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Virtual Teaching as a Mode of Undergraduate Medical Education during Covid 19 Pandemic: Its Effectiveness, Facilitators and Barriers for Medical Education- A Survey-Based Observational Study.

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Objective: To evaluate the effectiveness, facilitators and barriers of online teaching of undergraduate medical students during the covid 19 pandemic. **Methods**: This google survey was conducted at a tertiary health care institute (Dr Yashwant Singh Parmar Government Medical College Nahan, Himachal Pradesh) of North India in August 2020. MBBS students of 4th and 5th year participated in the study. The questionnaire prepared on Google Forms (Google LLC, Mountain View, CA, USA) was organized in five sections, namely: E-learning, Web Quality, Technology, Teaching Sessions and Management Support. This was shared with the students with a link. Students' participation was voluntary, anonymous and without any fear or reward. **Results:** About 41.6% (77) students were already familiar with it. Time flexibility was reported as a significant advantage by 48.1% (89), and network connectivity an important limitation by 44.9% (83). 60.5% (112) wanted post-pandemic in-person teaching.18.9% faced technical difficulty due to devices and gadgets.44.9% (83) suggested chatbox use for interaction to enhance clinical skills, 60.5% (112) opined videos demonstration, 31.9% (59) suggested sharing of the study material in advance, and 97.3% (180) opted for post-pandemic clinical catch-up classes to supplement its effectiveness. For Management support, 28.1% (52) opined for institutional policy, 27.6% (51) reported infrastructure inadequacy for providing online medical education and technical support was a concern for 18.4% (34). 88.6% (164) favoured establishing a medical digital library to access medical literature. **Conclusion:** This study picks up a few gaps in online teaching. Addressing these gaps will make it more meaningful and a step forward to meet the objectives of medical education.

Keywords: E-learning, Management support, Medical education, Teaching session

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Introduction

On Dec 31 2019, 27 cases of pneumonia of unknown aetiology were identified in Wuhan City, Hubei province in China [1]. This new disease was caused by SARS CoV 2. Later it was levelled as COVID 19. The global spread of COVID-19 led the World Health Organization to declare it a pandemic on Mar 11 2020 [2]. Social distancing is a key measure to slow virus transmission. Many countries, governments decided to close schools and universities, resulting in a switch to virtual teaching [3]. The novel coronavirus (SARS-CoV-2) pandemic has disrupted medical education worldwide [4]. Most medical schools have quickly adapted to the online classes with the shifting of live clinical exposure to the virtual one. The COVID-19 pandemic represents a transformation in medicine with the advancement of telehealth, adaptive research protocols, and clinical trials with flexible approaches to achieve solutions [5]. E-learning tools play a crucial role during this pandemic. [6]. An E-learning system is an important source of information due to its ubiquity (availability anywhere and anytime), low cost, ease of use and interactive character.

In 2018 American college of cardiology Fellows in Training Section Leadership Council proposed three educational strategies: Personalized Learning, Adaptive Learning with real-world situations and feedback, and the Flipped Class Room [7]. Converting from traditional learning will enable learners' access to e-learning systems like Blackboard 24 h per day and presents several benefits such as increased effectiveness and efficiency of learning services through improved connectivity with teachers and better access to learning materials [8]. Crises like this are opportunities for medical educators to leverage Technology for both undergraduate and postgraduate medical education. Since most of the institutes imparted medical education to their undergraduates through online mode. Institutes have used many ways for distant learning through videoconferencing, webinars etc. like; Zoom classes, Google classroom, Google hangouts, Google meet, Webex as per their convenience. The usefulness of a system depends on its users. The effectiveness of online teaching in providing high standard medical education depends on the Technology, familiarity of the system by the teachers and trainees, accessibility and affordability of the network, institutional support and infrastructure.

There are various factors and barriers which adversely affect its utility. The present study was planned to address these concerns and the absence of such research looking into the above factors in the Indian context; The profound effect of coronavirus disease 2019 may forever change how a future physician is educated [9]. E-learning could be a robust tool in continuing medical education in this time of crisis and afterwards.

Material and Methods

Study setting: This study was conducted in a tertiary health care institute of (Dr Yashwant Singh Parmar Government Medical College, Nahan, Himachal Pradesh 173001) North India.

Duration and type of study: this study was a Survey-based study done using online google forms, and the participants' responses were received over two days. After that, the link for recording the responses was disabled.

