E-learning-based medical education during COVID19 pandemic From Medical students' View Points

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Abstract

Background

Most universities around the world have replaced e-learning with face-to-face methods after Covid-19 Pandemic. The present study evaluates the students' viewpoints about the dimensions of e-learning during the COVID-19 pandemic.

Methods

This is a survey study aimed at investigating e-learning experiences of 550 students of Shiraz University of Medical Sciences(SUMS) during the time Coronavirus pandemic. To data collection, a research-made questionnaire was employed, and the data were analyzed using one sample T-test, Independent T-test, ANOVA, and MANOVA.

Results

The results demonstrated that the students had satisfactory e-learning experiences and the average dimensions of e-learning were: Technological facilities($M = 4.29 \pm 1.13$), Technical support ($M = 4.00 \pm 1.08$), e-Content quality(3.84 ± 1.05), Asynchronous education ($M = 3.73 \pm 1.20$), Teacher-learner interaction(3.63 ± 1.32) and Synchronous education($M = 3.59 \pm 1.31$) Respectively. Most important factor was the interaction and feedback between teacher and students. Students' views on the components of e-learning were related to their age, access to electronic devices, and their computer skills significantly.

Conclusion

It seems that e-Learning can be a relatively good alternative to face-to-face training, but the teacher-student interaction is the main element in the greater effectiveness of this method.

Background:

After Coronavirus pandemic, different pedagogical approaches in e-education have been utilized by 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 teachers and university lecturers had more difficulty adjusting to the new circumstances than university and school student at the beginning, teachers gradually started to develop their digital skills by going beyond using Internet just for searching. They started to design, format, make, and edit their own e-contents through various platforms they had not previously experienced. Students, equally, had to raise their digital literacy skills in order to locate and use various e-resources presented to them. However, 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 usually 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 School of Medical Sciences had been established 10 years prior to COVID-19 incidence, a few medical schools and faculty members at SUMS were actively involved in virtual medical education. After teachers were asked to shift from face-to-face education to the virtual mode, we thought it paramount to study SUMS students' viewpoints of e-learning-based medical education that their professors provided 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, 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(1). 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 beside their teaching load, therefore, their tendency and inclination to digital environments, and institutional support, and attitudes towards e-learning are but few reasons behind the success or failure of e-learning implementation at various medical universities (2–5). Likewise, students, at medical schools or else, have experienced variously based on their background, schools they attend, their digital literacy, e-learning resources as well as institutional support they receive during and after school among many others.

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, lead to a series of challenges for the students (6). Sometimes it is not the e-contents, per se, that produce challenges for students, but failure of teacher-student and student- peer communication that negatively influences students' productivity in e-learning (7). As Chapman and Mahlk (2004) point out, latest educational technology does not necessarily enhance instruction or students' participation (8). 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 (9). Sometimes lack of time management and absence of self-regulation are reported as major factors affecting students' e-learning experience (10). According to Pedrotti and Nistor (2019), not informing students as to when to access the contents means leaving it up to the students who, especially in fully presented on-line courses and due to time constraint and lack of effort regulation strategies, fail to strategically plan their e-learning activities during the course (11).

Pedagogically concerned, heightened cognitive load, as a result of teachers' ineffective teaching methods, is another challenge repeatedly reported by students (12). 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 (13). Extraneous or ineffective cognitive load presents students with unnecessary

information that inhibit their ability to process new information and to create long-term memories (14). As Uppal (2017) indicates, e-learning works only if teachers know how their students learn (15).

