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Original scientific paper

Erasmus Project BeEmTel – "Advancing Telemedicine for Non-Communicable Diseases: Simulation-Based Approaches and e-Learning Platform Evaluation"

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Abstract

Introduction. The key topics of e-health are education and training. The European Erasmus project BeEmTel aimed to create an innovative European curriculum dedicated to Telecare for chronic diseases and emergencies through educational tools based on an e-learning platform and on remote simulation techniques.

Aim. To describe the experience regarding the introduction of an online telemedicine and telesimulation course applied to chronic diseases on some degree and academic career courses.

Methods. The online course has lasted from May 15, 2023 to January 15, 2024, on the e-learning Moodle platform managed by Simnova. The students' population came from the nursing and medical faculties or departments of the four Partner Universities. The e-course has been structured into three sections: Non-Communicable Disease & Emergency, Health Simulation & Telecare, and New Forms of Proximity, with video lessons and resources, and a quiz area. Two immersive weeks have been reserved for a selected group of students. For the evaluation of the e-learning platform and the simulation method, we have referred to the first two levels of Donald Kirkpatrick's model: user feedback, linked to the student's reaction and level of satisfaction with the educational activity, and learning content, concerning learning and knowledge assessment.

Results. Among 394 participants, 38% have consistently attended the course, following a total of

57 theoretical lessons and 14 lectures using a telesimulation/telemedicine approach, and 31% have responded to the survey. Most of them have found the topics interesting (93.4%) and the lessons clear (81%), the platform interface has been considered user-friendly, although with certain practical problems; 91% of learners have been satisfied with the course overall. In terms of the two immersive weeks, all participating learners have been satisfied with the general organization. When analyzing the measures of association considering both degree course and nationality, only one association was statistically significant ("Do you think telemedicine courses should be integrated into your degree program?", Chi-squared test *p*-value=0.013).

Conclusions. The BeEmTel Erasmus+ Project has emerged as an innovative educational experience, effectively introducing the concept of telemedicine to healthcare students across different countries and academic disciplines, irrespective of their previous background or attitudes. Students have demonstrated strong receptiveness to this approach. The student audience has found the type of instruction useful in preparing for careers in the healthcare field. Notably, both in-person medical simulation and "telesimulation" have been proved to be effective pedagogical practices.

Introduction

The Covid-19 pandemic revealed the weaknesses of healthcare systems, especially in relation to vulnerable patients' care, and vocational training system, which remains unable to tackle the significant challenge of reforming the treatment and monitoring methods for chronic patients (1, 2). Various non-communicable diseases (NCD) are associated with a progressive reduction in functional capacity, leading to a persistent need for long-term care. At the European level, these diseases account for about 80% of mortality causes in people over 65 years old (3). Efforts to contain the Covid-19 pandemic have highlighted the need to improve the quality of care for NCD patients and mitigate the negative impact they have not only on patients but also on their families and society. To ensure consistent and high-quality support for NCD patients, their families and caregivers, it is necessary to decentralize medical care at the territorial level (4). In this ever-approaching future scenario, the new profile of a healthcare and social care professional must include additional advanced skills. Doctors, nurses, psychologists and psychiatrists will increasingly require multidisciplinary training that includes digital skills and more specific, practical and clinical competencies.

There are many definitions of competence. The most widely used formulation is the one proposed by G.O. Klempt in 1980 (5), taken up by Boyatzis (6) and then by Spencer&Spencer (7). Competence is "an intrinsic individual characteristic that is causally related to effective and/or superior performance in a task or situation and that is measured against an established criterion". Being the result of knowing how to act, the production of a competent action derives from a shared responsibility between the individual himself/herself, the management, the work context and the training programs. The main skills to be acquired for telehealth include: patient safety and appropriate use, access and equity, communication, data collection and assessment, technology, ethical practices and legal requirements (8).

In recent years, literature has reported certain telemedicine teaching experiences among university students, which indicate that telemedicine is a valuable experience and that an elective course in the medical school curriculum may be a useful way of providing future physicians with an understanding of telemedicine itself (9, 10, 11). Waseh and Dicker emphasized how undergraduate medical education preclinical years can be central to telemedicine training and exposure (12); while many studies focused on the importance of telemedicine as a support to medical professionalism (13), there are still few experiences of its application in curricular teaching programs.

The majority of integration projects apply telemedicine during the clinical years, into the doctoring stream or during lecture time (14), or insert telemedicine into objective structured clinical assessments (15) through existing telemedicine hospital systems, rather than recreating new technology platforms (16). Two widely utilized teaching techniques in telemedicine are lectures, that provide the fundamental ideas, and patient interactions (17, 18), using video-based communication (19, 20), workshops (21), reflection

and reflective writing (20, 22). The instruments most frequently used to gauge customer satisfaction in this field are questionnaires and interviews (23), and pre- and post-test assessment scores (24).

Indeed, by incorporating telemedicine into students' curricula, medical schools can augment their education and teach them competencies for patient care, giving them access to this form of training, which can significantly reduce healthcare costs and increase patient access to care (16).

Aim

The aim of this article is to describe the experience regarding the introduction of an online telemedicine and telesimulation course applied to chronic diseases on some degree and academic career courses. The BeEmTel project is an ongoing Erasmus K2 Action project, which took the opportunity to anticipate practical teaching to future assistance scenarios in chronic disease management.

Methods

The European project for the Erasmus+ Key Action 220 "*Strategic Partnership Program BeEmTel - Beyond the Emergency. Telecare for Non-Communicable Diseases through Simulation Techniques*" comes from a partnership of five European Countries (Italy, Germany, Greece, Romania, and Croatia). The two specific objectives are the creation of:

1. the e-course;
2. the Digital Toolkit, available for free download from the BeEmTel website at the end of the project.

