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Adapting Maritime Education for the Autonomous Era: A Pilot Program as Approach for MASS Operator Training

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ABSTRACT: The technological advancements leading to fully autonomous transportation systems are already shaping the fleets of the future. Contrary to expectations, artificial intelligence and autonomous systems are increasing the demand for highly skilled crews and operators. Based on the EMSA report and a new non-mandatory International Code for Safety for Maritime Autonomous Surface Ships (MASS Code), it is justified that MASS operators require STCW training as a baseline. These findings underscore the pressing need for Maritime Education and Training Institutions (METIs) to work diligently to promptly update their curricula. As part of a coordinated initiative to incorporate MASS into MET, four European METIs have collaborated to develop a new Blended Intensive Programme. This paper introduces the aforementioned course implemented as a pilot program in the second semester of the 2024-2025 academic year. Findings can guide the development of future curriculum, support the standardization of training programs across METIs, and help to establish international recommendations for maritime education in the era of autonomous systems.

1 INTRODUCTION

The current convergence of maritime technology and artificial intelligence (AI) is rapidly transforming the global shipping industry. The development of autonomous ships follows a progressive trajectory from conventional manual control toward the fully autonomous. However, all technological innovations require updated education and training to cover the demands of new job creation [1]. While the International Maritime Organization (IMO) [2] is engaged in meeting the goal to include autonomous ships in existing regulations, maritime education and training institutions (METIs) should be upgrading their programmes to prepare the professionals of the future. This means specialised and qualified staff who are capable of handling all new technologies and developments, both on board and ashore.

As per the latest report by EMSA [3] in relation to future crews and operators' tasks, it is evident that, beyond the competences mandated by STCW Convention programmes, the development of supplementary ones will be essential in meeting the changing demands of emerging maritime professions and future occupational roles. These new skills, knowledge and personal and social abilities are being captured and listed as groundwork for future training programmes that are still under development.

Several researchers have made efforts to identify new competences and topics to be taken into account as part of future MET programmes [4,5]. For instance, Sharma and Kim evaluated the significance of the existing 66 knowledge, understanding and proficiency (KUP) requirements in STCW table A-II/1 and concluded that 26 of them were less relevant in remotely controlled maritime autonomous surface ships (MASS) operations and that 11 new competences and cognitive skills should be included [6,7]. In another study, Kim and Mallam revealed that the main determinants for reliable MASS operations are the ability to apply decision-making techniques, handle large amounts of data and maintain situational awareness [8]. Very similar findings emerged from Saha's research [9], which proposed key competences for future shore control centre operators, with the three essential ones being system understanding, communication and technical knowledge, and maritime skills. Nasur and Bogusławski [10] identified autonomous merchant ships as a topic that is rarely addressed in maritime curricula and emphasised the importance of including comprehensive coverage of MASS in METIs.

As pointed out in previous studies [11,12,13], the suggestion to remove some competences might not be the main target. Conversely, including new topics and/or improving existing ones to adapt to new developments is the path ahead for future programmes. However, there is still much work to be done regarding maritime education and training in the context of unmanned ships. Several European maritime educational institutions have already incorporated autonomous shipping concepts in their curricula while the rest are trying to gradually incorporate similar fundamentals in their training programmes. For instance, Novia University of Applied Sciences (Finland) and Nikola Vaptsarov Naval Academy (Bulgaria) have already taken concrete steps in this direction. Others have contributed as research partners in various European projects—for example, Aalborg University (Denmark) in the AEGIS project [14], and the University of Strathclyde, Glasgow in AUTOSHIP [15]. Notably, the University of South-Eastern Norway has collaborated with DNV, Wilhelmsen and Kongsberg on projects related to MASS management, including the development of future training courses for remote control operators, which is particularly significant. Most of these institutions maintain close ties with companies developing technologies for autonomous vessels, granting them access to cutting-edge simulators and emerging remote control systems. Through their research, projects and academic initiatives, they are actively shaping the next generation of maritime professionals.

