Medical students' views of e-learning-based medical education during COVID-19 pandemic

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Abstract

The number of multimedia courseware developed to assist teaching and learning activities has increased tremendously, following the declaration of schools' closure during COVID-19 pandemic. This study aimed at e- learning experiences of 550 students of a medical school in Iran during the time Coronavirus pandemic hit Iran. To achieve the objectives of this study, a self-devised questionnaire was used, and the data were analyzed using Independent samples T. test, ANOVA, and MANOVA. Results have demonstrated that university students had a satisfactory e-learning experience during the lockdown with an exception for online synchronous classes. This study also showed that older students are more satisfied with e-learning and that there was a significant difference between the overall mean score of those who had access to PCs and laptops compared to those who had accessed only to mobile phones. Our results also showed a significant difference exists between the e-learning experience of students who had experienced virtual classes prior to Covid-19 pandemic and those who had not; however, no significant difference was seen in terms of the residence of the students and their gender.

Introduction

Because of Coronavirus pandemic, pedagogical approaches in e-education have been utilized for many teachers and students all around the world. Therefore, the number of multimedia courseware developed to assist teaching and learning activities has increased tremendously, following the declaration of schools' closure during COVID-19 pandemic. Reportedly, although at the beginning, teachers and university lecturers had more difficulty adjusting to the new circumstances than school students and university ones, gradually teachers started to develop their digital skills by going beyond using Internet just for searching and started to design, format, make, and edit their own e-contents using various platforms previously had not experienced before. Students, equally, had to raise their digital literacy skills in order to locate and use various e-resources their teachers presented.

However, all this technological growth happened overnight for teachers and students alike, something which contradicts '10,000 hours to master a skill' rule of thumb many suggest. On the other hand, culturally and mentally, there had always been a disinclination towards e-learning on behalf of many teachers including for example professors teaching at Shiraz University of Medical Sciences (SUMS). Reportedly, although Shiraz Virtual University of Medical Sciences had been established 10 years prior to COVID-19 incidence, there were a few medical schools and faculty members who were actively involved in medical virtual education. After teachers being forced to shift from face-to-face education to the virtual one mostly unwillingly, we thought it is paramount to study medical students' viewpoints of e-learning-based medical education that SUMS professors provided to their students during the time Coronavirus pandemic hit Iran.

E-learning

Prior to Coronavirus crisis, e-learning had maintained its prominent position at educational settings, especially for medical education. As Howlett et al. (2009) define it, e-learning is the usage of electronic technology for delivering, supporting, and enhancing both learning and teaching; however, it also involves an active communication between a teacher and students. In case of medical universities, presenting students with clinical cases, images, videos, and synchronous and asynchronous course activities blended with face-to-face lectures in classrooms has long been established all over the world with various degrees. University infrastructure, teachers' technical skills and digital literacies, teachers' teaching load and, therefore, their tendency and inclination to digital environments, and institutional support and attitudes towards e-learning are all few reasons behind the success or failure of e-learning implementation at various medical universities (O'Doherty et al., 2018; Shachar et al., 2016; Muhannad, 2013; Nour et al., 2019). Likewise, students, studying at medical schools or else, have experienced variously based on their background, schools they attend to, their digital literacy, and e-learning resources as well as institutional support they receive while and after school among many others. In terms of Infrastructure, for example, in one study conducted by Koh et al. (2014), majority of Malaysian medical students possessed smart devices with medical apps installed on them, and they reportedly had positive feelings regarding the effectiveness of these apps on their studies. Notably, Wi-Fi and 3G services were provided to all these medical students within the university and hospital. However, in another study, Masika et al., (2015) reported that in Kenya the main challenges of using mobile devices and apps for medical education are lack of smart devices, sub-optimal internet access, cost of acquiring apps, and limited device memory.

