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Virtual learning during the COVID-19 pandemic: What are the barriers and how to overcome them?

Sujata Yadneshwar Khobragade, Htoo Htoo Kyaw Soe, Yadneshwar Sudam Khobragade, Adinegara Lutfi bin Abas

Abstract:

CONTEXT: Virtual learning is not without challenges. It can cause stress, lack of motivation, and social isolation. Due to COVID-19 pandemic, our college shifted from face-to-face to virtual teaching–learning style. the aim was to find out the barriers in virtual learning among medical students and provide solutions to overcome them.

MATERIALS AND METHODS: This cross-sectional study was conducted among 3rd- and 4th-year Bachelor of Medicine and Bachelor of Surgery students in 2020. Prevalidated electronic survey forms on institutional barrier, technical barrier, and individual barrier were sent to students, 160 students responded. SPSS version 12 was used to calculate descriptive statistics and independent t-test.

RESULTS: The students had the highest mean score in individual barrier (mean: 2.82 [standard deviation (SD): 0.72]) followed by institutional barrier (mean: 2.79 [SD: 0.74]) and technological barrier (mean: 2.72 [SD: 0.75]). Regarding technological barriers, 38.6% of the students agreed difficulty in procurement of the laptop and 66.4% faced slow Internet connection. Regarding institutional barriers, 75.9% were stressed to join one lecture to another lecture as the lectures were continuous, 69.6% had limited opportunity to interact with lecturers, and 62.7% had poor communication between lecturers and students. Regarding individual barriers, 74.1% of the students were not motivated for online learning, 71.5% of the students could not learn as well as they were in the classroom, and 58.2% disagreed taking online courses in future.

CONCLUSION: Low motivation, communication, Internet connectivity, and technical problems were the main barriers. Smaller size class, highly motivated and well-trained lecturers, and interactive lectures may help in breaking the barriers of virtual learning.

Keywords:

Barrier, COVID-19, medical, online learning, pandemics, students, survey

Introduction

COVID-19 pandemic has disrupted medical education worldwide. The Malaysian government declared Movement Control Order from March 18, 2020, to reduce the spread of infection.[1] The government ordered the suspension of classes at all levels. Our medical college started online teaching–learning. Malaysia campus of our college offers clinical phase of Bachelor of Medicine and Bachelor of Surgery (MBBS) program; neither medical faculty nor students were ready for this as our teaching–learning was always face to face. Howlett *et al*. defined virtual learning or online learning as the use of electronic technology and media to deliver, support, and enhance both learning and teaching involves communication between learners and teachers utilizing online content.[2] Online learning can provide students with easier and more effective access to a wider variety and greater quantity of information and help students to develop self-directed learning skills.[3]

Department of Community Medicine, Melaka-Manipal Medical College, Melaka, Malaysia

Address for correspondence:
Dr. Sujata Khobragade, Associate Professor, Melaka-Manipal Medical College, Jalan Batu Hampar, Bukit Baru, Melaka 75150, Malaysia.
E-mail: sujata.khobragade@manipal.edu.my

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Medical graduates of the twenty-first century are expected to "hit the ground running," requiring not only a traditional clinical education but also one that is up to date with the latest technologies.[4] There is a great need for educators, students, and clinicians to continuously update their skills, and one of them is to remain "digitally literate" which is the ability to use digital technology and understand and use information in multiple formats.[5]

Previous evidence had shown that there were no significant differences regarding the effectiveness of well-designed online learning compared with well-designed in-person learning.[6] However, the transition from traditional to online learning is not without challenges. It is out of their comfort zone. Online learning can cause social isolation, difficulty in communicating with lecturers and classmates, poor motivation and interest in studies. Technical issues such as slow internet, power interruption and computer problems may cause difficulties in learning.[7,8]

Keeping this in mind, we conducted this study to find out the barriers that are faced by clinical-year medical students when attempting to learn online. Based on the findings of the present study, we aimed to provide the appropriate ways and strategies of how to overcome these barriers.

Materials and Methods

Study design and setting

This cross-sectional study was conducted among the 3rd- and 4th-year (6th to 9th semester) medical students at a private medical college in Malaysia from August to September 2020.

Study participants and sampling

There were a total of 513 students attending a 3rd- and 4th-year MBBS program during the time of data collection. The sample size was calculated using the formula for finite single population proportion with margin of error 3% and assumption of 95% confidence level,[9] and 6.7% of the students did not have satisfactory access to a computer.[10] The minimum sample size required was 176. We employed purposive sampling method and invited the 3rd- and 4th-year medical students who were attending online classes. The students who were willing to provide written informed consent were included in this study, and those students who refused to participate or refused to provide written informed consent were excluded.

