Assessment and Evaluation of Emergency Remote Teaching for a Project-Based Assignment on the Production of Eco-Innovative Food Products – A Case Study

Maria Katsouli[a], Virginia Giannou[a], and Petros Taoukis[a*]

[a] National Technical University of Athens, School of Chemical Engineering, Laboratory of Food Chemistry and Technology

*Corresponding author

taoukis@chemeng.ntua.gr

Abstract

Institutions of Higher Education (HEIs) faced great challenges, due to the COVID- crisis, on swiftly dealing with this unprecedented situation regarding the implementation of practical courses and interactive educational activities such as project-based courses. The aim of this work is to analyze the challenges and difficulties that arose through this process and the benefits that have emerged for both students and educators. For this reason, questionnaires were designed to study the pedagogical practices used for a project-based course, during the pandemic, and were distributed online to all students and supervisors enrolled in the course. The course entailed the design of an innovative food product, from the interactive analysis of different novel ideas to the production of a final product of high nutritional and ecological profile. Despite the concern that the enforcement of distance learning would significantly affect project-based courses, the majority of respondents confirmed that their institution adapted the curriculum successfully. They also declared satisfaction with the general format, and teaching procedures adopted, and agreed that the online modality can properly transmit educational content. Although, both faculty and students needed to adapt to the distance learning modality and become familiar with the use of new digital tools, they agreed that it can be very useful and provide benefits, when properly planned in advance and accompanied by the right technical support, equipment and class materials.

Keywords: Project-based courses; Distance learning; COVID-19 pandemic; Digital tools; Ecotrophelia contest

1 Introduction

In March 2020, the Director General of the World Health Organization (WHO) declared COVID-19 as a pandemic, after the assessment of the rapid spread and severity of the SARS-CoV-2 virus across the globe, and additionally announced social distancing as a means of containing its spread (World Health Organization, 2020). This worldwide health crisis forced the physical closure of businesses, sport activities and schools globally and pushed all institutions to migrate to online platforms. The online learning modality was seen by the United Nations (UN) and the WHO as a helpful tool for meeting educational needs during the pandemic. Higher Education Institutions (HEIs) have implemented numerous creative strategies to combat the crisis, using various software/apps such as Google Classroom, Zoom, Cisco Webex, Microsoft Teams and others, in order not only to

continue and complete the educational process but also to stay in constant contact with their students (Zalat et al., 2021).

The COVID-19 pandemic globally initiated the digital transformation of higher education within a limited number of days, which would take years, under normal circumstances, due to managerial regulations. Although the digital transformation of education is not a novel phenomenon, and some HEIs had adopted online learning over the past two decades, it was never considered as part of the formal education in undergraduate students in most countries, including Greece. And that's because there are five main common hurdles to the realization of the digital transformation of HEIs, namely change, financing, technology, pace and competencies (Adedoyin & Soykan, 2020). Thus, even though, the current health crisis led the entire world to rely on the online learning modality, the education offered should preferably be referred to as "emergency remote teaching" in contrast to quality or effective online learning (Iglesias-Pradas et al., 2021). Indeed, online education, when carefully designed based on the available theories and models, can be a student-centered, creative and flexible platform (Alhawsawi & Jawhar, 2021; Rahman et al., 2015). A truly beneficial remote learning course should look attractive, encourage participation, incorporate various activities and learning styles that support the learning objectives, and combine elements of asynchronous and synchronous learning to maximize students' engagement, while maintaining the core course's objectives and goals (Schreck et al., 2020).

Additionally, food science and engineering study programs have undergone, during the last years, a paradigm shift from the delivery of knowledge in a traditional lecture and laboratory system to a more inquiry-based and discovery process. Traditional laboratory practices often leave little room for creativity or contextualization (Flynn et al., 2017; Giannou et al., 2015). Innovations, such as the use of team-based learning, simulations or problem-based studies engage students more actively in the learning process. This educational approach, based on an integrated multidisciplinarity, allows graduates to enter the job market with the appropriate technical skills and knowledge, including food quality and safety, food analysis, processing and engineering. This shift emerged from the observation that students lacked practical competence at the beginning of their career, because they had limited or no exposure to practical experiences (Fonseca et al., 2015; Giannou et al., 2015). It was suggested that students need a way to put their classroom knowledge into practice and enhance their mastery of the curriculum, thus improving their preparation for employment in the field (Burke & Danaher, 2020; Flynn et al., 2017; Schreck et al., 2020). Project-based learning uses instructional strategies that are intended to engage students in authentic, "real world" tasks to enhance learning. It can be an individual or group activity that goes on over a period of time, resulting in a product, presentation or performance. Project-based learning typically has a timeline and milestones, and other aspects of formative evaluation as the project proceeds. Students engage in deeper learning and high-level reading, and their motivation is increased. Studies carried out in the United States of America and United Kingdom showed that students who enrolled on project-based assignments were superior in answering applied and conceptual problems (Gutierrez-Bucheli et al., 2022).

However, the emergency remote teaching methods adopted by universities during the pandemic were limited to delivery media, without taking full cognizance of these practices. Administrators and educators tried to effectively deliver remote teaching via e-lectures, e-tutorials, e-project-based learning, etc., to ceaselessly continue education during the quarantine period. The imposition of emergency remote teaching on all HEIs' courses forced the educators to decide abruptly which education modality and strategy to adopt; in this case, instructors had to rush to choose among multiple digital tools with different capabilities to support teaching. More particularly, some of these decisions included the support of asynchronous (content management systems, message boards, e-mail, pre-recorded videos of class sessions), or synchronous (chat, videoconferencing) or real-time collaboration systems (instant messaging/tools) and may have even involved changes in the assessment activities or assessment criteria. Nevertheless, the transition from traditional face-to-

face teaching to remote teaching is not a seamless task, particularly when educators do not have enough time to adapt and adjust their pedagogical assumptions. Such challenges can be more intense if the changes are suddenly introduced, as in the case of the COVID-19 pandemic. While enhancing technological literacy seems to be more easily achievable, changing teaching and learning assumptions might be the real challenge. This transition includes redefining the educators' roles, and rethinking how they interact with their students and how their students interact with each other in the new online environment. Nevertheless, the lack of resources, time, training and experience can be a burden during this transformation.

The compatibility of online learning with social sciences and humanities has proved effective in contrast with sports science, engineering and medical sciences where hands-on practical experiences are required as part of the instructional activities. Consequently, technological institutes of higher education faced great challenges on how to swiftly deal with this unprecedented situation regarding the implementation of practical courses and interactive educational activities such as project-based courses (Khan & Abdou, 2021). Where possible, virtual laboratories were commonly provided through online learning. However, these can only partly address theory into practice (Koulouris et al., 2015), with a substantial compatibility gap still waiting to be filled (Abumalloh et al., 2021).

This study accumulates information on project-based courses delivered online in the School of Chemical Engineering of the National Technical University of Athens (NTUA) and presents the difficulties that both educators and students have experienced during the abrupt shift from face-to-face classes to distance learning education, since the university had no previous experience with online learning before COVID-19. It also tries to decipher if the complexity of the structure of these project-based courses has been negatively affected by the COVID-19 crisis. In order to evaluate the changes imposed in the educational process, it is now necessary to record and analyze the experiences and opinions of all those involved in the virtual approach of teaching and learning, their possible suggestions for its improvement as

well as their preference towards going back to conventional learning. Finally, this study investigates the impact of such choices on academic performance so as to identify successful transitioning strategies.

With these issues under consideration, this study addresses the following questions:

- What were the challenges and obstacles of emergency remote learning during the COVID-19 crisis encountered by both educators and students during the project-based courses?

- How have instructors adapted their teaching of graduate courses to emergency remote teaching during the COVID-19 pandemic?

- Which were the best methods and modes to engage and motivate the students?

- Did the students obtain an effective and complete education on the project-based courses?

- Did the use of educational platforms and tools improve educators' competency necessary for online education?

- Did the familiarization of educators and students with the currently used platforms, tools and applications assist in enhancing and reinforcing education during the digital transformation?

2 Materials and Methods

2.1 The class

The class consisted of 43 undergraduate students, in the 4th year of the 5-years curriculum of the School of Chemical Engineering (NTUA), withing the course "Chemistry, Microbiology and Food Preservation Principles" organized by the Laboratory of Food Chemistry and Technology (FOOD LAB). The class was sub-divided into "project groups" with 5–6 members per group.

2.2 Curriculum

The module ran for 8 weeks during the spring semester (February-June) of the academic year 2020-2021. The main features of this module were theoretical lectures and practical laboratory exercises delivered online, and a project-based assignment that was conducted during the semester. The theoretical lectures and laboratory exercises of the curriculum cover the study of food ingredients, their physicochemical, biological and functional properties, their chemical and microbiological effects, their quality and safety, their alterations and their behavior under the range of conditions encountered during processing, packaging and preservation of food products.

The project-based assignment concerned the design of an innovative food product, from the interactive analysis of different novel ideas to the production of a final product. The basic idea for its design is based on the "ECOTROPHE-LIA" competition - a food innovation competition for higher education students to develop eco-innovative food products. This competition, which is widely known to agri-food HEIs, is fostering creativity and entrepreneurship European-wide, and reshaping the future of food by bringing together HEIs and the agri-food industry. The FOOD LAB has actively participated in the ECOTROPHELIA competition since 2011 and has won numerous awards, both in the national and international competition.

The experience gained from the ECOTROPHE-LIA competition and the implementation of the project-based assignment also resulted in the participation of the FOOD LAB in the European "DigiFoodEdu" project. It is a project funded by Erasmus+ which aims to foster the development of digital skills and exchange of good pedagogical practices in the digital era directed at the guidance of project-based learning approaches. Its main scope is to study the pedagogical practices put in place during the pandemic, collect and analyze the experiences from different partners European-wide and come up with a best-practice guide for the improvement of education in the digital era. Ultimately, the project aims to modernize the pedagogical practices used for coaching and supporting students during their project-based learning activities. The data presented in this study were collected within the framework of the "DigiFoodEdu" project and are specific (spring semester, 2021) to the project-based assignment in the FOOD LAB.

The project-based assignment was delivered by a teaching team consisting of 13 members, including teaching professors, laboratory and teaching staff and PhD students, and was supported with digital contact sessions (45 min - 1 h per week). The basic scheme followed during this procedure is described in Figure 1.

More specifically, students were asked to gather information and design their model food product based on a certain food category, namely bakery products, snacks, dairy products, frozen products, gluten-free products, meat products, alternative meat products or products containing functional ingredients from natural sources. Their final report - the product's technical folder - should include information on product's formulation, processing technology, packaging, distribution requirements, carbon footprint, conformity with National Safety Authority laws and European Food Regulations, as well as marketing and feasibility plans. By the end of the course, students were asked to deliver this technical folder and prepare a 15 min presentation of the product along with an advertising leaflet.