Sometimes the positive or negative attitudes students have towards e-learning are universal. For example, it is widely believed that the negative attitudes of university lecturers towards technology-based education can indirectly cause technology-based education resistance among students which, in turn, can cause a series of challenges for students (Kyong-Jee, et al. 2017). Sometimes it is not the e-contents, per se, that cause challenges for students, but failure of communication between a teacher and his/her students and students with their peers that negatively influences students' productivity in e-learning (Jang and Kim, 2014). As Chapman and Mahlk (2004) point out latest educational technology does not necessarily enhance instruction or students' participation. Also Daniels et al. (2019) indicate that the way e-learning materials are presented to students has a significant effect on the effectiveness of the lesson being taught. Sometimes lack of time management and absence of self-regulation are reported as major factors affecting students' e-learning experience (Jarvela et al., 2018). Not telling students "when" to access the contents, according to Pedrotti and Nistor (2019), is left up to students who especially in fully presented on-line courses, due to time constraint and lack of effort regulation strategies, fail to strategically plan their e-learning activities during the course.

Pedagogically, heightened cognitive load as a result of teachers' ineffective teaching methods is another challenge repeatedly reported by students. Cognitive load theory (CLT) offers a general framework of learning and its association with working memory as well as long-term memory within an e-learning environment (Clark & Mayer, 2007). Extraneous or ineffective cognitive load presents students with unnecessary information that inhibit students' ability to process new information and to create long-term

memories (Lambert et al., 2009). As Uppal (2017) indicates, e-learning works only if teachers know how students learn.

Apart from human factors, another challenge that impedes e-learning is technological facilities. Not only at schools and universities, but also at homes, so many students do not have access to foundational technology services, software, and hardware to fully explore opportunities computer-based teaching provides to them (Nor & Mohamad, 2013). Although it is assumed that in the 21st century we might or should not face such challenges anymore, in so many developing countries, bandwidth and connectivity issues still cause a perennial hurdle for synchronous and asynchronous e-learning/teaching (Bower et al., 2015). Even cost of buying Internet packages might be the concern for many students studying in such countries (Nor & Mohamad, 2013), which even now, during Coronavirus pandemic that all courses are presented online, this concern, undoubtedly, has aggravated.

E-learning and COVID-19 pandemic

Globally, many students have to receive their course contents virtually because of their schools' closure after the pandemic. This rapid adjustment to the current global phenomenon necessitates not only teachers but also students to adapt themselves to this new homeschooling system by pushing them to learn new digital skills and new learning and teaching strategies in a short run. As a result, any observations about the way the coronavirus pandemic is impacting e-learning should be the concern for many researchers at this stage. While online learning might be available, it is unlikely to be as effective as face-to-face teaching; those with less resources will disproportionately be disadvantaged due to many reasons, including lack of preparation in participation in online classes, technical issues and concerns, weak/interrupted internet signals during live lectures, lack of face-to-face interaction, lack of time management, and many more during Coronavirus pandemic.

Even before Coronavirus pandemic, there was little literature available on the effectiveness of asynchronous and synchronous e-learning in medical universities and previous studies show that perceived e- learning challenges have to do more with lack of technological facilities and the kind of Learning Management System (LMS) which is used in a particular school (Hadullo et al. 2018). Therefore, this study could be a significant contribution to knowledge in this area if we must understand the perceptions of students regarding inhibiting factors related to e-learning. Furthermore, e-learning is a relatively new innovation in the design of educational facilities at medical universities Iran, especially during Coronavirus pandemic during which the fast pace of transition from face-to-face classes to distance education could not really prepare the officials and university authorities to evolve their digital tools to ensure uninterrupted educational delivery to every one of the students.

Purpose of the study

Mainly, the purpose of this study was:

1. To identify SUMS medical students' views of e-learning-based medical education during Coronavirus pandemic.

2. To see if there are any differences in the students' general views and their age, gender, residence, digital and computer literacy, type of digital device used, prior e-learning experience, and degree of study.

Research Methodology

Research Design

After taking approval from the Ethical Review Committee of the Shiraz University of Medical Sciences, a cross-sectional descriptive study was conducted in March 2020 on the students' perception of e-learning experiences during the semester coincided with Coronavirus pandemic.

Population of the Study

The target population of this study was all students studying at SUMS, at various disciplines. SUMS is a public medical school located in Shiraz, Iran. It is ranked as one of Iran's top medical universities and it includes 11 main schools dealing with various academic studies related to medical sciences. Before Coronavirus pandemic, students had none to medium level experience in the format of blended learning. Therefore, the experience of pure e-learning was a completely new experience for all students.