The e-course was initially designed for 250 participants and was completely free, but due to high demand, we extended enrollment by the end of registration on April 25, 2023. The students' population comes from the nursing and medical faculties or departments of the four Partner Universities; to enroll, students had to register on the Moodle platform by the deadline through the BeEmTel website (www.beemtel.eu). The Università del Piemonte Orientale (UPO) focused on the recognition of credits, Croatian, Greek, and Romanian students were easily engaged, as they came from active departments accustomed to Erasmus educational opportunities; however, Ludwig-Maximilians-University (LMU) is a large university offering many structured projects and courses, so the accommodation for a non-recognized pilot course such as BeEmTel through official and compensatory means was not satisfactory.

The BeEmTel e-course engaged forty-six teachers from the partner countries and institutions: eight Croatians, five Greeks, twenty-five Italians, four Romanians, and four Germans. The development revolved around the three main areas: NCD & Emergencies (Area 1), Health Simulation & Telecare (Area 2), and New Forms of Proximity (Area 3). Fifty-seven theoretical lessons were delivered, with a total recording time of 35:02:26 hours. Additionally, fourteen lectures were prepared using a telesimulation/telemedicine approach (Table 1), simulating clinical cases in virtual scenarios set in real-world environments (patient's home, outpatient clinic in a hospital, or general practitioner's office).

Table 1. **Teachers and duration of lessons, divided by thematic areas**

Thematic area	Number of teachers	Average lesson time	Total lesson time
Non-Communicable Diseases & Emergency	12	00:50:00	9:59:54
Health simulation and Telecare	19	00:58:32	17:33:38
New Forms of Proximity	10	00:49:53	7:28:54

There were three hundred ninety-four participants (Table 2): the majority were female (84.3%), while 31.8% were from Italy, followed by Romania (29.7%), Greece (22.1%), Croatia (14.6%) and Germany (1.8%); the majority (44.8%) was represented by students in

nursing, 44.0% in medicine, 2.7% in physiotherapy and 8.5% in other faculties (Computer Science, Pharmacies, Biomedical Laboratory Techniques, School of Engineering and Design - Human Factor Engineering), while 20.6% were first year university students.

The online course designed for the project started on May 15, 2023 on the e-learning Moodle platform managed by Simnova, and ended on January 15, 2024. Simnova is the Interdepartmental Centre for Innovative Didactics and Simulation in Medicine and Health Professions of UPO. It relies on the external company Media Touch to manage the Moodle technology, a widely used open source Learning Management System, ensuring usability, technical control, and the platform's maximum security and reliability.

The e-course is structured into three sections: NCD & Emergency, Health Simulation & Telecare, and New Forms of Proximity; each section contains video lessons and resources, including abstracts and supplementary materials, as well as a quiz section. Teachers prepared traditional video lessons and innovative telesimulation videos, since *showcasing* is a teaching method that gained prominence during the Covid-19 pandemic at leading universities worldwide (3, 25, 26, 27). The quiz area includes three self-assessment tests on each section, and a final quiz; passing the final quiz was required to finish the course.

The course held during two immersive weeks reserved for a selected group of approximately 50 students at two telesimulation centers in Novara and Munich took place between February and March 2024. Telesimulation refers to a new teaching methodology that combines telecommunication and healthcare simulation to provide effective educational support.

For the evaluation of the e-learning platform and the simulation method, we relied on Donald Kirkpatrick's model (28), which analyzes and evaluates the results of training and educational programs. This framework identifies four levels of observation to assess the effectiveness of training:

- user feedback, linked to the student/resident's reaction and the student's level of satisfaction with the educational activity;
- learning content, concerning learning and knowledge assessment;
- workplace behavior, that looks into this topic and considers whether education has influenced behavior;
- impact on the organization, to assesses the effect on outcomes by improving the quality of care and applying best practices.

We considered the first two levels of this model, since the last two are not fully applicable to our project data, using the following indicators:

1. User feedback: students received a survey, developed through a review of relevant literature (29, 30, 31, 32, 33, 34) and a discussion process among the authors. The survey comprised 20 items, with an estimated time of five minutes to complete, six items were dichotomous questions and 14 were multiple-choice questions with answers designed on a 5-point Likert scale.

The survey is available in Appendix A, and it includes the following sections:

(i.) integration of telemedicine in degree programs;
(ii.) previous experience with telemedicine courses;
(iii.) perception of telemedicine's future applicability;
(iv.) continued study of telemedicine;
(v.) experience with e-learning course issues;
(vi.) practical telesimulation experience;
(vii.) relevance and interest of the course content;
(viii.) course notifications and online platform;
(ix.) clarity of the professors' lessons;
(x.) consistency in course attendance;
(xi.) consistency in course attendance;
(xii.) factors affecting participation;
(xiii.) overall satisfaction;
(xiv.) preference for learning mode.

The questionnaire was available from January 4 to January 17, 2024; filling in the survey was mandatory to complete the course.

2. Learning content: asynchronous distance learning has a great advantage for traceability, which allowed us to do an evaluation of this area based on the following indicators:

- user-platform interaction (at least one access to the platform);
- user-content interaction (at least once access to each lesson);

- the percentage of completion of objectives (three modules);
- the number of tests completed;
- the average and total score for each test;
- the percentage of those who would have passed the test by having 60% of the correct answers.

Ethics

The authors state that this it is not a study requiring approval by the ethics committee, according to the national regulations of the Italian Ministry of Health, Decree of 26 January 2023. At the time of registration for the course, the participating students have given their informed consent for the processing of personal data, according to information pursuant to General Data Protection Regulation (EU) 2016/679, although the data from our study were anonymised.