Sampling methods: In the absence of previous studies on the subject and availability of 200 students undergoing teaching in clinical issues in undergraduate medical education, a convenient sample of 200 students was considered for the survey. Of the intended 200 participants (with whom the questionnaire was shared), only 185 students completed the study.

Sample size calculation: A convenient sample of 200 was taken (all undergraduate students of clinical subjects studying in the college).

Inclusion criteria: Since the study was designed to include the clinical aspect of teaching, the undergraduate medical students (MBBS) undergoing clinical classes/clinical subject teaching were included in the study.

Exclusion criteria: Students of preclinical subjects were excluded from the study.

Data collection procedure: MBBS Students of clinical classes were approached for this online survey in August 2020. The participants were informed about the study details through text via email and WhatsApp group. Later the same was discussed by videoconferencing through the Google Meet platform (Google LLC, version 44.6.0). Following this, a unique ID was provided to each student to make it an anonymous survey. The drafted questionnaire was reviewed to check the appropriateness, correctness and relevance of the questions.

Necessary corrections were made to make the study more focused, concise and relevant to the topic. The final questionnaire prepared on Google Forms (Google LLC, Mountain View, CA, USA) was organized into two parts; part A and part B. Part A was for particulars of the student, and Part B had study questions. Part B was further divided into five sections, namely: E-learning (online teaching), Web Quality, Technology, Teaching Sessions and Management Support. The E-learning section contained six questions, Web Quality 3, technology 4, teaching session five and Management support had four questions each.

A total of 22 questions were framed. It had multiple choices questions (eighteen), five-point ordinal Like Scales [strongly agree (5), agree (4), uncertain (3), disagree (2) and strongly disagree (1)] (two) and full text open-ended (one). The survey was shared with Participants on Aug 7 2020, via email and WhatsApp group with a link (https://docs.google.com/forms/d/11F1jXLL8n0lZBEcNiOKbVYQDinKPlgvoaqm7RwgyLCI/edit) to access the survey on Google Forms (Google LLC, Mountain View, CA, USA). Responses from the participants were received over 48 hours (7th and 8th August 2020); after that, the link was disabled. Responders could answer the survey only once. Participation of students in the survey was voluntary, anonymous and without an award.

Scoring System: five-point ordinal Like Scales [strongly agree (5), agree (4), uncertain (3), disagree (2) and strongly disagree (1)] was used to record the responses in five questions.

Ethic consideration and permission: No intervention or surgical procedure was involved in the study. Therefore, the study was conducted after informed consent from the participants only.

Statistics: Descriptive statistics of counts with percentages were used for categorical data. Statistical analysis was performed using Google form results.

Results

Out of 200 MBBS students (contacted for the survey), 185 completed the questionnaire yielding a response rate of 92%. 72 (38.9%) males & 113(61.1%) females participated in the study. 62(33.5%) students were satisfied with online teaching, whereas 80(43.2%) were not satisfied, and the rest, 43(23.2%), were non-decisive. 93(53.1%) of the students were not familiar with this mode of teaching before this pandemic,77(41.6%) were familiar,15(8.1%) not sure of it. Concerning the advantages of online teaching, 89 (48.1%) reported time flexibility as a major advantage, 46 (23.2%) recognize it as user friendly 43(24.9%) responses said that it makes students self-learner and motivated 7(3.8%). In response to disadvantages to E-learning, 83 (44.9%) opined network connectivity is a major concern 41(22.2%) reported less interaction 38(20.5%) said less attention span during online teaching, whereas 20(10.8%) said individual assessment is poor as a disadvantage of online teaching. Students opinion was asked as to how can their professional study be improved through this model in this pandemic. The majority, 112(60.5%), opted for post-pandemic face to face teaching, 47(25.4%) internet learning may be continued in addition to in-person teaching post-pandemic and 22(11.9%) there should be a teaching programme to teachers and students on E-learning as an option to improve teaching. As an explorer to barriers for E-learning, the major limiting factor 82(44.3%) students marked poor interaction, 67(36.2%) poor internet connectivity 32(16.8%) less objective assessment non-affordable and non-accessible 4(2.2%) and not user-friendly 1(0.5%) (Table I)

