ORIGINAL RESEARCH ARTICLE

Medical education and the epidemics: How educational technology responded

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Abstract

The global disruption created by the Coronavirus Disease 2019 (COVID-19) pandemic in medical education and healthcare institutions is unparalleled. Consequently, it is essential to evaluate the usability of forms of educational technology and to identify their viability and suitability for medical education. The objective of the investigation was to present an assessment of the state of medical education during the COVID-19 epidemic and to identify the obstacles faced by educators while introducing online learning systems for medical students. Two cross-sectional surveys were conducted with 200 medical students and 75 staff members from Saudi Arabia's University of Health. A descriptive method was used to focus on the mechanisms of analysis, foresight, and comprehension of reality. The most significant findings were the obstacles posed by instructors' most urgent requirements for educational technology training and its applications in order to activate distance education in medical education. In addition to a detailed description of the academic and technological concerns and obstacles encountered by students and faculty of health colleges during the pandemic, this report includes a discussion of the pandemic itself. Several prospective recommendations for the use of online and blended learning in health colleges post-pandemic were also made. Additionally, the requirement to activate learning via virtual professional learning groups. *(Afr J Reprod Health 2024; 28 [1]: 94-109).*

Keywords: Educational Technology, Medical Education, Epidemics, online learning, synchronous distance education (SDE)

Résumé

La perturbation mondiale créée par la pandémie de maladie à coronavirus 2019 (COVID-19) dans les établissements d'enseignement médical et de soins de santé est sans précédent. Par conséquent, il est essentiel d'évaluer l'utilisabilité des formes de technologie éducative et d'identifier leur viabilité et leur adéquation à l'enseignement médical. L'objectif de l'enquête était de présenter une évaluation de l'état de l'enseignement médical pendant l'épidémie de COVID-19 et d'identifier les obstacles rencontrés par les éducateurs lors de l'introduction de systèmes d'apprentissage en ligne pour les étudiants en médecine. Deux enquêtes transversales ont été menées auprès de 200 étudiants en médecine et de 75 membres du personnel de l'Université de la Santé d'Arabie Saoudite. Une méthode descriptive a été utilisée pour se concentrer sur les mécanismes d'analyse, de prospective et de compréhension de la réalité. Les résultats les plus significatifs ont été les obstacles posés par les besoins les plus urgents des instructeurs en matière de formation en technologie éducative et ses applications afin d'activer l'enseignement à distance en médecine. éducation. En plus d'une description détaillée des préoccupations et des obstacles académiques et technologiques rencontrés par les étudiants et les professeurs des collèges de santé pendant la pandémie, ce rapport comprend une discussion sur la pandémie elle-même. Plusieurs recommandations prospectives concernant l'utilisation de l'apprentissage en ligne et mixte dans les établissements de santé après la pandémie ont également été formulées. À cela s'ajoute l'obligation d'activer l'apprentissage via des groupes d'apprentissage professionnel virtuels. *(Afr J Reprod Health 2024; 28 [1]: 94-109).*

Mots-clés: Technologie éducative, formation médicale, épidémies, apprentissage en ligne, enseignement à distance synchrone (SDE)

Introduction

The novel coronavirus (COVID-19) outbreak that began in December 2019 in the Chinese city of Wuhan has impacted life in nearly every region globally. Government anti-virus measures, such as citywide and nationwide lockdowns, have disrupted individuals' schedules[1] including school and universities closures. The cessation of educational institutions resulted in numerous changes, including the shift toward a greater emphasis on technology-based education. Regarding what to teach, how to teach, the burden of teaching staffs and students, the teaching environment, and the implications for

education equity, there was ambiguity and disagreement in the learning field[2]. COVID-19 has caused unprecedented disruption to the medical education process and healthcare systems worldwide[3].

Distance learning in medical education refers to using technologies based on health care delivered on distance. It includes telehealth (or e-health), telematics, telemedicine, Tele-education, etc. Many different technologies and communication systems are available to meet the needs of e-health, telemedicine, tele-education, and distance learning, ranging from conventional telephone lines to the system of transmitting digitalized signals with a modem, optical fiber, satellite links, wireless technologies, etc[4].