Statistics

Considering the descriptive analysis, categorical variables are reported as frequencies and percentages; for continuous variables, results are reported as median and interquartile range (IQR). We performed several measures of association, including the chi-square test and Cramer's test (35, 36). Such tests analyzed the associations between the answers given by students in the e-learning survey and both their course study or their nationality. In all the analyses, a p value of <0.05 was considered as statistically significant. The software used for data management was Stata version 18.0 (Stata Corporation, College Station, TX, USA).

Results

Considering participation and proficiency, the majority (86.5%) declared willingness to participate to the courses, however, only a third of them completed the quizzes for the thematic areas (33.3% the test for NCD and Emergency and 32.3% for the other 2 areas). Median scores were 79 (IQR 67-89), 77 (IQR 67-84) and 77 (7-88), respectively. The final test was completed by 32.3% of the students and the median score was 87 (IQR 79-93). As a proxy, the association between achieving a passing grade on the final test and the aforementioned variables (degree course, nationality and willingness to participate) was studied. It was found that passing the test was associated with the student's nationality (Table 3).

User feedback

One hundred and twenty-one students filled in the survey (30.7%). Figure 1 reports the user's general opinion on telemedicine and their experience with the course. Only 16% of the students already attended a telemedicine course (Figure 1c). Most of them consider telemedicine an important topic, noting that it should be integrated in their degree program (91%) and that they would continue independent study of the topic to strengthen their knowledge (88%) (Figure 1a, Figure 1b). Students encountered problems in using the platform in 32% of cases (Figure 1d).

Table 2. **Characteristic of the respondents and their level of participation in the courses**

	All (N=394)	Croatia (N=57)	Germany (N=7)	Greece (N=86)	Italy (N=124)	Romania (N=116)
Sex	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**	**N (%)**
Male	62 (15.7)	4 (7.0)	2 (28.6)	8 (9.3)	24 (19.4)	20 (17.2)
Female	332 (84.3)	53 (93.0)	5 (71.4)	78 (90.7)	99 (79.8)	96 (82.8)
First language						
Greek	68 (17.4)	0 (0.0)	0 (0.0)	68 (79.1)	0 (0.0)	0 (0.0)
Italian	124 (31.8)	0 (0.0)	0 (0.0)	3 (3.5)	120 (96.8)	1 (0.9)
English	46 (11.8)	2 (3.5)	1 (14.3)	15 (17.4)	4 (3.2)	24 (20.7)
Romanian	91 (23.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	91 (78.4)
German	6 (1.6)	0 (0.0)	6 (85.7)	0 (0.0)	0 (0.0)	0 (0.0)
Croatian	55 (14.1)	55 (96.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Faculty						
Medicine	165 (44.0)	0 (0.0)	1 (33.3)	0 (0.0)	73 (59.9)	91 (80.5)
Nursing	168 (44.8)	55 (100)	1 (33.3)	49 (59.8)	47 (38.5)	16 (14.2)
Physiotherapy	10 (2.7)	0 (0.0)	0 (0.0)	10 (12.2)	0 (0.0)	0 (0.0)
Other faculty	32 (8.5)	0 (0.0)	1 (33.3)	23 (28.0)	2 (1.6)	6 (5.3)
Year of enrolment						
First-year	76 (20.6)	20 (46.5)	0 (0.0)	25 (29.4)	28 (23.0)	3 (2.6)
Second year onwards	245 (66.4)	19 (44.2)	1 (33.3)	39 (45.9)	77 (63.1)	109 (94.0)
Other (working student, etc.)	48 (13.0)	4 (9.3)	2 (66.7)	21 (24.7)	417 (13.9)	3 (3.4)
Participation and proficiency						
Willingness to LTTA activities	319 (86.5)	41 (95.4)	2 (66.7)	82 (96.5)	88 (72.1)	106 (91.4)
Test CDE completed	131 (33.3)	27 (47.4)	2 (28.6)	17 (19.8)	71 (57.3)	14 (12.1)
Test HT completed	127 (32.3)	26 (45.6)	2 (28.6)	16 (18.6)	68 (54.8)	15 (12.9)
Test NFP completed	126 (32.1)	26 (45.6)	2 (28.6)	16 (18.6)	68 (54.8)	14 (12.1)
Final test completed	127 (32.3)	26 (45.6)	2 (28.6)	15 (17.4)	69 (55.7)	15 (12.9)
	Median (IQR)	**Median (IQR)**	**Median (IQR)**	**Median (IQR)**	**Median (IQR)**	**Median (IQR)**
Test CDE score %	79 (67-89)	89 (78-93)	80 (7-89)	68 (61-74)	78 (7-87)	71 (59-85)
Test NFP score %	77 (7-88)	90 (83-94)	80 (71-88)	70 (63-79)	77 (71-86)	70 (66-83)
Test HT score %	77 (67-84)	88 (5-18)	75 (75-75)	71 (57-79)	76 (67-84)	69 (53-80)
Final test score %	87 (79-93)	92 (87-97)	81 (79-82)	83 (69-94)	87 (80-92)	81 (46-95)

Abbreviations: LTTA = Learning, Training and Teaching Activities; CDE = Chronic Diseases (Non-Communicable Diseases) and Emergency; HT = Health simulation and Telecare; NFP = New Forms of Proximity. Missing data (reported for the total sample only): Country: 4; First Language: 4; Faculty: 19; Year of Enrolment: 25; Participation: 25; Quiz CDE: 1; Quiz HT: 1; Quiz NFP: 1; Final quiz: 1.

