



Medical Students' Attitude Toward E-learning During the COVID-19 Pandemic

Shabnam Niroumand ¹, Haniye Mastour ^{2,*}, AmirAli Moodi Ghalibaf ³, Ali Shamshirian ⁴ and Maryam Moghadasin ⁵

¹Department of Community Medicine, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

²Department of Medical Education, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

³Student Research Committee, Faculty of Medicine, Birjand University of Medical Sciences, Birjand, Iran

⁴Student Research Committee, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

⁵Department of Clinical Psychology, Faculty of Psychology and Education, Kharazmi University, Tehran, Iran

*Corresponding author: Department of Medical Education, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran. Tel: +98-5138002435, Email: haniye.mastour@gmail.com

Received 2021 November 23; Revised 2022 March 26; Accepted 2022 June 15.

Abstract

Background: The coronavirus disease 2019 (COVID-19) crisis has greatly impressed medical education by shifting traditional educational methods to e-learning.

Objectives: This study evaluated the undergraduate medical students' attitudes toward e-learning during the COVID-19 pandemic

Methods: This cross-sectional study included undergraduate medical students of Mashhad University of Medical Sciences, Mashhad, Iran, in the academic year 2020 - 21 by census sampling method, whose attitude toward e-learning was evaluated based on the Ghanizadeh et al. scale. Categorical variables were demonstrated with frequency and percentage, and quantitative variables were described using the mean and standard deviation. An independent-sample *t* test was run to study the hypothesis. Analysis of covariance (ANCOVA) was performed to compare pre-clinical and clinical groups' attitudes toward e-learning after gender control. Statistical analyses were performed by SPSS 23.

Results: The study enrolled 528 undergraduate medical students. The findings indicated that 85.4% of the students agreed with the necessity of more effective e-learning in medical education, and 95.5% believed that e-learning should play a complementary role in medical education. It was found that clinical students had a marginally statistically significantly better attitude toward e-learning than pre-clinical students ($t = -2.04$, $df = 526$, $P = 0.041$). Nevertheless, no significant difference was observed between the two groups after gender control ($t = 2.87$, $P = 0.091$). It was shown that males had more positive attitudes toward e-learning than females ($t = 2.28$, $df = 526$, $P = 0.023$).

Conclusions: The results revealed acceptable attitudes toward e-learning. Although many students declared e-learning's usefulness and confirmed its complementary role in medical education, some announced that it could not replace in-person training.

Keywords: E-learning, COVID-19, Attitude, Medical Student, Virtual Education, Medical Education

1. Background

In most parts of the world, the spread of the novel coronavirus disease (COVID-19) in the last days of 2019 caused a great disaster worldwide (1, 2). A recent report by the World Health Organization (WHO) on August 27, 2021, indicated that this virus infected more than 213 million people, and more than four million died due to COVID-19 worldwide (3). Although COVID-19 had devastating effects on human physical health, it should not be denied the effects of this crisis on other aspects of human life, including social life, mental health, and education (4). In a detailed view, the lockdowns led to extensive changes in people's

lives, especially in the educational field. Therefore, Hobson's choice made the universities, teachers, and students shift the teaching and learning to distance learning strategies commonly based on the internet and e-learning (5).

In the past decades, technological advances played a significant role in education and learning, where e-learning effectively achieves knowledge, taking into account the individual experience, practice, and knowledge through clouds (6). By the way, e-learning has changed the role of teachers as the only source of expertise in traditional learning styles. Virtual education makes learning more active and unlimited while learners can update, improve, and personalize their learning processes (7). The ad-

vantages of e-learning have made it one of the essential learning strategies in developed countries, although it is not devoid of disadvantages (8). Also, developing countries will utilize e-learning following the developed countries (9). The experts indicated that the attitude of the teachers and learners should be made positive about this type of learning, as one of the critical steps for the acceptance of changes in learning strategies is learners' attitude toward the new one (10).

According to the importance of e-learning and its impact on higher education planning and policy-making, different studies have been done in this field with various findings (11). As medical education and training of professional medical students are significant fields of educational studies, Ghanizadeh et al. used a scale in 2018 to assess medical students' attitudes toward e-learning in developing countries (12).

The emergence of COVID-19 has led to inevitable changes in medical education, which has caused the undeniable trend of e-learning and has made traditional education inapplicable (13). Furthermore, the suddenly unplanned shift of medical education from traditional methods to e-learning during the COVID-19 crisis would have specific effects on undergraduate medical students' educational and learning quality; in this way, medical students' attitude toward e-learning seems impressive.