Table I: Responses for Online Teaching

Section (I) Online teaching	Responses in Number (%)		
Do you find online teaching satisfactory and meets your academic needs?	No 80 (43.2)	Yes 62 (33.5)	May Be 43(23.2)
Were you previously familiar with this teaching model?	No 93(50.3)	Yes 76 (41.6)	May Be 15(8.1)
What do you think are the advantages of internet learning?	Time flexibility 89 (48.1)	User friendly 46 (24.9)	Makes students more active 43(23.2) Efficient 7(3.8)
What are the disadvantages/ limitations of E-learning?	Network connectivity is a major concern 83 (44.9)	Less interaction 41 (22.2) Less attention span 38(20.5)	Individual assessment is poor 20(10.8) Costly 3(1.6)
What are your recommendations to improve e-learning?	Post pandemic face to face revision/hands-on sessions may need 112(60.5)	May be continued post-pandemic 47(25.4)	Training programme for students and teachers 22(11.9)

			Formative assessment tools like Kahoot may be added 4(2.2)
What do you think is the most limiting factor in e-learning?	Poor interaction 82(44.3)	Net connectivity 67(36.2)	Less object assessment 32(16.8) Not affordable and not accessible 4(2.2) Not user-friendly 1(0.5)

Time flexibility was a significant advantage, and limited interaction was a considerable disadvantage reported by the participants.

Web quality was rated satisfactory by 86(46.5%) and good by 62(33.5%) respondents. Most students,96(51.9%), felt that they were not overloaded by using different kinds of software and apps being used for online teaching. 43.8% (81) students were neutral for using social medial like Twitter, Facebook and WhatsApp for medical education, whereas 61(33%) favoured it. The current mode (Google Meet) was easily accessible to 57.3% (106), technically less demanding to 21.6% (40) and affordable to 13.5% (25). 76.8% (142) of study subjects didn't want to change to another tool (like Webex, zoom etc.) for teaching purposes.82.7% (153) students did not require any technical assistance as per the survey, whereas 7% (13) needed some assistance. 67.7% (125) did not face any difficulty due to hardware, 18.9% had to (Table II).

Table II: Responses for Web quality and Technology

Section (II) Web Quality	Responses in Number (%)		
How do you rate the web quality you are using?	Satisfactory 86(46.5) Good 62 (33.5)	Very Good (15) 8.1 poor 13(7)	Excellent 7(3.8) Very poor 2(1.1)
Are you overloaded by using different kinds of software and apps for e-learning?	No 96(51.9)	Yes 50 (27)	Maybe 39(21.1)
Should social media/networks be used for teaching?	Neutral 81(43.8) Agree 61 (33)	Disagree 24 (13) Strongly disagree5.9(11)	Strongly agree 8(4.3)
Section (III) Technology	Responses in Number (%)		
What is your opinion regarding the current mode (Google meet) of e-learning	Easily accessible 106 (57.3)	Technically easy 40(21.6) Affordable 25(13.5)	Free of cyber threats 14(7.6)
Are you facing any difficulty because of hardware.?	No 125 (67.6)	Yes 35(18.9)	Maybe25(13.5)
Do you think we can try another videoconferencing tool (like zoom/Webex/hangout etc.) replacing the current Google meet for learning	Yes 142(76.8)	May be 27(14.6)	No 16(8.6)
Do you need any technical assistance for participating in online classes?	No 153(82.7)	Maybe 19(10.3)	Yes 13(7)

Web quality was satisfactory to 46.5%, and only 7% needed technical assistance.

Regarding *teaching sessions,* 78.9%(146) students opined that uploading more videos on skill can increase its utility,11.4%(21)were in favour of sharing more texts, ppts and articles along with online teaching 3.2%(6) wanted a student's feedback regarding teaching sessions, and 6.5 % (12)suggested time capping on the sessions. Most students, 97.3% (180), are keen to have clinical catch-up classes in the post-pandemic period. 44.9% (83) suggested the use of chat boxes to increase interaction among students and teachers, whereas 25.9% (48) were in favor of small group tutorials.60.5% (112) opined that teachers might do videos demonstration of clinical methods to enhance clinical skills among students. To make tutorials more useful, 31.9% (59) suggested uploading the study material one week earlier the scheduled teaching session,14.6% (27) shared study material on clouds and 4.9% (9) by adding transcription to slide. (Table III)