Apart from human factors, another challenge that impedes e-learning is technological facilities. Not only at schools and universities, but also at home settings, many students are deprived of access to foundational technology services, software, and hardware to fully explore opportunities that computer-based teaching provides to them (16). Although it is assumed that in the 21st century we might or should not face such challenges anymore, in most developing countries, bandwidth and connectivity issues still cause a perennial hurdle for synchronous and asynchronous e-learning/teaching (17). Even cost of buying Internet packages might be a major concern for many students studying in such countries (16). This has even aggravated undoubtedly during current Coronavirus pandemic that almost all courses are presented online. In terms of Infrastructure, for example, in one study conducted by Koh et al., majority of Malaysian medical students possessed smart devices with medical apps and had reportedly positive feelings regarding the effectiveness of those apps(18). Notably, Wi-Fi and 3G internet services were provided to all them in both university and hospital settings. However, in another study, Masika et al., reported that sub-optimal internet coverage cost of apps, lack of access to smart devices, and limited device memory were the major challenges of using mobile devices and apps for medical education in Kenya(19).

Globally reported, many students have had to receive their course contents in a virtual mode due to their schools' closure during the pandemic (20). This rapid adjustment to the current global phenomenon has necessitated not only teachers but also students to adapt themselves to this new trend of homeschooling system; in other words, they have been pushed 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 affecting e-learning should be the concern for many researchers at this stage. While online learning might be available during Coronavirus pandemic, 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 to attend 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. Even before Coronavirus pandemic, little literature was 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 to improve technological facilities and the kind of Learning Management System (LMS) which is used in a particular school (21). Therefore, this study could be a significant contribution to knowledge in this area if we mean to understand the perceptions of students regarding to e-learning-attributable inhibiting factors. Furthermore, e-learning is a relatively new innovation in the design of educational facilities at medical universities in Iran, especially during Coronavirus pandemic during which the fast pace of transition from face-to-face classes to distance education mode could not fully prepare the officials and university authorities to evolve their digital tools to ensure uninterrupted educational delivery to every one of the students. Mainly, this study aimed to identify SUMS medical students' views of e-learning-based medical education during Coronavirus pandemic; and To see if there are any differences regarding the students' general views and their age, gender, residence, digital and computer literacy, type of digital device used, their prior e-learning experience, and degree of study.

Methods

Research Design

A descriptive survey study was conducted in March 2020 on the students' perception of e-learning experiences during the semester coincided with Coronavirus pandemic.

All methods were performed in accordance with the relevant guidelines and regulations by Vice-Chancellor's Office for Research in Shiraz University of Medical Sciences.

It is worth noting that approval from the Ethical Review Committee of the Shiraz University of Medical Sciences had been obtained prior to the study (Ref.No. IR.SUMS.REC.1399.616).

Population of the Study

The target population of this study was all SUMS students in various disciplines. SUMS is a public medical sciences university 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 medical fields. As to the exposure to e-learning, Prior to the COVID-19 Pandemic, e-learning was used to a very limited extent in medical education, Therefore, the experience of pure e-learning was an unprecedented experience for SUMS students. The sample size of this study was determined to include 507 participants by means of Krejcie and Morgan's Table (22), 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 the questionnaire considering wide diversity of perceptions regarding students' e-learning experiences, an online focus group of heterogeneous sample was made consisting of 5 students studying at different SUMS schools and 5 SUMS faculty members.

With the permission of the participants, the focus group was video-recorded, and all the comments were then drafted, and conclusions were drawn by the researchers of this study.

Twenty six items were then extracted and presented in the Likert format of six items ranging from strongly agree (6) down to strongly disagree (1). The questionnaire was included 2 parts; part one comprised of demographic parameters such as gender, age, residence, digital and computer literacy, field of study, and their degree level (Continuous Bachelor and Discontinuous Bachelor degrees, Master's, PhD degrees, and professional doctorate degree (Doctor of Medicine, Dentistry, and Pharmacy)). Part two of the questionnaire was designed based on semantic and content linkages of all items in the questionnaire. Five questions evaluated technological facilities; 4 questions were related to technical support; 4 questions targeted asynchronous learning, 4 questions targeted synchronous online classes; 3 questions identified the quality of e-content made by faculty members, and 6 questions evaluated teacher-student interactions. In addition, four short questions measure students' general feelings towards e-learning. The cut-off point score

for each item was considered 3.5 equivalent to 50% which meant that the average above 3.5 for each component denoted students' satisfaction.

