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From classroom to screen: a cross-sectional study on medical students' first experiences with e-learning during the COVID-19 pandemic

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Introduction: Following the Coronavirus Disease 2019 (COVID-19) pandemic, most universities around the world transitioned from in-person classrooms to online learning methods. This study aimed to explore the initial experiences of medical students with e-learning during the pandemic at Shiraz University of Medical Sciences in Iran, as well as to identify differences in students' general perceptions based on their demographic characteristics.

Methods: This cross-sectional study was conducted on 507 medical students during the COVID-19 pandemic. To gather information for this study, a questionnaire created by the researchers was used, which consisted of six variables and 26 items on a Likert scale. The content validity of the questionnaire was assessed using Content Validity Index (CVI) and Content Validity Ratio (CVR). The reliability of the questionnaire, based on the internal consistency of the questions, was confirmed by a Cronbach's alpha of 97.5%. Data were analyzed using a one-sample *t*-test, independent *t*-test, ANOVA, and MANOVA.

Results: Students had satisfactory e-learning experiences, and the average of e-learning components was: technological facilities (4.29 ± 1.13), technical support (4.00 ± 1.08), e-content quality (3.84 ± 1.05), synchronous education (3.59 ± 1.31), asynchronous education (3.73 ± 1.20), and teacher-student interaction (3.63 ± 1.32). Students' perceptions of the e-learning environment were shown to be substantially connected to their age, access to electronic devices, computer proficiency, prior experience regarding e-learning, and the school in which they are studying, respectively ($P = 0.027$). Furthermore, students who had access to a computer were more satisfied than those who only had access to a mobile phone ($P < 0.001$). In medical schools where teacher-student interaction was better, more satisfaction was observed ($P < 0.001$). The gender factor had no effect on students' views.

Conclusion: Even though it seems like e-learning can be a good substitute for or complement to face-to-face training, the most important thing that makes this method more effective is the interaction between the teacher and the students.

KEYWORDS

e-learning, students, viewpoints, medical education, online learning, COVID-19 pandemic

Introduction

The Coronavirus Disease 2019 (COVID-19) pandemic necessitated a rapid and unprecedented shift from traditional, in-person education to online modalities across the globe (Shah et al., 2020). This transformation posed significant challenges for medical education, which relies heavily on hands-on clinical experiences (Papapanou et al., 2022; Rose, 2020). Although institutions like Shiraz University of Medical Sciences in Iran had established Learning Management Systems (LMS) prior to the pandemic, resistance to e-learning adoption and varying levels of preparedness among faculty and students created substantial obstacles. Studies underscore that e-learning's success in medical education depends on robust infrastructure, digital literacy, and adaptive pedagogy (Alsoufi et al., 2020; Delam et al., 2022; Hrastinski, 2008; Karimian et al., 2022; Subramanian and Rowland, 2022).

E-learning, defined as the use of electronic technologies to deliver and enhance education, typically combines synchronous and asynchronous methods (Howlett et al., 2009). While synchronous platforms offer real-time interaction, they are often hindered by connectivity issues, inadequate infrastructure, and limited engagement (Uppal et al., 2018). Conversely, asynchronous approaches are praised for their flexibility, enabling students to overcome geographical and time-related constraints (Hrastinski, 2008).

These challenges are not unique to Iran. Across low- and middle-income countries, students frequently encountered technological barriers, such as unreliable internet, insufficient access to devices, and lack of institutional support for digital learning (Ishak et al., 2022). In Kenya, for instance, medical students reported significant difficulties with internet connectivity and limited availability of smart devices, which not only disrupted their ability to attend online classes but also limited their engagement with interactive learning resources (Masika et al., 2015). Similarly, in Libya, students expressed dissatisfaction with the feasibility of implementing e-learning platforms. They cited poor infrastructure, insufficient technical support, and a lack of alignment between e-learning systems and their academic needs as major obstacles, which collectively undermined their learning experiences (Alsoufi et al., 2020). These issues highlight the disparities in readiness and capacity for e-learning implementation across different educational contexts (Moeinikia et al., 2022).

Conversely, countries with stronger digital infrastructures achieved more positive outcomes. For example, in Malaysia, the widespread availability of mobile technologies and robust digital frameworks, such as reliable internet access and institutionally supported e-learning platforms, enabled medical students to adapt more effectively to virtual education (Koh et al., 2014). Many students in Malaysia not only embraced online learning but also found it an effective supplement to traditional classroom education, particularly for accessing multimedia resources and improving time management. These contrasting experiences across countries underscore the importance of investing in technological infrastructure, providing equitable access to devices, and offering comprehensive training for both students and educators to ensure the success of e-learning initiatives (Al-Rikabi and Montazer, 2022).