A traditional clinical education combined with one that is current with the newest technologies is required of medical graduates in the twenty-first century in order to provide flexibility in a dynamic workplace. The need for educators, students, and doctors to regularly update their knowledge, stay current with the evolving healthcare landscape, and maintain their "digital literacy" has never been higher[5]. Since the outbreak of Covid-19, almost two billion students have been impacted by school closures. According to UNESCO, 192 nations had instituted statewide school closures, affecting almost 99.9% of the world's student population[6]. The advice of public health experts regarding social isolation could flatten the epidemic curve and lower the total number of Covid-19 deaths. Consequently, emergency e-learning is one of the proposed security methods to safeguard the community[7].

The most frequently suggested methods are scheduled live online video lectures with interactive discussions, the usage of numerous programs or self-study online-recorded lectures made available online for medical students at each university[8]. Another alternative advocated in reaction to the stoppage of clinical clerkship rotations was virtual clinical experience. E-learning was somewhat welcomed by medical students during the Covid-19 Pandemic shutdown. The following recommendations are made: better e-course design, enhanced engagement and motivation, and integrated learning[9,10].

Problem

The pandemic rapidly resulted to the temporary suspension of in-person medical student study; this outbreak represents a significant loss of learning time that could have long-term consequences for their education and careers. The condition poses issues for medical education, as instructors must give lectures safely while maintaining the process's integrity and continuity. The lecture- and patient-based medical education processes have been impacted by how challenging it is to carry on with lectures given the virus's high contagiousness. The college of Medicine and Pharmacy has stopped offering clinical rotations[10,11]. Further challenges include the potential for medical students to contract the virus while undergoing training and transmit it throughout the community[12]. Furthermore, students are required to stay at home and follow social distancing standards. As a result, institutions must build medical education technology that allows students to learn continuously while also minimizing delays caused by the pandemic[13]. The crisis will have a severe impact on two levels: the loss of education expenditure during the crisis, the resulting additional costs, and the anticipated reduction in future financial resources available to the education sector.

Furthermore, the COVID-19 pandemic and social distancing requirement has made it challenging for all stakeholders to get online because they are working under time and resource constraints. It must be proven that implementing an online learning environment is more than just a technological matter. It is an instructional and pedagogical difficulty. As a result, proper preparation for teaching materials, curriculum, and assessment knowledge is required in online education. The means of delivery is technology, which needs strong collaboration across instructional, content, and technology teams. Closing institutions and removing students and professors from the classroom requires a rapid mobilization of all university personnel and resources[14]. As a result, the research problem is to understand how educational technology dealt with

medical education problems during the Corona pandemic.

Questions

1. What are the challenges and issues of medical education in Saudi medical college during Covid 19?
2. What is the most essential technology that medical education has depended on throughout the pandemic?
3. What are the medical students' perspectives on the most influential instructional technologies?
4. What are the educational technology needs of the medical staff?
5. What are the most essential proposed solutions for medical education at a distance from the perspective of staff?

Framework

When the Net Generation began enrolling in universities around the turn of the millennium, instructors faced a new group of students with a wide range of backgrounds, priorities, and expectations. This is because they arrived on the planet at a time when technology growth was widespread and widely employed[15]. Medical students must exchange best practices for handling clerkship cancellations to learn from this worldwide epidemic and ensure that students remain in medical school and eventually meet graduation requirements on time[16].

ICT-based teaching in the face of the COVID-19 pandemic

On December 31, 2019, Wuhan, Hubei Province, China, reported an unexplained pneumonia cluster. On January 9, 2020, the China CDC discovered a new coronavirus as the outbreak's main agent, phylogenetically linked to SARS-CoV. The virus-associated sickness is known as new coronavirus disease 2019- COVID-19[17]. Coronavirus disease (COVID-19) is a viral infection caused by a newly discovered coronavirus[18].

Di Pietro[19] investigated the direct and indirect effects of the COVID-19 epidemic on education. They made forecasts regarding education's effect and future. Their main conclusions were: 1) learning is expected to suffer a setback on average; 2) the effect on academic performance is likely to vary with socioeconomic status; 3) inequality in socioeconomic status may manifest in an emotional response, as those from less privileged backgrounds may be under environmental stress; and 4) the widening social gap may persist and have long-term implications[19].