Data collection tool and technique

Electronic survey (Google Forms) was sent out to the students. A review of the literature was conducted to develop the questionnaire regarding barriers toward virtual learning. We modified the questionnaires which were used in the previous studies.[7,11] Our questionnaire included four parts. The first part included written consent from the students, and student's current semester, gender, ethnicity, and staying location were also asked. The second part included technological barriers regarding Internet access, use of computer/gadget, and use of social networking or online platform. The third part included institutional barriers such as class size, lecture's time management, learning materials, lecturer's technical skills, and timely feedback. The fourth part included individual barriers such as ability and confidence in online learning, communication with lecturers and peer group, motivation for learning, effectiveness of learning, social isolation, practical skills, and enjoyment of online learning.

Validity is defined as "the extent to which the instrument measures what it is intended to measure"[12] in which content validity is the "degree to which an instrument has an appropriate sample of items for the construct being measured."[13] The content validity of the items involved in barriers toward virtual learning was assessed using six experts who had expertise in medical education and educational research. The content validity of the items was assessed using median value of the item, item ambiguity (IA), percentage agreement (PA), item content validity index, content validity ratio (CVR), and content validity coefficient (VI_k).[12-14] The item which met the criteria of <4 methods (66.67% agreement) was removed.[14]

Before we performed exploratory factor analysis (EFA), we calculated the mean and standard deviation (SD) of each item. If the mean was close to either 1 or 4, we eliminated this item from the scale because it can decrease the correlation among the items.[15] We also examined skewness and kurtosis to check the normality of the data if these values were within the acceptable range of skewness and kurtosis which is between −1 and +1 in this study.[16] We performed the EFA to discover the number of factors which influence variables. In EFA, we used principal component analysis (PCA) with oblique rotation (direct oblimin). In initial analysis, correlation matrix was used to check whether there was a correlation between each pair of items in the scale. We inspected the correlation coefficient value above 0.3 and any variable with correlation coefficient value <0.3 was excluded.[17] We obtained the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity to determine that the EFA was appropriate for the data collected. Kaiser recommended that KMO values >0.5 were barely acceptable while Hutcheson and Sofroniou recommended that KMO values 0.5–0.7 are mediocre, 0.7–0.8 are good, 0.8–0.9 are great and above 0.9 are superb. In this study, we checked if the KMO value

is above 0.5. Bartlett's test of sphericity was used to examine whether the population correlation matric resembles an identity matrix. We checked if $P < 0.05$. Moreover, we also calculated KMO measures for individual item whether it is above 0.5.[17] We used multiple criteria to identify the number of factors to be retained. (1) Kaiser criterion to retain the factors that have eigenvalue >1.[17] (2) Cumulative percentage of variance explained is minimum of 50%.[17] (3) A scree plot was used to identify how many components should be retained. We retained the factors before the inflexion point of the graph.[17] (4) Parallel analysis was done to compare the actual eigenvalue to randomly ordered eigenvalues. We retained the factors when actual eigenvalues surpassed randomly ordered eigenvalues.[17] The items with factor loading <0.4 were not included. If the results of the EFA show items which are loading on the wrong factors or cross-loading on multiple factors, those items are deleted and the EFA re-performed until a simple solution is achieved.

Internal consistency refers to the extent to which items in subscale are intercorrelated, thus measuring the same construct.[18] Cronbach's alpha was calculated to examine the internal consistency of each subscale. Cronbach's alpha value between 0.7 and 0.9 indicates adequate internal consistency.[18,19]

We checked for duplication and missing data before we performed data analysis. SPSS version 12 (SPSS Inc., Chicago, IL, USA) was used for data analysis. Regarding measurement of technological barrier, institutional barrier, and individual barrier, we used a four-point Likert scale, ranging from 1 (strongly disagree) to 4 (strongly agree). Reverse scoring was done to the items which measured the positive aspect of barriers (strongly disagree was scored four and strongly agree was scored one). The total score of each subscale was computed by taking the sum of the items included and then divided by the number of items within each component. A higher score indicated more barriers toward virtual learning. Mean, SD, and median were calculated for each item in barriers toward virtual learning scale. For categorical variables, frequency and percentage were described. We calculated an independent *t*-test to compare the individual, technological, and institutional barriers toward virtual learning between different genders. All statistical tests were two-sided, and the level of significance was set at 0.05.