With the idea of developing a future curriculum focused on MASS, an Erasmus+ blended intensive programme (BIP) has been designed by four European universities: the University of South-Eastern Norway (USN), the Universitat Politècnica de Catalunya (UPC) in Spain, the University of Zadar (UNIZD) in Croatia and the Antwerp Maritime Academy (AMA) in Belgium. It involved a comprehensive global vision of the sector from a technical and operational point of view, with the objective of promoting new training content.

This represents an initial step toward the development of a revised maritime curriculum that is more closely aligned with the projected needs of the future maritime industry. The main objective of this contribution is to introduce the insights and outcomes of this newly developed BIP that has been designed to integrate MASS into current maritime training and guide the development of future programmes.

Following the introduction and background section (Section 1), the methodology applied in this study is described in Section 2. The results are presented in Section 3, including a student pre-survey analysis and the course programme description. Then, the implementation of the BIP course is analysed as a pilot (Section 4). Finally, the discussion, conclusions and the synthesis of the findings are presented in the final sections (Section 5 and Section 6).

2 METHODOLOGY

The methodology followed in this study is shown in Figure 1.

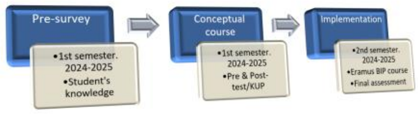

Figure 1. Methodology of the study

In the initial phase, a pre-survey (questionnaire) was conducted among bachelor's and master's students from three METIs to assess students' knowledge and interest in MASS, namely, the AMA, the UNIZD and the UPC. The questionnaire was set at the beginning of the first semester of the 2024-2025 academic year. The questions were divided into four sections: a) the respondents' profiles; b) their knowledge of autonomous shipping; c) their views on the social and ethical implications of MASS and d) the importance of including autonomous shipping for updated educational and professional development. From the results of the questionnaire, a conceptual course was designed during the first semester of the 2024-2025 academic year. Afterwards, a new course entitled "The Fundamentals of Maritime Autonomy: Principles and Technological Concepts" was implemented in the spring of 2025 (February–May 2025) as a pilot. This pilot course allowed materials and assessment methods to be tested. Feedback from participants was collected and analysed for further improvement. The pilot course was divided into four modules and included various activities and a final assessment. To evaluate the course, students completed both a pre-test and a post-test, which included identical questions to facilitate a comparative analysis of the results. Additionally, a final questionnaire was administered to gather feedback on various aspects of the course's implementation, including its structure, instructor performance and the relevance of the associated module content. The analysis of the data was both quantitative and qualitative. The outcomes of the implementation of the course were analysed to gather information on participants' opinions and possible improvements to enhance future programmes in relation to MASS.

3 RESULTS

3.1 *Pre-survey*

A total of 233 complete responses and 84 partial ones were collected from students across the three universities (50.64% from the AMA, 36.48% from the UPC and 12.88% from the UNIZD). Of the students, 94.42% were under 30 years old and just 1.29% were over 50, and 81.12% of them defined themselves as male and 18.03% as female, which aligns with the typical gender distribution in METIs. Regarding their academic background, 75.11% were enrolled in nautical bachelor's degrees (BSc), 18.45% were from marine engineering bachelor's degree disciplines and 6.44% were enrolled in master's degrees (MSc); 36.91% were finishing their studies.

The sample reflects a broad spectrum of students in terms of gender, age, academic background and academic career stage, which provides a comprehensive basis for the initial situation regarding students' interest in MASS.

The second set of questions focuses on students' knowledge of autonomous shipping to identify whether there is a need to increase their understanding and skills on this topic.