Validity and Reliability of Questionnaire

The validity of the questionnaire was assessed by calculating the Content Validity Ratio (CVR), Means the necessity of each item, and the Content Validity Index (CVI) with three sub index (Relevance, Clarity and Simplicity). To this end, ten experts in the fields of medical education, e-learning, medical sciences, and English Language reviewed the questionnaire items. Based on expert opinions, the CVR was between 70–100% for each items and total mean of CVR = 93.8%. Also, for CVI, the simplicity and clarity sub index for each question was between 70–100% and the relevance for each question was between 80–100%. total mean of CVI for simplicity = 95.3%, Clarity = 96.9% and Relevance = 97.3%. In addition, the face validity of the questionnaire was also checked. Following this, eight questions were modified in terms of grammar and eloquence.

The reliability of the questionnaire was also measured by sending the initial version of the questionnaire to 40 medical students. Using Cronbach's alpha for analysis, we found that the reliability of the questionnaire with 26 items was high (97.5%). Reliability was also calculated for each component. The reliability of each components including technological facilities = 0.90, technical support = 0.86, asynchronous education = 0.86, synchronous virtual classes = 0.90, quality of e-contents = 0.91, and teacher-student interactions = 0.93.

Data Collection

Upon obtaining the approval of the Ethical Committee of SUMS (Ref.No. IR.SUMS.REC.1399.616), data collection began. This study was conducted in June, 2020, and while collecting the data, we were still in quarantine as a result of Coronavirus pandemic. Therefore, to collect the data, an online survey was designed. The link was sent to all SUMS students through WhatsApp social media groups that faculty members had created to be in touch with their students.

Privacy and anonymity of the participants and confidentiality of data were granted, and informed consent was obtained from the participants.

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 One Sample T-test, Independent T-test, MANOVA, and ANOVA.

Results

As shown in Table 1, the demographic and profile information of 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%) discontinuous Bachelor students, 16 (3.2%) PhD, and finally 12 (2.4%) Master's students. Four hundred (78.9%) participants aged between 18–24 years old; 107 (21.1%) aged above 24, and the mean age average of the participants 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%) resided at the campus. Regarding the students' digital and computer literacy, the results showed that 287 (56.6%) participants had low to average digital and computer literacy, while 368 (72.6%) had a sufficient digital and computer literacy and had the knowledge and ability to efficiently use computers and related technology. Out of all the participants, 368 (72.6%) had a personal laptop to use for their online studies, 139 (27.4%) had only their mobile phones or occasionally had access to friends' or family members' computers and laptops. There were 125 (24.7%) participants who had experienced e-learning prior to Covid-19, and 382 (75.3%) had had no experience (Table 1).

Table 1
Demographic characteristics of the participants

Demographic characteristics		Frequency	Percentage
School	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
Gender	Male	164	32.3%
	Female	343	67.7%
Degree	Continuous Bachelor degree	207	40.8%
	Discontinuous Bachelor	79	15.6%
	Professional doctorate degree	193	38.1%
	MSc	12	2.4%
	PhD	16	3.2%
Age	18–24 years old	400	78.9%
	> 24 years old	107	21.1%)
	Mean	26.8 ± 23.7	
Residence	living in their hometowns	222	43.8%
	resided at the campus	258	56.2%
Computer skills	To some extent	287	56.6%
	Sufficient Skills	220	43.4%
Facilities	Personal PC or laptop + Mobile	368	72.6%
	Only Mobile phones	139	27.4%
Experienced online education prior to Covid-19 pandemic	experienced e-learning	125	24.7%