Ethical consideration

All ethical issues were taken into consideration. Before data collection, students were informed that their responses will be kept confidential and data will be used for research publication. The purpose of the study was explained in the survey form. Participation was strictly voluntary, and autonomy of the respondents was respected. Written informed consent was taken from each participant. Confidentiality was maintained and anonymity of respondents was ensured. In addition, data were kept secured and available only to the statistician. Approval for this study was taken from the Research Ethics Committee of our medical college in Malaysia (MMMC/FOM/Research Ethics Committee – 8/2020).

Results

A total of 160 students participated in this study, and the response rate was 66.12%. 74.1% of the students were female and 25.9% were male students.

Regarding validation of barriers toward virtual learning questionnaire, first, we calculated the median value of each item and a higher median value indicated that the item was more relevant. The criteria of median value more than 2.75 were used in this study, and all 32 items had median value of 3 or more. IA which was difference between item's highest rating and lowest rating was also calculated. As we used a rating scale of 1–4, the score of 3 or more indicated that the item was ambiguous. Among 32 items, 5 items were ambiguous. We also asked the judges that "Is this item essential to the scale," and they are asked to choose "Yes" or "No." The PA was calculated as number of judges rated "Yes" divided by total number of judges, and we used the cutoff of 80% as good agreement. Out of 32 items, 28 items had fulfilled the criteria. The content validity index for items (I-CVI) is the number of judges who rated 3 or 4 divided by total number of judges. We used six experts, so an I-CVI value of 0.83 or more was required to establish content validity beyond the 0.05 level of significance.[12] Among 32 items, 25 items had met the criteria. CVR was calculated in which the number of judges indicated "essential" of each item. The minimum value of CVR for six judges is 0.99 at a one-tailed test with $P = 0.05$.[20] Out of 32 items, 22 items had fulfilled the criteria. Finally, content validity coefficient (VI_k) was also calculated and the right–tail probability value of 0.78 was used for six judges rating four categories.[21] Out of 32 items, 16 items had met the criteria. After all the calculations were done, the results for each item were summarized. Finally, 24 items met the criteria of four methods fixed for this study, and it was decided to delete eight items that did not meet the set criteria [Table 1].

The skewness and kurtosis of each item in the scale were within –1 and 1; therefore, the data were approximately normally distributed. A PCA was run on a 24-item questionnaire that measured the barriers toward virtual learning among medical students. The suitability of PCA was assessed before analysis. Inspection of

Table 1: Content validity analysis of six experts regarding 32-item barriers toward virtual learning questionnaire

Number	Item	Median	IA	PA	CVI	CVR	VI_k	Decision
	Technological barrier							
T1	It is difficult to procure the laptop for online learning	3	2	100.0	0.67	1	0.61	Retain
T2	I face difficulty because of slow internet issue	4	2	100.0	0.83	1	0.89	Retain
T3	I am using online learning technology but not sure of my skills	3	3	83.3	0.83	0.67	0.67	Delete
T4	I feel confident and comfortable to use online learning technology	35	1	100.0	1.00	1	0.83	Retain
T5	I am using online technology but get very stressed while doing so	35	2	100.0	0.83	1	0.78	Retain
T6	In my area there is no access to internet	35	3	83.3	0.67	0.67	0.67	Delete
T7	In my area occasionally we face power interruption	3	2	83.3	0.67	0.67	0.61	Delete
T8	Online learning is costly affair	3	3	66.7	0.67	0.33	0.61	Delete
	Institutional barrier							
I1	I find limited opportunity to interact with lecturers	35	1	100.0	1.00	1	0.83	Retain
I2	I feel lecturers have inadequate technological skills	3	1	100.0	1.00	1	0.72	Retain
I3	I feel there is lack of timely feedback from lecturers	3	1	100.0	1.00	1	0.78	Retain
I4	I feel that there is poor communication between lecturers and students	3	2	100.0	0.67	1	0.61	Retain
I5	Online learning materials are of poor quality	3	3	83.3	0.67	0.67	0.56	Delete
I6	As lectures are continuous, I get stress to join from one lecture to another lecture	4	1	100.0	1.00	1	0.94	Retain
I7	Policies/practices are not good in online learning	3	1	66.7	0.83	0.33	0.61	Delete
I8	Class size is not right for online learning	3	2	100.0	0.83	1	0.72	Retain
I9	In online, teachers tend to focus more on theory rather than practical	4	1	100.0	1.00	1	0.89	Retain
	Individual barrier							
D1	I cannot learn as well online as I can in the classroom	4	1	100.0	1.00	1	0.94	Retain
D2	I find no difference in learning by online or classroom	3	2	100.0	0.83	1	0.72	Retain
D3	I can learn better through online learning compared to being in classroom	3	2	83.3	0.83	0.67	0.72	Retain
D4	I can learn better in the classroom	3	2	66.7	0.83	0.33	0.72	Delete
D5	I find difficulty in adjusting online learning style	35	1	100.0	1.00	1	0.83	Retain
D6	I do not get motivated for learning	35	1	100.0	1.00	1	0.83	Retain
D7	I find difficulty in communicating with my peer group	4	1	100.0	1.00	1	0.94	Retain
D8	I feel lonely when learning online	3	2	100.0	0.83	1	0.72	Retain
D9	I have ability and confidence with online learning technology	3	1	83.3	1.00	0.67	0.78	Retain
D10	I feel online learning is effective	35	1	100.0	1.00	1	0.83	Retain
D11	I enjoy the online learning experience	4	1	100.0	1.00	1	0.89	Retain
D12	I wish the online classes continue forever	3	3	66.7	0.67	0.33	0.61	Delete
D13	I feel the lack of practical training in online learning	3	1	100.0	1.00	1	0.78	Retain
D14	I will voluntarily take a future online course	3	1	100.0	1.00	1	0.78	Retain
D15	I will suggest others to take up online courses	3	1	100.0	1.00	1	0.72	Retain