Context

The main focus of the module was to provide students with an opportunity to integrate all their previous academic experience in food science, technology and engineering within a single project by practically exploiting the skills and knowledge gained through their studies. The module focused specifically on the understanding of the key concepts and processes; scientific ability to seek and evaluate information, communicate in an accurate and coherent way, act as a group member and successfully complete the project. As a group, they were in control of an entire project, from planning to implementation and evaluation, with each member taking responsibility for his or her part within the project. Nearly half of the contact sessions were spent focusing on theory, the application thereof and
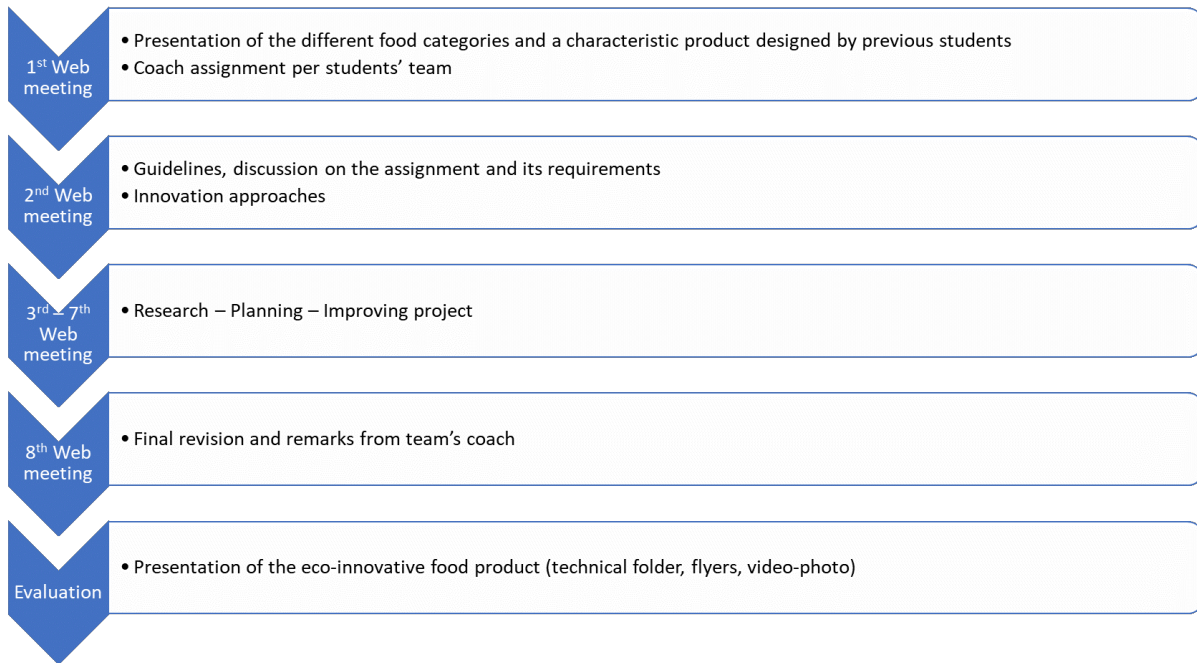
1st Web meeting
- Presentation of the different food categories and a characteristic product designed by previous students
- Coach assignment per students' team

2nd Web meeting
- Guidelines, discussion on the assignment and its requirements
- Innovation approaches

3rd – 7th Web meeting
- Research – Planning – Improving project

8th Web meeting
- Final revision and remarks from team's coach

Evaluation
- Presentation of the eco-innovative food product (technical folder, flyers, video-photo)

Figure 1: Stages in the project-based learning assignment.

project planning. The other half was spent in presenting the implementation of their projects.

Total energy

Direct assessment

Summative assessment is product-oriented and assesses the final product, technical folder and final presentation, whereas formative assessment focuses on the process toward completing the project assignment. Both were used to assess the students as described below.

Summative

Final report (technical folder): The final report accounted for 100% of the total grade of the module. The technical folder consisted of the following sections: (1) Introduction, (2) Food category definition – Food legislation, (3) Raw materials – Technical characteristics of the product (composition, manufacturing flow chart), (4) Innovation characteristics – Environmental impact, (5) Business and marketing plan, (6) Technical feasibility at an industrial scale and (7) References. The outcome of the module is considered successful when students' final grade is above 5 on a 10-point grading scale, and along with the other laboratory exercises, accounts for 50% of the final grade of the course.

Formative

Informal observation: The teaching team was able to observe each individual student's approach during the planning and development of the project assignment over the 8 weeks of the remote classes.

Indirect assessment

Questionnaire

Upon completion of the course, students were asked to answer a series of questions on the distance project-based course they attended. The initial questions were more general and related to the evaluation of students' overall experience

from distance learning courses. The following questions were more detailed, so that participants' opinions and observations could be outlined. The questions were closed-ended and could be answered with a yes or no, by choosing between a list of possible answers or by choosing between a scale (e.g., strongly agree to strongly disagree). There was also an open-ended question that concerned the difficulties and problems of presentation in a distance learning course. A corresponding questionnaire was designed to capture the experience of the teaching staff as well. The questionnaires developed were jointly evaluated and approved by the group of experts/educators participating in the "DigiFood-Edu" project and were then distributed online to the 43 bachelor students and the 13 course supervisors enrolled in the course. The structure of the questionnaires is presented in Table 1.

3 Results and Discussion

3.1 Profile of the respondents

During the survey, 50 questionnaires were filled in completely or partly; 13 from professors and pedagogical staff and 37 from students (86% response rate). Considering the distribution of gender, females dominated the population size (62% female professors versus 38% male, and 70% female students versus 27% male). Regarding age, teaching experience and rank of the supervisors' project group, they were divided as follows: ages below 30 (31%), between 31-50 (61%) and above 51 (8%), teaching experience of less than 5 years (39%), 6 to 10 years (38%), 11 to 20 years (15%) and above 20 years (8%). 15% of the respondents were professors, 19% were research associates and only 8% were PhD students-researchers. Considering the students' project group, 78% were between 19 and 23 years of age and 22% between 24 and 29 years (Table 2).

3.2 Distance learning modality offered by Higher Education Institutions before and during the COVID-19 pandemic

Regarding the experience of distance learning prior to the COVID-19 pandemic, the majority of professors (85%) answered that they were not familiar with distance learning (Fig. 2a) and all the respondents answered that they used remote lectures only for theoretical sessions (Fig. 2b). Moreover, at the beginning of the COVID-19 era, 61% of the pedagogical staff stated that they had no experience with distance learning, while 31% that it was their first experience with the online teaching modality (Fig. 2c). Prior to the COVID-19 outbreak, the majority of supervisors preferred the presential synchronous learning modality (face-to-face classes on campus) (84%), and only 8% used distance synchronous learning (online live courses that are interactive between teacher and students in real-time) (Fig. 2c). Despite the limited experience of supervisors with distance learning, 46% of them believed that they were technically prepared for remote teaching or expressed a neutral opinion (23%) (Fig. 2e). Overall, they were accustomed to the use of technology and digital tools, as 71% of them were very confident when it comes to working with technology at home or at university and they did not avoid using technology when necessary to offer feedback on students' assignments. Moreover, the majority of supervisors stated that they enjoyed using digital tools (53% strongly agreed and 35% agreed), while 35% of the respondents strongly disagreed, 6% disagreed and 29% expressed a neutral opinion on the statement that digital pedagogical tools hinder the educational process (Fig. 3a). The results emphasize that even though the distance learning modality was not common before COVID-19, the respondents were confident that they will carry out remote teaching successfully as most of them were familiar with the use of technology and digital tools in the educational process. However, in other studies, different results were observed as before the pandemic, the educators did not understand the importance of having advanced or even novice technology skills or online plat-
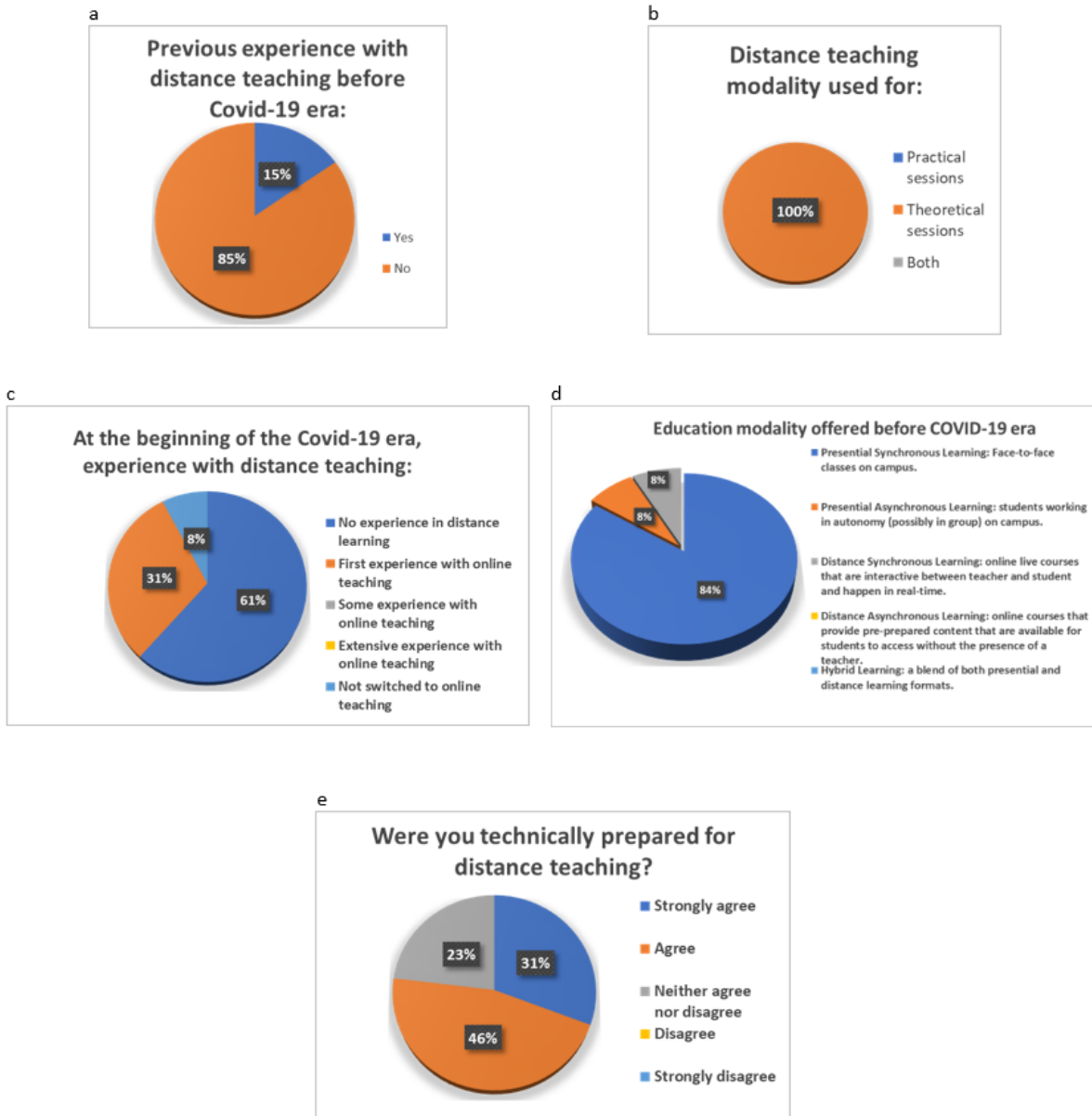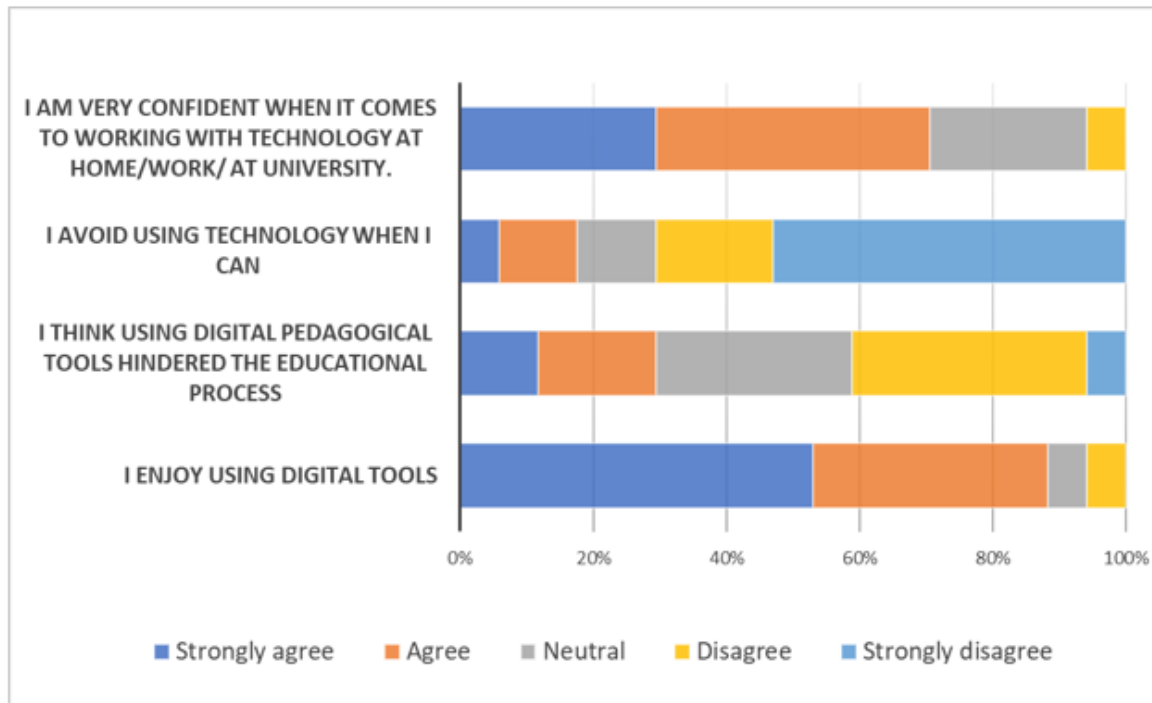
Figure 2: (a-e) Professors' and pedagogical staff's responses regarding the education modality before COVID-19 pandemic.
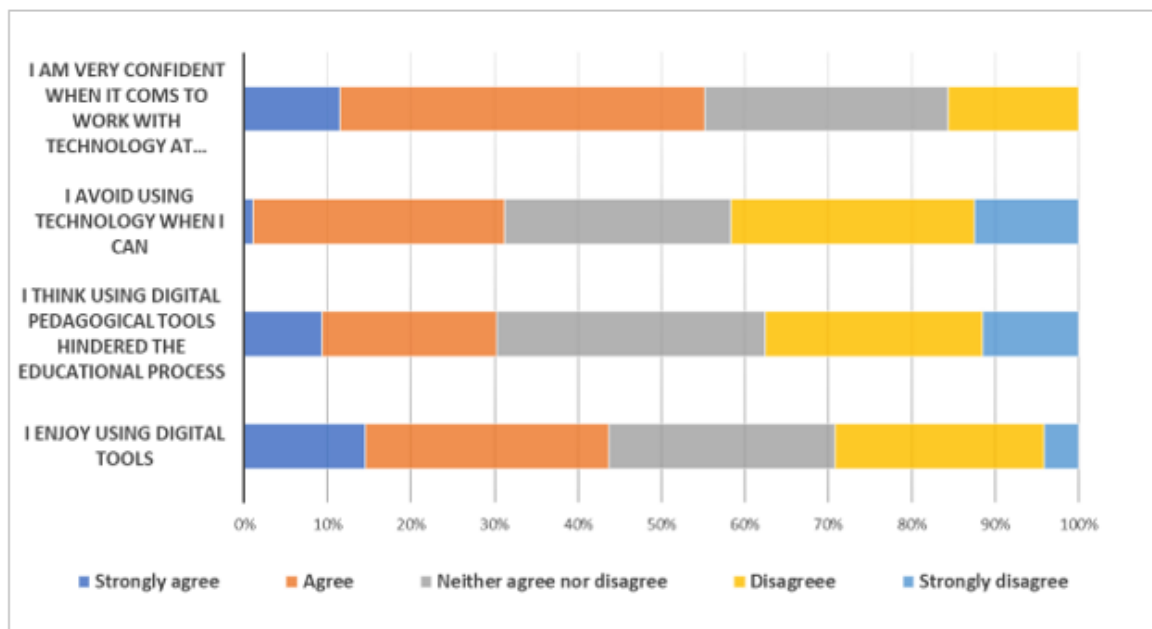
a