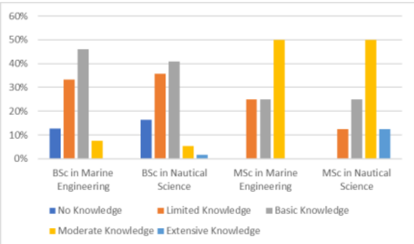

Figure 2. Distribution of the familiarity with the concept of MASS and/or remote operations centres (ROCs) (based on participants' responses)

As we can see in Figure 2, out of 233 responses, over 50% reported modest or no knowledge of MASS and/or ROCs, while 40% were somewhat familiar with them, with just a few answers demonstrating relevant knowledge of the subject. Of the master's students, 50% had moderate knowledge of these subjects, which is likely due to most of them having a professional background as well as higher education and training that involve more knowledge of new technologies.

The third part of the questionnaire looks into the social and ethical implications of MASS. As shown in Figure 3, most of the participants were interested in social, economic and environmental awareness and education on MASS.

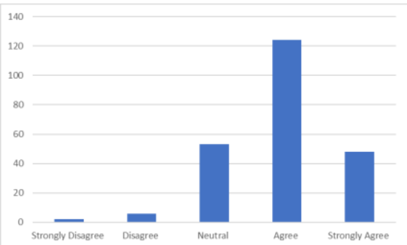

Figure 3. Number of participants who agree that they should receive education on social, economic and environmental impacts (based on participants' responses)

An overwhelming majority of the students (96.5%) agreed on the importance of incorporating these topics in their curricula. Of them, 67% were from the bachelor's degrees, with the responses from master's students being more neutral.

Finally, the fourth set of questions looks into the relevance of receiving more educational and professional training in relation to MASS. As shown in Figure 4, more than 96% of participants agreed that knowledge related to autonomous vessels should be included in their current degree programmes and that incorporating these subjects in their programmes was important.

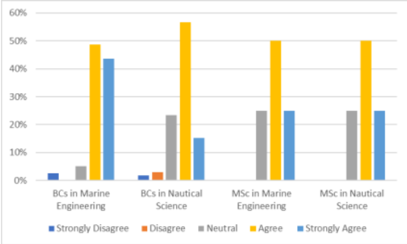

Figure 4. Distribution of participants who agree that knowledge about autonomous vessels should be incorporated in their degree programmes (based on participants' responses)

These preliminary results highlight the importance and relevance of the initiative to develop new programmes, courses and training that meet students' need to be able to respond to the changing needs of the maritime industry of the future.

To address the need for foundational knowledge in the field of autonomous vessels, the creation of an introductory course offering a broad overview of contemporary developments, regulatory frameworks, ongoing projects and other relevant aspects of autonomous vessels is fully warranted.

3.2 *Model course proposal*

Based on the need detected, a new conceptual course was designed. The main characteristics of this course are shown in Table 1.

Table 1. Framework of the course

Title	The Fundamentals of maritime autonomy: principles and technological concepts
Duration	12 weeks
Objectives	Acquire knowledge of concepts, technologies and tools regarding MASS. Gain a broad view of degrees of autonomy and their implications. Gain an understanding of human factors related to the design of equipment, the integration of technology and autonomous operations. Acquire the ability to identify and understand cybersecurity threats. Acquire the competences and skills needed to handle remote control operations in a range of simulation scenarios.
Teaching methodology	Theory: Blended teaching and flipped classroom. All the theoretical content is provided through digital resources such as on-line classes and seminars. Gamification to reinforce understanding through activities and answering questions; Real problem solving as part of the activities in class. Presentation to students of near-future professional problems to initiate a process of enquiry aimed at finding possible solutions. Practice: Cooperative learning is used in activities that are designed to create a highly structured and organised learning environment that requires everyone's active participation.
Type	Blended elective course
Structure	4 modules

3.2.1 *Course content*

The course combines theoretical classes and practical experiences and is divided into four modules. Each theoretical module spans a three-week period (totalling 12 hours) via online sessions. The Moodle platform was used to support and facilitate interaction. The modules' content is summarised below.