The sample size of this study was determined to include 507 subjects by means of Kergesi Morgan's Table and simple random sampling was applied to collect the data.

Research Instrument

To achieve the objectives of this study, a self-devised questionnaire was used. In order to design a questionnaire with wide diversity of perceptions regarding students' e-learning experiences, an online focus group of heterogeneous sample consisting of 5 students studying at different medical schools within SUMS as well as 5 faculty members were held while we were still in the Covid-19 quarantine. With the permission of the participants, the focus group was video-recorded and all the comments were later drafted and conclusions were drawn by the researchers of this study. Thirty items were extracted and were presented in the format of Six-Likert items from strongly agree down to strongly disagree. The questionnaire was divided into 2 parts. Part one comprised of demographic parameters such as gender, age, students' discipline of study, their degree level (Associate degrees, continuous bachelor and non-continuous bachelor degrees, Master's and doctoral degrees, and professional doctorate degree (Doctor of Medicine, Dentistry, and Pharmacy)), residence, and their digital and computer literacy. Part two of the questionnaire was designed based on semantic and content linkages of all items in the questionnaire. Six questions allocated to evaluate technological facilities factors; 5 questions were related to university technical support; 5 questions targeted asynchronous learning, 5 questions targeted synchronous virtual classes; 3 questions identified students' perceptions of quality of e-contents made by faculty members; 6 questions evaluated teacher-student interactions. Also 5 questions aimed at general feelings of students

towards e-learning. The cutoff point score was considered 3.5 equivalent to 50% which showed that the average greater than 3.5 for each component shows students' satisfaction.

Furthermore, 2 close-ended questions were asked from students and they were asked to choose from a distinct set of pre-defined responses. Students were asked if they thought e-learning education they had during Coronavirus pandemic was a) interesting, or b) horrible; if they preferred using blended learning in the future compared to pure face-to-face medical education after the eradication of Coronavirus. Furthermore, and 1 open ended-question was also asked from students to see what they have missed the most in the traditional learning environment.

Validity and Reliability

The validity of the questionnaire was assessed by calculating the Content Validity Index (CVI) and the Content Validity Ratio (CVR). To this end, ten experts in the fields of medical education (2), e-learning (2), medical sciences (4), and English Language (2) reviewed the questionnaire items. The CVI for each question was 0.90 – 1 that demonstrated high agreement among the content experts and CVR= 0.80-1. In addition to content validity, the face validity of the questionnaire was measured. Following this, eight questions were modified in terms of grammar and eloquence. The reliability of the questionnaire was also measured after sending the initial version of the questionnaire to 40 medical students. Using Cronbach's alpha for analysis, the findings indicated a high reliability (94.8%). We also measured internal consistency reliability of all items in the questionnaire; out of 30 items in the questionnaire, 4 items were deleted using Cronbach's alpha if item deleted. As a result, the reliability increased to 97.6%.

Data Collection Procedures

After this study was approved by Ethical Committee of SUMS (Ref.No. IR.SUMS.REC.1399.616), data collection began. This survey was conducted in June, 2020, and while we were collecting the data, we were still in quarantine as a result of Coronavirus pandemic. Therefore, to collect the data, an online survey was designed to be sent to all students studying at SUMS, using WhatsApp social media group faculty members had with their students. Privacy and anonymity of the participants and confidentiality of data were granted, and subjects' informed consent was obtained.

Data Analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) for windows (version 24). Demographic characteristics of the participants were calculated by descriptive statistics (frequency and percentage of frequency). The data were also analyzed by Independent samples T. test, MANOVA, and ANOVA.

