA analysis of variance, Fisher test (F), and Bonferroni t-test were used.

3. Perception of innovative Teaching/Learning Methods and instruments

Any TLM and tool have advantages and disadvantages, as well as the fact that each student involved in the assessment process has his own perception of them, depending on the skills and experiences acquired in the education process (Burlacu, 2020). The study aims to evaluate innovative TLMs and tools in relation to classical ones.

The statistical analysis of the respondent's perception of the innovative methods under study is presented in Table 1.

The answers of the respondents reveal, according to the average values, that both categories of respondents have an above-average position for the use of innovative methods. It is noted that the simulation method is the most agreed upon by the respondents (3.64), and the students from the O&H appreciate it as the main method of teaching/learning (3.77). Compared to the innovative methods, the classical method is appreciated the least by both categories of respondents (3.12 – students from NEC and 3.33 from O&H). No significant differences are found between the two categories of students.

Table 1. Students' Perception of TLMs

TLM	Mean	Std.dev.	Master's students		F	Sign. dif.
			O&H N=9	NES N=39		
Simulation	3.64	0.52	3.77	3.61	0.69	No

Discovery	3.60	0.57	3.66	3.59	0.12	No
Experimental	3.58	0.57	3.55	3.59	0.02	No
Classically	3.16	0.83	3.33	3.12	0.43	No

The statistical analysis of the perception of the two groups of respondents on innovative teaching tools is presented in Table 2.

Table 2. Students' Perception of Teaching Tools

Teaching tools	Mean	Std.dev.	Master's students		F	Sign. dif.
			O&H N=9	NES N=39		
Whiteboard	2.95	0.898	3.000	2.949	0.023	No
PowerPoint	3.354	0.699	3.111	3.410	1.348	Yes
Prezi	2.979	0.812	2.889	3	0.134	No
Videoclips	3.583	0.577	3.556	3.590	0.025	No
Interactive software	3.646	0.526	3.889	3.590	2.442	Yes

From the analysis of the averages of the five teaching tools, the use of videos (3.58) and interactive software (3.64) stands out in preference to teaching on the blackboard and with the help of "PowerPoint" and Prezi. From the comparison of the answers of the 2 groups, significant differences can be observed in the use of "PowerPoint" and interactive software: the students from O&H value "PowerPoint" less (3.11) than those from the NES, valuing interactive software more (3.88). The analysis regarding the use of tools for the use of didactic resources in the learning process is presented in Table 3. The most appreciated tool, by both categories of respondents, is the university's web platform (mean 3.72). Also, resources provided on sites with didactic content and those with didactic videos are appreciated, there being no significant differences between the appreciation of both categories of students.

Resources provided by AI-based information sites (2.72) and those from the university library (2.60) are perceived as below average by both categories of respondents.

Table 3. Learning Tools Students' Perception

Teaching tools	Mean	Std. dev.	Master's students		F	Sign. dif.
			O&H N=9	NES N=39		
University's Web Platform	3.72	0.49	3.77	3.71	0.10	No
University Library	2.60	1.10	3	2.51	1.43	Yes
Videoclips	3.41	0.73	3.55	3.38	0.38	No
Educational Sites	3.41	0.71	3.44	3.41	0.01	No
Educational Software	3.22	0.77	3.77	3.10	6.09	Yes
Artificial Inteligence Sites	2.72	1.12	3.22	2.61	2.18	Yes

4. Perception of the use of smart technologies

Smart technologies are increasingly used in both industry and education (Kiryakova, 2020). Table 4 presents three broad categories of smart technologies that have been analyzed.

Table 4. Smart Technologies Use Students' Perception

Teaching intelligent technologies	Mean	Std. dev.	Master's Students		F	Sign. dif.
			O. & H N=9	NES N=39		
AR and VR	3.56	0.74	3.66	3.53	0.21	No
Database analysis and modeling	3.60	0.61	3.66	3.59	0.09	No
Data collection	3.58	0.68	3.77	3.54	0.86	Yes

It can be seen that both categories of respondents appreciate above average the use of augmented reality (AR) and virtual reality (VR) in the educational process, as well as data collection, analysis, and modeling technologies, such as machine learning. A difference in perception is observed regarding the given collection technologies namely, the students of O&H in relation to those of NES because the former use these technologies more in their field (mean 3.77 versus 3.54).

5. The perception of the beneficiaries' involvement in the education process

Six proposed activities were subjected to the study to find the involvement of beneficiaries from the maritime industry (Figure 1). The most appreciated activity, by both categories of respondents, is the development of a web platform for achieving communication between companies and the university environment (3.71), even though there is a significant difference indicated by the Bonferroni t-test (F=1.31). Also, the other activities proposed for evaluation are valued above average by both categories of students. Among these, the involvement of companies in research projects (3.63), the development of mentoring programs in which professionals are mentors for students, and the development of internship programs (3.60) stand out.

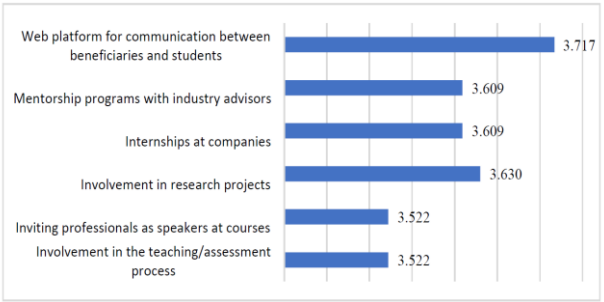

Figure 1. Students' Perception

6. Conclusions

As a result of the analysis, it can be concluded:

- The most suitable innovative TLMs for maritime postgraduate education are the methods of simulation and research that provide both competencies in the field studied and in the adjacent ones and competencies in the use of scientific web resources.
- Students prefer the use of videos, interactive software and tools that use web sources during teaching.
- Didactic learning resources are primarily provided by the university's web platform, but also by sites with didactic videos and those with didactic content. Sites based on artificial intelligence (e.g. GPT chat) and resources provided by the university library are less used by students.
- All respondents consider the use of the following intelligent technologies appropriate: augmented reality (AR), virtual reality (VR), database analysis and modeling technologies â, and intelligent data collection technologies.
- Most students consider the involvement of maritime industry beneficiaries very useful in the education process, through the development of a web platform for communication between the university environment and maritime industry beneficiaries, the participation of students in research projects, the development of mentoring programs with professional mentors from the industry, as well as the organization of internships within specialized companies.

Thus, it is concluded that the marine higher education system to offer specific skills, by implementing innovative methods and tools based mainly on the web, and on intelligent technologies in the field in order to be efficient and adapted to the current market requirements. Also, the involvement of beneficiaries in the training of students is important both for the permanent updating of the curriculum to the demands of the labor market and for the development of research within the universities.

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