Despite these contextual differences, one common theme across studies is the pivotal role of teacher-student interaction. Effective engagement can mitigate many challenges of e-learning, yet inadequate feedback and limited interaction during synchronous classes have been persistent issues (Alimi et al., 2021). Furthermore, the abrupt transition to online learning exposed the lack of preparedness among students and educators, underscoring the need for institutional support and digital literacy development (Nor and Mohamad, 2013).

This study aims to examine medical students' perceptions of e-learning during the pandemic at Shiraz University of Medical Sciences. It explores how technological facilities, technical support, e-content quality, and teacher-student interactions shaped their experiences, while considering demographic factors such as age, gender, and access to resources. By addressing these dimensions, the study contributes to the broader discourse on e-learning in medical education, providing insights into how educational systems can better adapt to similar crises in the future.

Mainly, this study aims:

1. To identify medical students' perceptions about learning components in electronic environment during the COVID-19 pandemic.
2. To identify students' perceptions about learning components in electronic environment, considering contextual variables including age, gender, degree, residence status, school, field of study, computer skills, and previous experience in e-learning.

Abbreviations: LMS, Learning Management System; NAVID-LMS, the name of the National LMS of Universities of Medical Sciences in Iran; CEEL, Center of Excellence in E-Learning; CVI, Content Validity Index; CVR, Content Validity Ratio.

Materials and methods

Research design

A descriptive cross-sectional study was conducted across Iranian medical schools using an internet-based data collection method during the COVID-19 pandemic. This design was chosen to allow the researchers to assess the viewpoints of medical students from various disciplines, as well as students of various ages, genders, degrees, residence statuses, schools, fields of study, computer skills, and previous experiences in e-learning.

Participants and sampling

The target population of this study included all 7,000 students in various disciplines at SUMS that is a public medical sciences university located in Iran. It is ranked as one of Iran's top medical universities, and it includes 11 main schools dealing with various academic medical fields. Out of all the students studying, random sampling was used to obtain an unbiased, representative sample of the SUMS population.

Inclusion criteria

All undergraduate and postgraduate students of SUMS who were studying in the 1st-year coinciding with the COVID-19 pandemic and had experienced e-learning without attending the classroom were considered eligible to be included in this study.

Exclusion criteria

Questionnaires of students who did not answer more than 20% of the questions were excluded.

The sample size was estimated based on Cochran's formula with a limited statistical population (about 7,000 students). In this formula, p and q were both 0.5, and the z was considered to be 1.96 with a 95% confidence interval and an acceptable error of $d = 0.05$. A total of 364 students were expected to be included in the sample.

$$N = \frac{N Z_{1-\alpha/2^2} p(1-p)}{d^2(N-1) + N Z_{1-\alpha/2^2} p(1-p)}$$

Due to the lack of access to the students during the COVID-19 pandemic, we designed the questionnaire electronically, and due to the possibility of dropping samples, we randomly selected 520 samples from the list of students' names by lottery and sent them the link of the questionnaire *via* email. We also distributed the questionnaire link through the students' WhatsApp group.

Tools/instruments

For this research, a self-devised questionnaire. In order to design the questionnaire considering the wide diversity of perceptions regarding students' e-learning experiences, first the literature was reviewed thoroughly and systematically to enable the researchers to identify antecedent factors that could potentially affect students' perceptions regarding e-learning. However, at the time of writing this paper, the research on COVID-19 was relatively new, and all the already existing questionnaires, we felt, would not meet our objectives completely. When evaluating online learning communities, Ke and Hoadley (2009) propose that there are no "one-size-fits-all frameworks." Therefore, we built our theoretical framework based on the literature on e-learning but considered, at the same time, all the factors, especially the forcing factors that forced the students to become online learners and the challenges that our medical students faced during the COVID-19 pandemic. After categorizing all the factors, we created an online focus group of heterogeneous samples consisting of five students studying at different schools and five faculty members in order to make sure we had thoroughly considered all the factors that might affect students' perception of e-learning. After that, 26 items were then extracted and presented in the Likert format of six items ranging from strongly agree (6) down to strongly disagree (1).

The finalized version of the questionnaire includes 26 items in six components: technological facilities (5 items); technical support (4 items); asynchronous learning (4 items); synchronous education (4 items); quality of e-content (3 items); and teacher-student interactions (6 items). In addition, four short questions measure students' general feelings toward e-learning. The cut-off point score for each item was considered 3.5, which means that an average score greater than 3.5 for each component indicated that students were satisfied with the e-learning experiences.

Validity

The validity of the questionnaire was assessed by calculating the Content Validity Ratio (CVR) and the Content Validity Index (CVI) with three sub-indices (relevance, clarity, and simplicity). To this end, ten experts in the fields of medical education, e-learning, medical sciences, and English language as a Foreign Language reviewed the questionnaire items.