Results Of The Study

Demographic and Profile Characteristics

As shown in Table 1, the demographic and profile information regarding those 507 students who responded to the online survey indicates that 343 (67.7%) were females and 164 (32.3%) were males. The highest percentage of the respondents, 207 (40.8%), was studying at a continuous bachelor degree, followed by 193 (38.1%) professional doctorate degree, 79 (15.6%) non-continuous bachelor degree, 16 (3.2%) PhD, and finally12 (2.4%) held Master's degree. Four hundred (78.9%) respondents aged between 18-24 years old; 107 (21.1%) aged more than 24, and the mean average of the respondents was 26.8± 23.7. There were 222 (43.8%) who were living in their hometowns at the time of quarantine and 258 (56.2%) who were resided at the campus. From students' digital and computer literacy viewpoint, the results showed that 287 (56.6%) respondents had low to average digital and computer literacy, and 368 (72.6%) had a sufficient digital and computer literacy and had the knowledge and ability to use computers and related technology efficiently. Out of all the participants, 368 (72.6%) had a personal laptop for their studies, 139 (27.4%) only accessed their mobile phones or occasionally had access to friends' or family members' computers and laptops. There were 125 (24.7%) who had experienced e-learning prior to Covid-19, and 382 (75.3%) had not had such an experience at all. Table 1 shows the number of students who participated in this study from various schools within SUMS.

Inferential statistics

The mean and standard deviation for the responses of the participants to the questionnaire items are illustrated in Table 2. The overall mean score of all items in the questionnaire regarding the medical students' views of e-learning education was satisfactory (3.87 ± 1.03, $p< 0.001$). However, the findings indicate that all e-learning components except the satisfaction towards online classes ($p=0.14$) have obtained a score of over 50%.

Considering the age factor, the students were divided into two groups: 18 to 24 years and more than 24. The results of the independent samples t-test showed a significant difference in the overall mean of the students' responses to the questionnaire items with respect to the age factor ($p=0.027$). It means that the greater the age, the more satisfaction students experienced regarding e-learning education except for synchronous classes ($p=0.98$), technological facilities ($p=0.39$), and support ($p=.08$) components in which no significant difference was identified.

In terms of gender, the results of the independent samples t-test indicate no significance difference between the opinions of the male and female students' e-learning experience ($p> 0.05$) not only in the overall mean but also in the sub-components.

The results also showed that there is a significant difference between the overall mean score of those who had access to PCs and laptops compared to those who had accessed only to mobile phones ($p=0.002$). This difference was significant in terms of all the e-learning components.

Likewise, no significant difference was seen in terms of the residence of the students. However, a significant difference was observed in both the overall mean and the mean of each e-learning component

in terms of students' computer and digital literacy. In other words, students' digital competence had a significant role in their adjustment to the virtual learning.

The results also showed that there is a significant difference between the students who had experienced virtual classes prior to Covid-19 pandemic and those who had not (p=0.01). This difference was significant in terms of all the e-learning components except for asynchronous classes (p=0.11).

Finally, we evaluated the relationship between students' degree (Associate degrees, continuous bachelor and non-continuous bachelor degrees, Master's and doctoral degrees, and professional doctorate degree) and their views of e-learning education. The results show that the students of dentistry, pharmacy, and medicine (professional doctorate degree) had a lower mean score than the undergraduates (p = 0.02), Master's students (p = 0.001), and PhD students (p = 0.03).

Since the investigated variables in the present study were in fact different facets of e-learning education, an interaction between them was assumed and MANOVA was used. For running MANOVA, at first, four indexes including Pillai's Trace, Hotelling's Trace, Roy's Largest Root, and Wilkes Lambda index were checked to ensure that the assumptions for conducting a MANOVA were not violated. The findings confirmed the interaction between the variables in the present study (P=0.000).

As it can be seen in Table 8, the results of MANOVA showed that the impact of different factors on each other was significant. This implies that all of the factors had an impact on each other. Further investigations revealed that the teacher-learner interaction factor (Adjusted R Squared = .060; F=4.23 and using NAVID factor (Adjusted R Squared = .050; F=3.69) had the greatest impact on the students' desirability of e-learning education, respectively.

In terms of responses to close/open-ended questions, the results show that 322 (67%) of students thought e-learning education is interesting; however, 302 students (60%) preferred using blended learning in the future compared to 205 (40%) reluctant students who preferred pure face-to-face medical education after the eradication of Coronavirus. Three hundred and fifty six students (75%) believed the physical presence of the teacher sensed throughout the semester; likewise, 410 students (80%) reported missing the peer-to-peer interaction they used to have in the traditional learning environment.