IA=Item ambiguity; PA=Percentage agreement; CVI=Content validity index; VI_k=Content validity coefficient

the correlation matrix showed that all variables had at least one correlation coefficient >0.3 except D13 (individual barrier item 13). For preliminary analysis of 24-item questionnaire, the overall KMO measure was 0.850 with individual KMO measures all >0.5 except D13 (individual barrier 13). Therefore, we excluded item D13 (individual barrier item 13) for further analysis. Bartlett's test of sphericity was statistically significant ($P < 0.001$), indicating that the data were appropriate for factor analysis.

PCA revealed six components that had eigenvalues >1 and which explained 37.09%, 8.65%, 8.04%, 5.58%, 5.02%, and 4.35% of the total variance, respectively. Visual inspection of the scree plot indicated that three components should be retained [Figure 1]. Parallel analysis suggested that eigenvalues of three components surpassed randomly ordered eigenvalues. In addition, a three-component solution met the interpretability criterion. As such, three components were retained. The three-component solution explained 53.78% of

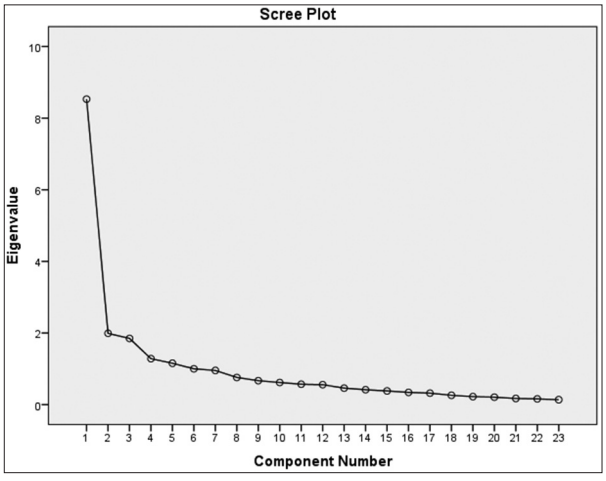

Figure 1: Scree plot showing components to be retained

the total variance. From 23-item questionnaire, 4 items which have loading <0.4 and 1 item which was loading on multiple factors were removed from the final questionnaire. Therefore, we included a total of 18 items in questionnaire which consisted of 3 items in technological barriers, 6 items in institutional barriers, and 9 items in individual barriers. The internal consistency of technological barriers, institutional barriers, and individual barriers was checked by calculating Cronbach's alpha coefficient. The Cronbach's alpha coefficient of technological barriers (C1) was 0.633, institutional barriers (C2) was 0.807, and individual barriers (C3) was 0.900 [Table 2].

Table 3 shows the frequency and percentage of student's agreement about technological, institutional, and individual barriers toward virtual learning. Regarding technological barriers, 38.6% of the students agreed difficulty in procurement of the laptop and 66.4% faced slow Internet connection. Regarding institutional barriers, 75.9% were stressed to join one lecture to another lecture as the lectures were continuous, 69.6% had limited opportunity to interact with lecturers, and 62.7% had poor communication between lecturers and students. 74.1% of the students were not motivated for online learning, 71.5% of the students could not learn as well online as they were in classroom, and 58.2% disagreed taking online courses future [Table 3].