(a) In the CVR method presented by Lawshe (1975), the necessity of items in research in the three spectrums of "necessary," "useful but not necessary," and "not necessary" was examined from the perspective of experts, and an agreement was reached according to the following formula. In this formula, "n_e" is the number of expert opinions that have chosen "necessary" and N is the total number of experts. According to the CVR method, if the number of experts is 10, the agreement rate is expected to be at least 62.5% (Lawshe, 1975).

$$\text{CVR} = \frac{n_e - (N/2)}{N/2}$$

(b) In the CVI method, the agreement of experts in the three components of relevance, clarity, and simplicity in the range 1–4 is measured, and only options 3 and 4 are acceptable for calculating the validity, and finally, the agreement is expected to be about 79% (Waltz and Bausell, 1981).

$$CVI = \frac{Number\ of\ rates\ giving\ a\ rating\ of\ 3\ or\ 4}{Total\ number\ of\ raters}$$

Based on the results of CVE and CVR calculation in this research, the total mean of CVR was equal to 93.8% for CVI: simplicity = 95.3%, clarity = 96.9%, and relevance = 97.3%, and the total average was 95.8%. In addition, the face validity of the

questionnaire was also checked. Following this, eight questions were modified in terms of grammar and eloquence.

Reliability

The reliability of the questionnaire with 26 items and 40 samples was found to be high when Cronbach's alpha was used for the study (97.5%). Additionally, reliability scores were computed for each component, including the following: technological facilities scored 0.89; technical support scored 0.85; synchronous education scored 0.90; asynchronous education scored 0.86; quality of e-content scored 0.91; and teacher-student interactions scored 0.93.

Data collection

The data collection process was supervised by the Ethical Committee. The research was carried out in June–August of 2020. As a result, an online survey was developed in order to collect the necessary information. First, we sent the link to the questionnaire through email to the research samples, but due to the lack of in-person access to the students and the possibility of missing the questionnaires, the link was provided to all students using online social platforms, which were established by faculty members in order to stay in touch with their students and keep them updated. It was agreed that the participants' privacy and identity, as well as the confidentiality of the data, would be protected, and informed consent was obtained from all of the participants.

Considering that the questionnaires were distributed electronically and through a link, there was a potential that students might answer the questions more than once. To prevent this issue, in the introduction section of the questionnaire, we asked the students to read the questions carefully and answer them only once. Also, the student's computer or mobile IP address and the exact time of data recording could be seen in the Excel data output. If the demographic characteristics of the students were completely similar and they were registered from the same IP, we considered the last and most completed questionnaire. Of course, we did not have a case like this in this research.

Data analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) for Windows (version 24). The data were also analyzed by a one-sample *t*-test, an Independent *t*-test, an ANOVA, and a MANOVA.

Results

As shown in Table 1, the demographic information of those 507 students who responded to the online survey indicates that 343 (67.7%) were females. The highest percentage of the respondents, 207 (40.8%), were studying for a continuous bachelor's degree. The mean age of the participants was 26.8 ± 23.7. Detailed demographic information is provided in Table 1.

We were following two main objectives in this research.

Q1. To identify medical students' perceptions about learning in electronic environment during the COVID-19 pandemic. Findings indicate that all e-learning components significantly showed an average above the cut-off point ($P < 0.01$) except for the component of synchronous education ($P = 0.14$) (Figure 1).

Also, the mean and standard deviation (SD) for the participants' viewpoints of each item are illustrated in Table 2.

Among the items (Table 2), the item with the lowest score was item 13: planned, regular, and sequential presentation of the lesson (3.01 ± 1.72). Also, see item 22 regarding the communication with the professor in the virtual class (3.37 ± 1.54) and item 12 regarding the platform of quizzes and exams in NAVID-LMS (3.38 ± 1.64).

Q2. To identify students' perceptions about e-learning components, considering contextual variables including age, gender, degree, residence status, school, field of study, computer skills, and previous experience in e-learning.

Age

Considering the age factor, the students were divided into two groups, including those aged 18–24 and those aged over 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 ($P = 0.027$). That is, the older the students, the more satisfied they were with their e-learning education, with the exception of synchronous classes ($P = 0.98$), technological facilities ($P = 0.39$), and support ($P = 0.08$), where no significant difference was found (Table 3).

Gender

In terms of gender, the results indicate there is no statistically significant difference between male and female students' views in either the overall mean or the sub- divisions ($P > 0.05$).

Residence status

No significant difference was seen in terms of the students' residence ($P > 0.05$).

Students' computer skills

We asked the students about their level of mastery of computer skills. The findings revealed that students with greater computer abilities performed better on e-learning components ($P < 0.001$) (Table 4).

Previous experience of students in e-learning

Before the COVID-19 pandemic, students who had e-learning experience scored higher on average than those who did not ($P = 0.002$), according to the results of a survey.