Module 1: Introduction to MASS and ROCs. The initial module provides students with foundational knowledge related to autonomy and autonomous vessels, covering topics such as degrees of autonomy (DA), levels of autonomy (LOA) and human-automation interaction (HAI). An overview of current regulations and the work of the Maritime Safety Committee (MSC) is addressed and the non-mandatory MASS code is presented. The remote operations centres' features, facilities and organisation are presented together with knowledge of ongoing research projects worldwide. To end this module, the STCW competences related to MASS are analysed with students and the advantages and disadvantages of current changes are listed. Additionally, this module includes seminars on the MASS code and legal framework, the application of artificial intelligence (AI) on vessels and the design of an autonomous prototype. These multidisciplinary seminars help students to increase their comprehension of the topic. Furthermore, group exercises and discussions assessments prepare students for the following modules and enhance their comprehension.

Module 2: Human factor, human-machine interaction and cybersecurity. Students are introduced to the main concepts related to human factors and situational awareness in the context of autonomous shipping by examining the role of the operator in remote settings and the influence of attention, decision-making and workload on system safety. The principles of user-centred design and usability frameworks are addressed, focusing on their relevance for human-machine interaction (HMI) development and remote operations centres (ROCs) operations. Communication flows and information-sharing strategies within ROCs are analysed to identify best practices and potential challenges in maintaining efficient coordination.

A general introduction to maritime cybersecurity is presented, covering common types of cyberattacks and how they can affect the interconnected systems used in MASS. The importance of cybersecurity in ensuring safe MASS operations is emphasised. Students are introduced to basic principles of prevention, detection and response to cyber incidents in a remote control environment. To end this module, students reflect on the interaction between humans and automated systems and the associated risks and responsibilities. Seminars on usability, human error and cybersecurity scenarios help students to increase their comprehension of the topic.

Module 3: Operational aspects of unmanned and autonomous vessels. This module covers the following sections: applications and operational assumptions in the design of autonomous vessels; electronic navigation and communication support systems; ship dynamics and manoeuvring characteristics of vessels; technological improvements of ports and terminals; economic perspectives in autonomous maritime transport; aspects of navigation safety, environmental protection and pollution control; and STCW and non-STCW training requirements for autonomous vessel operators.

In the concluding part, students are organised into small groups and assigned seminar topics that mirror the lecture's thematic structure. Each group is responsible for preparing a focused section of a collective report and presenting its findings in class. Each participant defends their contribution during an open discussion, fielding questions from peers and the professor. This approach is introduced to cultivate critical engagement with the material, foster collaborative research skills and ensure that all students thoroughly understand maritime autonomy's operational dimensions.

Module 4: Practical and basic simulation on MASS and ROCs. This module constitutes the face-to-face and most practical part. Students have the opportunity to visit a remote operations centre and an autonomous vessel to put all the knowledge acquired in the previous modules into practice. Additionally, they have simulation lessons in several operational situations and with differing autonomy levels. The principal structure is as follows: visit to ROC simulator; visit to MASS vessel; demonstration on maritime autonomy; robot navigation exercises; and final assessment and group presentation.

3.2.2 *Course assessment*

Course assessment comprises several assessment methods, such as a continuous and formative appraisal. Each theoretical module makes up 20% of the credit load. The remaining 40% is attained at the end of the course in a final symposium with a group presentation and a discussion session conducted during the face-to-face module.

The final assessment is structured into distinct stages to foster active and cooperative learning. Initially, each student engages in an individual preparation stage, during which they independently formulate questions and develop responses. This is followed by a collaborative group session in which students consolidate their individual contributions. Within the group, participants are required to organise, compare, categorise and critically evaluate all proposed answers in order to identify the most relevant and high-quality responses. These selected responses are subsequently presented to other groups and submitted for evaluation by the instructors.

This pedagogical framework promotes cooperative learning—a well-established instructional approach that is known to enhance cognitive development, deepen conceptual understanding and foster the acquisition of both disciplinary knowledge and cross-disciplinary skills such as critical thinking, communication and teamwork.