Table 4 shows the mean and SD and median of each item as well as total score of each component. The mean total score was highest in individual barrier (mean: 2.82 [SD: 0.72]) followed by institutional barrier (mean: 2.79 [SD: 0.74]) and technological barrier (mean: 2.72 [SD: 0.75]). Table 5 shows that there was no statistically significant difference of technological barrier, institutional barrier, and individual barrier between male and female students [Tables 4 and 5].

Discussion

Online courses are conducted in various faculties of arts, commerce, science, and management by distance education wing of regular universities, open universities, and multimedia universities. This mode of education requires laptop, mobile, Internet facility, strong satellite network, and well-trained teaching staff. During online teaching–learning, students do face barrier, which can be (1) technical, (2) administrative, (3) individual, (4) organizational, (5) interaction with teachers and colleagues, (6) supporting staff services, (7) multimedia issues, (8) accessibility to online classes and time constraints, (10) availability of faculty for online teaching, and (11) legal and negative attitude of all.[22] During COVID-19 pandemic lockdown, we shifted from face-to-face to online teaching–learning for approximately 6 months at Melaka-Manipal Medical College [MMMC], Melaka, from March 2020 to August 2020. We conducted the present study to find out technological barrier, institutional barrier, and individual barrier that students faced during online learning.

Introduction of information technology as a tool for teaching in schools and colleges led to development

Table 2: Factor loading of 18-item barriers toward virtual learning questionnaire

Number	Item	C1	C2	C3
T1	It is difficult to procure the laptop for online learning	0.682		
T2	I face difficulty because of slow internet issue	0.763		
T5	I am using online technology but get very stressed while doing so	0.582		
I1	I find limited opportunity to interact with lecturers		0.680	
I2	I feel lecturers have inadequate technological skills		0.682	
I3	I feel there is lack of timely feedback from lecturers		0.851	
I4	I feel that there is poor communication between lecturers and students		0.796	
I6	As lectures are continuous, I get stress to join from one lecture to another lecture		0.532	
I8	Class size is not right for online learning		0.595	
D1	I cannot learn as well online as I can in the classroom			0.639
D2	I find no difference in learning by online or classroom			0.704
D3	I can learn better through online learning compared to being in classroom			0.817
D6	I do not get motivated for learning			0.499
D9	I have ability and confidence with online learning technology			0.665
D10	I feel online learning is effective			0.766
D11	I enjoy the online learning experience			0.745
D14	I will voluntarily take a future online course			0.846
D15	I will suggest others to take up online courses			0.749
	Eigen values	1.848	1.990	8.531
	Variance explained (%)	8.04	8.65	37.09
	Cronbach's alpha	0.633	0.824	0.900

C1=Technological barrier; C2=Institutional barrier; C3=Individual barrier

Table 3: Technological, institutional, and individual barriers toward virtual learning among medical students

Number	Item	Strongly disagree, *n* (%)	Disagree, *n* (%)	Agree, *n* (%)	Strongly agree, *n* (%)
	Technological barrier				
T1	It is difficult to procure the laptop for online learning	39 (24.7)	58 (36.7)	40 (25.3)	21 (13.3)
T2	I face difficulty because of slow internet issue	12 (7.6)	41 (25.9)	46 (29.1)	59 (37.3)
T5	I am using online technology but get very stressed while doing so	18 (11.4)	35 (22.2)	46 (29.1)	59 (37.3)
	Institutional barrier				
I1	I find limited opportunity to interact with lecturers	17 (10.8)	31 (19.6)	45 (28.5)	65 (41.1)
I2	I feel lecturers have inadequate technological skills	16 (10.1)	50 (31.6)	49 (31.0)	43 (27.2)
I3	I feel there is lack of timely feedback from lecturers	22 (13.9)	51 (32.3)	39 (24.7)	46 (29.1)
I4	I feel that there is poor communication between lecturers and students	13 (8.2)	46 (29.1)	54 (34.2)	45 (28.5)
I6	As lectures are continuous, I get stress to join from one lecture to another lecture	15 (9.5)	23 (14.6)	49 (31.0)	71 (44.9)
I8	Class size is not right for online learning	43 (27.2)	52 (32.9)	23 (14.6)	40 (25.3)
	Individual barrier				
D1	I cannot learn as well online as I can in the classroom	14 (8.9)	31 (19.6)	45 (28.5)	68 (43.0)
D2	I find no difference in learning by online or classroom	73 (46.2)	43 (27.2)	26 (16.5)	16 (10.1)
D3	I can learn better through online learning compared to being in classroom	68 (43.0)	47 (29.7)	27 (17.1)	16 (10.1)
D6	I do not get motivated for learning	7 (4.4)	34 (21.5)	39 (24.7)	78 (49.4)
D9	I have ability and confidence with online learning technology	12 (7.6)	47 (29.9)	62 (39.5)	1 (22.9)
D10	I feel online learning is effective	32 (20.4)	58 (36.9)	51 (32.5)	16 (10.2)
D11	I enjoy the online learning experience	19 (12.0)	58 (36.7)	53 (33.5)	28 (17.7)
D14	I will voluntarily take a future online course	40 (25.3)	52 (32.9)	44 (27.8)	22 (13.9)
D15	I will suggest others to take up online courses	60 (37.5)	39 (24.4)	45 (28.1)	16 (10.0)