Discussion And Conclusion

Although a random sample of 507 students sought out to participate in this study, the findings and conclusions are limited in their generalizability because they were derived from only one medical university in Iran and most specifically the data were collected at the unusual time of Covid-19 pandemic, the time that results of any research is significantly overshadowed by the disease. Furthermore, because of the university closure, the data were collected only electronically, so perhaps students who did not have access to Internet could not fill out the questionnaire despite having negative views regarding e-learning education. With these caveats in mind, results have demonstrated that SUMS university students had a positive e-learning experience during the lockdown. This finding parallels another research carried out

during the lockdown. Hyseni Duraku and Hoxha (2020) reported that although students faced challenges in terms of lack of attention in online classes due to various reasons, generally, they had a positive feeling towards e-learning not only because psychologically e-learning drew their attention away from the pandemic, but also because learning wise, they had more time for lessons and interactions with the professors. Our result is contradictory to another similar study conducted in Pakistan College of Medicine and Dentistry since the majority of the Pakistani students had a negative feeling towards e-learning, were more inclined towards face-to-face learning in the future, and most importantly felt e-learning had little impact on their learning in general during the pandemic (Abbasi, Ayoob, Malik, Memon, 2020). Considering medical students' e-learning experience literature before Covid-19, the results are mixed with a greater number of medical studies reporting students' positive feelings towards e-learning (see for example, Ali, Jamil, Sethi, Ali, 2016; Singh & Min, 2017; Attaran & Zainuddin, 2018).

This study also revealed that SUMS students were dissatisfied with online synchronous classes perhaps because not all students could access synchronous classes reliably due to their geographical zone insufficient bandwidth, peer-to-peer traffic, and streaming of audio and video (Sanga, Kilima, & Busagala, 2010).

In our study, lack of interaction with the professors was also mentioned as one of the reasons why students are dissatisfied with synchronous classes. In comparison with asynchronous classes, many studies reported that students prefer asynchronous classes over live class sessions as in the latter teachers do not have time to answer their questions and do not have the required skills to properly handle online classes (see for example, Jackson, Jones, & Rodriguez, 2010; Callaway, 2012; Cole et al., 2014). A successful synchronous session requires four types of interactivity: learner-teacher interaction, learner-learner interaction, learner-content interaction and learner-interface interaction (Sims, 1999).

This study also showed that older students are more satisfied with e-learning. This finding does not support another study conducted in which it was reported that age is not a significant factor influencing both the future use intentions and satisfaction with e-learning (Fleming, Becker, and Newton, 2017). Another study carried out by Dabaj (2009) also reported similar finding. This result is interesting because it seems that younger generation is supposed to be more digital literate and more competent with e-learning; however, it seems that in our study, experience and wisdom acquired by age has a more contributing role in e-learning acceptance especially at the time of over-night shift to virtual learning due to Covid-19 pandemic. McSporran and Young (2001) reported that because mature female students are better at scheduling their learning and are better at communicating online, they are more motivated towards distance learning; this finding is partly consistent with our result because we could not find any significant relationship between students' gender and their e-learning experience. This is supported by a study, which had been conducted in Malaysia (Rahman et al., 2012).

No significant difference was seen in terms of the residence of the students. In other words, living at home or residing in the hostel did not play any role in students' e-learning experience. However, our finding revealed that students' computer and digital literacy played a significant part in their e-learning

experience. This finding parallels previous research in this area that students' digital literacy is a prerequisite for learning effectively in a blended learning environment (see Tang & Chaw, 2016; Mohammadyari & Singh, 2015). However, Concannon et al. (2005) believe that this is not the students' digital literacy that should be the main concern, but it is their attitude towards e-learning that matters the most. In their study, they reported that even the least digital literate students had a positive attitude towards e-learning and as a result none of students stated difficulties while using technologies. In contrast, Mohammadyari and Singh (2015) believe that digital literacy is not merely about having the computer knowledge; it is, instead, one of many other literacies people need, in the 21st century, to understand and comprehend various type of information.