Table III. Responses for Teaching sessions and Tutorials

Section (IV)Teaching	Responses in Number (%)		
How can teaching sessions be made more productive?	Uploading more videos on skills and demonstration 146(78.9)	Sharing texts, ppts and articles 21(11.4) Setting a time limit for session 12(6.5)	Feedback after each session 6(3.2)
Are clinical catch-up classes required post-pandemic?	Yes 180 (97.3)	Maybe 4(2.2)	No 1(0.5)
Suggest ways to improve interaction in these classes	use of chatbox 83(44.9) small group tutorial 48(25.9)	The class followed by feedback 30(16.2)	Not interested in online teaching 8(4.3) short session with small group 2(1.1)

		microphone and the camera on a must 8(4.3)	
How can online teaching facilitate practical/clinical skills?	Video demonstration by teacher 112(60.5)	By adding problem-based learning, 36(19.5)	By technologies such as augmented or virtual reality 13.5(25) Supplemented by simulations 12(6.5)
How can the tutorials be made more useful?	Upload materials slightly earlier (~1week) if possible59(31.9)	Mini quizzes 51(27.6) Small group tutorial 35(18.9)	share study material on clouds 27(14.6) Adding transcription to slides 9(4.9)

About 60.5% of students reported video demonstrations by the teacher to improve clinical learning.

Management support was not enough for carrying online teaching sessions. 28.1% (52) opined for institutional policy, 27.6% (51) reported inadequate infrastructure and technical support was a concern for 18.4% (34). 45.4% (84) agreed, and 24.3% (45) strongly agreed with the institute's online website/portal/software for remote learning and sharing academic materials and videos. 88.6% (164) participants favoured setting up a digital library to augment distance learning. Having a digital library in Himachal to share study material among medical colleges, 94.4% (170) students labelled it useful. (Table IV)

Table IV. Responses for Management Support

Section (V) Management support	Responses in Number (%)		
Regarding management support for E-learning, what is your opinion?	The institutional policy of e-learning is required 52(28.1)	Infrastructure is inadequate 51(27.6) Better formal assessment may be designed 44(23.8)	Technical support is needed 34(18.4)
Should your institute start its platform (website/portal/software) for remote learning and sharing academic materials and videos?	Agree 84(45.4) Neutral 46(24.9)	Strongly agree 45(24.3) Strongly disagree 7(3.8)	Disagree 3(1.6)
Are you in favor to establish an electronic library to have online library services	Yes 164(88.6)	Maybe 11(5.9)	No10(5.4)
What is your opinion of having a digital library shared with other medical colleges in Himachal Pradesh?	will be helpful to 170(94.4)	No need 10(5.6)	

To have easy access to medical literature Digital Medical Library was suggested by 94.4%.

Discussion

Covid 19 pandemic has dramatically affected medical education all over the globe. It hurt undergraduate medical education, especially clinical learning, in the absence of contact with the patient and social lockdown. A survey of about 1500 undergraduate students at Arizona State University (ASU), one of the largest public universities in the United States, in late April 2020 revealed that due to the COVID-19 pandemic, 13% of students had delayed graduation, 40% have lost a job, internship, or job offer, and 29% expect to earn less at age 35.

Moreover, these effects have been highly heterogeneous. One-quarter of students increased their study time by more than 4 hours per week due to COVID-19, while another quarter decreased by more than 5 hours per week [10]. The major challenge has been to sustain clinical learning in the absence of patient contact. Nearly half of the students indicated that their academic grades were affected during the pandemic. Clinical years' students (51.0%) were more likely to be negatively affected than students in primary years (36.1%) [11].

Additionally, medical students also reported higher levels of anxiety, stress, and exhaustion, with female students writing this more than male students [12]. The new limitations of physical presence have accelerated the development of an online learning environment, comprising both asynchronous and synchronous distance education and the introduction of novel ways of student assessment [13]. The teaching-learning process is primarily dependent on the online (virtual) mode.

To meet the demand, various virtual platforms were developed. Some of the famous EdTech start-ups include Byju's, Adda24*7, Alolearning, AptusLearn, Asmakam, Board Infinity, ClassPlus, CyberVie, Egnify, Embibe, ExtraaEdge, iStar, Jungroo Learning, GlobalGyan, LidoLearning, Pesto, Vedantu, Edubrisk, ZOOM Classroom, ZOOM Business, Toppr, Unacademy, Coursera, Kahoot, Seesaw, Khan Academy, e-pathshala, GuruQ, and the list is long [14].