Attendance is systematically recorded and constitutes a compulsory component of students' final assessment.

3.2.3 *Course competences*

A list of competences and related KUPs is shown in Table 2.

Table 2. List of course competences

Competence	Knowledge, understanding and proficiency	Assessment	Assessment criteria
Fundamentals of Maritime Autonomy	Ability to identify degrees of autonomy Knowledge of the fundamentals of autonomous vessels Knowledge of the fundamentals of remote operations centres Ability to analyse regulations governing autonomous vessels Ability to analyse the new competences related to autonomous vessels Knowledge of the fundamentals of the MASS code	Assessment of evidence obtained from theoretical and practical demonstration or examination	Legislative requirements, fundamentals and basic contents are correctly identified.
Identification, prevention and mitigation of cyber attacks	Ability to analyse the human factor in relation to autonomous shipping Knowledge of the fundamentals of user-centred design and usability frameworks for HMI design and ROC operations Ability to identify and understand appropriate communication and information sharing in ROC operations Ability to identify, prevent and mitigate cyber-attacks'	Assessment of evidence obtained from theoretical and practical demonstration or examination	Fundamentals and basic contents are correctly identified.
General remote control operations of the vessel under navigation	Knowledge of the applications of and operational assumptions in the design of autonomous vessels Ability to operate electronic navigation and communication support systems Knowledge of ship dynamics and manoeuvring characteristics of autonomous vessels Knowledge of the technological improvements of ports and terminals and the economic perspectives of autonomous maritime transportation Ability to establish and maintain navigation safety, environmental protection and pollution control	Assessment of evidence obtained from theoretical and practical demonstration or examination	Fundamentals and basic contents are correctly identified.
Control of sensors and automation systems	Handling and manoeuvring ability Ability to operate an autonomous vessel in different situations Ability to communicate and handled dangerous situations Leadership and teamwork	Assessment of evidence obtained from practical demonstration or examination in an approved simulator training session	The handling and manoeuvring of the vessel comply with procedures to maintain navigation safety. The handling of dangerous situations complies with international regulations and normal procedures. Communications are clearly understood and consistently successful.

4 PILOT COURSE

Based on the proposed course, a blended intensive programme (BIP) was implemented by four maritime education and training institutions (METIs) during the second semester of the 2024-2025 academic year (February–May 2025). A BIP is an Erasmus+ short, intensive programme that uses innovative ways of learning and teaching, including the use of short online cooperation challenge-based courses that combine online collaboration and a brief physical mobility in which students meet face-to-face [16].

4.1 *Course specifications*

As a BIP, this course is divided into two complementary components: a theoretical segment and a practical one. The theoretical component is delivered through the systematic presentation of key topics, aimed at establishing the conceptual, normative and doctrinal foundations of the discipline. In parallel, the practical component is developed in a coordinated manner through student-led resolution of applied exercises and case studies, designed to reinforce and contextualise the theoretical knowledge acquired. This BIP is an elective course with a credit load of 6 ECTS credits, in accordance with the European Higher Education Area (EHEA) framework.

The BIP course partners are the following ones:

- The University of South-Eastern Norway (USN), the host university, which has a competence framework, training programme and pilot course for land operators of autonomous ships to create a specific training programme for qualified navigators to become land-based operators of autonomous ships.
- The Barcelona School of Nautical Studies (FNB) of the Universitat Politècnica de Catalunya, in Spain, the coordinator, which has projects and doctoral research related to MASS under way.
- The Maritime Department of the University of Zadar (UNIZD), in Croatia, a partner institution, already offers an undergraduate course on the dynamic positioning of marine vessels and a graduate course on MASS. The Department is also involved in numerous research projects on autonomous navigation, digital innovations, artificial intelligence and modern seafarer training programmes.
- The Antwerp Maritime Academy (AMA), in Belgium, a partner institution, which integrates MASS-related training and research through international collaboration, simulator-based learning and studies on the evolving role of the navigator, with a focus on the human element in autonomous ship operations.