Demographic characteristics	Frequency	Percentage
No experience	382	75.3%

based on One Sample T-test with cut-off point of 3.5 findings indicate that all e-learning components significantly showed an average above the cut-off point (Minimum Score) except for the component of Synchronous education ($P = 0.14$). (Table 2)

Also the mean and standard deviation for the participants' responses to each items are illustrated in Table 3. As the table shows, the overall mean score of all items in the questionnaire regarding the medical students' views towards e-learning education was satisfactory (3.87 ± 1.52). (Table 3)

Table 2
Mean of e-learning components from students' point of view

Components	Mean+	SD	t	P-value
Technological facilities	4.29	1.13	15.23	0.00
Technical support	4.00	1.08	10.12	0.00
Asynchronous education	3.73	1.20	4.25	0.00
Synchronous education	3.59	1.31	1.46	0.14
e-Content quality	3.84	1.05	6.10	0.00
Teacher-learner interaction	3.63	1.32	2.06	0.04

Table 3
Mean of e-learning items from students' point of view

Components	Items	N	Mean	SD
Technological facilities	I had access to a computer or mobile phone to learn via the virtual system.	504	5.13	1.16
	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
	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 education	10. Working with different parts of Navid system (offline) was easy	505	4.47	1.23
	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 education	14. The virtual system was a proper platform for providing online classes	479	3.54	1.56
	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
e-Content quality	18. The electronic contents presented by the professors were understandable and informative	500	3.87	1.48

Components	Items	N	Mean	SD
	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
	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
	26. After doing the assignments, I received feedback from my professors.	463	3.63	1.54
Total			3.82	1.52

Considering the age factor, the students were divided into two groups including 18 to 24 years and above 24. In Table 4, 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 ($P = 0.027$). That is, the greater the age, the more satisfaction the 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 (Table 4).

Table 4
Relationship between students' opinions about e-learning components and age factor

Components	Age	N	Mean	SD	t	P-value
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 education	18-24	375	3.60	1.22	4.69	0.000
	> 24	100	4.23	0.99		
Synchronous education	18-24	339	3.59	1.32	0.02	0.98
	> 24	96	3.59	1.30		
e-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		

In terms of gender, the results of the independent samples t-test indicate no significance difference between the male and female students' e-learning experience ($P > 0.05$) in neither the overall mean nor the sub-components. Likewise, no significant difference was seen in terms of the students' residence.

Students' computer skills were questioned in three levels: low, to some extent, and Sufficient Skills. None of the students were in the low skills category. However, a significant difference was observed in both the overall mean and the mean of each e-learning component in terms of students' computer skills. In other words, students with better computer skills scored better on e-learning components ,(Table 5)

Table 5

Relationship between students' opinions about e-learning components and their computer skills

Components	Students' computer skills	N	Mean	SD	t	P-value
Technological facilities	to some extent	269	3.95	1.09	8.16	0.000
	Sufficient Skills	200	4.76	1.01		
Technical support	to some extent	271	3.78	1.01	5.37	0.000
	Sufficient Skills	196	4.31	1.10		
Asynchronous education	to some extent	274	3.54	1.18	4.19	0.000
	Sufficient Skills	201	4.00	1.19		
Synchronous education	to some extent	256	3.31	1.24	5.49	0.000
	Sufficient Skills	179	3.99	1.32		
e-Content quality	to some extent	215	3.58	0.97	5.89	0.000
	Sufficient Skills	142	4.22	1.04		
Teacher-learner interaction	to some extent	248	3.51	1.23	2.29	0.023
	Sufficient Skills	174	3.81	1.43		
Total	to some extent	215	3.61	0.95	6.03	0.000
	Sufficient Skills	142	4.25	1.02		

The results of Table 6 also showed a significant difference between the overall mean score of those who had access to PCs or laptops compared to those who had only their mobile phones ($P = 0.002$). This difference was significant in terms of all the e-learning components (Table 6)

Table 6
Relationship between students' opinions about e-learning components and their access to digital devices