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	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 (based on students' self-expression)	To some extent	287	56.6
	Sufficient skills	220	43.4
Facilities	PC or laptop + mobile	368	72.6
	Only mobile phones	139	27.4
Experienced e-learning (before the COVID-19 pandemic)	Experienced e-learning	125	24.7
	No experience	382	75.3

Degree

Postgraduate students scored higher on e-learning divisions than undergraduate students, with the difference between MSc students (P = 0.001) and Ph.D. students (P = 0.031) being statistically significant.

Facilities

In this question, it was investigated whether students who have more facilities and electronic devices have a different view point compared to students who have less? The results of Figure 2 revealed a statistically significant difference in the total mean score between those who had access to PCs or laptops and those who just had their mobile phones (P = 0.002) When considering all of the e-learning components, this was a considerable difference (Figure 2).

In other words, students who had better access to facilities had a better learning experience in all aspects of e-learning in synchronous online classes, asynchronous learning, use of e-content, technological and technical support, and have experienced better of student-teacher interactions.

School

One of the questions was whether the status of e-learning components was influenced by the factor of school. The MANOVA test was used to investigate the probability of a between-subjects effect of the e-learning components first, and the results were positive. Four indices, including Pillai's Trace, Hotelling's Trace, Roy's Largest Root, and Wilkes Lambda index, were used to confirm that the assumptions for performing a MANOVA were not broken (Table 5). Then the data was entered into MANOVA and analyzed. In accordance with the findings, the interaction between all of the e-learning dimensions was verified ($P < 0.001$). Asynchronous learning (Adjusted R Squared = 0.050; F = 3.69) and teacher-learner interaction (Adjusted R Squared = 0.060; F = 4.23) were shown to be responsible for the bulk of these effects, according to the results of the experiment (Table 6). It follows that the teacher-student interaction has been the most important element in causing the differences in students' opinions across schools and that this

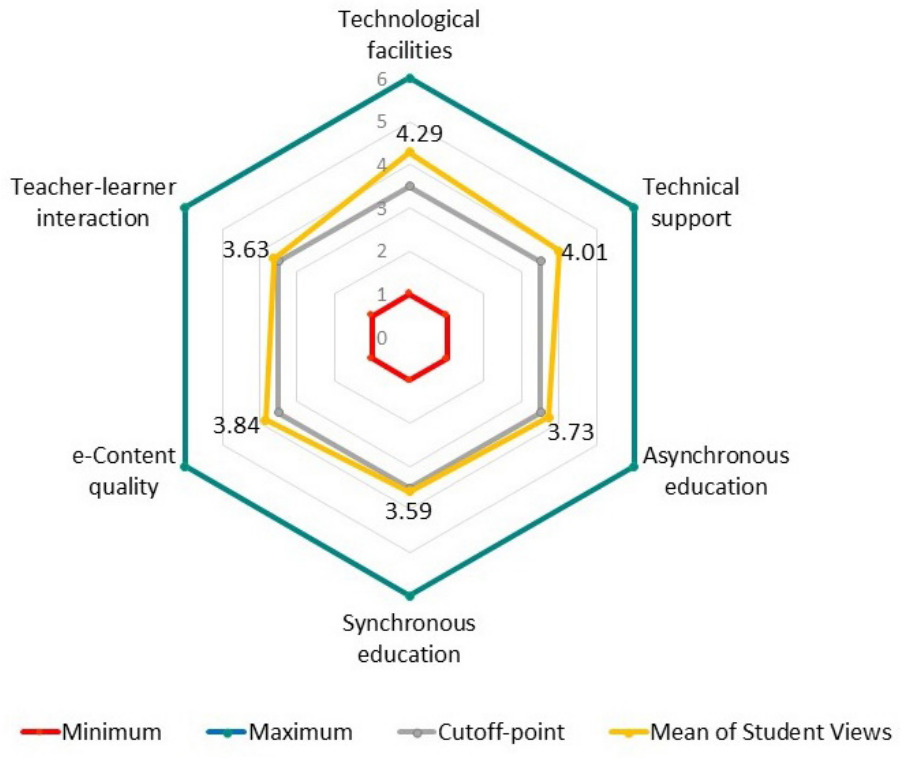

FIGURE 1
Mean score of e-learning components from students' viewpoints.

variable has also had an impact on the between-subjects effect of e-learning components.

A summary of research findings on e-learning components from students' perspectives and their relationship to demographic variables is shown in Figure 3.

Other findings

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 the eradication of the COVID-19 pandemic, 356 (75%) believed a lack of physical presence of the teacher was 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 an unusual time during the COVID-19 pandemic, when results of any research are 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 the 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 medical students had a positive e-learning experience during the lockdown. This finding parallels another research carried out during the lockdown. 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 toward e-learning because not only did it draw their attention psychologically away from the pandemic, but also learning-wise, they had more time for lessons and interactions with the professors.