b

Figure 3: (a) Professors' and pedagogical staff's and (b) students' responses, regarding the use of technology and digital tools in education.

Table 1: Dimensions of the questionnaires' structure

Questionnaire structure	
Students	
Section 1 Digital pedagogical practices during the COVID-19 era for project-based distance learning course	· Experience with distance teaching before and after COVID-19 · Digital tools and supplementary materials used in project-based e-learning
	· Validation of the digital tools used and the overall teaching experience · Familiarity with ECOTROPHELIA competitions · Familiarity with project-based e-learning · Information on project-based e-learning · Validation of the digital tools used and the overall learning experience · Comparison of the online experience with traditional face-to-face courses · Difficulties/problems encountered from distance learning · Suggestions for the improvement of the online experience
Section 2 Student-Teacher dynamic and communication during distance courses	· Effect of distance learning on student-teacher relationship · Validation of students-teachers interaction/communication during project-based e-learning courses
	· Validation of the online learning experience · Contribution of project-based courses to students' future career
Section 3 Attitudes to technology	· Equipment used in distance learning courses · Problems with internet connection and experience from the use of digital tools · Evaluation of the impact of distance teaching in future school practices
Section 4 Information of the respondent	· Demographic data · Information on respondents' status and grade
Teachers	
Section 1 Digital pedagogical practices during the COVID-19 era for project-based distance learning course	· Type of education modality offered before COVID-19 · Experience with distance teaching before and after COVID-19
	· Familiarity with ECOTROPHELIA competitions · Familiarity with project-based e-learning · Supplementary materials used for distance learning · Technical preparation for distance teaching · Digital tools used in project-based e-learning · Validation of the digital tools used and the overall teaching experience · Comparison of the online experience with traditional face-to-face teaching · Difficulties/problems encountered from distance learning · Suggestions for the improvement of the online experience · Evaluation of the technical skills acquired from distance teaching
Section 2 Student-Teacher dynamic during distance courses	· Rating of the involvement of students in the project-based e-learning courses · Validation of students-teachers interaction/collaboration/ communication during project-based e-learning courses · Degree of difficulty to switch to the e-learning courses · Use of technology and online tools/sources to improve the learning process and offer feedback on students' assignments · Contribution of project-based courses to students' future career
Section 3 Attitudes to technology	· Equipment used in distance learning courses · Problems with internet connection and experience from the use of digital tools · Evaluation of the impact of distance learning in future school practices
Section 4 Information of the respondent	· Demographic data · Teaching experience · Information on respondents' status and position

Table 2: Socio-demographic data of the studied class

Professors & Pedagogical Staff (Total answers: 13)			
Gender:		**Rank:**	
Female	62%	PhD candidates -researchers	8%
Male	38%	Research Associates	19%
Prefer not to say	-	Professors	15%
Age:		**Teaching experience:**	
<30	31%	<5 years	39%
31-50	61%	6-10 years	38%
>51	8%	11-20 years	15%
		>20 years	8%
Students (Total answers: 37)			
Gender:		**Age:**	
Female	70%	19-23	78%
Male	27%	24-29	22%
Prefer not to say	3%		

forms knowledge and relied only on their ability to interact face-to-face with students in the classrooms (Alhawsawi & Jawhar, 2021; Rasheed et al., 2020).

Similar results were observed from students' responses as they were very confident when it comes to working with technology (11% strongly agreed and 44% agreed with the statement). Moreover, when they were asked if they avoided the use of technology whenever possible, responses were divided amongst three options: 30% agreed, 29% disagreed and 27% neither agreed nor disagreed. The students gave similar answers to the question "if they enjoy the use of digital skills": 29% agreed, 25% disagreed and 27% neither agreed nor disagreed. However, regarding the question "if the use of digital pedagogical tools hinders the educational process", interestingly 30% of the students agreed, whereas 29% disagreed with this statement and 27% of them had a neutral opinion (Fig. 3b). Others studies, similarly confirmed that high educational competence skills help educators pedagogically and increase the level of students learning (Núñez-Canal et al., 2022; Reisoğlu & Çebi, 2020).

The situation changed drastically as the COVID-19 pandemic led to massive closures of HEIs and many countries took measures to limit the disruption to education, necessitating a move to online and distance learning. 92% of respondents stated that their HEI turned to distance education using a Learning Management System (LMS), Video Conferencing (VC) platforms or learning materials and tools available on the internet. 77% of the educators confirmed that their institution provided them with supplementary materials for distance learning (online libraries subscriptions, digital tools, premium user accounts to e-learning platforms) (Fig. 4a). Also, it was also very encouraging that students had access to supplementary materials for distance learning, thereby facilitating the lectures, and 57% of students had subscriptions to online libraries or were premium users of an LMS or VC platform. Cisco Webex, Google Meet, Microsoft Teams and Zoom were the most widely VC platforms used, whereas, Google classroom, Moodle, Blackboard, Discord, BigBlueButton and Jamboard were the LMS platforms and other digital tools used to different extents (Fig. 4b). The results showed that a large variety of digital educational tools was available for educators to cover the needs of their students during the distance learning/education process. It was also observed that the instructors seemed to resort to digital tools that they were most familiar with, and with instructional methods that most

easily resembled the face-to-face learning practices (Iglesias-Pradas et al., 2021). Moreover, it should be highlighted that the younger educators were keener to use digital tools and LMS or VC platforms. However, after more than a year, the situation was very different as the majority of educators (54%) stated, at that stage, that they had some (54%) or extensive experience (38%) with online teaching (Fig. 4c).

Similarly, the majority of students stated, at the beginning of the COVID-19 era, that they first came into contact with distance learning (16%) or had no experience with it (59%), while only 14% of the respondents had some experience with online learning (Fig. 4d). However, a year after the COVID-19 outbreak, the students were confident enough to state that they had gained extensive (60%) or some experience (32%) with distance learning. Only an inconsiderable percent of 3% expressed that after one year of online learning modality they were still not familiar with distance learning (Fig. 4e).

Considering the question "if they encountered problems during online lectures", 59% of the educators answered affirmative, stating that the poor internet connection hindered the educational process. The outcome was the same for students, as 62% of the respondents stated that the poor internet connection hindered their attendance at lectures. Regarding the equipment used, 77% of the educators answered that they used a personal computer to attend the lecture, or several devices (23%) depending on the sessions. Similar results were observed for students as 68% of them attended the lectures using their personal computer, 24% of them used several devices alternatively depending on the sessions and only 8% of the students used several devices simultaneously (Fig. 5).

3.3 Readiness of Educational Institutions to continue the project-based courses during the distance learning era

The enforcement of distance learning significantly affected the project-based courses and the relevant educational competitions for higher education students. The impact of the pandemic became particularly noticeable to the participants of the "ECOTROPHELIA" competitions. Following the transformation of education and educational activities, the national and European ECOTROPHELIA competitions reinvented themselves to continue to provide students and HEIs a platform to showcase their talents during the COVID-19 pandemic. In the 2020 the competition took place virtually, and the majority of students and educators were very well informed about the change, as 65% of the students and all the educators (100%) confirmed that they were aware of the new form of the competition (Fig. 6).

The results of the survey confirmed the significance of the incorporation of such project-based courses in the curriculum, as 46% of the educators strongly agreed and 31% of them agreed that the project-based courses prepare and support the students for a future career (Fig. 7a). However, the opinion of students regarding the significance of project-based courses was divided (35% of them agreed and 33% neither agreed nor disagreed) (Fig. 7b). These results support claims made in the literature that an experiential learning approach can improve the graduate attributes needed by students, making them more employable (Schreck et al., 2020).

Inspired by the "ECOTROPHELIA" competition, the students enrolled in the course "Chemistry, Microbiology and Food Preservation Principles" were assigned a project-based course, where they were motivated and coached by an educator to develop their eco-innovative food products virtually. At the same time, the educators faced similar difficulties and new challenges, as 23% of the supervisors and 43% of the students confirmed that the transformation of the project-based learning courses into an online modality was difficult (Fig. 8a, b). However, the majority of educators (54%) expressed a neutral opinion regarding the difficulties of transformation of project-based courses in the distance learning modality.