Table 3. **Measures of association between final test and students' nationality, country and willingness to participate in frontal activities**

	Final test not passed	Final test passed	Chi-squared test	Cramer V
Faculty	**%**	**%**	***p***	
Medicine	9.0	91.0	0.804	0.09
Nursing	4.8	95.2		
Other faculty	0	100.0		
		Country		
Croatia	3.8	96.2	**0.015**	0.31
Germany	0	100.0		
Greece	6.7	93.3		
Italy	2.9	97.1		
Romania	26.7	73.3		
Willingness to participate in LTTA activities				
No	5.0	95.0	0.743	0.00
Yes	7.0	93.0		

Abbreviations: LTTA = Learning, Training and Teaching Activities.

Table 4. **Measures of association considering degree course**

	Medicine	Nursing	Other faculty	Chi-squared test	Cramer V
	%	%	%	*p*	
Do you think telemedicine courses should be integrated into your degree program?					
No	17.0	2.0	0.0	**0.013**	0.27
Yes	83.0	98.0	100.0		
The subjects covered in the course were useful for my future professional life					
Agree	57.6	42.4	66.7	0.310	0.20
Disagree	0	1.7	0		
Neither agree nor disagree	13.7	5.1	0		
Strongly agree	28.8	49.1	33.3		
Strongly disagree	0	1.7	0		
Do you prefer face-to-face or e-learning mode?					
e-Learning	59.3	49.1	100.0	0.156	0.18
Face-to-face	40.7	50.9	0		
Are you satisfied with the course overall?					
Very unsatisfied	0	6.8	0	0.455	0.15
Neither unsatisfied nor satisfied	6.8	5.1	0		
Satisfied	69.5	57.6	66.7		
Very satisfied	23.7	30.5	33.3		
Which of the following factors positively influenced your participation in the course?					
Topics	47.5	56.0	100.0	0.235	0.21
Teachers	15.2	25.4	0		
Platform interface	20.3	5.0	0		
Lesson Breakdown	8.5	6.8	0		
Other	8.5	6.8	0		

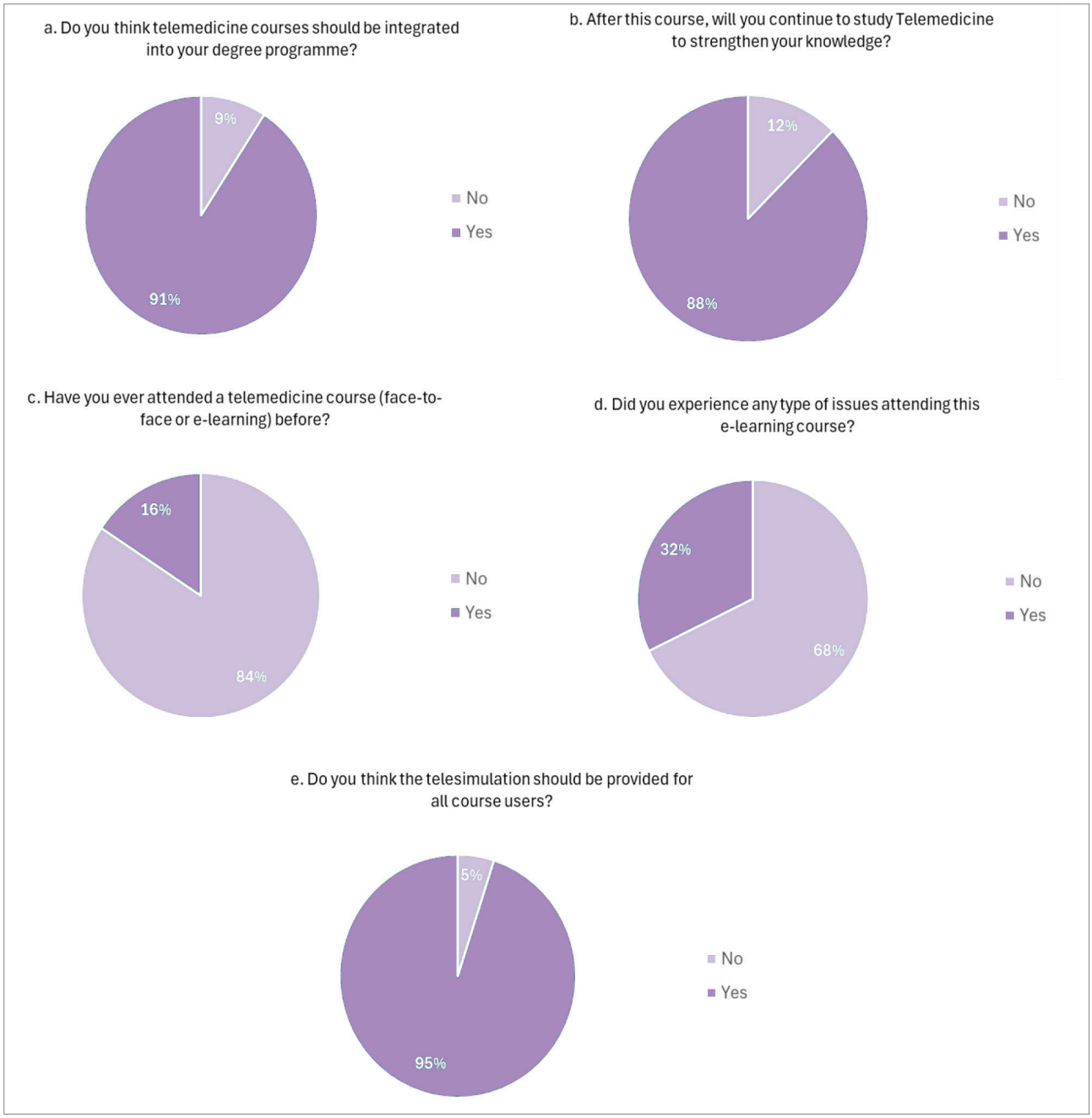

Figure 1. **User's general opinion on telemedicine and their experience (N=121)**

Considering learners' general opinion on the e-course (Figure 2), most of them found the topics covered interesting (93.4%) and in line with their knowledge (79.4%) (Figure 2c, Figure 2a). Students considered topics useful for their future professional life in 89% of cases (Figure 2d).