The utility of these platforms is dependent mainly on their usage. Many barriers blunt its usefulness, like the willingness of the user, availability of devices, network connectivity, Technology, technical support, audio-video disturbances, financial burden etc. This study highlights the effectiveness, facilitators and barriers of e-learning in resource limiting settings. Considering that the use of digital tools in education has dramatically increased during this crisis, and it is set to continue, there is a pressing need to understand the impact of distance learning [15].

01. **Effectiveness:** Present study showed that 76(41.6%) were familiar with this mode of learning before the pandemic. A survey in Riyadh showed 41.8% had little or no online teaching/learning experience before this pandemic [16]. In this study majority of students, 62(33.5%), were satisfied with online teaching compared to 67% for quantity and 62% for quality of courses through virtual learning [17]. Another study shows satisfaction with a mean of 18.48 (4.15) with online teaching [18]. This contrasts with Li et al., who reported satisfaction of 36.5% among students [19]. Hence, there is a need to identify and address the barriers in distance learning to make it more effective.

02. **Facilitators:** Concerning the advantages of online teaching, 89 (48.1%) reported time flexibility as a significant advantage in concordance with Mukhtar K et al. [20]. 46 (23.2%) recognize it as user friendly 43(24.9%) opined that it makes students self-learner and motivated. This finding is in concordance with another study which revealed that online learning provided greater flexibility (84%) and led to unchanged or even higher attendance of courses (70%) [21]. The most incredible perceived benefits of online teaching platforms included their flexibility [22]. Web quality was rated satisfactory by 86(46.5%) and sound by 62(33.5%) respondents. Most students,96 (51.9%), felt that they were not overloaded by using different kinds of software and apps being used for online teaching. The current mode (Google Meet) was easily accessible to 57.3% (106), technically less demanding to 21.6% (40). 82.7% (153) students did not require any technical assistance as per the survey. 67.7% (125) did not face any difficulty due to hardware.

    A similar observation was made in a study done in Libya, where the more significant part of participants (47.5%) reported that they were very good or proficient (19%) in using electronic devices [23]. Students are well versed with the Technology, and only a few need technical assistance

03. **Barriers:** 58.4 % of the students were not familiar with this teaching mode before this pandemic compared to 24 % reported by Gismalla et al. and 35% reported by Kuldeep et al. [24,25]. The major challenge faced during online teaching and learning in the Indian setup was lack of skills, time management, lack of infrastructure and poor communication at various levels, as reported by Nirav et al. [26]. This study reveals poor network connectivity 41(22.2%), less teacher-student interaction 38(20.5%), inadequate infrastructure as limiting factors in virtual learning 27.6% (51) and technical support was a concern for 18.4% (34) students, similar barriers have been reported by Zalat MM [27]. As an explorer to barriers for E-learning, 32(16.8%) reported less objective assessment of students, non-affordable and non-accessible to 4(2.2%) and not user-friendly 1(0.5%). Management support was not enough to carry online teaching sessions. 28.1% (52) opined that institutional policy is a must to run online teaching sessions. At the same time, the commonly perceived barriers to using online teaching platforms in another study included family distraction (26.76%) and poor internet connection (21.53%) [22]. Less attention span during online teaching is also reported by few in this study, whereas and it was affordable to only13.5% (25) participants.

04. **Way Ahead:** In a question, How to improve online teaching, the majority 112(60.5%) opted for post-pandemic face to face (physical classroom/bedside) teaching, 47(25.4%) suggested internet learning may be continued in addition to in-person teaching post-pandemic a similar finding reported by Mohammad H. Rajab Where 62.5% preferred blending online and face-to-face instruction/teaching [16]. Majority of students are competent in Technology, a similar observation made by Belfi LM [28]. 22(11.9%) opined that there should be a teaching programme for teachers and students on E-learning as an option to improve teaching.

Regarding teaching sessions, 78.9%(146) students opined that uploading more videos on skill can increase its utility compared to 83.3% reported by Poonam Joshi et al.[29] 11.4% (21)were in favor of sharing more texts, ppts and articles along with online teaching, 3.2%(6) wanted a student's feedback regarding teaching sessions, and 6.5 %(12)suggested time capping on the sessions. Online education could be improved by making it more interactive, showing medical procedures in real situations, giving concise information, and providing 3D virtual tools to mimic the actual situation, a similar observation to this study. [30] In a study by Aaron J. Harries, most students (74.7%) agreed the pandemic had significantly disrupted their medical education and believed they should continue with normal clinical rotations during this pandemic (61.3%).[31] Most students, 97.3% (180), are keen to have clinical catch-up classes in the post-pandemic period. 44.9% (83) suggested the use of chat boxes to increase interaction among students and teachers, whereas 25.9% (48) were in favor of small group tutorials.60.5% (112) opined that teachers might do videos demonstration of clinical methods to enhance clinical skills among students. Virtual simulation may have an important role to play is in line with this study. [32].