Since the majority of Pakistani students had a negative attitude toward e-learning and were more attracted to face-to-face learning in the future, our findings are in direct conflict with the findings of the study done at the Pakistan College of Medicine and Dentistry. Their main concern was that they believed e-learning had little influence on their learning throughout the pandemic (Abbasi et al., 2020). Medical students' e-learning experiences in the literature prior to COVID-19 reveal a mixed picture, with a higher proportion of medical studies indicating students' positive views about e-learning than negative feelings toward it (Jang and Kim, 2014; Singh and Min, 2017). Surprisingly, during the pandemic, the attitudes of medical students in various Middle Eastern nations moved from positive to mediocre or unfavorable (Al-Balas et al., 2020; Gismalla et al., 2021; Ibrahim et al., 2021). This is likely due to the fact that prior to the pandemic, only fully trained lecturers

TABLE 2 Mean score of e-learning items from students' viewpoints.

Components	Items	Mean ± SD
Technological facilities	I had access to a computer or mobile phone to learn *via* the virtual system.	5.13 ± 1.16
	When downloading offline videos, I did not face any problems in terms Internet	4.01 ± 1.66
	When having virtual classes, I did not face any problems in terms of the Internet	3.53 ± 1.68
	My computer hardware and software settings were suitable for e-learning	4.51 ± 1.40
	I did not face any problems accessing LMS in terms of authentication	4.38 ± 1.67
Technical support	Despite the suspension of classes, the technical infrastructure was able to maintain training	3.52 ± 1.61
	Training guidelines were provided on how to use the virtual systems	4.20 ± 1.36
	I received the necessary information and support through my faculty and university	3.82 ± 1.35
	Necessary software was introduced for using websites and virtual classes	4.53 ± 1.27
Asynchronous education	Working with different parts of national LMS was easy	4.47 ± 1.23
	LMS (NAVID) was a proper platform for receiving lessons and assignments	4.09 ± 1.42
	LMS (NAVID) was a proper platform for quizzes and exams	3.38 ± 1.68
	The lessons were presented in a planned, regular, and sequential manner	3.01 ± 1.72
Synchronous education	The virtual system was a proper platform for providing online classes	3.54 ± 1.56
	I had no particular problem entering the online classes	3.77 ± 1.62
	I could raise my questions in online classes with the professor	3.49 ± 1.63
	Getting connected and attending the online classes was easy for me	3.53 ± 1.60
E-content quality	E-contents presented by the professors were understandable and informative	3.87 ± 1.48
	E-contents were rich enough to make up for the absence of face-to-face classes	3.54 ± 1.57
	The e-contents course presentation was interesting and effective in motivating me	3.47 ± 1.66
Teacher-learner interaction	I could stay in touch with my professors through LMS (NAVID) modules	3.60 ± 1.52
	I was able to stay in touch with my professors through online virtual classes	3.37 ± 1.54
	I was able to stay in touch with my professor through social media	3.63 ± 1.58
	My professors provided quick and efficient feedback on my educational needs	3.62 ± 1.54
	My professors encouraged me to interact and participate in lessons and discussions	3.64 ± 1.53
	After doing the assignments, I received feedback from my professors.	3.63 ± 1.54
Total		3.82 ± 1.52

SD, Standard Deviation.

would choose electronically assisted instruction, whereas, during the pandemic, all university lecturers and students were suddenly bombarded with technology upgrades, cultural acceptance, and reduced social and cultural interaction.

However, according to the findings of this study, medical students were dissatisfied with online synchronous classes, possibly because not all students could reliably log into synchronous classes because of geographical limitations, insufficient bandwidth, peer-to-peer traffic, and inadequate video streaming services. In our study, the variable of synchronous education received a lower overall score than the other divisions. There have been several studies that have found that students prefer asynchronous classrooms over live class sessions because, in the latter, professors do not have enough time to answer their inquiries and do not have the necessary abilities to adequately conduct virtual classes (Cole et al., 2014; Rehman and Fatima, 2021). It is possible that this dissatisfaction can be attributed to what Sims (1999) states about the types of interactions that a synchronous session requires in order to be successful: student-teacher interaction, student-learner interaction, learner-content interaction, and learner-interface interaction. Students' class sizes at this medical university may also be a factor in their discontent with online programs. Studies have shown that online classrooms should not contain more than 30 people despite contradictory results on the link between class size and instructor effectiveness (Lowenthal et al., 2019). It was advised by Sieber (2005) and Lin et al. (2019) that a 12-student class size be used for new instructors to online teaching, regardless of the instructor's prior online teaching experiences.

For undergraduate courses, Taft et al. (2019) recommend a maximum class size of 20 and between 8 and 15 for graduate courses; a class size that allowed students to engage in a way that didn't make them feel alone or disjointed but also did not leave them with too few opportunities to do so.