Digital natives, millennials, net generation, and digital generation describe today's students. Their arrival coincided with widespread technical advancement[20]. Net generation paradoxes and delusions should be considered since they think they know everything about ICT, which is fatal. World Bank agrees that directing students and instructors to massive online collections without guidance would not bode well during the COVID-19 pandemic lockdown[21].

Professors, lecturers, and teaching assistants are indispensable to the implementation of ICT-integrated learning[18,22]. Therefore, it is crucial that they have the proper attitude and perceptions regarding ICT to effectively incorporate technology into instruction. Similarly, the perceptions and ambitions of students must be taken into account because they have a direct impact on their learning space and style[22,23].

In spite of its organizational and execution problems, the exceptional situation that followed COVID-19 has faced staff, students, and administrators with obstacles to accept online learning. ICT have become a crucial influence in transforming the educational landscape on a worldwide scale. In response to COVID-19, extensive deliberation, coordination, and planning are required to prepare for the departure from traditional physical classrooms. Integrating technology in a novel manner into medical education will allow students to develop collaboration and adaptability skills. Managing the challenges of remote collaboration with colleagues provides a

basis for professional cooperation and telemedicine in our future careers.

Challenges of medical college throughout the Corona epidemic

At the onset of the pandemic, the Association of American Medical Colleges took the unprecedented action of suspending clinical rotations and publishing recommendations for medical students to avoid activities requiring direct patient contact. Numerous countries followed suit. Since then, the COVID-19 epidemic and subsequent social distancing measures have continuously disturbed medical students', schools', and institutions' routines, vigorously testing the resilience of medical education systems worldwide[24,25].

Clinical coursework in undergraduate medical education relies primarily on traditional face-to-face interactions to develop clinical competence and skills. Most rotations require the patient, physician, and student to be physically present at the same location and until recently, this delivery paradigm required little curricular innovation. Even medical specialties that can be highly integrated on digital platforms, such as radiology, pathology, and clinics using telehealth videoconferencing, continue to offer in-person rotations, despite the introduction of new remote rotation opportunities[16,26]. The Association of Medical Colleges strongly suggested that medical students stop working directly with patients. As a result, most colleges took most medical students out of in-person clinical clerkships and made it so they couldn't go back to the wards.

Class cancellations will make it difficult to reconnect students with the ethics of community at medical college if limitations are eased. Through webinars and teleconferences, interactive learning groups like team-based learning and small group case-based learning can continue throughout the COVID-19 outbreak and may offer an early glimpse of what medical school may look like in the future[16,20].

In addition, it is essential to consider the technical obstacles that online teaching and learning can present to medical students, such as audio and video issues, downloading or streaming errors, login problems, poor internet quality, and security concerns, as well as students' and instructors' limited technical skills.

Experience in medical education to deal with the COVID challenge

Without a doubt, the COVID-19 pandemic has wreaked havoc on the long-standing, conventional framework of medical education. The increased physical presence limits have accelerated the development of an online learning environment, encompassing both asynchronous and synchronous distance education and introducing novel ways of assessing learners. Moreover, this protracted crisis had significant effects on medical students' lives, particularly their mental health and academic careers[27].

The epidemic may have set in motion changes in the way education is delivered around the world that will last millennia. Some educational institutions have been obliged to make a speedy transition to technology-based remote learning approaches. Numerous individuals are adequately prepared for the challenges ahead due to the sudden move to online learning[18,28]. This transition to remote learning had to happen as soon as possible. Many educational institutions experienced it several months into the academic year, leaving staff and students with little time to plan, modify, and respond[29].

Also, Stojan *et al.*[26]; Abu Talib *et al.*[28] employed a systematic literature review, education, and information technologies for the purpose to assess the influence of technology on educational institutions throughout the COVID-19 era[27,29]. They confirmed that SDE is commonly used for educational reasons among health science students. Many research comparing knowledge gains indicated that eLearning intervention groups gained much more than traditional learning groups, but others found no significant changes or mixed findings. Some studies found considerably larger skill increases in the online eLearning intervention groups, while others found no differences between groups[18,30].