Components	access to digital devices	N	Mean	SD	t	P-value
Technological facilities	Only Mobile	126	3.68	1.14	7.56	0.000
	PC/Laptop	343	4.52	1.04		
Technical support	Only Mobile	135	3.84	1.03	2.05	0.04
	PC/Laptop	332	4.07	1.09		
Asynchronous education	Only Mobile	136	3.65	1.15	1.01	0.31
	PC/Laptop	339	3.77	1.22		
Synchronous education	Only Mobile	128	3.29	1.22	3.12	0.002
	PC/Laptop	307	3.72	1.33		
e-Content quality	Only Mobile	113	3.59	0.96	3.06	0.002
	PC/Laptop	244	3.95	1.07		
Teacher-learner interaction	Only Mobile	125	3.61	1.19	0.23	0.817
	PC/Laptop	297	3.64	1.38		
Total	Only Mobile	113	3.62	0.95	3.12	0.002
	PC/Laptop	244	3.98	1.04		

Also The results of showed a significant difference between who had experienced online education 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 method ($p = 0.11$) (Table 7).

Table 7

Relationship between students' opinions about e-learning components and their experiences

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

We evaluated the relationship between the students' degree (Undergraduate and Postgraduate student) and their views of e-learning education. The results show that the Postgraduate student scored e-learning components higher than Undergraduate students significantly MSc students ($P = 0.001$), and PhD students ($P = 0.03$).

Since the investigated components in the present study were in fact different facets of e-learning education, an interaction between them was assumed and, therefore, MANOVA was used. For running MANOVA, at first, four indices 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 ($P = 0.000$). (Table 8)

Table 8

Confirmation of the internal relationship of e-learning components with the impact of the School factor

Effect School factor * Components (Between-Subjects Factors)		Value	F	Error df	P-value
School	Pillai's Trace	.359	3.171	2094.0	.000
	• Medicine (N = 66)				
	• Dentistry (N = 26)				
	Wilks' Lambda	.683	3.264	1616.9	.000
	• Pharmacology (N = 32)				
	• Nursing (N = 52)				
	• Paramedicine (N = 57)				
	Hotelling's Trace	.407	3.317	2054.0	.000
	• Rehabilitation Sciences (N = 25)				
	• Health (N = 45)				
	• Nutrition and Food Sciences (N = 54)				
	Roy's Largest Root	.197	9.827 ^c	349.0	.000

As it can be seen in Table 8, the results of MANOVA showed that the impact of different components on each other was significant. This implies that all of the components had an impact on each other. Further investigations revealed that the teacher-learner interaction factor (Adjusted R Squared = .060; F = 4.23) and asynchronous learning (Adjusted R Squared = .050; F = 3.69) had the greatest impact on the students' desirability of e-learning education. (Table 9).

Table 9
The interaction between the components of e-learning education

Components	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	P-value
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 education	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 education	Corrected Model	27.53	7	3.93	2.35	.023
	Error	582.38	349	1.66	(Adjusted R Squared = .026)	
	Total	5276.68	357	-		
e-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	-		

In terms of responses to short questions, the results show that 322 (67%) of students thought online education was interesting; however, 302 students (60%) preferred using blended learning in the future after eradication the COVID-19 pandemic, 356(75%) believed lack of physical presence of the teacher sensed throughout the semester; likewise, 410 students (80%) reported missing the peer -peer interaction they used to have in the traditional learning environment.

Discussion

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, when 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 the likelihood of their having negative views regarding e-learning education. With these caveats in mind, results have demonstrated that SUMS 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 because not only did e-learning draw their attention psychologically away from the pandemic, but also learning wise, they had more time for lessons and interactions with the professors (23). Our result is contradictory to the study conducted in Pakistan College of Medicine and Dentistry since it showed that the majority of Pakistani students had a negative feeling towards e-learning and were more inclined towards face-to-face learning in the future; most importantly, they felt e-learning had little impact on their learning during the pandemic (24). Considering medical students' e-learning experience literature prior to COVID-19, the results are mixed with a greater number of medical studies reporting students' positive feelings towards e-learning (25–27). This study, however, 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 poor video streaming services (28).