2. Objectives

This study was conducted to investigate and explain the medical students' attitude at Mashhad University of Medical Sciences (MUMS), Khorasan Razavi province, Northeastern Iran, toward e-learning during the COVID-19 pandemic based on Ghanizadeh et al. scale and compare undergraduate medical students based on their curriculum phase (pre-clinical and clinical) and gender.

3. Methods

3.1. Study Design

A descriptive, cross-sectional survey was conducted online in April and May 2021, when the medical schools were closed due to COVID-19. This study was performed on medical students at MUMS. Undergraduate medical students in the academic year 2020 - 21 in the pre-clinical phase (basic science and physiopathology courses corresponding to the first three years of the general medicine curriculum) and clinical phase (clerkship and internship courses) were eligible to participate in this research. They were informed of the purpose of the study. According to Cochran's formula, the sampling size was calculated at about 327

individuals ($d = 0.05$, $z = 1.96$, $P = q = 0.5$) (14, 15), but the census sampling strategy was determined to cover the whole eligible medical students; by the way, incomplete questionnaires were excluded from the final analysis. All procedures were in line with the MUMS ethics committee guidelines (approval date 2021-04-24 with reference code IR.MUMS.REC.1400.017), and all respondents provided informed consent. All the forms were gathered with identification codes without names to protect the confidentiality of students' information.

3.2. Survey Development

A self-reported electronic questionnaire was implemented using Porsline® Forms. The students were asked to complete the questionnaire to participate in the study. We sent all undergraduate medical students at MUMS an anonymous online survey by email and WhatsApp messenger to fill in upon their consent. The online survey consisted of a validated and reliable Persian version of the Ghanizadeh et al. scale designed to investigate the medical students' attitude toward e-learning (12). The survey gathered the participants' demographic characteristics such as gender, age, and educational phase (basic science, physiopathology, clerkship, and internship), their access to computers and the internet, the use of the internet for medical education and training, familiarity with e-learning, and the reasons for computer use. There were also 27 self-report questions to assess the participants' knowledge of e-learning, personal computer and internet service availability, their attitude toward the e-learning effectiveness in medical education, and their views about the future of e-learning in medical education and its limitations at their university. The questions about the duration of using the internet, computers, and similar electronic devices were scored from 4 = daily usage to 0 = never, familiarity with and use of e-learning by medical students were evaluated as 2 = yes, 1 = to some extent, and 0 = no, and their attitudes toward e-learning were scored from 6 = absolutely agree to 1 = absolutely disagree (12). Also, the present study calculated the reliability of the attitude, internet, and computer use, and familiarity with and use of e-learning, showing the values of 0.83, 0.74, and 0.75, respectively. Data were collected within two weeks, from April 26, 2021, to May 10, 2021. Daily reminders were sent to the participants to increase the response rate during the study period. In addition, it was possible to submit the form only once from one device. A total of 528 valid questionnaires were retrieved.

3.3. Statistical Analysis

Categorical variables were demonstrated with frequency and percentage, and the quantitative variables

were described using mean and standard deviation. The Kolmogorov-Smirnov test confirmed the normality assumption. An independent-sample *t* test was run to compare the research groups in terms of the mean difference of quantitative variables. Also, an analysis of covariance (ANCOVA) was performed to compare attitudes toward e-learning between pre-clinical and clinical groups after gender control. All tests were two-tailed at a 5% significance level. Statistical analyses were performed with SPSS 23.

4. Results

The current study enrolled 528 undergraduate medical students. The mean age was 21.88 ± 2.11 years, ranging between 18 and 34 years. Regarding gender, 212 (40.2%) students were male, and 316 (59.8%) were female. Generally, 326 (61.8%) students were in the pre-clinical phase (209 in basic science and 117 in physiopathology courses), and 202 (38.3%) were in the clinical phase (117 in clerkship and 85 in internship courses).

Table 1 demonstrates the various reasons medical students use the internet, computers, and other electronic devices according to their self-declaration. As shown, 528 students who completed the questionnaires most commonly reported activities such as using social media (88.3%), searching for information (85%), downloading (77.5%), and learning medicine (48.7%).

Table 2 shows that only 5.5% of the students were familiar with e-learning, and 15.7% took advantage of e-learning daily. Also, 46.6% of the students mentioned that multimedia was not readily available at the university, and 57.4% said they used the internet for education to some extent. At the same time, only 9.1% explicitly declared the regular internet use for learning, 33.2% believed that e-learning was not helpful for medical education, and 17.2% expressed that e-learning would be more widespread in medical education.