During the lectures for the project-based distance courses, the educators stated that they used various dynamic teaching techniques, such as live deductions, writing on a virtual board, video projections, online quizzes, online workbooks, etc., to engage and motivate their stu-
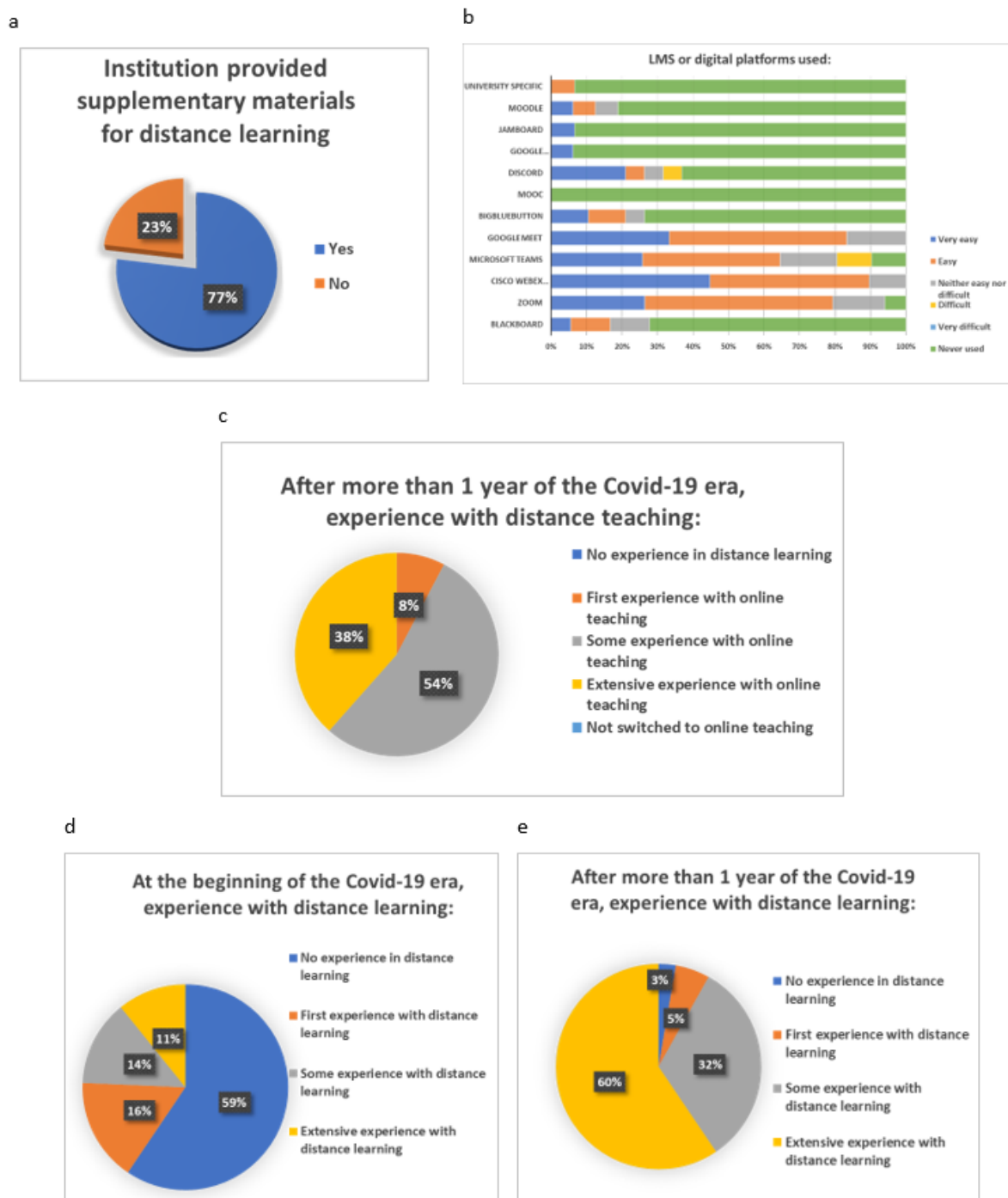
a

Institution provided supplementary materials for distance learning

- 23% No
- 77% Yes

b

LMS or digital platforms used:

(Bar chart showing LMS or digital platforms: UNIVERSITY SPECIFIC, MOODLE, JAMBOARD, GOOGLE..., DISCORD, MOOC, BIGBLUEBUTTON, GOOGLE MEET, MICROSOFT TEAMS, CISCO WEBEX..., ZOOM, BLACKBOARD)

Legend: Very easy, Easy, Neither easy nor difficult, Difficult, Very difficult, Never used

c

After more than 1 year of the Covid-19 era, experience with distance teaching:

- 8%
- 38%
- 54%

Legend:
- No experience in distance learning
- First experience with online teaching
- Some experience with online teaching
- Extensive experience with online teaching
- Not switched to online teaching

d

At the beginning of the Covid-19 era, experience with distance learning:

- 11%
- 14%
- 16%
- 59%

Legend:
- No experience in distance learning
- First experience with distance learning
- Some experience with distance learning
- Extensive experience with distance learning

e

After more than 1 year of the Covid-19 era, experience with distance learning:

- 3%
- 5%
- 32%
- 60%

Legend:
- No experience in distance learning
- First experience with distance learning
- Some experience with distance learning
- Extensive experience with distance learning

Figure 4: (a-c) Professors' and pedagogical staff's responses regarding the teaching experience during the COVID-19 pandemic. (d-e) Students' responses regarding the teaching experience during the COVID-19 pandemic.

a

b
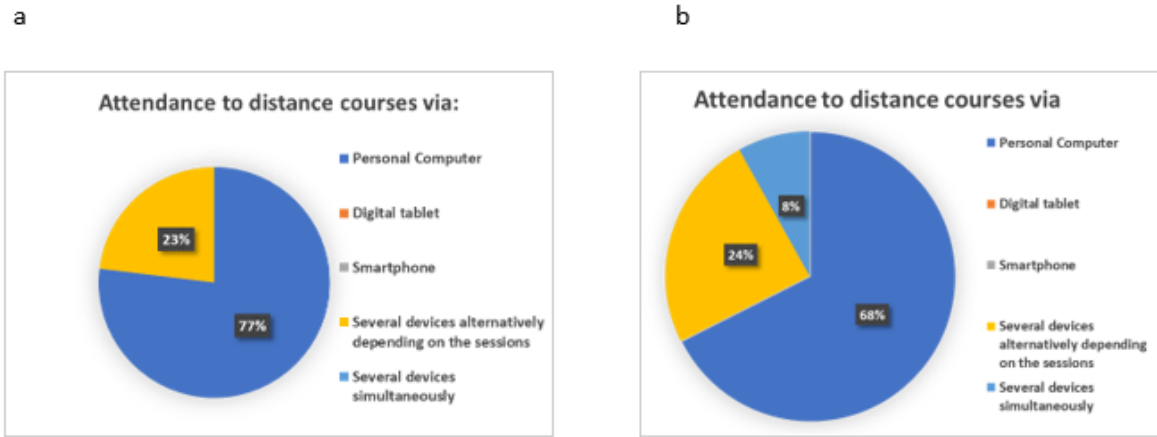
Figure 5: (a) Professors' and pedagogical staff's and (b) students' responses regarding the use of devices for their attendance on the distance learning courses.

a

b
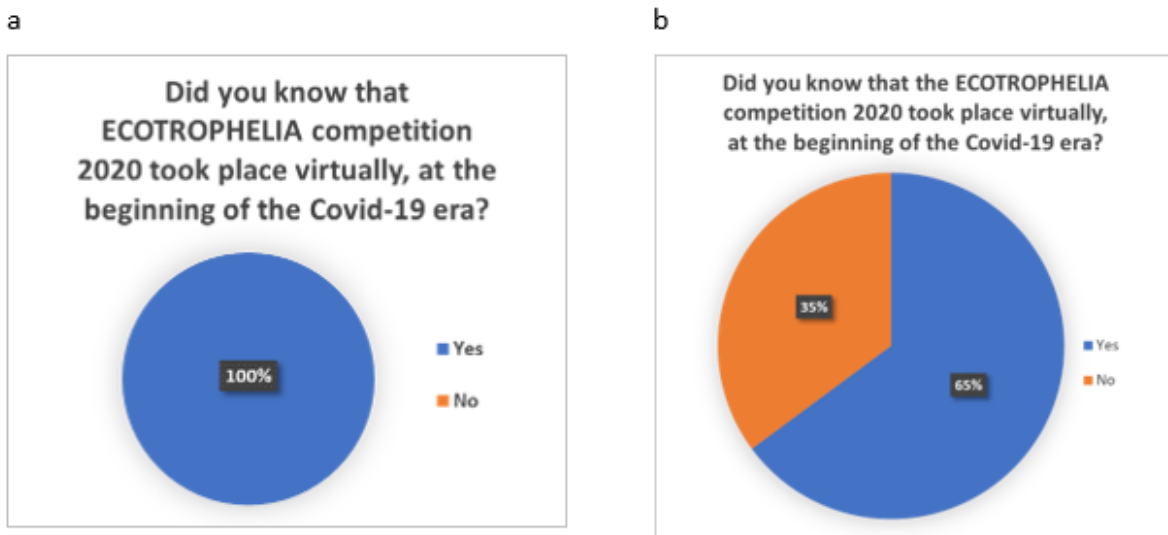
Figure 6: (a) Professors' and pedagogical staff's, and (b) students' responses regarding the virtual conduct of the ECOTROPHELIA competion in 2020.

dents (Fig. 9).

Also, the majority of educators agreed with the statement that the digital tools used were appropriate for the project-based e-learning courses (23% strongly agreed and 46% agreed) (Fig. 10a). As in can been seen in Figure 10b, educators seem to resort to digital tools that they are most familiar with and use instructional methods that most easily resemble their current practices, such as synchronous sessions that mimic face-to-face learning.

Overall, the instructors were satisfied with the teaching procedures adopted for project-based distance learning courses, believing that their methods were suitable for the course's objective, as 35% of them strongly agreed and 53% of them agreed with the statement (Fig. 11). Also, 18% of them were strongly satisfied and 41% were satisfied with the general format of online teaching (the teaching procedure, the selected digital tools, the number of students, the teaching hours), while 41% of them were neutral regarding this matter. Considering the asynchronous modality used, the answers were divided as 41% of the instructors agreed with the statement that the asynchronous modality can transmit the educational content properly and 41% of them had a neutral opinion (Fig. 11). Other studies also indicated the importance of using effective technological tools and emphasized the role of information sharing and collaborative actions on a project-based course (Abumalloh et al., 2021; Adedoyin & Soykan, 2020).

Moreover, 12% of the educators strongly agreed and 35% of them agreed that the quality of education offered through distance learning was good enough. Unfortunately, 47% of the respondents were skeptical about it. Despite the optimistic results of the modality and the quality of distance learning, unfortunately, 41% of the educators believed that they were not motivated enough to teach a class through remote teaching or expressed a neutral opinion (41%), and only 6% were more motivated to do so (Fig. 11). Moreover, 24% of the respondents strongly agreed and 59% agreed with the statement that more effort was needed to complete a discipline in the distance learning modality than in the face-to-face modality (Fig. 11).

From the students' perspective, they also agreed (51%) that the distance learning class material for project-based courses was useful and accurate, and 32% strongly agreed. Moreover, 49% of the students agreed and 27% strongly agreed that the procedures adopted by professors and pedagogical staff were suitable for the course's objective. The majority of students believed that the digital tools used were appropriate for project-based e-learning courses (43% agreed and 16% strongly agreed) (Fig. 12) and were also appropriately used (87%). Moreover, they believed that their professors were technically prepared to deliver a project-based e-learning course (59% agreed, 16% strongly agreed and 30% expressed a neutral opinion). Therefore, teachers who have the appropriate technical skills for synchronous teaching, are more ready to adopt and diversify their teaching approaches in order to deal with unforeseen circumstances in education such as the COVID-19 outbreak (Alexander et al., 2017; Alhawsawi, 2017; Alhawsawi & Jawhar, 2021).