This study also revealed that a significant difference exists between the overall mean score of those who had access to PCs and laptops compared to those who had accessed only to mobile phones. This shows that the choice of hardware plays a significant role not only in students' e-learning experience in general, but also in all the sub-components of this study, content quality, interaction with teachers, and asynchronous classes, to name a few. From a synchronous classes and content quality, this result might be justifiable in terms that almost all the multimedia contents made during Covid-19 pandemic were not designed and developed for mobile users; they were simply made out of necessity. Therefore, while developing the contents, perhaps teachers did not consider the smaller screen of the mobile phone users and the type and the size of the fonts they were using. Sung, Chang, and Liu (2015) believe that teachers need teacher-development training to improve mobile-enhanced instruction. Insufficient preparation on behalf of teachers, according to Frohberg et al. (2009), is one of the major factors in students' learning failure using mobile devices. Although in our study, only about 28% accessed their mobile phones for studying and did not have any personal computers and laptops, teachers should customize their teaching program rather than "simply designing their own program around the use of technology" (Sung et al. 2015, p.266).

Our results also showed a significant difference exists between the e-learning experience of students who had experienced virtual classes prior to Covid-19 pandemic and those who had not. In other words, those students who had experienced blended learning before had a more positive e-learning experience during the semester presented during the pandemic. Interestingly, this difference was significant in terms of all the e-learning components except for the asynchronous classes. This is because only after the pandemic, SUMS launched Navid Academic Learning Management System for the multimedia contents to be uploaded by the teachers for the students and this experience was new to all the students studying at SUMS. Therefore, perhaps, unfamiliarity with the system and all its modules might be the reason why there was a significant relationship between all the e-learning components except for the Navid system. This result is supported by Shafiei Sarvestani, Mohammadi, Afshin, Raeisy (2019) who reported that students from Virtual School of SUMS reported that a large number of modules has led to increased application complexity.

Our result also demonstrated that there is a significant difference between students' degree (continuous bachelor and non-continuous bachelor degrees, Master's and doctoral degrees, and professional

doctorate degree) and their views of e-learning education. It seems that the lower the degree, the more satisfied students were in terms of e-learning medical education.

Finally, further investigations revealed that the teacher-learner interaction factor and using NAVID factor had the greatest impact on the students' desirability of e-learning education, respectively.

We also reported that more than half of students thought e-learning education is interesting; however, 60% of the students preferred using blended learning in the future compared to 40% reluctant students who preferred pure face-to-face medical education after the eradication of Coronavirus. This result is not in line with what Dabaj and Basak (2008) reported that although students may choose to study in online courses, they still prefer the traditional courses.

Implication of the Study

This study holds clear implications for e-learning medical education in the future since having insight regarding medical students' views of e-learning could help teachers, course designers and university authorities to develop general principles and standards through a systematic model to design relevant e-learning courses for medical students. Since it is not known when we get back to old normal and face-to-face or blended learning education, the results of this study provide yet more evidence for curriculum designers or instructional coordinators to design and facilitate multimedia courses that are tailored to all students, especially those who do not have the opportunities everyone else might have. Our result also highlights the importance of professional development resources for teachers in order to support them build necessary skills for developing virtual contents and delivering remote teaching, which in turn help the students not only develop their academic abilities but also learn more independently at home.

Suggestions for future research

Although the findings of this study showed that medical students had positive views regarding e-learning education, longer experiments with larger samples need to be conducted in the future to further investigate the effectiveness of e-learning medical education, especially under normal circumstances. Furthermore, since teachers are the providers of this education, it is vital to study their viewpoints regarding e-learning.

Declarations

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

L. KH devised the study concept and created the first and final draft of the study. E. N. devised the questionnaire and helped editing the final version of the manuscript. Z. K. ran the reliability and validity tests and analyzed the data, and S. Sh. collected the data.