The attitude of medical students toward e-learning is demonstrated in Table 3. As shown, 85.4% of the students agreed (absolutely agree, agree, and less) with the necessity of more effective e-learning in medical education, and 95.5% said that e-learning should play a complementary role in medical education. In addition, 44.5% believed that e-learning could not replace lectures in the classroom.

Next, we categorized basic science plus physiopathology students as the pre-clinical group and clerkship plus internship students as the clinical group. An independent-sample *t* test compared the pre-clinical group against the clinical group for the mean values of attitude, internet and computer use, and familiarity with and use of e-learning. Table 4 shows the mean and standard deviation of variables for the two groups. The results indicated that clinical

students had marginally statistically significantly better attitudes toward e-learning than pre-clinical students ($P < 0.05$). In contrast, no significant difference was observed in the internet and computer use and familiarity with and use of e-learning between the two groups ($P > 0.05$).

The independent *t* test showed that male students had a statistically significantly better attitude toward e-learning during the COVID-19 pandemic than female students ($P < 0.05$). However, no significant difference was observed in internet and computer use, and familiarity with and use of e-learning between males and females ($P > 0.05$) (Table 5).

The comparison of gender distribution in pre-clinical (male 34%, female 66%) and clinical (male 49.5%, female 50.5%) groups showed a significant difference between the two groups ($\chi^2 = 14.566$, $df = 1$, $P < 0.05$). Because males had better attitudes toward e-learning than females, an ANCOVA was performed to compare the mean attitudes of pre-clinical and clinical students after gender control (Table 6). The results declared that by controlling for gender, there was no significant difference between the two groups in attitudes toward e-learning ($P = 0.091$).

5. Discussion

The present cross-sectional study aimed to evaluate the medical students' attitudes toward e-learning, which was proposed as a platform for providing medical education during the COVID-19 pandemic, and to compare them according to their curriculum phases (pre-clinical and clinical) and gender. The results revealed an acceptable level of attitudes toward e-learning among undergraduate medical students of MUMS during the COVID-19 crisis, evidencing the usability of virtual education in our university, despite nearly half of the students stating that multimedia was not readily available at our university. Although many students declared that e-learning is useful and confirmed its complementary role in medical education, some announced that it could not replace in-person training. The findings indicated that the undergraduate medical students used the internet and electronic devices for social media more than for educational aims, which may mean that learning is not the students' primary concern. Moreover, clinical students had significantly better attitudes toward e-learning than pre-clinical students, which can be assumed due to their desire for e-learning and virtual education; however, nearly all of our study participants emphasized the complementary role of e-learning in medical education.

E-learning ensures flexibility (16) and allows good contact possibilities (17) At the same time, most students dis-

Table 1. Reasons for Using the Internet, Computers, and Similar Electronic Devices Among Undergraduate Medical Students (N = 528)^a

Using Internet and Computer for...	Daily	Several Times a Week	Several Times a Month	Seldom	Never
Searching for information	449 (85)	53 (10)	5 (0.9)	21 (4)	0
Downloading	409 (77.5)	77 (14.6)	28 (5.3)	13 (2.5)	1 (0.2)
Learning medicine	257 (48.7)	178 (33.7)	49 (9.3)	40 (7.6)	4 (0.8)
Writing texts	164 (31.1)	131 (24.8)	95 (18)	122 (23.1)	16 (3)
Planning the appointments	150 (28.4)	117 (22.2)	54 (10.2)	149 (28.2)	58 (11)
Doing their calculations	109 (20.6)	125 (23.7)	65 (12.3)	170 (32.2)	59 (11.2)
Adjusting the pictures and images	223 (42.2)	135 (25.6)	67 (12.7)	78 (14.8)	25 (4.7)
Playing computer games	165 (31.3)	105 (19.9)	65 (12.3)	120 (22.7)	73 (13.8)
Sending E-mail	74 (14)	90 (17)	138 (26.1)	202 (38.3)	24 (4.5)
Using social media	466 (88.3)	39 (7.4)	5 (.9)	15 (2.8)	3 (.6)
Research	72 (13.6)	111 (21)	136 (25.8)	185 (35)	24 (4.5)
Designing websites	22 (4.2)	11 (2.1)	18 (3.4)	94 (17.8)	383 (72.5)

^a Values are expressed as No. (%).**Table 2.** Familiarity with and Use of E-learning by Undergraduate Medical Students (N = 528)^a