Although, both educators and students were satisfied with the distance learning modality of project-based e-learning courses, the majority of educators think that the final presentation of the assigned project-based course was challenging (54%) or very challenging (8%). The results highlighted that the educators were not very satisfied with the final presentation of the students as they probably detected that the students were more anxious or less prepared as speakers and unfamiliar with the online presentation modality. However, the students had a different opinion as they found the procedure in the distance learning modality as difficult as in the traditional presentation (35% of them found the online presentation challenging, while 30% of students found the procedure easy) (Fig. 13). These results indicated that even though it was easy for the students to attend asynchronous classes, some students faced difficulties presenting online to their classmates. During the final presentation various education platforms were used, with Zoom, Cisco Webex and Microsoft teams being the most popular and user-friendly according to the respondents.
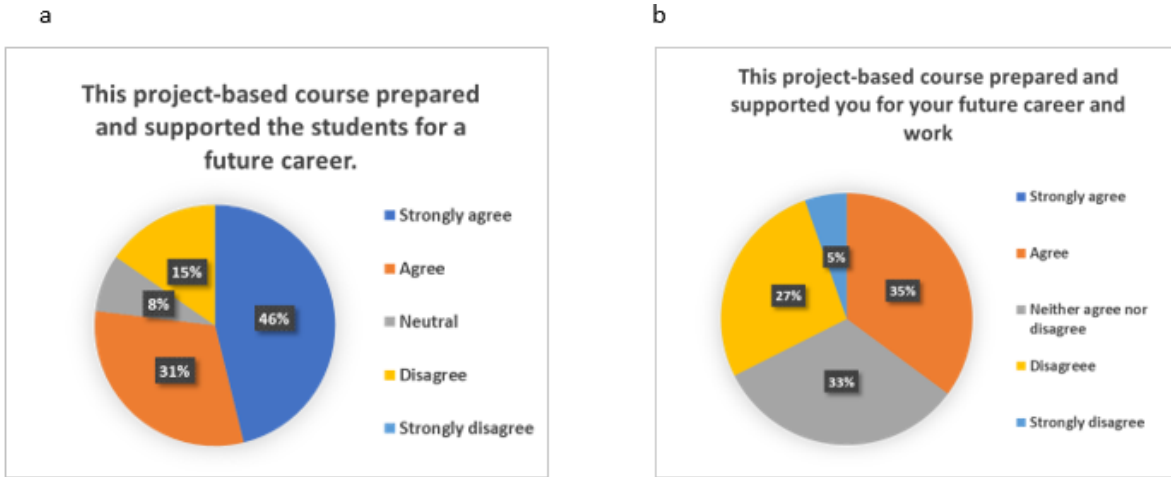
Figure 7: (a) Professors' and pedagogical staff's, and (b) students' responses regarding the importance of project-based courses.
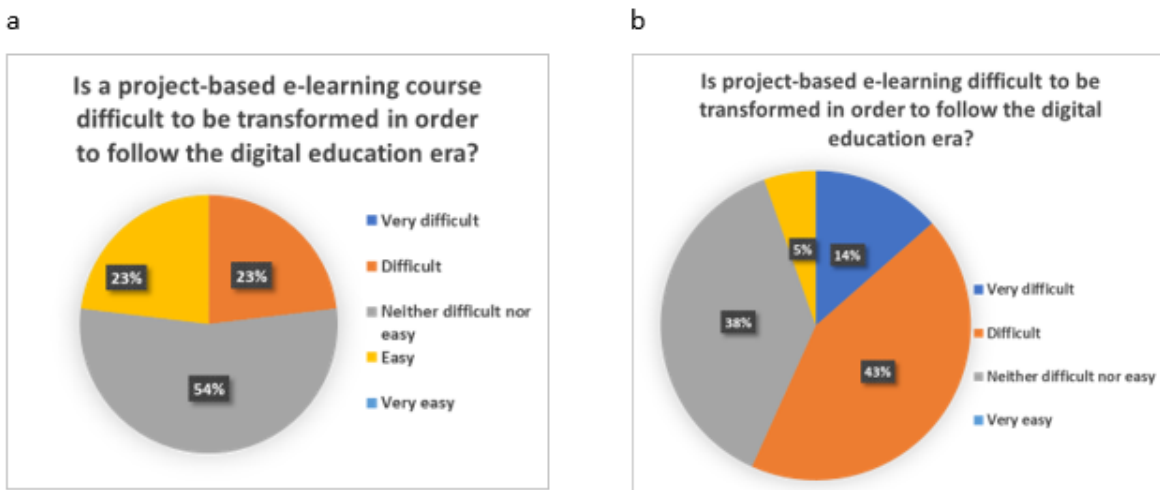

Figure 8: (a) Professors' and pedagogical staff's, and (b) students' responses, regarding the transformation of project-based distance learning courses.
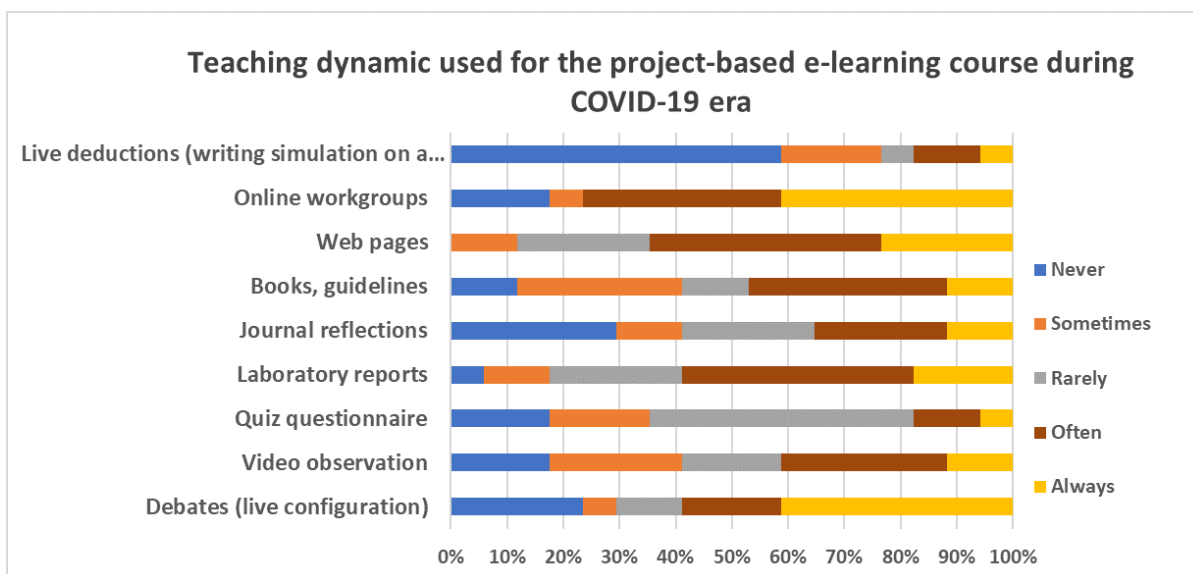
Figure 9: Dynamic teaching techniques used by professors and pedagogical staff during the lectures on the project-based courses.

3.4 Student-Teacher dynamic during the project-based distance courses

Another important factor that should be studied due to the imposition of emergency distance learning is the relationship and communication among students and educators, and students' participation during the online lectures. The ability to ask a question, to share an opinion or to disagree on a topic are all key learning activities (Rahman et al., 2015).

Some studies observed that the digital environment can result in a poor learning experience for students (Ghomi & Redecker, 2019; Núñez-Canal et al., 2022). Therefore, it was expected that the teacher-student relationship would be negatively affected. This was confirmed by students' answers as 51% of them believe that the relationship was negatively affected and only 35% of them believe that it was not affected (Fig. 14a). Moreover, regarding the students' participation during the online lectures, the answers were divided as 26% of them were eager to express their opinion or ask questions during the online lectures, 21% were hesitant and 29% of the students

were neutral about it (Fig. 14b).

Overall, the distance learning modality for the project-based courses did not affect the student-student and student-professor relationship, as the students stated that the collaboration with their fellow students and their educators was very good (62% and 76% respectively) (Fig. 14a). These results are encouraging for the future of remote learning, as most educators were worried about the participation and the interaction of the students during the remote classes.

They are also in accordance with the educators' opinion, as 39% of them stated that students had high involvement during the online lectures on the project-based courses (Fig. 15a). Moreover, they stated that the collaboration with the students was very good (23%) or good (54%) (Fig. 15c). Similarly, the communication among them was good (31%) or very good (23%) (Fig. 15d). Their attitude towards the students played an important part in the establishment of such a good relationship with them, as all respondents encouraged their students to express their thoughts during the lectures on the project-based distance learning course. Also, the majority of educators encouraged their students to search on-
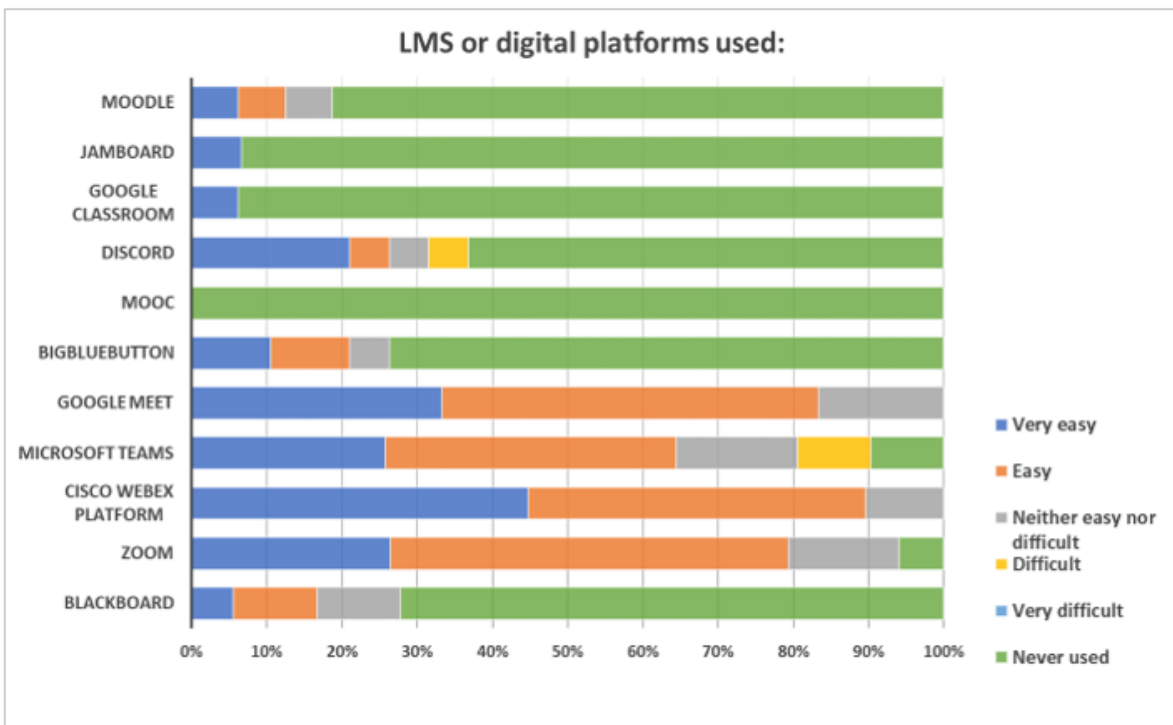
a
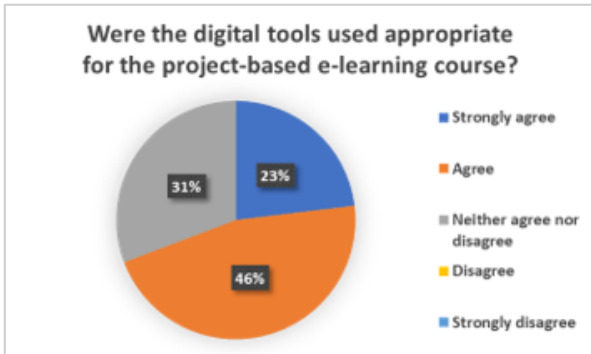
b

Figure 10: Digital tools used by professors and pedagogical staff during lectures on the project-based courses.
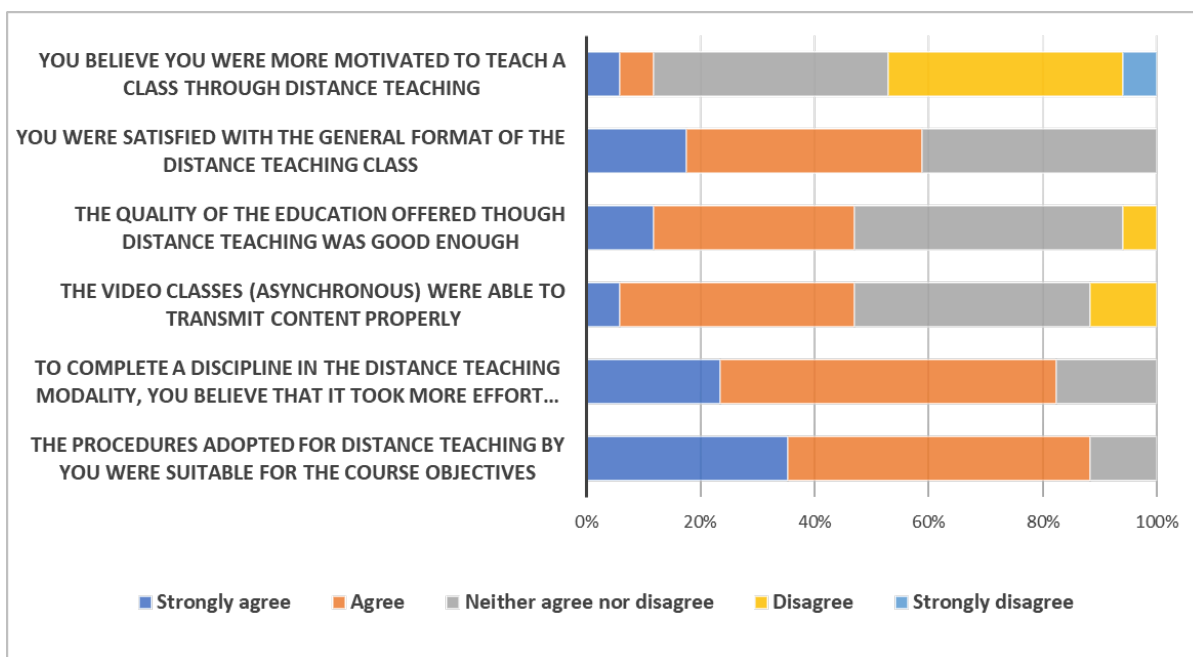
Figure 11: Professors' and pedagogical staff responses regarding the quality of project-based distance learning courses.

line for material relevant to the course and contact them after the class if they had any questions (Fig. 15b).