As for the user's experience on the course' organization (Figure 3), lessons were clear and easy to understand (81%) (Figure 3c), the platform interface was useful and user-friendly for 88% of them, although 17% of the students encountered practical problems with it (Figure 3e).

During the entire year, thirty-eight percent of the learners consistently attended the e-course (Figure 4d). Among the aspects that positively influenced the e-course, the topics covered were indicated by

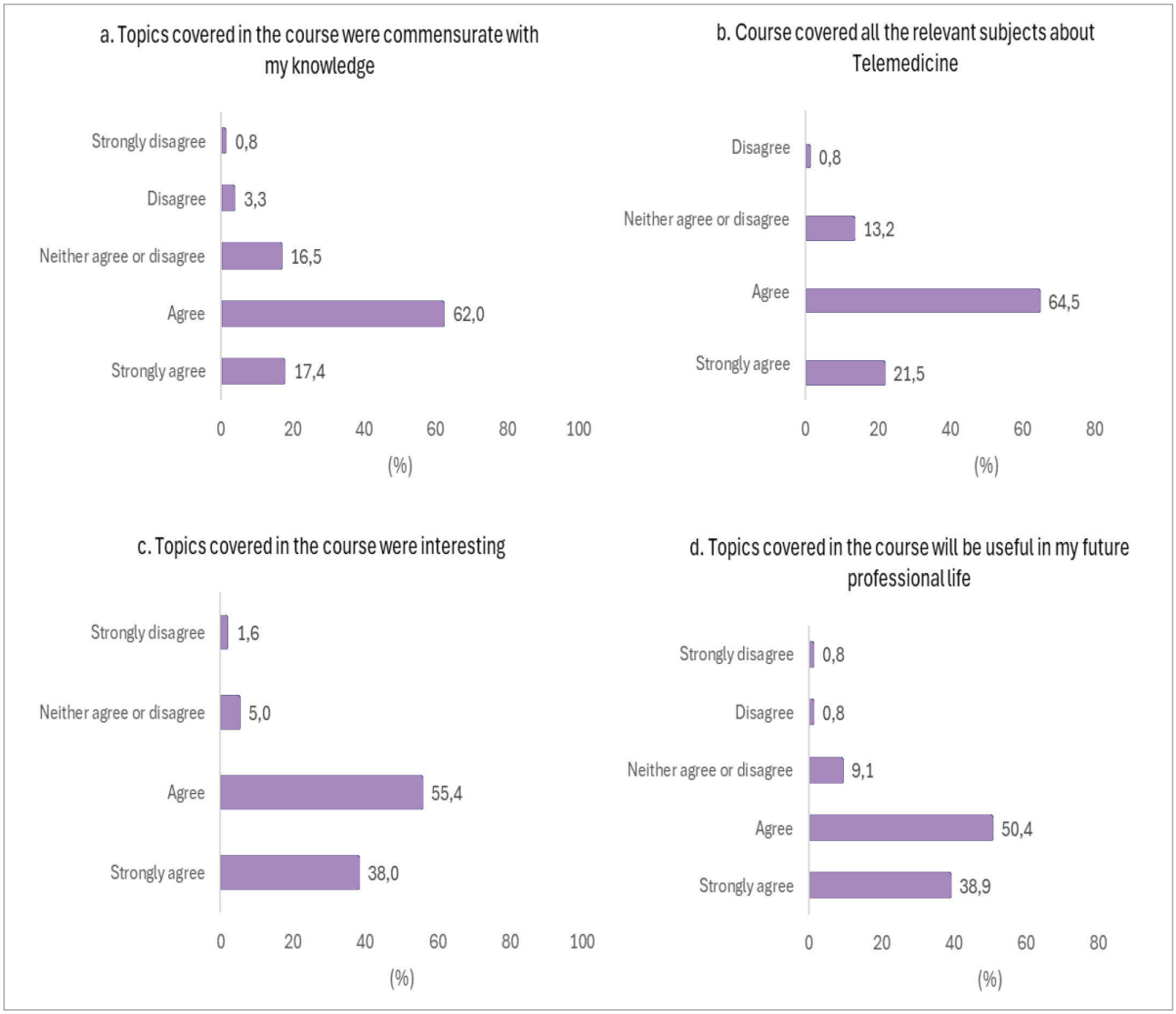

Figure 2. **User's general opinion on the BeEmTel course (N=121)**

52.9%, 19.8% preferred the teachers and 12.4% the platform interface (Figure 4b). Conversely, among the aspects that negatively influenced the course, lack of time to devote to the course was indicated by 67.8% (Figure 4a). Finally, 91% of students were satisfied or very satisfied with the course overall (Figure 4c). When asked if they prefer face-to-face or e-learning lessons, more than half of the students (55.4%) opted for the latter (Figure 4e).

When analyzing the measures of association considering both degree course and nationality (Tables 4 and 5), only one association was statistically significant ("Do you think telemedicine courses should be integrated into your degree program?"). A univariate analysis was performed to verify the effect that area of study, nationality and willingness to participate in activities may have had on the final test score. The analysis did not provide significant findings (results not shown).