In our study, lack of interaction with the professors was also mentioned as one of the reasons why students were dissatisfied with synchronous classes. As to asynchronous classes, many studies reported that students preferred 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 (29–31). This dissatisfaction can be attributed to what Sims (1999) states regarding the types of interactivity a synchronous session requires to be successful : learner-teacher interaction, learner-learner interaction, learner-content interaction and learner-interface interaction(32).

As to the age factor, this study showed that older students were more satisfied with e-learning. This piece of finding is not in line with the result of the study conducted by Fleming, Becker, and Newton (2017) in which it was reported that age was not a significant factor influencing both satisfaction with e-learning and the future use intentions (33) Another study carried out by Dabaj (2009) also reported similar finding (34). 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 had a more contributing role in e-learning acceptance especially at the time of the over-night shift to virtual learning due to COVID-19 pandemic. McSporran and Young (2001) reported that because mature female students out preform at scheduling their learning and function better at communicating online, they are more motivated towards distance learning (35) taking gender into account, this finding is partly inconsistent 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 conducted in Malaysia (36).

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 stating students' digital literacy as a prerequisite for learning effectively in a blended learning environment (37–38). However, Concannon et al. (2005) have a different viewpoint as they 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 them stated difficulties with using technologies(39). 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 types of information (38).

This study also revealed a significant difference between the overall mean score of those who had access to PCs and laptops compared to those who had only their mobile phones to use. 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 asynchronous classes and content quality point of view, this result might be justifiable in 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 (40). 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(41). Although in our study, only about 28% had only their mobile phones for studying and did not have access to any personal computers and laptops., teachers should customize their teaching program to meet the need of majority of students rather than "simply designing their own program around the use of technology" without taking the accessibility of the required devices into account (40). Our results also showed a significant difference 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 shortly after the pandemic began, 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 its different 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 using a large number of modules in Navid System has led to increased application complexity (42).

Furthermore, our investigations revealed that the teacher-learner interaction factor and asynchronous learning factor had the greatest impact on the students' desirability of e-learning education, respectively.

The potential of interactivity and the ability to respond contingently to the learner's action has been placed as one of the most important factors in adult learning education (43). In a study conducted by Begum, Ali, and Panda (2020), findings showed that medical students' Knowledge, interaction, attendance, and engagement in class significantly increased following the application of interactive teaching module (44). In terms of asynchronous e-learning, Hrastinski (2008) reported that because of its flexible modus operandi, asynchronous mode of learning has been the most prevalent form of e-learning (45). Perveen (2016), though, reported that in her study, students favored the ideal blend of the two modes of instruction, asynchronous and synchronous, after better technological advancements and speed of the Internet (46).

Conclusion

This study holds clear implications for e-learning based 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 the traditional, 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-based 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 content 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.

Abbreviations

SUMS: Shiraz University of Medical Sciences

LMS: Learning Management System

Declarations

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Availability of data and materials

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

Author's contributions

LKH devised the study concept and involved in study planning, developed the questionnaire and created the first and final draft of the study. **ZK** devised the study concept and involved in study planning, developed the questionnaire, ran the reliability and validity tests and analyzed and interpreted statistical data. **EN** devised the questionnaire and helped editing the final version of the manuscript. **SSH** collected the data, and **MRF** contributed to study design and oversaw. All authors read and approved the final manuscript.

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Ethics approval and consent to participate

Written ethical approval was taken from the Shiraz University of Medical Sciences's local ethics committee (approval number (Ref.No. IR.SUMS.REC.1399.616)) and written informed consent obtained from all the participants.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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