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Tables

Table 1 Frequency and Percent of Respondents

School	Frequency	Valid Percent
Medicine	121	23.9
Dentistry	37	7.3
Pharmacology	54	10.7
Nursing	71	14.0
Paramedicine	72	14.2
Rehabilitation Sciences	33	6.5
Health	53	10.5
Nutrition and Food Sciences	66	13.0
Total	507	100.0

Table 2 The mean and standard deviation for the responses of the participants to the questionnaire items

Components	Items	Items			Components		
		N	Mean	SD	Mean+SD	t	Sig
Technological facilities	I had access to a computer or mobile phone to learn via the virtual system.	504	5.13	1.16	4.29 ± 1.13	15.23	0.000
	2. When downloading my offline video contents, I did not face any problems in terms of network and the Internet	499	4.01	1.66			
	3. when having online classes, I did not face any problems in terms of network and the Internet	481	3.53	1.68			
	4. My computer hardware and software settings were suitable for e-learning	506	4.51	1.40			
	5. I did not face any problems to access Navid (LMS) in terms of authentication	506	4.38	1.67			
Technical support	6. Despite the suspension of classes, the technical infrastructure was able to maintain trainings	504	3.52	1.61	4.00 ± 1.08	10.12	0.000
	7. Training guidelines were provided on how to use the virtual systems	503	4.20	1.36			
	8. I received the necessary information and support through the faculty and university to attend the virtual classes	471	3.82	1.35			
	9. Necessary software was introduced for using websites and virtual classes	505	4.53	1.27			
Asynchronous learning	10. Working with different parts of Navid system (offline) was easy	505	4.47	1.23	3.73 ± 1.20	4.25	0.000
	11. Navid system was a proper platform for receiving lessons and assignments	506	4.09	1.42			
	12. Navid system was a proper platform for quizzes and exams	477	3.38	1.68			
	13. The lessons were presented in a planned, regular, and sequential manner	507	3.01	1.72			
Synchronous learning	14. The virtual system was a proper platform for providing online classes	479	3.54	1.56	3.59 ± 1.31	1.46	0.14
	15. I had no particular problem for entering the online classes	467	3.77	1.62			
	16. I could raise my own questions in online classes with the professor	458	3.49	1.63			
	17. Getting connected and attending the online classes was easy for me	467	3.53	1.60			
Content quality	18. The electronic contents presented by the professors were understandable and informative	500	3.87	1.48	3.84± 1.05	6.10	0.000
	19. In the current situation, electronic contents were rich enough to make up for the absence of a professor and the absence of face-to-face classes	504	3.54	1.57			
	20. Presenting lessons in the form of electronic content was very interesting and effective in motivating me	500	3.47	1.66			
Teacher-learner interaction	21. I could stay in touch with my professors through Navid system modules (conversations and forums)	504	3.60	1.52	3.63 ±1.32	2.06	0.04
	22. I was able to stay in touch with my professors through online virtual classes	468	3.37	1.54			
	23. I was able to stay in touch with my professor through social media	495	3.63	1.58			
	24. My professors provided quick and efficient feedback to my educational needs and questions.	471	3.62	1.54			

	25. My professors encouraged me to interact and participate in lessons and discussions	465	3.64	1.53			
	After doing the assignments, I received feedback from my professors.	463	3.63	1.54			
Total					3.87 ± 1.03	6.77	0.000

Table 3 The relationship between students' responses to the questionnaire items with respect to the age factor

Components	Age	N	Mean	Std. D	t	Sig
Technological facilities	18-24	370	4.32	1.15	0.85	0.39
	>24	99	4.21	1.07		
Technical support	18-24	364	3.96	1.08	-1.72	0.08
	>24	103	4.17	1.04		
Asynchronous learning	18-24	375	3.60	1.22	-4.69	0.000
	>24	100	4.23	0.99		
Synchronous learning	18-24	339	3.59	1.32	-0.02	0.98
	>24	96	3.59	1.30		
Content quality	18-24	274	3.76	1.06	-2.48	0.01
	>24	83	4.09	0.96		
Teacher-learner interaction	18-24	326	3.52	1.33	-3.12	0.002
	>24	96	4.00	1.22		
Total	18-24	274	3.80	1.04	-2.22	0.027
	>24	83	4.09	0.94		

Table 4 students’ digital competence role in students’ adjustment to the virtual learning