3.5 Challenges and needs of project-based distance learning courses – Recommendations for improvement

To keep abreast of the distance learning education trends, the respondents were asked how the distance learning modality can be evolved, and how the educational competence of the pedagogical staff could be improved. According to the educators' responses, it would have been helpful to have access to quick courses on online learning (professional development) (25%), websites with lists of useful resources (21%), more free resources and digital tools (18%), easy contact with experts (an ICT technical expert) (14%) and clear guidance for online lectures by the Ministry of Education (11%). However, the least preferred recommendations were: video clips/lesson plans of good practice, more educational tv programs by national media and the creation of webinars and TeachMeet for teachers to share ideas and challenges (0%) (Fig. 16a).

In addition, the creation and use of audio-visual materials, interactive media, simulations, virtual manipulations and virtual tours in lab rooms were considered as very effective ways to improve the lectures on the project-based courses (92%) (Fig. 16b). At the same time 54% of the respondents agreed and 46% of them strongly agreed that the technical skills acquired from distance learning courses, in general, improved the educational competence of the pedagogical staff and professors (Fig. 16c). Similarly, various studies observed that the technological skills required to provide online courses increase the educational competence of the faculty staff members (Rapanta et al., 2020; Zalat et al., 2021).

Similar responses were collected from students, who agreed that the most helpful solutions to
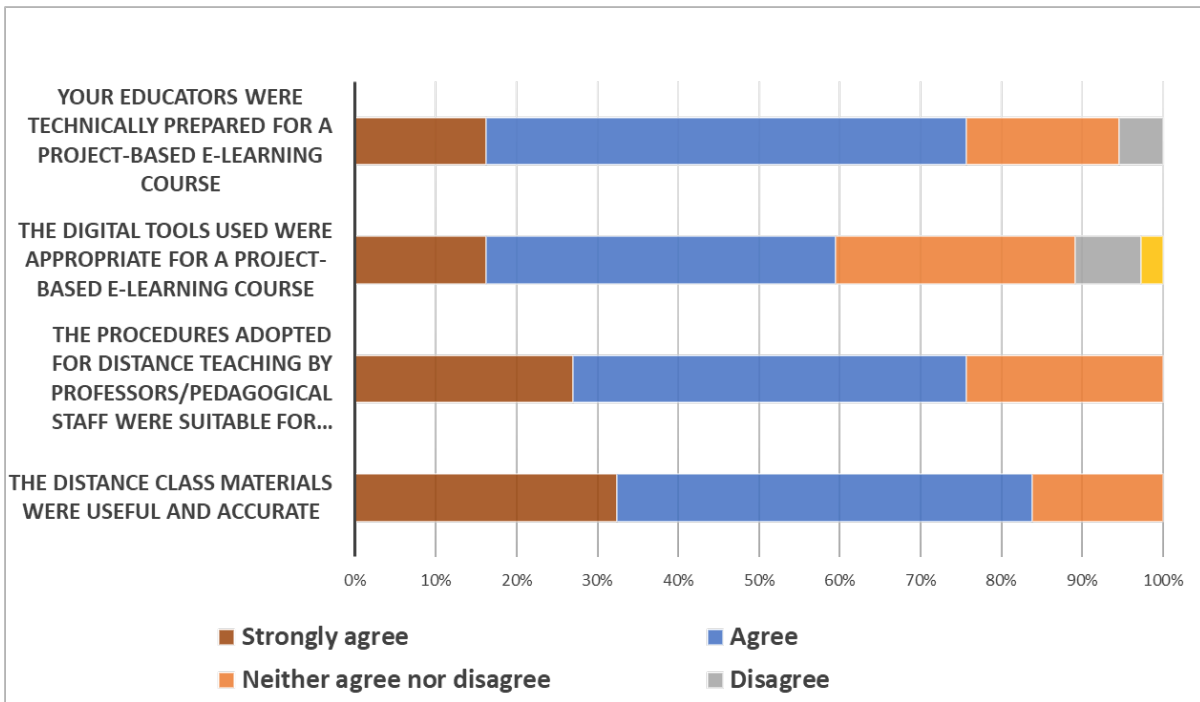
Figure 12: Students' responses regarding the quality and modality of project-based distance learning courses.
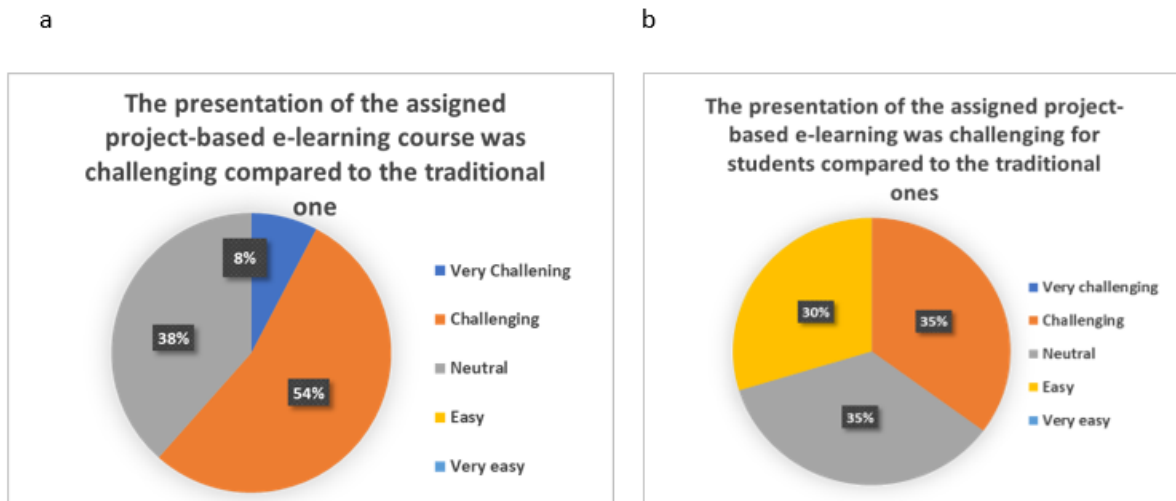