Items	Yes	No	To Some Extent
I am familiar with e-learning completely.	29 (5.5)	261 (49.4)	238 (45.1)
I use the benefits of e-learning every day.	83 (15.7)	230 (43.6)	215 (40.7)
I use computer programs regularly.	54 (10.2)	159 (30.1)	315 (59.7)
Multimedia is readily available at our university.	93 (17.6)	246 (46.6)	189 (35.8)
I use the internet for education regularly.	48 (9.1)	177 (33.5)	303 (57.4)
E-learning is useful in medical education.	61 (11.6)	170 (33.2)	297 (56.3)
E-learning must be more prevalent in medical education.	91 (17.2)	148 (28)	289 (54.7)

^a Values are expressed as No. (%).**Table 3.** Undergraduate Medical Students' Attitudes Toward E-learning (N = 528)^a

Items	Absolutely Agree	Agree	Somewhat Agree	Less Disagree	Disagree	Absolutely Disagree
E-learning should play a more effective role in medical education.	190 (36)	119 (22.5)	142 (26.9)	43 (8.1)	16 (3)	18 (3.4)
E-learning can replace lectures in the classroom.	118 (22.3)	71 (13.4)	104 (19.7)	85 (16.1)	65 (12.3)	85 (16.1)
There is no significant reason for e-learning in medical education.	22 (4.2)	30 (5.7)	49 (9.3)	129 (24.4)	163 (30.9)	135 (25.6)
E-learning should play a complementary role in medical education.	201 (38.1)	178 (33.7)	125 (23.7)	10 (1.9)	12 (2.3)	2 (.4)
I am not interested in using English programs for medical education.	24 (4.5)	32 (6.1)	59 (11.2)	128 (24.2)	126 (23.9)	159 (30.1)
E-learning has no advantage over traditional teaching methods (books and notebooks).	29 (5.5)	58 (11)	85 (16.1)	154 (29.2)	123 (23.3)	79 (15)
Chatting on social media is easier for me than talking in class.	88 (16.7)	131 (24.8)	112 (21.2)	79 (15)	79 (15)	39 (7.4)

^a Values are expressed as No. (%).

Table 4. Attitudes Toward E-learning for Pre-clinical and Clinical Undergraduate Medical Students

Variables	Pre-clinical (N = 326)	Clinical (N = 202)	t-Value	df	P-Value
Attitude	29.84 ± 6.04	30.97 ± 6.37	-2.04	526	0.041
Internet and computer use	30.59 ± 7.21	30.29 ± 7.69	1.84	526	0.064
Familiarity with and use of e-learning	9.71 ± 3.01	9.49 ± 3.27	0.765	526	0.444

Table 5. Attitudes Toward E-learning for Male and Female Undergraduate Medical Students

Variables	Male (N = 212)	Female (N = 316)	t-Value	df	P-Value
Attitude	31.02 ± 6.61	29.77 ± 5.84	2.28	526	0.023
Internet and computer use	31.59 ± 8.29	30.75 ± 7.50	1.22	526	0.225
Familiarity with and use of e-learning	9.74 ± 3.30	9.55 ± 2.99	0.658	526	0.511

Table 6. Comparison Between Mean Values of Attitudes Toward E-learning for Pre-clinical and Clinical Undergraduate Medical Students After Gender Control in One-Way Analysis of Covariance

Sources	Type III Sum Squares	df	Mean Square	F	P-Value
Gender-factor (control variable)	146.79	1	146.79	3.875	0.05
Group (pre-clinical and clinical students)	108.78	1	108.78	2.871	0.091
Error	19888.74	525	37.88	-	-
Corrected total	20194.73	527	-	-	-

agree with the statement that e-learning should replace traditional forms of teaching (18). Since there are several definitions for attitude, it is difficult to compare various studies. Nevertheless, this research is in line with studies highlighting e-learning's potential to reach medical students and transform medical training; additionally, there is a concern about how e-learning could be applied. According to Thapa et al. only about 34% (n = 470) of the students found e-learning as effective as traditional face-to-face learning during the COVID-19 pandemic in Nepal. Overall, 58.9% had a favorable attitude toward e-learning (19). Some researchers stated that the participants' attitude toward e-learning was positive (12, 20-22). However, some others found different results. Olum et al. declared an overall negative attitude toward e-learning by medical and nursing students in Uganda (23). Abbasi et al., in their study at the Liaquat College of Medicine and Dentistry, Karachi, Pakistan, during the COVID-19 pandemic in 2021, showed that attitudes toward e-learning were generally negative (24). Half of medical and nursing students (n = 214, 49%) believed that e-learning is not an effective education strategy (23). Alsoufi et al. evaluated the Libyan medical students' attitudes through questions centered on the applicability and usability of e-learning in the school of medicine. The minority of students (n = 3,348, 38.2%) agreed that e-learning could replace traditional teaching methods, and only 20.2% believed that medical schools could implement e-learning throughout