The BIP´s schedule is shown in Table 3.

Table 3. BIP schedule

Week /Period	Module	Type	MET responsible
Weeks 1 to 3. 17 February-7 March 2025	Pre-test Module 1. Welcome to the BIP and introduction to MASS and ROCs Includes: - Seminar on autonomous navigation legislation in Spain. - Seminar on the application of intelligence in tugboats. - Seminar on the NASHI project. Design and construction of an autonomous LCC prototype.	Virtual	FNB
Weeks 4 to 6. 10–28 March 2025	Module 2. Human factors, human-machine interactions and cybersecurity	Virtual	AMA
Weeks 7 to 9. 31 March-25 April 2025	Module 3. Operational aspects of unmanned and autonomous vessels	Virtual	UNIZD
Week 10. 28 April – 2 May 2025	Deadline for course tasks/theory assessment	Virtual	FNB/ AMA/ UNIZD
Week 11. 05-09 May 2025	Module 4. Practical and basic simulation on MASS and ROCs and final assessment/post-test Final questionnaire	On-site	USN

Due to BIP funding requirements, there is a limit of only 20 students. However, two more students were sponsored by their university so finally 22 students were selected from the non-hosting universities: 6 from the FNB, 7 from the AMA and the last 9 from the UNIZD. Of them, 90% are younger than 30 years, and only 14% are women. Regarding their degrees, 50% are from the bachelor's degree in Nautical Science, 25% belong to the bachelor's degree in Marine Engineering, 25% are from the master's degree in Nautical Science and the rest are from the master's degree in Marine Engineering. Eleven professors and professionals offering seminars have made the implementation of this pilot course possible

4.2 *Course assessment*

The analysis of students' grades indicates a homogeneous academic performance, even though their backgrounds and profiles were diverse (see Figure 5).

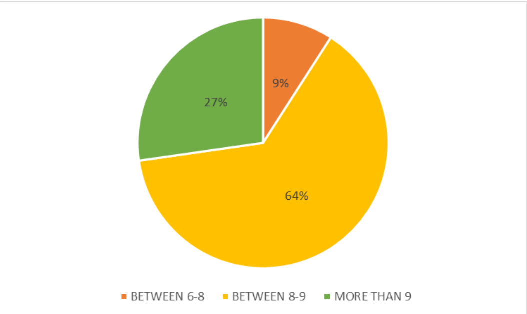

Figure 5. Students' final grades (based on participants' global assessment)

Therefore, these results are a very successful outcome for all the professors, as it proves that the content has been transmitted within a good framework and proper methods.

5 DISCUSSION

In order to analyse the achievements obtained by the students quantitatively, a post-test was conducted with the same pre-test questions. The responses obtained were analysed to determine whether there was any significant difference between the pre- and post-test results among the students that took the pilot course.

The main finding is that the goal of enhancing knowledge of MASS was achieved, as shown in Figure 6.

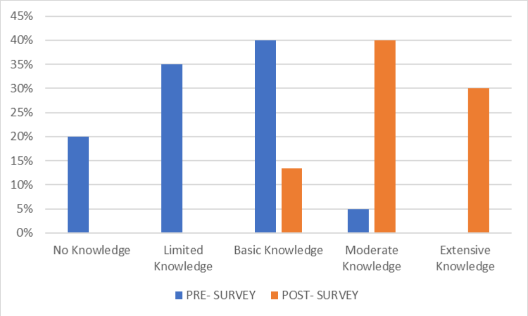

Figure 6. Distribution of familiarity with the concept of MASS and/or ROCs (based on participants' responses)

The results revealed that the implementation of the course brought notable changes in students' knowledge and perceptions.