Components	Students’ digital competence	N	Mean	Std. D	t	Sig
Technological facilities	Low/ to some extent	269	3.95	1.09		
	Expert	200	4.76	1.01	-8.16	0.000
Technical support	Low/ to some extent	271	3.78	1.01		
	Expert	196	4.31	1.10	-5.37	0.000
Asynchronous learning	Low/ to some extent	274	3.54	1.18		
	Expert	201	4.00	1.19	-4.19	0.000
Synchronous learning	Low/ to some extent	256	3.31	1.24		
	Expert	179	3.99	1.32	-5.49	0.000
Content quality	Low/ to some extent	215	3.58	0.97		
	Expert	142	4.22	1.04	-5.89	0.000
Teacher-learner interaction	Low/ to some extent	248	3.51	1.23	-2.29	0.023

Table 5 The relationship between students’ access to computers/laptops/mobile phones and virtual learning

Components	Computer access	N	Mean	Std. D	t	Sig
Technological facilities	No-PC/Lap	126	3.68	1.14		0.000
	PC/Lap	343	4.52	1.04	-7.56	
Technical support	No-PC/Lap	135	3.84	1.03		
	PC/Lap	332	4.07	1.09	-2.05	0.04
Asynchronous learning	No-PC/Lap	136	3.65	1.15		
	PC/Lap	339	3.77	1.22	-1.01	
Synchronous learning	No-PC/Lap	128	3.29	1.22		
	PC/Lap	307	3.72	1.33	-3.12	0.002
Content quality	No-PC/Lap	113	3.59	0.96		
	PC/Lap	244	3.95	1.07	-3.06	0.002
Teacher-learner interaction	No-PC/Lap	125	3.61	1.19		0.817
	PC/Lap	297	3.64	1.38	-0.23	
Total	No-PC/Lap	113	3.62	0.95		
	PC/Lap	244	3.98	1.04	-3.12	0.002

Table 6 The relationship between students' prior e-learning experience and their current experience

Components	Prior experience	N	Mean	Std. D	t	Sig
Technological facilities	No	357	4.17	1.12		
	Yes	112	4.69	1.07	-4.29	0.00
Technical support	No	356	3.91	1.06		
	Yes	111	4.29	1.10	-3.27	0.00
Asynchronous learning	No	366	3.69	1.17		
	Yes	109	3.90	1.30	-1.61	0.11
Synchronous learning	No	332	3.48	1.27		
	Yes	103	3.94	1.38	-3.08	0.00
Content quality	No	281	3.76	1.01		
	Yes	76	4.12	1.13	-2.65	0.01
Teacher-learner interaction	No	327	3.57	1.27		
	Yes	95	3.83	1.49	-1.66	0.10
Total	No	281	3.80	0.99		
	Yes	76	4.13	1.12	-2.49	0.01

Table 7 Between-subjects factors

Effect		Value	F	Error df	Sig.
School	Pillai's Trace	.359	3.171	2094.000	.000
	Wilks' Lambda	.683	3.264	1616.955	.000
	Hotelling's Trace	.407	3.317	2054.000	.000
	Roy's Largest Root	.197	9.827[c]	349.000	.000

Table 8 The interaction between the components of e-learning education

Components	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Technological support	Corrected Model	24.61	7	3.51	2.76	.008
	Error	444.50	349	1.27	(Adjusted R Squared = .033)	
	Total	6759.88	357	-		
Technical support	Corrected Model	18.69	7	2.67	2.35	.023
	Error	396.40	349	1.13	(Adjusted R Squared = .026)	
	Total	6265.93	357	-		
Asynchronous learning	Corrected Model	37.53	7	5.36	3.69	.001
	Error	506.92	349	1.45	(Adjusted R Squared = .050)	
	Total	5734.93	357	-		
Synchronous learning	Corrected Model	27.53	7	3.93	2.35	.023
	Error	582.38	349	1.66	(Adjusted R Squared = .026)	
	Total	5276.68	357	-		
Content quality	Corrected Model	17.63	7	2.51	2.35	.023
	Error	373.09	349	1.06	(Adjusted R Squared = .026)	
	Total	5649.24	357	-		
Teacher-learner interaction	Corrected Model	45.41	7	6.48	4.23	.000
	Error	534.89	349	1.53	(Adjusted R Squared = .060)	
	Total	5448.66	357	-		