the pandemic (25). The likely explanation could be that students are more familiar with the traditional learning environments and since medical education includes skill achievement, learning by doing is more important. In addition, the absence of face-to-face interaction can be an obstacle to experiencing effective communication, which can thus prompt dissatisfaction (26).

Moreover, some studies suggest that participants' experiences reflected accepting e-learning and using it (27). According to research, students preferred blended learning, incorporating traditional classroom or bedside lectures and e-learning (18, 24, 28). Although e-learning has a lot of novel opportunities, universities meet difficulties in the development and maintenance process. In the latest research on some ideas of university students, online courses' quality was evaluated as low (9). There exists a gap between the technology and teachers' existing pedagogy. Therefore, the preparation and training of students on e-learning and available learning platforms are essential to improve the attitude and use of virtual education (23).

The present study found that male students had a better attitude regarding e-learning during the COVID-19 pandemic than female students, consistent with several studies (29, 30). However, it should be noted that some research studies revealed no significant correlation between the gender of the students and their attitude (12, 18, 22, 23). The answer to this contradiction could be a meta-analysis examining gender differences in attitudes toward technol-

ogy use. Its findings indicated that males still hold more favorable attitudes toward technology use than females, but such differences would be characterized as small effect sizes (31). As for student attitudes toward e-learning, we found that the curriculum phase could affect students' attitudes. Our results showed that clinical students had marginally statistically significantly better attitudes toward e-learning than pre-clinical students. In line with our study, Shawaqfeh et al. showed a statistically significant difference in attitude among professional years one to four. The highest attitude score was observed among P4 students (22). However, our study findings indicated no significant difference between the two groups after gender control. Alsoufi et al., in a study in Libya in 2021 during the COVID-19 pandemic, announced that only 21.1% (n = 3348) of students agreed that e-learning could be used for clinical aspects while 49.7% agreed that e-learning could cover practical lessons (25). This inconsistency can be justified by referring to Compton et al., who surveyed DukeNUS Medical School students in Singapore less than a month after the pandemic. According to the findings, around 30% of the 179 surveyed students did not prefer to return to the clinical setting. Besides, their tendency to return to the clinical environment was correlated with their personality characteristics and risk perception of the healthcare system (32, 33). Some students and universities may have needed more time to adjust to exclusive e-learning (28). Whereas student perception is vital in virtual education (8), such a study can provide helpful information for stakeholders. As we confront the fifth wave of virus transmission in Iran, we must take specific measures to reduce the impacts of COVID-19 on medical education by providing practical solutions, such as online training promotion and virtual clinical experience. In the post-pandemic situation, e-learning is likely to be an integral part of higher education, so it is essential to plan and research efficient strategies to support students' learning and achieve education standards.

This research has some limitations, including the cross-sectional nature of the study design, which confined our ability to derive causal associations. Convenience sampling was used, so a limited list of demographic and psychosocial variables resulted in limitations in evaluating possible factors influencing the students' attitudes. It must be considered that the primary goal of this research was explaining the medical students' attitude toward e-learning, and further studies can identify multiple variables to shed more light on the underlying causes. In addition, our study was performed in a single university with specific settings. Therefore, the results must be validated by further studies in different institutions and countries to obtain an overview of the utility of electronic learning

platforms as a mode of teaching and learning.

Acknowledgments

We thank our colleagues and participants at Mashhad University of Medical Sciences, who provided expertise and insight that greatly assisted the research.

Footnotes

Authors' Contribution: Study concept and design, H.M. and S.N.; Acquisition of data, A.M. and A.S.; Analysis and interpretation of data, S.N. and M.M.; Drafting of the manuscript, H.M., S.N., M.M., A.M., and A.S.; Critical revision of the manuscript for important intellectual content, S.N. and H.M.; Statistical analysis, M.M.; Study supervision, S.N. and H.M.

Conflict of Interests: The authors declare no competing interests.