Table 4: Descriptive statistics of technological, institutional, and individual barriers toward virtual learning among medical students

Number	Item	Mean (SD)	Median
	Technological barrier		
T1	It is difficult to procure the laptop for online learning	2.27 (0.98)	2.00
T2	I face difficulty because of slow internet issue	2.96 (0.97)	3.00
T5	I am using online technology but get very stressed while doing so	2.92 (1.03)	3.00
	Total	2.72 (0.75)	2.67
	Institutional barrier		
I1	I find limited opportunity to interact with lecturers	3.00 (1.02)	3.00
I2	I feel lecturers have inadequate technological skills	2.75 (0.97)	3.00
I3	I feel there is lack of timely feedback from lecturers	2.69 (1.04)	3.00
I4	I feel that there is poor communication between lecturers and students	2.83 (0.94)	3.00
I6	As lectures are continuous, I get stress to join from one lecture to another lecture	3.11 (0.98)	3.00
I8	Class size is not right for online learning	2.38 (1.14)	2.00
	Total	2.79 (0.74)	2.83
	Individual barrier		
D1	I cannot learn as well online as I can in the classroom	3.06 (0.99)	3.00
D2	I find no difference in learning by online or classroom*	3.09 (1.01)	3.00
D3	I can learn better through online learning compared to being in classroom*	3.06 (1.01)	3.00
D6	I do not get motivated for learning	3.19 (0.93)	3.00
D9	I have ability and confidence with online learning technology*	2.22 (0.89)	2.00
D10	I feel online learning is effective*	2.68 (0.91)	3.00
D11	I enjoy the online learning experience*	2.43 (0.92)	2.00
D14	I will voluntarily take a future online course*	2.70 (1.00)	3.00
D15	I will suggest others to take up online courses*	2.89 (1.03)	3.00
	Total	2.82 (0.72)	2.89

*Reverse item: strongly disagree (4) & strongly agree (1); SD=Standard deviation

of computer laboratories in various institutions, and computers are used for teaching face to face.[23] Availability of computer with students and faculty and Internet connectivity is a must for online teaching, but not every student has a computer and other relevant technological tools.[24] Technological barriers can be numerous ranging from purchase and testing of equipment to its implementation by institutions.

Table 5: Barriers toward virtual learning between male (*n*=32) and female (n=100) medical students

Variables	Mean (SD)		Mean difference (95% CI)	*P*
	Female	Male		
Technological barrier	2.75 (0.70)	2.52 (0.85)	0.23 (−0.06, 0.52)	0.123
Institutional barrier	2.74 (0.73)	2.84 (0.80)	−0.10 (−0.40, 0.20)	0.495
Individual barrier	2.86 (0.64)	2.84 (0.79)	0.02 (−0.25, 0.30)	0.862

P<0.05 is significant; CI=Confidence interval; SD=Standard deviation

Nonavailability of computer, accessories, and Internet facility by the students can be a barrier in distance/online learning. The software that is used for audio and video conferencing must function well during online courses as most of the teaching require Internet usage. Most of the Internet-based teaching do have problems due to unfamiliar environment both for teachers and students, but these problems are transitory in nature and are overcome by teachers with proper training by technical staff, and students learn to find ways to use audio and video conferencing even in the presence of inadequate technology. Sufficient bandwidth is essential for audio and video conferencing. Students get frustrated when they do not have access to their web page and E-mail server or if the Internet is slow.[25] Our students do possess computer and use it in face-to-face teaching–learning in seminar presentations. However, some of the students agreed difficulty in procurement of the laptop for online learning. The students also faced the issue of slow Internet. Moreover, we got the communication that two students who were stationed at West Malaysia were unable to join the online classes due to poor Internet connectivity.