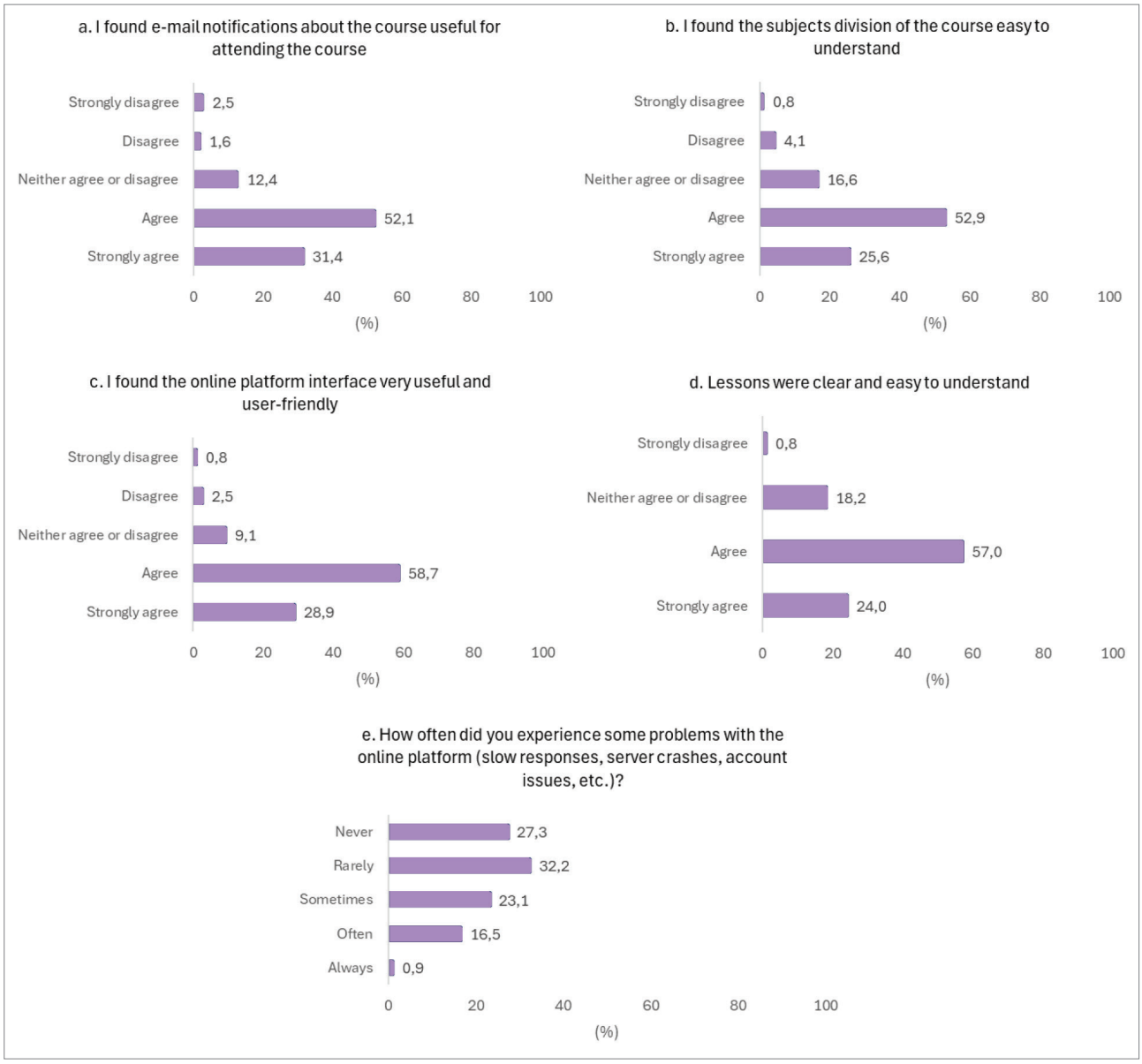

Figure 3. **User's experience on the course' organization (N=121)**

Discussion

Recent major advances in technology have made it easier and more cost-effective to connect patients and their family members/caregivers with remote health care providers. Many experiences tested the use of educational programs aimed at knowledge implementation, such as telesimulation and telemedicine, in the field of chronic diseases (8, 13), and the recent Covid-19 pandemic period Covid-19 was a major driver. However, traditional university teaching across Europe has lagged significantly behind in incorporating even rudimentary elements of telemedicine and telenursing into medical and nursing curricula (37). To address this gap in university education, the Erasmus BemTel project proposed a pilot online course with an immersive experience lasting one week. The BeEmTel project aimed to highlight the potential of digital health education in fostering skills such as digital literacy, patient safety, and communication in telehealth settings. This study,