Figure 13: (a) Professors' and pedagogical staff's and (b) students' responses regarding the challenges of the presentation on the project-based course.
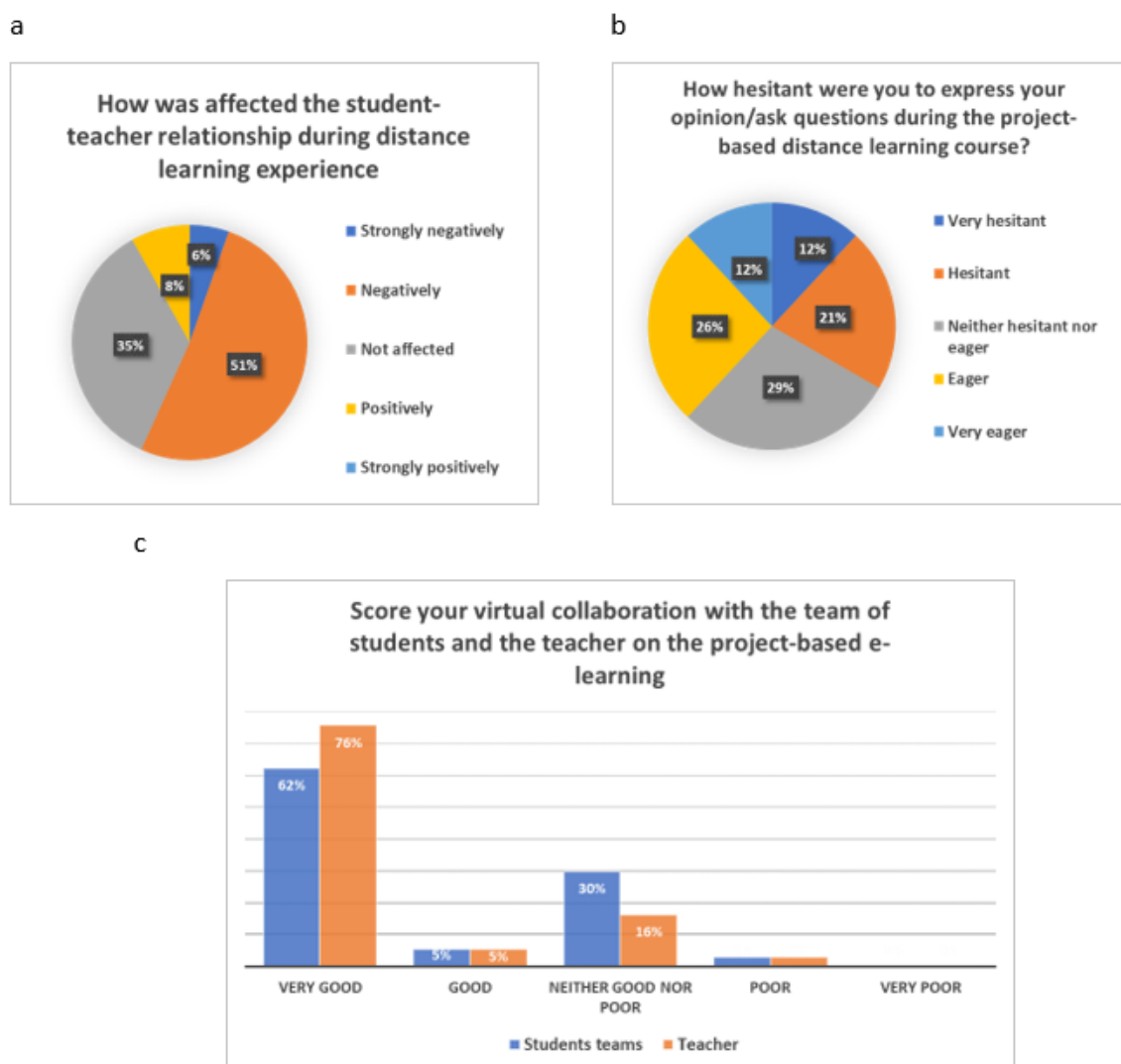
Figure 14: (a) Student-teacher relationship, (b) students' participation and (c) virtual collaboration between the students' team and the educator during distance learning project-based courses.
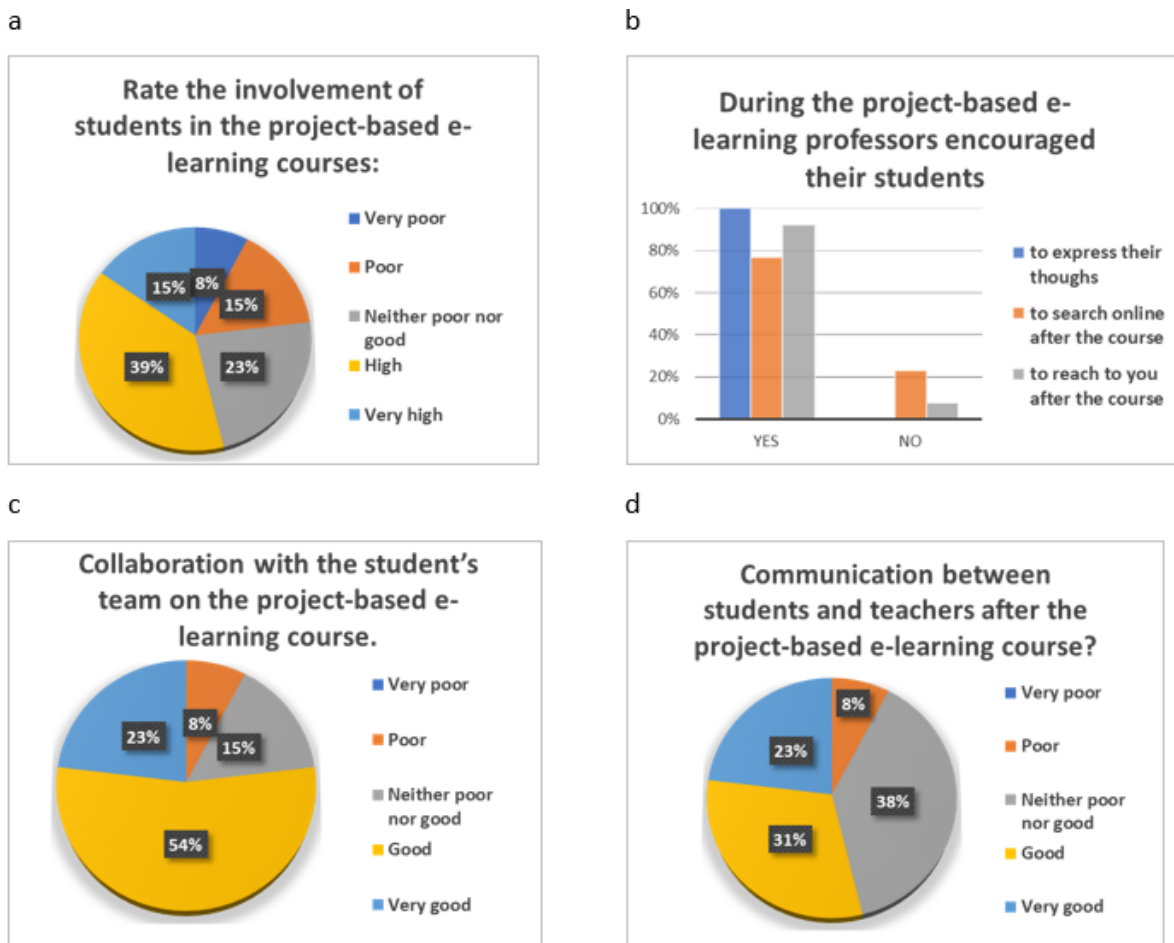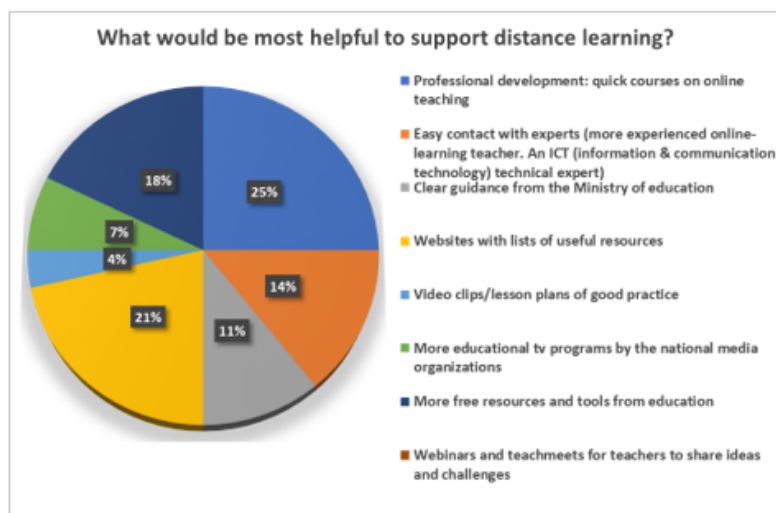
Figure 15: (a-d) Professors' and pedagogical staff's responses regarding the students-teachers dynamic during project-based courses.

support distance learning classes were: the professional development by quick courses on online teaching (14%), access to more free educational resources and digital tools (22%), webinars and TeachMeet for teachers to share ideas and challenges (14%), video clips/lesson plans of good practice (14%) and websites with lists of useful resources (13%). Moreover, the majority of students considered e-learning necessary for the future, as 54% of them agreed that the technical skills acquired from distance learning courses would improve the educational competence of the pedagogical staff and professors. However, regarding the use of audio-visual materials, inter-active media, simulations, virtual manipulations and virtual tours in lab rooms as a tool to improve the lectures of the project-based courses, the opinion of the students was divided as 51% of the respondents preferred it, while 49% of them did not (Fig. 17).

However, both students and educators stated that the alternative/virtual laboratories offered by online learning can only fill the theory-into-practice gap. Actually, online learning cannot be effectively and efficiently applied in some disciplines and this compatibility gap is yet to be filled (Adedoyin & Soykan, 2020). Specifically, the students expressed their wish to return with a
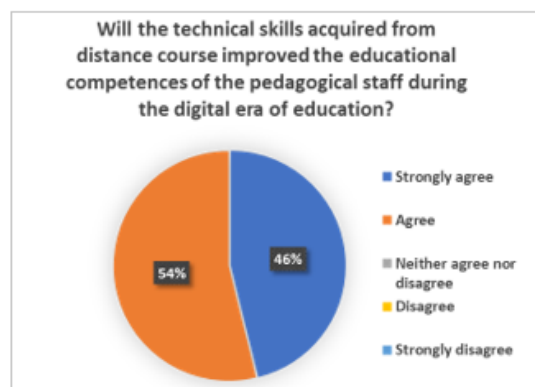
a

b

c

Figure 16: (a-d) Professors' and pedagogical staff's responses regarding the students-teachers dynamic during project-based courses.
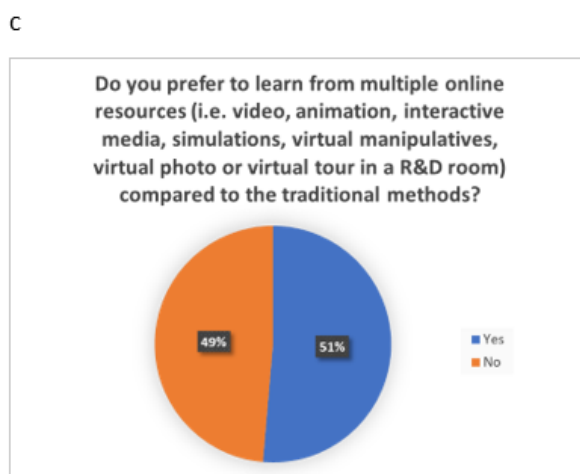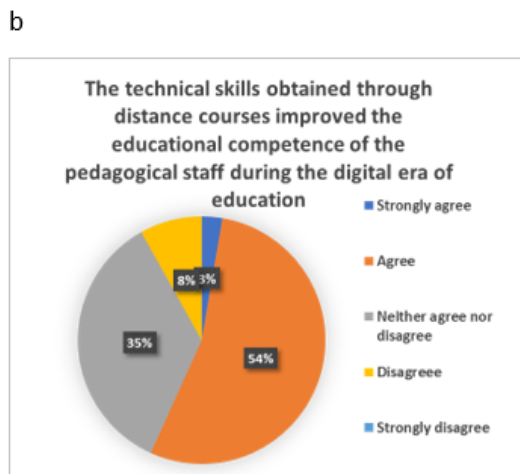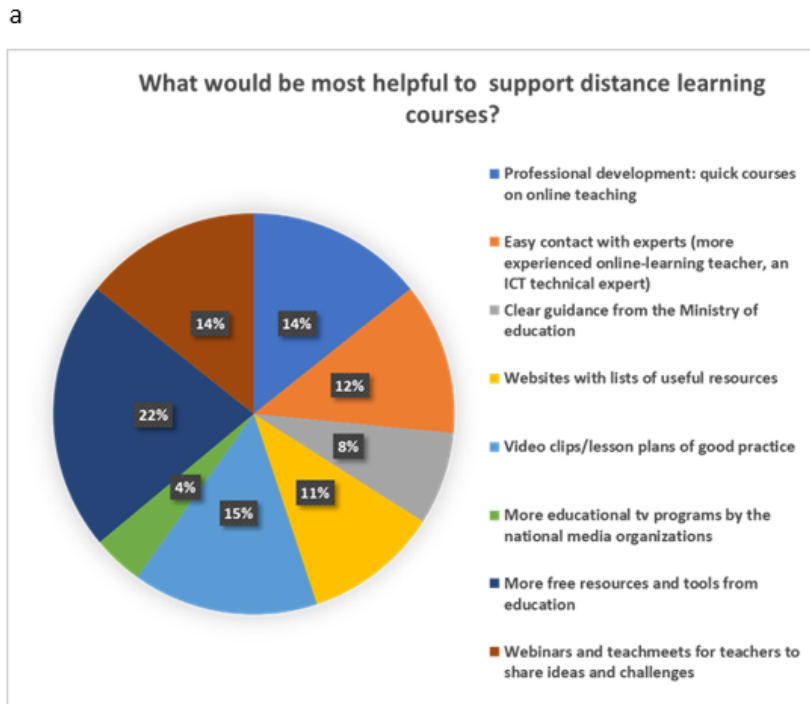
a

b

c

Figure 17: (a-d) Professors' and pedagogical staff's responses regarding the students-teachers dynamic during project-based courses.
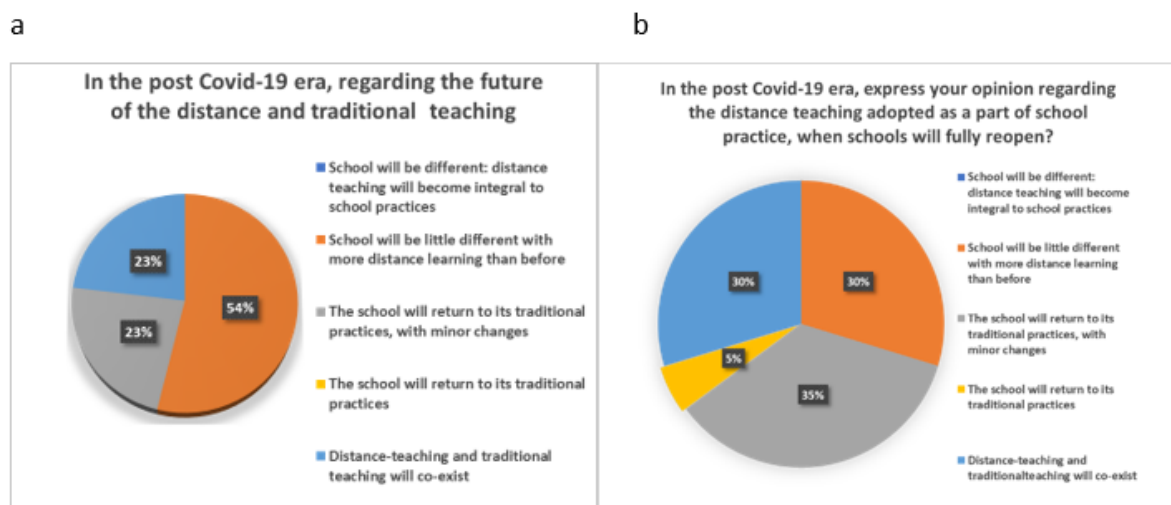
Figure 18: (a-d) Professors' and pedagogical staff's responses regarding the students-teachers dynamic during project-based courses.

physical presence to the laboratories to complete their training. This implies that online learning is not compatible with laboratory practices but can only be used to augment face-to-face training methods where there is later a chance to go back to the normal traditional settings. These remote project-based programs are necessary systems for continuing education but to advance the education process additional work is needed.