In online learning, students are connected to Lecturer from their place of residence which may be their home, hostel, relative's house, or rented apartment. The students may have difficulties in connecting with teachers, and colleagues. Communication can be difficult during lecture on resolving his/her doubts Anxiety and stress may build up in students as lectures are one after another and problem may get aggravated if unable to communicate with instructor and colleagues. The quality of teaching gets affected by barriers such as poor skill in online delivery of lectures, time constraints, inadequate infrastructure, lack of online teaching platform such as Google, Microsoft, and Zoom, absence of institutional strategies, lack of institutional support, and lack of interest and motivation or negative attitude of lecturers.[7] Therefore, an educator must be well versed with online technology, able to solve minor issues that may crop up during conduct of online class, and able to solve student's queries within a limited time span. Teachers had been educated on the usage of computer and other multimedia for teaching purposes by technical staff. When asked students on their experience on distance education learning, they reported limited interaction and feedback from lecturers. They also felt lack of adequacy in technological skills amongst teachers. Online lectures were from 8:00 AM to 4.30 PM, and students had to join from one lecture to another; when asked whether it was stressful experience, majority said in affirmation especially while switching over the classes. Student's class size is directly correlated with optimal learning. The smaller the size, the better is the interaction between students and instructor. Interaction, participation, and collaboration are important for successful learning. Interactive groups promote desirable conditions for participation of all members in group and create favorable conditions for their collaborative interaction and discussion.[26] For optimal online learning where instructor can use his/her expertise effectively and consistently and can have quality feed-back with students, the class size should be 12–21 students.[27] With small size of class and active participation of teacher, students' interaction and learning output increase.[28] Taft *et al*. in their study observed that for foundation courses which require fundamentally acquisition of knowledge and lesser student–teacher interaction, size of the class can be up to 40 students, whereas for courses intended for acquiring complex knowledge, critical thinking, and special skill development where individualized student-teacher interaction is required, recommended size of class is not more than 15 students.[29] During online teaching, our tutorial class size was 12–15 students, and for lecture, it was 88 students. However, many of the students felt that the size of class does not affect learning.

No significant differences have been found in learning outputs between well-organized online and classroom teaching provided by the same teacher. Virtual learning can be a viable alternative in a blended education program if practical training is provided by the same teachers to both online and offline groups.[30] For online learning, individual barriers that can act as a hurdle in imbibing knowledge and skill include age, gender, interest and motivation, self-confidence, perceived effectiveness, satisfaction and enjoyment in online learning, and desire to take further online courses. Learning had been better in younger age group than older because of their preexisting utilization, greater confidence, and high efficiency in used technological tools for learning purposes. Elders perceived technical skill as a barrier for online learning because of lack of (a) familiarity with newer technology, (b) motivation, and (c) training necessary for effectively using technology. Furthermore, those who are

more comfortable in classroom teaching–learning had impediment in online learning.[31] This study included students in the age group of 21–23 years and both females and males. We did not find the perceptual differences in female and male students. Furthermore, no statistical differences in individual barrier, institutional barriers, and technological barrier were observed between two genders [Tables 2 and 3].

Arias J J *et al*.[32] observed a statistically significant higher examination score among students having face-to-face learning compared to online learners. Furthermore, statistically significant greater improvement was observed in posttest. Perhaps, this improved performance can be due to (1) students' interest and motivation toward face to face learning and (2) constant direct observation, supervision, and monitoring by the teachers. In online learning, students are not supervised and monitored. Moreover, their doubts may not be clarified immediately as happens in face-to-face teaching–learning. This can be one of the demotivation factors in online learning. We found that many students have a feeling that they cannot learn well in online teaching as compare to in classroom teaching. One more study[33] did not find any difference in learning output between blended synchronous online learning and face-to-face learning. We do use audio and video during online teaching and disseminate the same information as face to face, and also, we do ask questions and clarify doubts. Few of our students found no difference between online and offline learning, however, many of them found a difference in learning between online and classroom. Maske *et al*. observed full attendance and better participation of students with WhatsApp than traditional classroom learning. Students enjoyed this learning because it is easy, feasible, and effective as it can be learned anytime, anywhere without doubts.[34] In our study we observed, that majority of the students were strongly disagreeing with online teaching is better way of learning.