To make tutorials more useful, 31.9% (59) suggested uploading the study material one week earlier the scheduled teaching session,14.6% (27) shared study material on clouds and 4.9% (9) by adding transcription to slide. 45.4% (84) agreed, and 24.3% (45) strongly agreed with the institute's online website/portal/software for remote learning and sharing academic materials and videos. 88.6% (164) participants favoured setting up a digital library to augment distance learning. Having a digital library in Himachal to share study material among medical colleges, 94.4% (170) students labelled it useful.

In preparation for the post-COVID era, a comprehensive online curriculum and evaluation tools are needed, which require the necessary infrastructure and adequate resources.[33] Mentoring groups or networks developed during COVID-19 should be continued beyond this pandemic. This would allow students to interact with others and obtain advice and guidance about the study, research, and future training prospects. [34] This is in concordance with the present study. There is a pressing need to improve the infrastructure, solve net connectivity issues, affordability, planning of teaching schedules, video demonstrations and adding more simulations in teaching, sharing texts in advance, making tutorials more interactive, short teaching sessions and designing practical assessment tools to make online education more effective and valuable.

Limitations of the study: This was a single institute-based study that included 4th and 5th year (learning clinical subjects) only, so generalization of the study may be difficult. However, it does indicate some advantages, limitations, technical, academic and management support issues in imparting medical education through virtual platforms.

Conclusion

Use of Technology is a valuable tool in imparting medical education. Addressing Gaps will make it more effective in achieving the objectives of medical education.

Author's Contribution

Ankur Dharmani (MD) was involved in manuscript writing, data analysis and critical appraisal

Corresponding author - Jiya Lal (MD, DCH) was involved in the conception of study, design, data collection, literature review, analysis and manuscript writing.

Reference

01. Lu H, Stratton CW, Tang YW. Outbreak of pneumonia of unknown etiology in Wuhan, China: The mystery and the miracle. J Med Virol. 2020 Apr;92(4):401-402. *doi: 10.1002/jmv.25678 [Crossref][PubMed][Google Scholar]*

02. Cucinotta D, Vanelli M. WHO Declares COVID-19 a Pandemic. Acta Biomed. 2020 Mar 19;91(1):157-160. *doi: 10.23750/abm.v91i1.9397 [Crossref] [PubMed][Google Scholar]*

03. Almarzooq ZI, Lopes M, Kochar A. Virtual Learning During the COVID-19 Pandemic: A Disruptive Technology in Graduate Medical Education. J Am Coll Cardiol. 2020 May 26;75(20):2635-2638. *doi: 10.1016/j.jacc.2020.04.015 [Crossref][PubMed] [Google Scholar]*

04. Pather N, Blyth P, Chapman JA, Dayal MR, Flack NAMS, Fogg QA, et a. Forced Disruption of Anatomy Education in Australia and New Zealand: An Acute Response to the Covid-19 Pandemic. Anat Sci Educ. 2020 May;13(3):284-300. *doi: 10.1002/ase.1968 [Crossref][PubMed][Google Scholar]*

05. Rose S. Medical Student Education in the Time of COVID-19. JAMA. 2020 Jun 2;323(21):2131-2132. *doi: 10.1001/jama.2020.5227 [Crossref] [PubMed][Google Scholar]*

06. Almaiah MA, Al-Khasawneh A, Althunibat A. Exploring the critical challenges and factors influencing the E-learning system usage during COVID-19 pandemic. Educ Inf Technol (Dordr). 2020 May 22:1-20. *doi: 10.1007/s10639-020-10219-y [Crossref][PubMed][Google Scholar]*

07. Narang A, Velagapudi P, Rajagopalan B, LeBude B, Kithcart AP, Snipelisky D, Sinha SS. A New Educational Framework to Improve Lifelong Learning for Cardiologists. J Am Coll Cardiol. 2018 Jan 30;71(4):454-462. *doi: 10.1016/j.jacc. 2017.11.045 [Crossref][PubMed][Google Scholar]*