Data Reproducibility: The data presented in this study are openly available in one of the repositories or will be available on request from the corresponding author by this journal representative at any time during submission or after publication. Otherwise, all consequences of possible withdrawal or future retraction will be with the corresponding author.

Ethical Approval: IR.MUMS.REC.1400.017 (ethics.research.ac.ir/EthicsProposalView.php?id=192386).

Funding/Support: This research was funded by the Research Council (code: 990794) of Mashhad University of Medical Sciences, Iran (<https://research.mums.ac.ir/general/homePage.action>).

Informed Consent: All respondents provided electronic versions of informed consent. We sent all medical students at MUMS an anonymous online survey by email and WhatsApp messenger to fill in upon their consent.

References

1. Acter T, Uddin N, Das J, Akhter A, Choudhury TR, Kim S. Evolution of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) as coronavirus disease 2019 (COVID-19) pandemic: A global health emergency. *Sci Total Environ*. 2020;730:138996. doi: [10.1016/j.scitotenv.2020.138996](https://doi.org/10.1016/j.scitotenv.2020.138996). [PubMed: [32371230](https://pubmed.ncbi.nlm.nih.gov/32371230/)]. [PubMed Central: [PMC7190497](https://pubmed.ncbi.nlm.nih.gov/PMC7190497/)].
2. Dadgarmoghaddam M, Najaf Najafi M, Ebrahimi A, Talaei A, Najafnaji N, Moodi Ghalibaf A. Social Mental Health during COVID-19 Pandemic in Iran: A Cross-sectional Study among the General Population of Razavi Khorasan Province, Iran. *Iran Red Crescent Med J*. 2021;23(11). e1010. doi: [10.32592/ircmj.2021.23.11.1010](https://doi.org/10.32592/ircmj.2021.23.11.1010).
3. World Health Organization. *WHO Coronavirus (COVID-19) Dashboard*. World Health Organization. Geneva, Switzerland: World Health Organization; 2021, [cited 2021]. Available from: <https://covid19.who.int/>.