Regarding the challenges and the future needs of HEIs towards successful distance learning, some educators mentioned that they faced difficulties with obtaining the required knowledge and skills in order to perform distance learning project-based courses, problems on establishing productive communication and difficulties to deliver the lecture, while they observed minimum interaction during distance learning classes and the discouragement of students to ask questions or to participate in the lecture. They also stated that they initially struggled due to lack of ICT equipment, insufficient internet connection, low motivation or lack of support.

Most students stated that the low internet speed hampered the lectures and disrupted their concentration. It also made them feel anxious and stressed when presenting their projects. Respondents agreed that they faced problems manag-

ing the stress caused by the demands of online learning classes, as well as meeting the deadlines and requirements set by the project assignments. Both teachers and students complained about the short period of time available to become familiar with the use of new digital tools and the changes in the learning processes. Specifically, they responded that "the lack of awareness about all the possibilities and uses of online tools available was a problem", or "both faculty and students needed to adapt". Others studies also stated that shifting mindsets is probably the teachers' main challenge to produce and deliver online lectures (Alhawsawi & Jawhar, 2021; Brinkley-Etzkorn, 2018; Martin et al., 2019; Rasheed et al., 2020).

Regarding the distance project-based courses, some educators stated that "maybe in other courses professors had already worked in the distance learning modality but in the project-based or practical courses, we still used a blackboard in face-to-face sessions". However, they suggested that distance learning, when properly implemented and planned in advance, may be useful in some instances. The main problem is the short time they had to move from face-to-face to online teaching. Proper training was considered necessary for educators to enable them to use

the various software available for video recordings among other aspects. All these statements emphasize the need for continuing training on the use of digital educational tools and their incorporation to traditional practices as a means to facilitate transition in times of crisis (Abumalloh et al., 2021).

On the other hand, the respondents stated some positive findings, such as their interest in digital education tools and their expectations for further use in the future, as well as their belief that the intensive use of digital technology in distance education will benefit the educational process and enhance competence.

The respondents agreed that the imposition of distance learning due to the COVID-19 outbreak set a precedent in education and the future will be different. Various studies observed that the great objective impelled by the post-COVID era is the digitization of universities (Amhag et al., 2019; Núñez-Canal et al., 2022). According to this study, the most popular statements are that, in the post-COVID era, the HEIs will be different with more distance learning than before (54%) or that the HEIs will return to their traditional practices, with minor changes (23%) (Fig. 18). The students' point of view is the same, as 30% of the students believe that the HEIs will return to their traditional practices, with minor changes, and 35% of them believe that HEIs will be different with more distance learning than before. Thus, HEIs should carefully plan how to offer distance learning education to their students.

4 Conclusions

This project-based course was delivered in a distance learning modality during the COVID-19 era and the participating students had to work in remote groups. The module focused on integrating theory with practice by means of experimental learning. The study intended to determine if the distance learning approach implemented was successful and efficient for students to develop graduate attributes.

The majority of students and teachers agreed that, despite the short adjustment period, the tools and techniques adopted in distance learning were satisfactory. However, they were di-

vided on the effectiveness of distance education and maintaining the relationship and communication between them. A significant percentage of educators faced difficulties in obtaining the required knowledge and skills to deliver the distance learning project-based courses, problems on establishing productive communication or difficulties in giving online lectures. A common observation was the unexpectedly low level of interaction during distance learning classes and the reluctance of students to ask questions. Adaptation of laboratory or project-based learning courses was less effective as hands-on experience was deemed irreplaceable. Students, in general, readily adapted to the distance-learning modality. However, many of them reported problems with the flow of the online lectures, disruption of concentration and anxiety and stress for meeting the deadlines and requirements for their assignments or project presentations, as well as technical difficulties with respect to internet connection and audio-visual equipment.

According to the results of the survey, when the appropriate tools, techniques, equipment and technical support are available, distance learning can be very useful and provide multiple benefits. However, the ideal is to develop a system that combines traditional teaching with the new methods and digital tools developed or reformed during the pandemic, in order to improve education and achieve maximum interaction and communication among professors and students. It is also recognized that the future remote learning processes, especially in project-based courses, as opposed to the emergency remote teaching applied under the circumstances of the pandemic, should feature in prompt learning analytics, alert systems for those who are passive and personalized feedback from both students and teachers.

Following the digital era of education, the education system should be transformed. HEIs will have to play a vital role in this journey of transition since they are responsible for providing training and workshops for both educators and students and to equip them with the necessary skills and knowledge. The institutions should continue monitoring, evaluating and evolving their educational activities, such as project-based courses, to determine best practices and establish a learning environment that

provides students with the opportunity to deepen and apply their knowledge and develop skills and competencies, enhancing successful employment and career prospects.

References

Abumalloh, R. A., Asadi, S., Nilashi, M., Minaei-Bidgoli, B., Nayer, F. K., Samad, S., Mohd, S., & Ibrahim, O. (2021). The impact of coronavirus pandemic (COVID-19) on education: The role of virtual and remote laboratories in education. *Technology in Society*, *67*, Article 101728. https://doi.org/10.1016/j.techsoc.2021.101728

Adedoyin, O. B., & Soykan, E. (2020). Covid-19 pandemic and online learning: The challenges and opportunities. *Interactive Learning Environments*, 1–13. https://doi.org/10.1080/10494820.2020.1813180

Alexander, B., Becker, S. A., Cummins, M., & Giesinger, C. H. (2017). *Digital literacy in higher education, part II: An NMC horizon project strategic brief* (tech. rep. No. 3.4). The New Media Consortium. Austin. Retrieved March 14, 2023, from https://library.educause.edu/resources/2017/8/digital-literacy-in-higher-education-part-ii-an-nmc-horizon-project-strategic-brief

Alhawsawi, H. (2017). *Teacher educators' approaches to teaching foundation of Islamic education at a university in Kingdom of Saudi Arabia* [Doctoral thesis]. University of Sussex. Retrieved March 14, 2023, from http://sro.sussex.ac.uk/id/eprint/71503

Alhawsawi, S., & Jawhar, S. S. (2021). Negotiating pedagogical positions in higher education during COVID-19 pandemic: Teacher's narratives. *Heliyon*, *7*(6), Article e07158. https://doi.org/10.1016/j.heliyon.2021.e07158

Amhag, L., Hellström, L., & Stigmar, M. (2019). Teacher educators' use of digital tools and needs for digital competence in higher education. *Journal of Digital Learning in Teacher Education*, *35*(4), 203–220. https://doi.org/10.1080/21532974.2019.1646169

Brinkley-Etzkorn, K. E. (2018). Learning to teach online: Measuring the influence of faculty development training on teaching effectiveness through a TPACK lens. *The Internet and Higher Education*, *38*, 28–35. https://doi.org/10.1016/j.iheduc.2018.04.004

Burke, R. M., & Danaher, P. (2020). Assessment and evaluation of student learning through a project-based assignment on note by note cooking [Number: 2]. *International Journal of Food Studies*, *9*(2), 282–294. https://doi.org/10.7455/ijfs/9.2.2020.a2

Flynn, K. M., Ho, P., Vieira, M. C., Pittia, P., & Rosa, M. D. (2017). Food science and technology students self-evaluate soft and technical skills [Number: 2]. *International Journal of Food Studies*, *6*(2), 129–138. https://doi.org/10.7455/ijfs/6.2.2017.a1

Fonseca, S. C., Pinheiro, R., Barbosa, C., Araújo, A., Vaz-Velho, M., & Alves, R. (2015). Food innovation and entrepreneurship in higher education: A case study [Number: 2]. *International Journal of Food Studies*, *4*(2), 141–147. https://doi.org/10.7455/ijfs/4.2.2015.a3

Ghomi, M., & Redecker, C. (2019). Digital competence of educators (DigCompEdu): Development and evaluation of a self-assessment instrument for teachers' digital competence. *Proceedings of the 11th International Conference on Computer Supported Education - Volume 1: CSEDU*, 541–548. https://doi.org/10.5220/0007679005410548

Giannou, V., Lakner, Z., Pittia, P., Mayor, L., Costa, R., Silva, C. L. M., & Oreopoulou, V. (2015). Qualifications of food science and technology/engineering

professionals at the entrance in the job market. *International Journal of Food Studies*, *4*(2), 173–187. https://doi.org/10.7455/ijfs/4.2.2015.a6

Gutierrez-Bucheli, L., Kidman, G., & Reid, A. (2022). Sustainability in engineering education: A review of learning outcomes. *Journal of Cleaner Production*, *330*, Article 129734. https://doi.org/10.1016/j.jclepro.2021.129734

Iglesias-Pradas, S., Hernández-García, Á., Chaparro-Peláez, J., & Prieto, J. L. (2021). Emergency remote teaching and students' academic performance in higher education during the COVID-19 pandemic: A case study. *Computers in Human Behavior*, *119*, Article 106713. https://doi.org/10.1016/j.chb.2021.106713

Khan, M. S. H., & Abdou, B. O. (2021). Flipped classroom: How higher education institutions (HEIs) of Bangladesh could move forward during COVID-19 pandemic. *Social Sciences & Humanities Open*, *4*(1), Article 100187. https://doi.org/10.1016/j.ssaho.2021.100187

Koulouris, A., Aroutidis, G., Vardalis, D., Giannoulis, P., & Karakosta, P. (2015). Enhancing food engineering education with interactive web-based simulations. *International Journal of Food Studies*, *4*(1), 1–11. https://doi.org/10.7455/ijfs/4.1.2015.a1

Martin, F., Ritzhaupt, A., Kumar, S., & Budhrani, K. (2019). Award-winning faculty online teaching practices: Course design, assessment and evaluation, and facilitation. *The Internet and Higher Education*, *42*, 34–43. https://doi.org/10.1016/j.iheduc.2019.04.001

Núñez-Canal, M., de Obesso, M. d. l. M., & Pérez-Rivero, C. A. (2022). New challenges in higher education: A study of the digital competence of educators in COVID times. *Technological Forecasting and Social Change*, *174*, Article 121270. https://doi.org/10.1016/j.techfore.2021.121270

Rahman, N. A. A., Hussein, N., & Aluwi, A. H. (2015). Satisfaction on blended learning in a public higher education institution: What factors matter? *Procedia - Social and Behavioral Sciences*, *211*, 768–775. https://doi.org/10.1016/j.sbspro.2015.11.107

Rapanta, C., Botturi, L., Goodyear, P., Guàrdia, L., & Koole, M. (2020). Online university teaching during and after the COVID-19 crisis: Refocusing teacher presence and learning activity. *Postdigital Science and Education*, *2*(3), 923–945. https://doi.org/10.1007/s42438-020-00155-y

Rasheed, R. A., Kamsin, A., & Abdullah, N. A. (2020). Challenges in the online component of blended learning: A systematic review. *Computers & Education*, *144*, Article 103701. https://doi.org/10.1016/j.compedu.2019.103701

Reisoğlu, İ., & Çebi, A. (2020). How can the digital competences of pre-service teachers be developed? Examining a case study through the lens of DigComp and DigCompEdu. *Computers & Education*, *156*, Article 103940. https://doi.org/10.1016/j.compedu.2020.103940

Schreck, C. M., Weilbach, J. T., & Reitsma, G. M. (2020). Improving graduate attributes by implementing an experiential learning teaching approach: A case study in recreation education. *Journal of Hospitality, Leisure, Sport & Tourism Education*, *26*, Article 100214. https://doi.org/10.1016/j.jhlste.2019.100214

World Health Organization. (2020). WHO director-general's opening remarks at the media briefing on COVID-19 - 11 march 2020. Retrieved March 14, 2023, from https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19--11-march-2020

Zalat, M. M., Hamed, M. S., & Bolbol, S. A. (2021). The experiences, challenges, and acceptance of e-learning as a tool for teaching during the COVID-19 pandemic among university medical staff (G.-J. Hwang, Ed.). *PLoS ONE*, *16*(3),