An attention, relevance, confidence, and satisfaction model are important for developing instructional material. Providing subject study material followed by online teaching helps students learn better. For students, self-motivation, and determination is necessary for acquisition of knowledge, skill and good performance. Students feel satisfied when they actively learn and perform better. Motivation is a critical factor for online learning and should be taken seriously. Changiz *et al*. observed a low score for motivation and online discussion among postgraduate medical students in a distance medical education program.[35] We observed that students strongly feel that they are not motivated to learn through virtual mode. Students may have a strong desire and motivation to take online courses, but he/she will be handicapped if poor in handling Internet and other technological tools required for online learning. Another study[36] observed that students having Internet efficiency could transform their motivation into action and performance. Those who were good in online learning technology outperformed in examination than those having low efficiency in Internet technology. These students had a high level of confidence and completed online courses satisfactorily. When asked students regarding the usage and management of technological tools in online learning, very few of them said that they have strong confidence and ability to deal with online learning technology. Efficacy of online teaching to have effective learning amongst students depend on teachers. Teacher have mainly six roles; pedagogical, course designer, social, life skill promoter, technical and managerial. Online teaching becomes more effective if instructor designs syllabus which are transparent, adds more audio-visuals in teaching and promotes collaborative learning activities to reduce frustrations.[37] In online teaching, we have PowerPoint presentation and videos if necessary. When asked on effectiveness, only a few students strongly disagree that online learning is an effective tool of learning compared to face to face learning. In online teaching-learning environment, teacher should be more supporting and interactive with the students. He/she should develop a sense of responsibility among students and promote self-directed learning. Teaching must be relevant and delivery of lecture should satisfy students' needs.[38] If well-disciplined and sufficiently motivated students enjoy learning through online mode.[39] Our study found that the students feel happy and satisfied with online learning, but there are students who did not have a pleasant experience. Effectiveness of previous/present online courses determines the acceptance and taking up of future online courses. Positive perception of online delivery, ease of participation, and self-reflection on learning of online courses are strengths of online delivery. Strong motivation and positive perception are important aspects of learning and future learning.[40] In our study, we found that few students strongly disagreed to take up voluntary online courses in the future. Many of our students were neutral about going for online courses and recommending online courses to others compared.

"Our research provides the insight of barriers to virtual learning not only in our setting but in any of the medical education or other higher educational institutions. This research will be beneficial for medical educators to understand the barriers and the ways to overcome these for better teaching and learning environment."

Recommendation to overcome the barriers of online learning

Under individual barriers students have less motivation toward learning, the solution for this is to

be self-motivated. Make a clear goal to build a new career, do a better job, or just make yourself proud, motivation matters.[41] Building strong self-motivation and self-discipline to avoid distractions will help the students to get motivated toward learning.

Most of the students were having no confidence in online learning technology. There are lots of technical support systems to assist, and many digital tool providers offer customer support as well as a large learning base to their users to get knowledge about the technology.

A large number of students were stressed to switch over the lecture classes. However, many organizations have launched online educational and training programs. Students having dedicated work time for e-learning, access to technology, and user-friendly platforms utilize these facilities and improve their knowledge and technical skills. Medical education and Continuous Professional D evelopment platforms adapted e-learning approaches which are flexible, low cost, and user centric are helping students in improving technical skills and knowledge.[42] Students need to master time management to optimally utilize these facilities.

To improve communication, online students must team up with a virtual learning community. Make sure to post regularly and interact with teachers and classmates.[41] Keep online communication by video conferencing with teachers and peer-to-peer group activities. Add video chats, discussion boards, and chatrooms. There are many ways to engage students during the online lessons: PowerPoint presentations, short videos, quizzes, etc. Ensuring constant contact tracking the progress, and giving feedback is another step to keeping each student engaged.

More than half of the students were agreeing that there is a lack of adequacy of technological skills in teachers. Insufficient knowledge on information and communication technologies with poor infrastructure can inhibit educator's willingness and ability to engage with the development or delivery of online learning. However, students and teachers agree to the fact that e-learning has the potential for teaching and learning.[43]

To gain the necessary skills, it was acknowledged that engaging with e-learning, including the development of such programs, was important for gaining skills for teaching practice.[8] An additional class of computer literacy for both teachers and students is always a good idea. Many webinars were conducted for faculty development to improve the technological skills.

When everywhere and everyone goes online, there are issues of slow Internet connectivity. Somehow, we must adapt to a slow Internet speed amid the coronavirus lockdown and learn to live with it. However, we can upgrade the Internet plan or can use mobile data or can call for help from the information technology department.

Conclusion

From this study, we observed that students were having barriers in virtual learning during the COVID-19 pandemic. Online learning in medical education is a relatively new concept and one which is rapidly expanding.[7] Once students are aware of the barriers and solutions to the virtual learning, they will be better prepared for the challenges faced in this digital age.

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Conflicts of interest

There are no conflicts of interest.

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