4. Dwivedi YK, Hughes D, Coombs C, Constantiou I, Duan Y, Edwards JS, et al. Impact of COVID-19 pandemic on information management research and practice: Transforming education, work and life. *Int J Inf Manage*. 2020;55:102211. doi: [10.1016/j.ijinfomgt.2020.102211](https://doi.org/10.1016/j.ijinfomgt.2020.102211).
5. Rashid S, Yadav SS. Impact of Covid-19 Pandemic on Higher Education and Research. *Indian Journal of Human Development*. 2020;14(2):340-3. doi: [10.1177/0973703020946700](https://doi.org/10.1177/0973703020946700).
6. Anshari M, Alas Y, Guan LS. Developing online learning resources: Big data, social networks, and cloud computing to support pervasive knowledge. *Educ Inf Technol*. 2015;21(6):1663-77. doi: [10.1007/s10639-015-9407-3](https://doi.org/10.1007/s10639-015-9407-3).
7. Lau F, Bates J. A review of e-learning practices for undergraduate medical education. *J Med Syst*. 2004;28(1):71-87. doi: [10.1023/b:joms.0000021522.30587.ff](https://doi.org/10.1023/b:joms.0000021522.30587.ff). [PubMed: [15171070](https://pubmed.ncbi.nlm.nih.gov/15171070/)].
8. Naresh B, Reddy BS. Challenges and opportunity of E-learning in developed and developing countries-a review. *Int J Emerg Res Manag Technol*. 2015;4(6):259-62.
9. Long PD, Tram NHM, Nga DQ. E-Learning Systems of Asian Developed Countries and Lessons for Vietnam. *J Crit Rev*. 2020;7(19):1472-9.
10. Sun P, Tsai RJ, Finger G, Chen Y, Yeh D. What drives a successful e-Learning? An empirical investigation of the critical factors influencing learner satisfaction. *Comput Educ*. 2008;50(4):1183-202. doi: [10.1016/j.compedu.2006.11.007](https://doi.org/10.1016/j.compedu.2006.11.007).
11. Means B, Toyama Y, Murphy R, Bakia M, Jones K. *Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies*. Washington, USA: U.S. Department of Education Office of Planning, Evaluation, and Policy Development Policy and Program Studies Service; 2009.
12. Ghanizadeh A, Mosallaei S, Sharifian Dorche M, Sahraian A, Yazdanshenas P. Attitude and Use of E-Learning, education by medical students in Shiraz, Iran. *Intern Med and J Med Invest*. 2018;3(3):108. doi: [10.24200/jimminv.v3i3.83](https://doi.org/10.24200/jimminv.v3i3.83).
13. Ahmed H, Allaf M, Elghazaly H. COVID-19 and medical education. *Lancet Infect Dis*. 2020;20(7):777-8. doi: [10.1016/s1473-3099\(20\)30226-7](https://doi.org/10.1016/s1473-3099(20)30226-7).
14. Cochran WG. *Sampling Technique*. n ed. New Jersey, USA: Wiley & Sons; 1963.
15. Israel GD. *Determining Sample Size*. Florida, USA: University of Florida; 1992, [cited 2021]. Available from: https://www.researchgate.net/profile/Subhash-Basu-3/post/how_could_i_determine_sample_size_for_my_study/attachment/5ebaa4924f9a520001e613b6/AS:890361492811785@1589290130539/download/sample1.pdf.
16. World Health Organization. *eLearning for undergraduate health professional education: a systematic review informing a radical transformation of health workforce development*. Geneva, Switzerland: World Health Organization; 2015. xvii p.
17. Förster C, Eismann-Schweimler J, Stengel S, Bischoff M, Fuchs M, von Luckner AG, et al. Opportunities and challenges of e-learning in vocational training in General Practice—a project report about implementing digital formats in the KWBW-Verbundweiterbildungplus. *GMS J Med Educ*. 2020;37(7). doi: [10.3205/zma001390](https://doi.org/10.3205/zma001390). [PubMed: [33364376](https://pubmed.ncbi.nlm.nih.gov/33364376/)]. [PubMed Central: [PMC7740008](https://pubmed.ncbi.nlm.nih.gov/PMC7740008/)].
18. Link TM, Marz R. Computer literacy and attitudes towards e-learning among first year medical students. *BMC Med Educ*. 2006;6:34. doi: [10.1186/1472-6920-6-34](https://doi.org/10.1186/1472-6920-6-34). [PubMed: [16784524](https://pubmed.ncbi.nlm.nih.gov/16784524/)]. [PubMed Central: [PMC1534040](https://pubmed.ncbi.nlm.nih.gov/PMC1534040/)].
19. Thapa P, Bhandari SL, Pathak S. Nursing students' attitude on the practice of e-learning: A cross-sectional survey amid COVID-19 in Nepal. *PLoS One*. 2021;16(6). e0253651. doi: [10.1371/journal.pone.0253651](https://doi.org/10.1371/journal.pone.0253651). [PubMed: [34166444](https://pubmed.ncbi.nlm.nih.gov/34166444/)]. [PubMed Central: [PMC8224981](https://pubmed.ncbi.nlm.nih.gov/PMC8224981/)].
20. Okhovati M; Sharifpoor Ghahestani E; Islami Nejad T; Hamzezhadeh Marzooni M; Motamed Jahroomi M. Attitude, Knowledge and Skill of Medical Students Toward E-Learning Kerman University Of Medical Sciences. *Bimonthly of Education Strategies in Medical Sciences*. 2015;8(1):51-8.