According to the findings of this study, older students were happier with their e-learning experience. However, this conclusion is at odds with the findings of Fleming et al. (2017), who discovered that age did not appear to have any significant impact

TABLE 3 Mean score of e-learning components from students' viewpoints by age.

Components	Age	*N*	Mean	SD	*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 education	18–24	375	3.60	1.22	4.69	<0.001
	>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	0.011
	>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		

SD, Standard Deviation.

TABLE 4 Mean score of e-learning components from students' viewpoints by their computer skills.

Components	Students' computer skill	*N*	Mean	SD	*t*	Sig
Technological facilities	Low/to some extent	269	3.95	1.09	8.16	<0.001
	Expert	200	4.76	1.01		
Technical support	Low/to some extent	271	3.78	1.01	5.37	<0.001
	Expert	196	4.31	1.10		
Asynchronous education	Low/to some extent	274	3.54	1.18	4.19	<0.001
	Expert	201	4.00	1.19		
Synchronous education	Low/to some extent	256	3.31	1.24	5.49	<0.001
	Expert	179	3.99	1.32		
E-content quality	Low/to some extent	215	3.58	0.97	5.89	<0.001
	Expert	142	4.22	1.04		
Teacher-learner interaction	Low/to some extent	248	3.51	1.23	2.29	0.023
	Expert	174	3.81	1.43		
Total	Low/to some extent	215	3.61	0.95	6.03	<0.001
	Expert	142	4.25	1.02		

SD, Standard Deviation.

on either satisfaction with e-learning or future usage intentions. Another research conducted by Dabaj (2009) showed that the younger generation is expected to be more digitally literate and more proficient with e-learning tools and techniques. However, it appears that in our study, age-related experience and wisdom had a more substantial impact on e-learning adoption, particularly during the period of the COVID-19 pandemic, when the majority of students were forced to switch to virtual learning overnight. Similar findings were observed by Christozov et al. (2019), who stated that older students had more confidence in their computer competency and learning skills than younger pupils. They are more driven, have more positive views, and are less worried than before.

According to McSporran and Young (2001), mature female students outperform mature male students when it comes to arranging their studies and conversing online, and as a result, they are more motivated to pursue remote learning. Taking gender into consideration, this finding is partially in conflict with our conclusion because we were unable to detect any statistically significant association between students' gender and their e-learning experience. This is supported by a study conducted in Malaysia (Nikiforidou et al., 2012).

As a result of our research, we discovered that students' computer skills played an important role in their e-learning experience. Interestingly, this conclusion is consistent with prior research in this field, which has found that students' computer skills

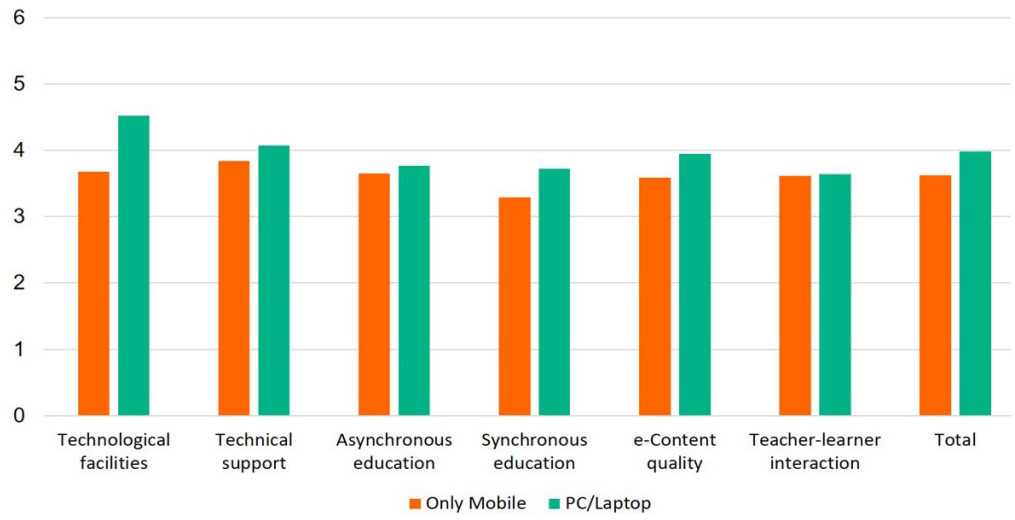

FIGURE 2
Mean score of e-learning components from students' viewpoints by access to e-devices.

TABLE 5 Confirm of between-subjects effect of e-learning components based on school factor.