The advantages of online learning in ME

The urgency of the current crisis appears to have demanded a swift shift from a more 'analog' model to a more 'digital' model, even in circumstances where the usage of digital tools was previously substantially less popular. This pandemic has demonstrated to how medical education can be highly vulnerable during health crises, especially in the context of future COVID-19 waves and epidemics[26].

Adoption of online learning in ME can have various advantages: One of the most advantageous characteristics of online distance education is the flexibility of time and location, which leads to enhanced convenience, allowing medical students to more easily adjust their schedules[31]. Besides schedule flexibility, online distance education can also be much more cost-effective than classroom-based learning, as it does not require educators to move, while more individuals across different institutions (or even countries) can participate in virtual courses. In addition, e-learning assists medical students to better adapt to a web-based medical world that increasingly uses digital health services[10,13].

Infrastructure's effect on online learning

The World Bank is cognizant of the fact that few education systems, even the highest performing ones, may not be equipped to provide online education to all pupils on such a massive scale. Frequently, technological advancements outpace the capacity of decision-makers to keep up with infrastructure costs and support[32]. Infrastructure disparities between regions and universities' frequently limited technological resources may contribute to inequality among students[3,33]. Nonetheless, to enhance the effectiveness of distance education, academics should provide excellent teaching and fair assessment and evaluation activities[2,34]. Academics and students are required to use a PC, laptop, tablet, or smartphone to engage in digital teaching and learning activities.

Nonetheless, learners from diverse socioeconomic backgrounds may not have similar technological capabilities[2]. In this context, insufficient technology ownership, connectivity challenges owing to network overload and infrastructure, lack of digital tool knowledge and abilities, lousy family conditions, and failure to keep up with coursework may affect students' education[4,34]. It must be determined that, in order to provide effective online and hybrid learning, infrastructure and tools, as well as hardware and software support systems, are required for ICT support.

Methods

Design

A cross-sectional study was carried out to evaluate (1) challenges and problems of medical education during Covid 19, (2) the most important technology that has been relied on in medical education, (3) the most influential technology, (4) the medical staff, and (5) important proposed solutions for distance medical education.

The descriptive technique was required due to the nature of the study, which concentrated on the processes of reflection, foresight, and comprehension of reality. To achieve the previous objectives, a questionnaire consisting of 66 items was returned and reviewed by 8 experts to ensure its reliability and validity. Confirmatory factor analysis was used to verify the three-factor model. The results revealed that the model had accepted fit according to the indicators, as NNFI = .91, SRMR = .011, GFI = .92, AGFI = .91, RMSEA = .050, X2 = 60.96 (P=.000).

Participants

The study sample was selected using a convenience sampling strategy, with an e-questioner put up on the Google Forms platform. Undergraduate medical students and lecturers at UOH in KSA were emailed a link via their e-learning accounts (n= 200 students, and 75 lecturers). Every undergraduate medical student seated in class who received online

instruction during the COVID-19 epidemic is eligible.

Instrument

A 45-question survey was distributed to students, while a 36-question survey was distributed to a staff member via the google forms tool. For submission, all multiple-choice questions had to be answered.

Data collection

The form was available from May 20, 2021 to May 30, 2021, for 10 days long. Four and seven days later, a reminder was sent. The informed consent for participation in the study has been obtained verbal.

Results

To answer Q1 (For medical students Perspectives): Challenges and problems of medical education during Covid 19 in Saudi medical colleges relative weight, We calculated mean and standard deviations as shown in Table 1.

From table 1, In the absence of challenges, the response of the statement lectures and observations was raised, but the degree of acceptance of the response is intermediate, and this may 'median' that the students' management of the problem levels is acceptable to some extent. The degree of acceptance of the responses to the challenges is closely distributed between the 'high' and very-high' responses. Except for the item variations regarding the ability to interact in and actively participate in the remote setting and attendance and lecture feedback, the maximum 'No Challenges' response rate was 64%.