08. Idris, Fadlelmoula Abd Alla, and Yasin Babeker Osman. "Challanges facing the implementation of e-learning at University of Gezira According to view of staff members". International Conference on e-Learning (econf), IEEE. 2015. *[Crossref][PubMed] [Google Scholar]*

09. Rose S. Medical Student Education in the Time of COVID-19. JAMA. 2020 Jun 2;323(21):2131-2132. *doi: 10.1001/jama.2020.5227 [Crossref] [PubMed][Google Scholar]*

10. Aucejo EM, French J, Ugalde Araya MP, Zafar B. The Impact of COVID-19 on student experiences and expectations: Evidence from a survey. J Public Econ. 2020;191:104271. *doi: 10.1016/j.jpubeco .2020.104271 [Crossref][PubMed][Google Scholar]*

11. Al-Husban N, Alkhayat A, Aljweesri M, Alharbi R, Aljazzaf Z, Al-Husban N, et al. Effects of COVID-19 pandemic on medical students in Jordanian universities: A multi-center cross-sectional study. Ann Med Surg (Lond). 2021 Jun 10;67:102466. *doi: 10.1016/j.amsu.2021.102466 [Crossref][PubMed] [Google Scholar]*

12. Mittal R, Su L, Jain R. COVID-19 mental health consequences on medical students worldwide. J Community Hosp Intern Med Perspect. 2021 May 10;11(3):296-298. *doi: 10.1080/20009666. 2021.1918475 [Crossref][PubMed][Google Scholar]*

13. Papapanou M, Routsi E, Tsamakis K, Fotis L, Marinos G, Lidoriki I, et al. Medical education challenges and innovations during COVID-19 pandemic. Postgrad Med J. 2021 Mar 29:postgradmedj-2021-140032. *doi: 10.1136/postgradmedj-2021-140032 [Crossref] [PubMed][Google Scholar]*

14. Dhawan S. Online Learning: A Panacea in the Time of COVID-19 Crisis. Journal of Educational Technology Systems. 2020;49(1):5-22. *doi:10.1177/0047239520934018 [Crossref] [PubMed][Google Scholar]*

15. Goudeau S, Sanrey C, Stanczak A, Manstead A, Darnon C. Why lockdown and distance learning during the COVID-19 pandemic are likely to increase the social class achievement gap. Nat Hum Behav. 2021 Oct;5(10):1273-1281. *doi: 10.1038/s41562-021-01212-7 [Crossref][PubMed] [Google Scholar]*

16. Rajab MH, Gazal AM, Alkattan K. Challenges to Online Medical Education During the COVID-19 Pandemic. Cureus. 2020;12(7):e8966. *doi: 10.7759 /cureus.8966 [Crossref][PubMed][Google Scholar]*

17. Stoehr F, Müller L, Brady A, Trilla A, Mähringer-Kunz A, Hahn F, et al. How COVID-19 kick-started online learning in medical education-The DigiMed study. PLoS One. 2021 Sep 21;16(9):e0257394. *doi: 10.1371/journal.pone.0257394 [Crossref] [PubMed][Google Scholar]*

18. Otaki F, Zaher S, Du Plessis S, Lakhtakia R, Zary N, Inuwa IM. Introducing the 4Ps Model of Transitioning to Distance Learning: A convergent mixed methods study conducted during the COVID-19 pandemic. PLoS One. 2021 Jul 15;16(7):e0253662. *doi: 10.1371/journal. pone.0253662 [Crossref][PubMed][Google Scholar]*

19. Li W, Gillies R, He M, Wu C, Liu S, Gong Z, Sun H. Barriers and facilitators to online medical and nursing education during the COVID-19 pandemic: perspectives from international students from low- and middle-income countries and their teaching staff. Hum Resour Health. 2021 May 12;19(1):64. *doi: 10.1186/s12960-021-00609-9 [Crossref] [PubMed][Google Scholar]*

20. Mukhtar K, Javed K, Arooj M, Sethi A. Advantages, Limitations and Recommendations for online learning during COVID-19 pandemic era. Pak J Med Sci. 2020 May;36(COVID19-S4):S27-S31. *doi: 10.12669/pjms.36.COVID19-S4.2785 [Crossref][PubMed][Google Scholar]*

21. Stoehr F, Müller L, Brady A, Trilla A, Mähringer-Kunz A, Hahn F, et al. How COVID-19 kick-started online learning in medical education-The DigiMed study. PLoS One. 2021 Sep 21;16(9):e0257394. *doi: 10.1371/journal.pone.0257394 [Crossref] [PubMed][Google Scholar]*