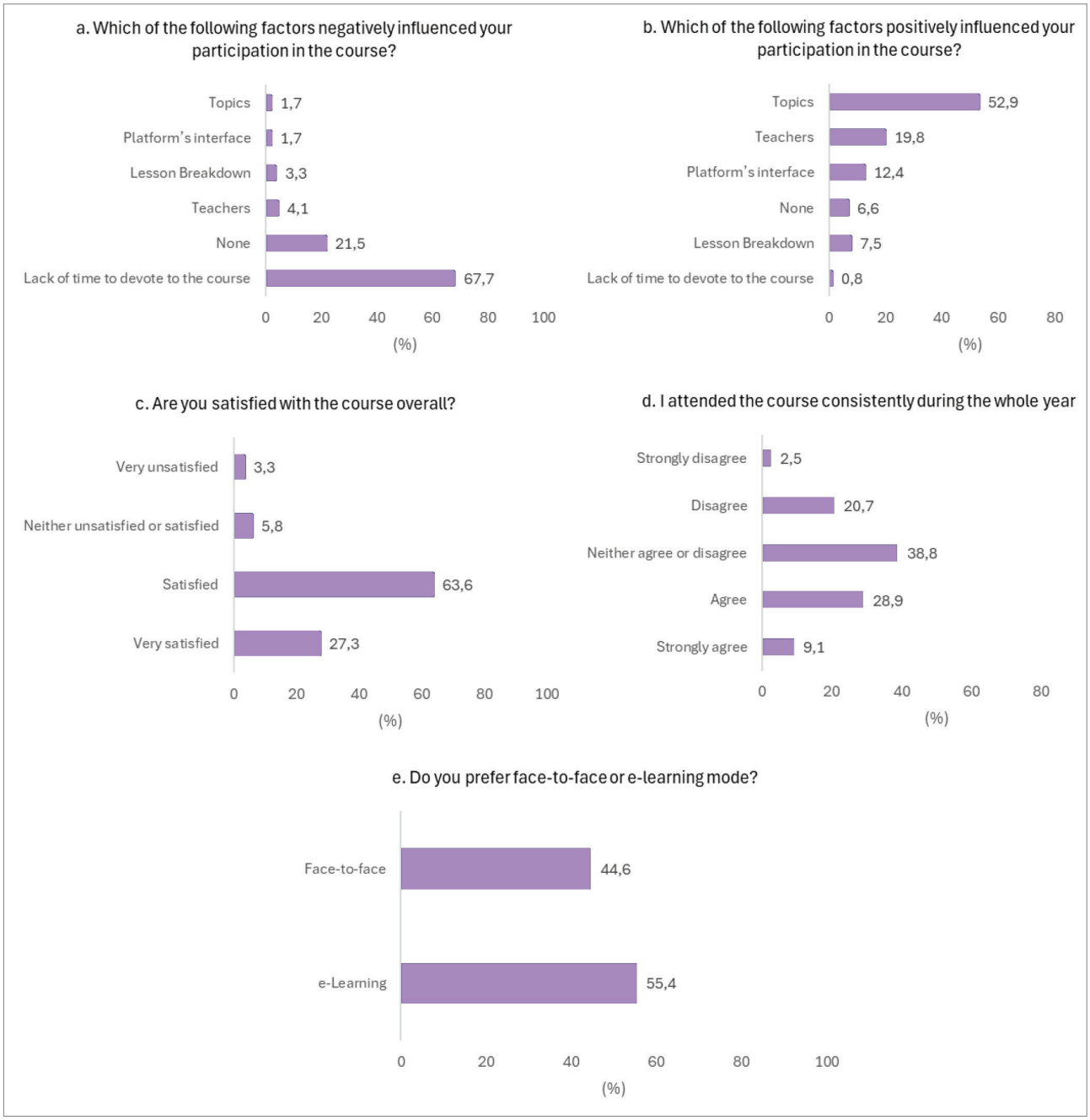

Figure 4. **User's overall opinion (N=121)**

conducted as a final evaluation of the BeEmTel project's outcomes, sought to determine whether integrating telemedicine and telesimulation courses into academic curricula could help prepare healthcare professionals for evolving care models, particularly in managing chronic diseases. This approach is crucial for gaining a deeper understanding of how early exposure to telemedicine training may support students in addressing future healthcare challenges and promoting more accessible, patient-centered care models. The success of this 10-month teaching and learning experience was measured by the satisfaction and approval of the primary targets, as well as by the breadth and diversity of the content focused on NCD, emergencies, telemedicine, and simulation. Additionally, thanks to the new and creative teaching methods of telesimulation, it was possible to deliver practical content even in a distance-learning format.

Table 5. **Measures of association considering respondent's nationality**

	Croatia	Germany	Greece	Italy	Romania	Chi-squared test	Cramer V
	%	%	%	%	%	*p*	
Do you think telemedicine courses should be integrated into your degree program?							
No	0	0	6.7	15.4	0	0.120	0.25
Yes	100.0	100.0	93.3	84.6	100.0		
The subjects covered in the course were useful for my future professional life							
Agree	39.1	33.3	53.3	53.9	53.3	0.124	0.22
Disagree	4.4	0	0	0	0		
Neither agree nor disagree	0	0	0	16.9	0		
Strongly agree	52.1	66.7	46.7	29.2	46.7		
Strongly disagree	4.4	0	0	0	0		
Do you prefer face-to-face or e-learning mode?							
e-Learning	56.5	0	46.7	57.0	66.7	0.284	0.20
Face-to-face	43.5	100.0	53.3	43.0	33.3		
Are you satisfied with the course overall?							
Very unsatisfied	8.7	0	0	3.1	0	0.891	0.13
Neither unsatisfied nor satisfied	8.7	0	0	6.2	6.7		
Satisfied	60.9	66.7	66.7	66.2	53.3		
Very satisfied	21.7	33.3	33.3	24.6	40.0		
Which of the following factors positively influenced your participation in the course?							
Topics	60.9	100	46.6	52.3	40.0	0.216	0.20
Teachers	21.7	0	40.0	12.3	33.3		
Platform interface	0	0	6.7	20.0	6.7		
Lesson Breakdown	4.4	0	6.7	9.2	6.7		
Other	13.0	0	0	6.2	13.3		

The positive overall impact of the BeEmTel project demonstrates that it is both possible and desirable to export and implement simulation-based teaching (both in-person and remotely) for telemedicine and, more broadly, for telecare.

BeemTel e-course has been analyzed from two different perspectives: user's feedback and learning of contents. Regarding the user's feedback, only learners who attended the e-course for its entire duration received the satisfaction survey and their responses appeared to be positive because, after the e-course was completed, most of them answered that telemedicine should be integrated into their degree programs and that they would continue to study this subject (Figure 1a, Figure 1b). This kind of interest appears to be an important result, since the majority of the responding students did not experience a telemedicine course before (Figure 1c). Other positive feedback was given regarding the topics covered in the lectures (Figure 2, Figure 3 b, Figure 4b) and the e-course organization (Figure 3). The overall experience has been rated as positive by majority of the students who participated in the entire course (Figure 4c), despite some of them experienced some sort of problem (Figure 1d). Although the attending learners come from different faculties and countries, user's feedback does not appear to be influenced by degree course or nationality (Table 2, Table 3).