Another relevant outcome emerged when participants were asked about receiving further educational and professional training in relation to autonomous vessels. As shown in Figure 7, the "Strongly agree" result on including knowledge related to autonomous vessels in their current degree programmes increased from 55% to almost 70%. It is important to emphasise that in both tests none of the responses came out as a negative answer.

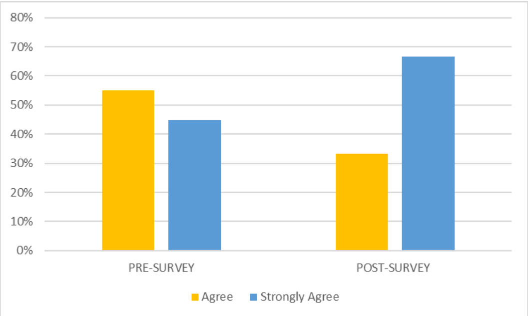

Figure 7. Distribution of participants who agree on the need to include knowledge about autonomous vessels in their degree programmes (based on participants' responses)

The result shows that, the more they know about autonomy, the more they realise that there is a need to include this topic in their degrees. This highlights the need for enhanced efforts to expand the range of topics and subjects related to MASS and ROCs, thereby enabling a greater number of students to attain comprehensive and in-depth knowledge in this field.

At the end of the course, a final questionnaire was sent to all participants, with the aim of qualitatively analysing satisfaction with the pilot course, including aspects such as structure, professors, academic aspects and activities.

To highlight some of the results obtained, as shown in Figure 8, 90% of the students "Agree" and "Fully agree" that they are satisfied with the academic aspects of the theory modules.

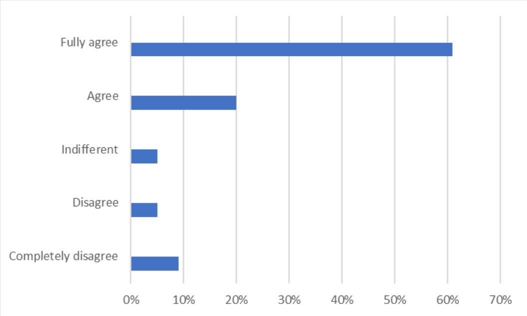

Figure 8. Satisfaction with the academic aspects of the theory part (based on participants' responses)

Similar results were achieved when respondents were asked about the seminars held during the initial weeks of the course.

Regarding the practical part, as shown in Figure 9, student satisfaction exceeded 90% for most of the activities performed.

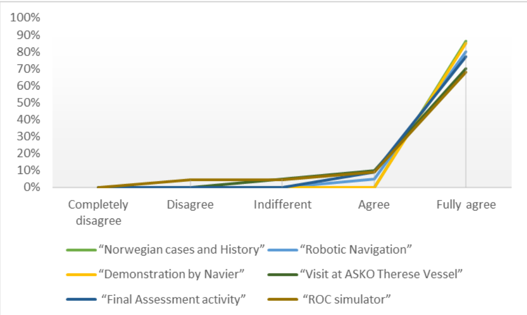

Figure 9. Satisfaction with the practical activities (based on participants' responses)

Therefore, it is relevant to say that the course was very satisfying and rewarding for most of the students.

As part of the qualitative analysis, how to enhance students' understanding of these new topics is an important matter to be discussed. The availability of appropriate materials and the equipment employed, the capacity of the professors, the seminars and the agility and flexibility with which the course can be adapted to developments are some of the key points to be evaluated and upgraded based on the outcome.

Regarding materials and equipment, the virtual training plan for the theory part, which included group exercises, online discussions and seminars by professionals related to the MASS field, gave students a broader view and better context of the current status of the matter. Students were surveyed regarding the perceived adequacy of the virtual platform, audiovisual resources and supporting technological infrastructure; Figure 10 shows that between 70% and 80% of them considered the tools used to be fully appropriate.