22. Dost S, Hossain A, Shehab M, Abdelwahed A, Al-Nusair L. Perceptions of medical students towards online teaching during the COVID-19 pandemic: a national cross-sectional survey of 2721 UK medical students. BMJ Open. 2020 Nov 5;10(11):e042378. *doi: 10.1136/bmjopen-2020-042378 [Crossref] [PubMed][Google Scholar]*

23. 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 Nov 25;15(11):e0242905. *doi: 10.1371/journal.pone.0242905 [Crossref][PubMed] [Google Scholar]*

24. Gismalla MD, Mohamed MS, Ibrahim OSO, Elhassan MMA, Mohamed MN. Medical students' perception towards E-learning during COVID 19 pandemic in a high burden developing country. BMC Med Educ. 2021 Jul 10;21(1):377. *doi: 10.1186/s12909-021-02811-8 [Crossref][PubMed] [Google Scholar]*

25. Singh K, Srivastav S, Bhardwaj A, Dixit A, Misra S. Medical Education During the COVID-19 Pandemic: A Single Institution Experience. Indian Pediatr. 2020 Jul 15;57(7):678-679. *doi: 10.1007/s13312-020-1899-2 [Crossref][PubMed] [Google Scholar]*

26. Nimavat N, Singh S, Fichadiya N, Sharma P, Patel N, Kumar M, Chauhan G, Pandit N. Online Medical Education in India - Different Challenges and Probable Solutions in the Age of COVID-19. Adv Med Educ Pract. 2021 Mar 4;12:237-243. *doi: 10.2147/AMEP.S295728 [Crossref][PubMed][Google Scholar]*

27. Zalat MM, Hamed MS, Bolbol SA. The experiences, challenges, and acceptance of e-learning as a tool for teaching during the COVID-19 pandemic among university medical staff. PLoS One. 2021 Mar 26;16(3):e0248758. *doi: 10.1371/journal.pone.0248758 [Crossref][PubMed] [Google Scholar]*

28. Belfi LM, Dean KE, Bartolotta RJ, Shih G, Min RJ. Medical student education in the time of COVID-19: A virtual solution to the introductory radiology elective. Clin Imaging. 2021 Jul;75:67-74. *doi: 10.1016/j.clinimag.2021.01.013 [Crossref][PubMed] [Google Scholar]*

29. Joshi P, Murry LL, Sharma R, Mary C, Sharma KK, Jena TK, Lodha R. Evaluation of an Online Interactive IMNCI Training Program in Nursing Students. Indian J Pediatr. 2021 Apr;88(4):372-373. *doi: 10.1007/s12098-020-03542-2 [Crossref] [PubMed][Google Scholar]*

30. Mahdy MAA. The Impact of COVID-19 Pandemic on the Academic Performance of Veterinary Medical Students. Front Vet Sci. 2020 Oct 6;7:594261. *doi: 10.3389/fvets.2020.594261 [Crossref][PubMed] [Google Scholar]*

31. Harries AJ, Lee C, Jones L, Rodriguez RM, Davis JA, Boysen-Osborn M, et al. Effects of the COVID-19 pandemic on medical students: a multicenter quantitative study. BMC Med Educ. 2021 Jan 6;21(1):14. *doi: 10.1186/s12909-020-02462-1 [Crossref][PubMed][Google Scholar]*

32. Shankar PR, Wilson IG. The COVID-19 pandemic and undergraduate medical student teaching-learning and assessment. Can Med Educ J. 2021 Feb 26;12(1):e190-e191. *doi: 10.36834/cmej.70800 [Crossref][PubMed][Google Scholar]*

33. Lee IR, Kim HW, Lee Y, Koyanagi A, Jacob L, An S, Shin JI, Smith L. Changes in undergraduate medical education due to COVID-19: a systematic review. Eur Rev Med Pharmacol Sci. 2021 Jun;25(12):4426-4434. *doi: 10.26355/eurrev_202106_26155 [Crossref] [PubMed][Google Scholar]*

34. Sharma D, Bhaskar S. Addressing the Covid-19 Burden on Medical Education and Training: The Role of Telemedicine and Tele-Education During and Beyond the Pandemic. Front Public Health. 2020 Nov 27;8:589669. *doi: 10.3389/fpubh.2020.589669 [Crossref][PubMed][Google Scholar]*