Effect		Value	*F*	Error df	Sig
School	Pillai's Trace	0.359	3.171	2094.000	<0.001
	Wilks' Lambda	0.683	3.264	1616.955	<0.001
	Hotelling's Trace	0.407	3.317	2054.000	<0.001
	Roy's Largest Root	0.197	9.827[c]	349.000	<0.001

are a precondition for learning efficiently in a blended learning setting (Isakova et al., 2020; Resien et al., 2020). Müller and Wulf (2020), on the other hand, have a different point of view, believing that it is not the students' computer skills that should be the primary issue but rather their attitude toward e-learning that should be the primary focus. Students with even the most limited computer skills exhibited a favorable attitude toward online learning, as evidenced by the fact that none of them expressed any issues with technology use in their studies (Muflih et al., 2021). Mohammadyari and Singh (2015), on the other hand, feels that computer skill is not only about knowing how to use a computer but rather is one of many different literacies that individuals require in the twenty-first century in order to grasp and interpret diverse sorts of information.

This study also demonstrated a statistically significant difference between the overall mean score of those who had access to PCs and laptops and the overall mean score of those who could only use their mobile phones. Thus, not only does the choice of hardware have an impact on students' e-learning experiences in general, but it also has an impact on all of the sub-divisions of this study, as seen above. This outcome may be justified by the fact that practically all of the multimedia material created during the COVID-19 pandemic was not conceived or produced for mobile users; rather, it was created as a consequence of urgency. Consequently, when producing the material, it is possible that professors did not consider the smaller screen of mobile phone users, nor did they consider the kind and size of the typefaces they were employing. Teachers require teacher development training to improve mobile-enhanced instructional methods (Baran et al., 2023). Frohberg et al. (2009) claim that inadequate preparation on the part of instructors is one of the most significant factors contributing to students' learning failure while utilizing mobile devices. Although approximately 28% of students in our study had only their mobile phones and no access to any personal computers or laptops, teachers should tailor their teaching programs to meet the needs of the majority of students rather than "simply designing their own program around the use of technology" without considering the accessibility of the required devices (Sung et al., 2016).

Additionally, students who had already encountered blended learning prior to the COVID-19 pandemic had a more pleasant e-learning experience than those who had not. Surprisingly, this difference was statistically significant in all aspects of e-learning, with the exception of asynchronous classes. This is because this medical university just opened the academic Learning Management System (NAVID) for the multimedia content to be uploaded by professors for the students shortly after the pandemic began, and this was a new experience for all of the students studying at SUMS at the time of the outbreak. As a result, it is possible that participants' unfamiliarity with the system and its many modules was the reason why there was a statistically significant association between all of the e-learning variables except for the navigation system. Shafiei Sarvestani et al. (2019) found that students reported that using a large number of modules in the LMS system increased the complexity of the application. The major elements that decide whether a user would accept or

TABLE 6 Between-subjects effect of e-learning components based on school factor.

Components	Dependent variable	Type III sum of squares	df	Mean square	*F*	Sig
Technological support	Corrected model	24.61	7	3.51	2.76	0.008
	Error	444.50	349	1.27	(Adjusted *R* Squared = 0.033)	
	Total	6759.88	357	–		
Technical support	Corrected model	18.69	7	2.67	2.35	0.023
	Error	396.40	349	1.13	(Adjusted *R* Squared = 0.026)	
	Total	6265.93	357	–		
Asynchronous learning	Corrected model	37.53	7	5.36	3.69	<0.001
	Error	506.92	349	1.45	(Adjusted *R* Squared = 0.05)	
	Total	5734.93	357	–		
Synchronous learning	Corrected model	27.53	7	3.93	2.35	0.023
	Error	582.38	349	1.66	(Adjusted *R* Squared = 0.026)	
	Total	5276.68	357	–		
Content quality	Corrected model	17.63	7	2.51	2.35	0.023
	Error	373.09	349	1.06	(Adjusted *R* Squared = 0.026)	
	Total	5649.24	357	–		
Teacher-learner interaction	Corrected model	45.41	7	6.48	4.23	<0.001
	Error	534.89	349	1.53	(Adjusted *R* Squared = 0.06)	
	Total	5448.66	357	–		