21. Mirzaei M, Ahmadipour F, Azizian F. Viewpoints of students of Shahid Sadoughi University of Medical Sciences towards e-Learning in teaching clinical biochemistry. *J Med Educ Dev*. 2012;7(2):67-74.
22. Shawaqfeh MS, Al Bekairy AM, Al-Azayzih A, Alkatheri AA, Qandil AM, Obaidat AA, et al. Pharmacy Students Perceptions of Their Distance Online Learning Experience During the COVID-19 Pandemic: A Cross-Sectional Survey Study. *J Med Educ Curric Dev*. 2020;7:1-7. doi: [10.1177/2382120520963039](https://doi.org/10.1177/2382120520963039). [PubMed: [33088916](https://pubmed.ncbi.nlm.nih.gov/33088916/)]. [PubMed Central: [PMC7543106](https://pubmed.ncbi.nlm.nih.gov/PMC7543106/)].
23. Olum R, Atulinda L, Kigozi E, Nassozi DR, Mulekwa A, Bongomin F, et al. Medical Education and E-Learning During COVID-19 Pandemic: Awareness, Attitudes, Preferences, and Barriers Among Undergraduate Medicine and Nursing Students at Makerere University, Uganda. *J Med Educ Curric Dev*. 2020;7:1-9. doi: [10.1177/2382120520973212](https://doi.org/10.1177/2382120520973212). [PubMed: [33283049](https://pubmed.ncbi.nlm.nih.gov/33283049/)]. [PubMed Central: [PMC7682244](https://pubmed.ncbi.nlm.nih.gov/PMC7682244/)].
24. Abbasi S, Ayooob T, Malik A, Memon SI. Perceptions of students regarding E-learning during Covid-19 at a private medical college. *Pak J Med Sci*. 2020;36(COVID19-S4). doi: [10.12669/pjms.36.COVID19-S4.2766](https://doi.org/10.12669/pjms.36.COVID19-S4.2766).
25. Alsoufi A, Alsuyihili A, Msherghi A, Elhadi A, Atiyah H, Ashini A, et al. Impact of the COVID-19 pandemic on medical education: Medical students' knowledge, attitudes, and practices regarding electronic learning. *PLoS One*. 2020;15(11). e0242905. doi: [10.1371/journal.pone.0242905](https://doi.org/10.1371/journal.pone.0242905). [PubMed: [33237962](https://pubmed.ncbi.nlm.nih.gov/33237962/)]. [PubMed Central: [PMC7688124](https://pubmed.ncbi.nlm.nih.gov/PMC7688124/)].
26. Li Y, Duan Y, Fu Z, Alford P. An empirical study on behavioural intention to reuse e-learning systems in rural China. *Br J Educ Technol*. 2012;43(6):933-48. doi: [10.1111/j.1467-8535.2011.01261.x](https://doi.org/10.1111/j.1467-8535.2011.01261.x).
27. Hayat AA, Keshavarzi MH, Zare S, Bazrafcan L, Rezaee R, Faghihi SA, et al. Challenges and opportunities from the COVID-19 pandemic in medical education: a qualitative study. *BMC Med Educ*. 2021;21(1):247. doi: [10.1186/s12909-021-02682-z](https://doi.org/10.1186/s12909-021-02682-z). [PubMed: [33926439](https://pubmed.ncbi.nlm.nih.gov/33926439/)]. [PubMed Central: [PMC8082480](https://pubmed.ncbi.nlm.nih.gov/PMC8082480/)].
28. Puljak L, Civljak M, Haramina A, Malisa S, Cavic D, Klinec D, et al. Attitudes and concerns of undergraduate university health sciences students in Croatia regarding complete switch to e-learning during COVID-19 pandemic: a survey. *BMC Med Educ*. 2020;20(1):416. doi: [10.1186/s12909-020-02343-7](https://doi.org/10.1186/s12909-020-02343-7). [PubMed: [33167960](https://pubmed.ncbi.nlm.nih.gov/33167960/)]. [PubMed Central: [PMC7652670](https://pubmed.ncbi.nlm.nih.gov/PMC7652670/)].
29. Zabadi AM, Al-Alawi AH. University Students' Attitudes towards E-Learning: University of Business & Technology (UBT)-Saudi Arabia-Jeddah: A Case Study. *Int J Bus Manag Sci*. 2016;11(6):286. doi: [10.5539/ijbm.v11n6p286](https://doi.org/10.5539/ijbm.v11n6p286).
30. Rhema A, Miliszewska I. Analysis of Student Attitudes towards E-learning: The Case of Engineering Students in Libya. *Issues Informing Sci Inf Technol*. 2014;11:169-90. doi: [10.28945/1987](https://doi.org/10.28945/1987).
31. Cai Z, Fan X, Du J. Gender and attitudes toward technology use: A meta-analysis. *Comput Educ*. 2017;105:1-13. doi: [10.1016/j.compedu.2016.11.003](https://doi.org/10.1016/j.compedu.2016.11.003).
32. Reddy RK, Palmer EG. Response to: 'Medical students' preference for returning to the clinical setting during the COVID-19 pandemic'. *Med Educ*. 2020;54(12):1192. doi: [10.1111/medu.14283](https://doi.org/10.1111/medu.14283). [PubMed: [32564376](https://pubmed.ncbi.nlm.nih.gov/32564376/)]. [PubMed Central: [PMC7323239](https://pubmed.ncbi.nlm.nih.gov/PMC7323239/)].
33. Compton S, Sarraf-Yazdi S, Rustandy F, Radha Krishna LK. Medical students' preference for returning to the clinical setting during the COVID-19 pandemic. *Med Educ*. 2020;54(10):943-50. doi: [10.1111/medu.14268](https://doi.org/10.1111/medu.14268). [PubMed: [32519383](https://pubmed.ncbi.nlm.nih.gov/32519383/)]. [PubMed Central: [PMC7300867](https://pubmed.ncbi.nlm.nih.gov/PMC7300867/)].