The findings indicate that there is a collection of challenges and problems that students face (and worry in the future) in relation to (Nos. 1, 4, 5, 6, 7, 8, 9, 12, 13, and 14), as well as others with a comparable level of difficulty (Nos. 2, 3 and 11). While the students notice differences in their ability to interact with and actively participate in the remote

environment, as well as in attendance and lecture feedback (which they do not encounter in distance learning), this can be explained by the fact that medical students are constantly striving for excellence and continuous self-learning as a 21st century skill. This is shown in their desire to achieve good grades in final exams, the acquisition of practical and clinical skills, and their understanding of the significance of safeguarding their health security while undergoing practical training in hospitals. Due to the tremendous competition among them, we constantly discover that medical students are curious about the nuances of their education and strive to learn to the best of their abilities. The prior results are consistent with the results of both Stojan *et al.*[26]; Papapanou *et al.*[13]; Ibrahim *et al.*[9]; Khasawneh *et al.*[12]; and Chiodini[32].

To answer Q1 (for medical Staff Perspectives): Challenges and problems of medical education during Covid 19 in Saudi medical colleges. We calculated relative weight, mean and standard deviations as shown in Table 2.

From Table 2, Staff identify (through their experience of distance teaching during the Corona pandemic) the most significant challenges and problems of distance education to a very high degree (Nos. 7, 8, and 9). They also see that the problems (Nos. 2, 3, 4, 6, and 10) are of a high degree. As for the problems (No. 1 and 5), they are moderate. The previous findings are related to digital skills, which teaching staff have not previously been exposed to as one of the skills required for distance teaching, whether in their specialized preparation within their colleges or in their professional preparation for the teaching profession through various training programs. This is confirmed by Murphy[7]; Harden, & Laidlaw[5]; Papapanou *et al*[33]; Sindiani *et al.*[25]; Zhang *et al.*[2] which emphasized the need for teaching staffs in medical colleges to have various training programs related to distance teaching skills.

To answer Q2: The most important technology that has been relied on in medical education during the pandemic: we calculated relative weight, mean and standard deviations as shown in Table 3.

Table 1: Relative weight, mean and standard deviations for CHALLENGES and problems of medical education during COVID 19 in Saudi medical colleges (medical students Perspectives)

Challenges or problems	Degree of Challenges or problems				Mean	Std.	Degree
	Very high	high	Medium	No Challenges or problems			
1- Medical students' final exams.	93 46.5%	65 32.5%	40 20%	2 1%	3.97	.17	**Very high**
2- Real-time evaluation and feedback.	43 21.5%	85 42.5%	44 22%	28 14%	3.12	.34	**high**
3- lecturers must conduct courses safely.	80 40%	84 42%	22 11%	10 5%	3.49	.19	**high**
4- Clinical rotations in medical education have been suspended.	128 64%	72 36%	-	-	3.98	.26	**Very high**
5- Medical students might catch the virus during training and spread it to others.	97 48.5%	82 41%	21 10.5%	-	3.88	.40	**Very high**
6- Students are expected to adhere to social distance rules and remain at home.	85 42.5%	73 36.5%	20 10%	22 11%	3.71	.31	**Very high**
7- Infection transmitted by an asymptomatic contact.	80 40%	84 42%	22 11%	10 5%	3.54	.23	**Very high**
8- The online technology-based education pedagogy used to support teaching and learning.	97 48.5%	82 41%	21 10.5%	-	3.55	.34	**Very high**
9- Having the ability to focus on learning despite distractions at home.	95 47.5%	84 42%	16 8%	5 2.5%	3.60	.51	**Very high**
10- Variations in the capacity to actively engage and contribute in the remote environment.	60 30%	45 22.5%	31 15.5%	64 32%	1.23	.43	No Challenges
11- Daily assignments	80 40%	82 41%	28 14%	10 5%	3.11	.36	Big
12- Interactive	95 47.5%	84 42%	16 8%	5 2.5%	3.98	.76	**Very high**
13- There were no formal guidelines given to students regarding ambient light during medical education during Covid 19	95 47.5%	84 42%	16 8%	5 2.5%	3.56	.40	**Very high**
14- Internet connectivity challenges.	77 38.5%	52 26%	51 25.5%	20 10%	3.50	.50	**Very high**
15- Attendance and Lecture Feedback.	5 2.5%	16 8%	84 42%	95 47.5%	1	.35	No Challenges

According to Table 3, responses in agreement ranged from "high" to "veryhigh" with 50% in high, 62% in "very high", and a "median" response of 50% in virtual guide interactions. Except for the item, videoconference calls to patients were 48%. (Not relied).