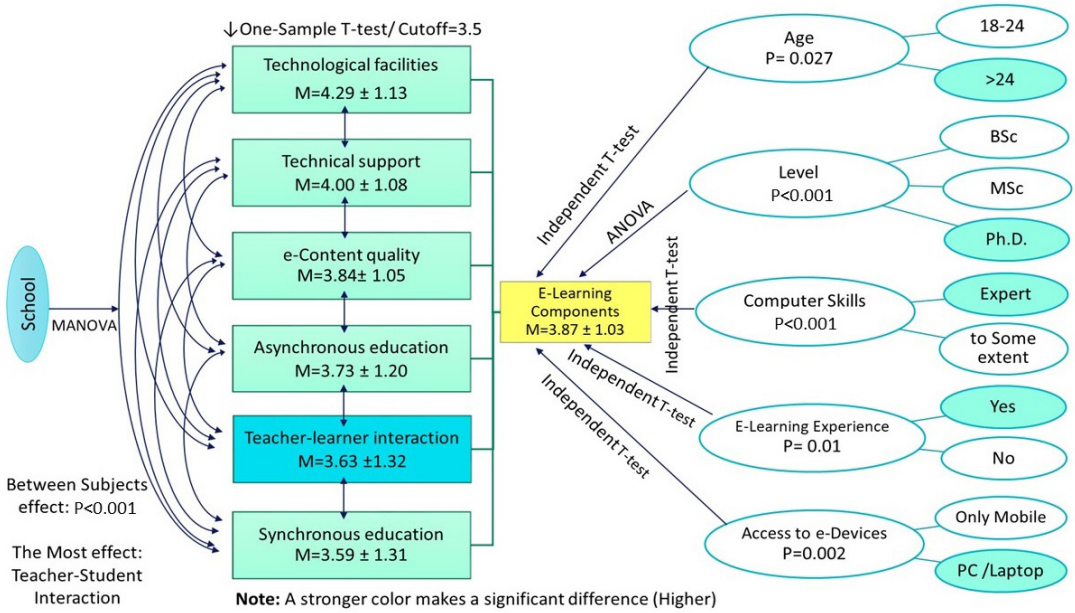

FIGURE 3
An overview of the research findings based on students' viewpoints.

reject a new technology, according to the Technology Acceptance Model (TAM), are one's views of ease of use and usefulness of the new technology. Our research also demonstrated that the teacher-learner contact factor and the asynchronous learning factor both played a significant role in determining whether or not students found e-learning education to be desirable. When it comes

to adult learning education, the possibility for interactivity and the capacity to respond contingently to the learner's actions have been identified as two of the most significant variables to consider (Tang and Chaw, 2016). According to the findings of a study done by Begum et al. (2020), medical students' knowledge, interaction, attendance, and participation in a class all improved dramatically after the implementation of an interactive teaching module. In terms of asynchronous e-learning, Amiti (2020) noted that, because of its adaptability, the asynchronous mode of learning has become the most widely used type of e-learning worldwide. However, some studies reported that students favored the ideal blend of the two modes of instruction, asynchronous and synchronous, after better technological advancements and the speed of the Internet (Tang and Chaw, 2016).

Conclusion

While students expressed a degree of satisfaction with all six components of e-learning, asynchronous approaches are generally preferred due to their flexibility, which eliminates geographical restrictions and time constraints. Additionally, multimedia e-content can somewhat replicate the presence of a teacher in the classroom. However, the most crucial factor influencing students' sentiments and satisfaction with e-learning is the quality of teacher-student interaction, which serves as an important lesson for educators and administrators alike.On the other hand, some students lack access to electronic devices such as laptops or PCs. Therefore, it is advisable to design electronic materials and learning tools that are optimized for mobile phones. School administrators should also develop strategies to assist underprivileged or disadvantaged students. Our findings underscore the importance of providing professional content development resources for teachers to help them build the necessary skills for creating virtual content and delivering remote instruction. This support not only enhances students' academic abilities but also fosters independent learning at home.A review of medical students' experiences during the pandemic reveals that their responses and perceptions regarding the new learning environment and the shift from in-person to online formats are influenced by multiple factors. Part of this influence stems from the nature of the electronic learning environment, while contextual factors such as demographic characteristics and access to resources also play significant roles.Although it appears that we have moved beyond the COVID-19 era, the effects of this period remain pervasive. It can be argued that our experiences, particularly in education and learning, can be categorized into three phases: before, during, and after the pandemic. Many aspects have changed, leading to fundamental transformations in higher education. Teachers who once preferred face-to-face instruction and were unfamiliar with online teaching methods have now become adept at using various online tools and techniques due to the pandemic, experiencing their benefits firsthand. Today's university students primarily belong to the digital generation, spending a substantial portion of their academic and daily lives in the digital realm. Furthermore, this rapidly evolving world presents us with new phenomena every day, contributing to increasing uncertainty in the higher education landscape. The emergence of technologies such as electronic simulations, augmented and virtual reality, mobile-based education, and artificial intelligence is reshaping the foundations of education—particularly in medical sciences, which heavily relies on technology. As a result, the future landscape of universities and higher education will be markedly different from what we see today due to these developments and future occurrences.

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. Also, since teachers are the ones giving this education, it is important to find out what they think about e-learning.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Shiraz University of Medical Sciences Ethics Committee, with the code number IR.SUMS.REC.1399.616, and registered with the National Ethics Committee in Environmental Research. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

LK: Conceptualization, Investigation, Project administration, Supervision, Writing – original draft, Writing–review & editing. ZK: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing–review & editing, Writing – original draft. EN: Investigation, Writing – review & editing. SS: Investigation, Writing – review & editing. MF: Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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