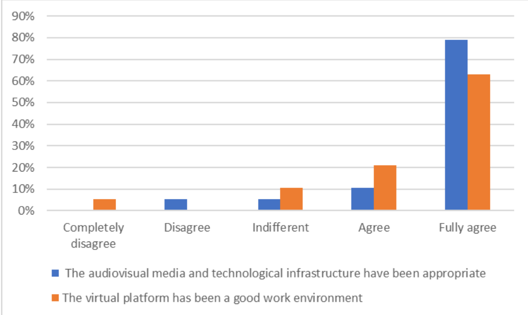

Figure 10. Students' opinion on the virtual platform, audio-visual media and technological infrastructure (based on participants' responses)

Overall, the instructors' evaluations revealed that student satisfaction with professors and seminar leaders exceeded 80%.

As for the open questions about what the students would improve or change, most of the answers were in respect of the practical part. The students suggested more practical activities and more activities in general as the main aspects to be improved, as well as including practicals in the ROC simulators to emulate a range of autonomous navigation scenarios. This aspect is surely the main one to reinforce on upcoming courses as it will enhance the context of the course.

These results suggest that students not only expected to deepen their knowledge of this topic, they also wanted to develop their skills at the operational level. This reflects the aspiration to update their curricula in relation to MASS.

As a result of their feedback, while waiting for the outcomes from the next master's degree sessions [2] and future courses from the EMSA [3], METIs should concentrate on those new topics to be developed and welcomed in order to adapt and update their curricula to technological improvements and the future specific needs of the maritime sector.

In relation to the BIP, it will have to be updated continuously, and more activities and practical hours must be added.

6 CONCLUSIONS

The main goal of this paper is to propose a new training approach that ensures a comprehensive preparation of students for the complexities of working with MASS. To achieve this objective, new content in the maritime curriculum was designed to address the following key areas:

- MASS concepts, technologies and fundamental principles that power these vessels.
- Autonomy Levels and being able to evaluate the operational, legal, ethical, and safety implications of each one, preparing students for decision-making in real-world scenarios.
- Human factors and integration of human operators with automated systems.
- Cybersecurity, network systems and communication technologies.
- Remote control operations and e-navigation.

By addressing these areas in the curriculum, the training will prepare students to meet the challenges posed by MASS technology, ensuring they are well equipped to contribute to the industry's future developments. Students will acquire the ability to think critically about the integration of technology, understand the broader sociotechnical implications and confidently navigate the new maritime landscape.

In order to expand this knowledge in a general way within the maritime curriculum, an option would be to include this training in Section B of the future STCW as a guideline on the minimum knowledge to be achieved on autonomous vessels, with the flexibility to be updated and adapted to the sector's specific needs as it changes and develops.

The initiative to introduce new topics into future maritime bachelor's and master's degree programmes is indeed a forward-thinking strategy. While the process may take time, it is essential to ensure that existing curricula are reviewed thoroughly and updated to reflect the rapid advancements in MASS. As technology continues to evolve, staying current with new developments will be crucial in maintaining the relevance and quality of educational programmes. Once basic knowledge is acquired, additional competences and topics should be added to future courses, as previously suggested by other researchers [6-10]. Skills such as teamwork, quick thinking, confidence and self-discipline might be important attitudes to be developed. Moreover, it is essential to introduce new subjects or upgrade and update current ones. It is important not only to add new subjects but also to address emerging skills and competences that will be vital for future maritime professionals. This includes knowledge on remote control operations, autonomy systems, data analysis, cybersecurity and the integration of AI and machine learning in maritime technologies. We should ensure that future seafarers are well prepared, whether they continue their roles on board ships or operate them remotely from control centres. This proactive approach will help prevent gaps in knowledge and equip professionals with the tools needed to adapt to future challenges and opportunities in the maritime industry.

The focus on upgrading existing degree programmes is the key to staying ahead of industry developments, anticipating future trends and effectively preparing students for the evolving landscape of maritime operations.

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