Nevertheless, it has to be noticed that only 32.30% of enrolled students completed the e-course and passed the final test, meaning that over 2/3 of them dropped out of the course before it was over (January 2024). However, as shown in Table 2, the number of learners remained constant for the entire duration. This could suggest that the students who abandoned the e-course did that at its beginning, while

those who started attending the lessons decided to do it until the end of the e-course.

Furthermore, it is worth noting that almost all enrolled learners declared their willingness to attend the LTTA (Learning, Training and Teaching Activities) before abandoning the e-course. Perhaps the perspective of a course based almost entirely on an e-learning platform, also suggested from the answers registered from the survey (Figure 1e, Figure 4e), could explain the observed dropout rate. The observed learning indicators confirm the positive feedback about the e-course, too. Lectures appear to have provided learners with well-established knowledge about all the subjects, as shown by the results of self-assessment tests and the final test (Table 2), although a small difference was observed among learners from different countries (Table 3).

However, despite the generally positive feedback from students, their willingness of integrating telemedicine topics into their study program had some heterogeneity and showed a statistically significant association with both the type of degree program and the respondents' country of origin (Table 5). This finding suggests that, despite the overall favourable opinions, students' willingness to add new subjects to their study path varies significantly depending on their specific program and the country where it is pursued. These differences may be attributed to the varying structure of academic programs across disciplines and countries, leading to differing perceptions of workload among students.

No statistically significant differences were found regarding the preference between online or in-person courses, suggesting that the uncertainty expressed on this topic does not appear to be influenced by the field of study or nationality. The same conclusion applies to questions addressing the overall course satisfaction, the perceived usefulness of the topics covered, or the factors influencing participation. None of these items show any association with the respondents' academic or geographical background.

Limitations

This study has some limitations. The first limitation is that the course was voluntary and represented an extra step in comparison to the already demanding university work of the students. This has certainly limited the active and full participation of students.

The other limitation is linked to the methodology of analysis chosen, the four levels proposed by Kirkpatrick: the structure of the project and the course has allowed us to evaluate only the first two levels, user feedback and learning content, leaving aside workplace behaviour, to consider whether education has influenced practice, and impact on the organization, to assess the effect on outcomes by improving the quality of care and applying best practices. Considering only the first two levels of this model, since the last two are not fully applicable to our project data, our work surely needs to be completed.

Conclusion

The BeEmTel Erasmus+ Project has emerged as an innovative educational experience, effectively introducing the concept of telemedicine to healthcare students across different countries and academic disciplines, irrespective of their previous background or attitudes. Considering the growing importance of these fields, both now and in the future, it is crucial to impart this knowledge early in undergraduate education. Students have demonstrated strong receptiveness to this approach. Multicultural initiatives such as the BeEmTel project offer significant opportunities to solidify these emerging disciplines at the European level, promoting community growth and standardization. The experience of the BeEmTel Project lays a strong foundation for future efforts to assess the impact of these lessons and to explore how telemedicine and telesimulation modules can be integrated into university curricula, ensuring that future healthcare professionals are well prepared for the real-world challenges that await them. The results of this project could be used as a basis for a subsequent one, structured to assess its effectiveness by evaluating all four levels proposed by Kirkpatrick.

Author contributions

Conceptualization and methodology (MBo, EL, MBa); Data curation and formal analysis (GDL, CD); Data extraction (AS); Original draft (MBo, MBa, EL, GDL); Review and editing (MBo, GDL, CD, MBa, MS, VDN, GA, AS, EL); Supervison of the project (GA, MS).

Conflict of interest

The authors declare no conflicts of interest.

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SUPPLEMENTARY MATERIAL

Appendix A.

The appendix contains supplementary information which may be helpful in providing a more comprehensive understanding of the research subjects.

BeEmTel USERS' FEEDBACK SURVEY

Course Topics

- The subjects covered in the course were commensurate with your knowledge (5 points agreement Likert)
- The subjects covered in the course were interesting (5 points agreement Likert)
- The course covered all the relevant subjects about Telemedicine (5 points agreement Likert)
- The subjects covered in the course were useful for my future professional life (5 points agreement Likert)
- In your opinion, Telemedicine will find greater applicability in the future? (Yes/No)
- After this course, you will continue to study Telemedicine to strengthen your knowledge on this topic? (Yes/No)

Structure and Platform

Did you experience any type of issues attending to this e-learning course? (Yes/No)

I found e-mail notifications about the course useful for attending the course (5 points agreement Likert)

How often did you experience some problems with the online platform (slow responses, server crashes, account issues, etc.)? (5 points frequency Likert)

I found the online platform interface very useful and user-friendly (5 points agreement Likert)

I found the subjects division of the course very easy to understand (5 points agreement Likert)

Teachers

- Professor's lessons were clear and easy to understand (5 points agreement Likert)

Participation and appreciation

- I attended the course consistently during the entire year (5 points agreement Likert)
- Which of the following factors negatively affected your participation in the course? (Topics; Platform interface; Lessons breakdown; Teachers; Lack of time to devote to the course; None)
- Which of the following factors positively influenced your participation in the course? (Topics; Platform interface; Lessons breakdown; Teachers; Lack of time to devote to the course; None)
- Are you satisfied with the course overall? (5 points satisfaction Likert)
- Do you prefer face-to-face or e-learning mode? (Face-to-face; e-Learning)
- Do you think that in the future the practical experience of telesimulation should be provided to all course users? (Yes/No)