The findings can be explained in light of the unexpected and unplanned move from face-to-face to online learning. The teaching staff's experiences with various technological applications and tools varied, as the impressions or judgments of some instilled in others a passion for the importance of

Table 2: relative weight, mean and standard deviations for challenges and problems of medical education during COVID 19 in Saudi medical colleges (For medical Staff Perspectives)

Challenges or problems	Degree of Challenges or problems						Degree
	Very high	high	Medium	No Challenges or problems	Mean	Std.	
1- Time constraints.	5	5	45	10	2.30	1.01	Median
	6.7%	6.7%	60%	13.3%			
2- Poor technical skills.	7	36	18	14	3.21	.21	**high**
	9.3%	48%	24%	18.7%			
3- Inadequate infrastructure.	10	50	10	4	3.13	.41	**high**
	13.3%	66.7%	13.3%	5.3%			
4- Absence of institutional strategies.	25	40	5	3	3.45	.40	**high**
	33.3%	53.3%	6.7%	4%			
5- Everyone participating has both positive and bad attitudes.	10	20	40	5	2.19	.23	Median
	13.3%	26.7%	53.3%	6.7%			
6- Cultural resistances amongst staff	15	30	15	15	3.40	.50	**high**
	20%	40%	20%	20%			
7- Online education approach that uses technology to support teaching and learning.	60	6	9	-	4	.00	**Very high**
	80%	8%	12%				
8- Design synchronous live sessions for medical students.	60	6	9	-	4	.00	**Very high**
	80%	8%	12%				
9- Helping to plan their daily e-activities.	45	5	20	5	3.90	.23	**Very high**
	60%	6.7%	26.7%	6.7%			
10-Give feedback for daily assignments.	12	48	10	5	3.18	.43	**high**
	16%	64%	13.3%	6.7%			

using these applications or tools, as evidenced by the teaching staff's responses to the significance of all applications and their desire to train on as many of them as possible. They believe it will allow them to effortlessly teach remotely.

This is consistent with the findings of Muller *et al.*[16]; George[29]; Papapanou *et al.*[13]; Sindiani *et al.*[25]; and Zhang *et al.*[1], which emphasized the existence of a large number of applications, programs, and tools that teaching staffs require when teaching remotely. Also, these tools and applications require an appropriate methodology and educational philosophy for medical education.

To answer Q3: The medical students' views on educational technology that have the most influence, we calculated mean and standard deviations as shown in Table 4.

The responses in Table 4 indicated a median influence on blogging and vlogging, collaborative writing, and content development, as they demand a learner proficient in educational technology. The "median" response received the greatest approval scores, ranging from 15% to 38.5%. On concerns such as Wiki-building, virtual environment scenarios, plagiarism checking, and virtual gallery walks, rejection answers averaged 48%. This could be because students are unaware of its significance and are unfamiliar with its application. While the remainder of the tools and applications had a high and very high degree of influence. Which could explain why they were used in prior stages (in the subject of computer skills). As well as the students' skills to utilize them, as well as the familiarity of teaching staff with their use that is simple to use in the distance learning process. It is the same interpretations and results of the study of both Di Pietro[19]; Mian and Khan[8]; Sindiani *et al.*[25]; and Khalifa *et al.*[24] .

To answer Q4: The medical staff needs in terms of educational technology: we calculated mean and standard deviations as shown in Table 5.

Table 3: relative weight, mean and standard deviations for the most important technology that has been relied on in medical education during the pandemic

Item	Degree of relied on				Mean	Std.	Degree
	Very high	high	Medium	Not relied			
1- Calls to patients through video conferencing.	12 6%	12 6%	80 40%	96 48%	1.33	.23	Not relied
2- Reviewing the electronic health record.	25 12.5%	80 40%	73 36.5%	22 11%	3.09	.36	high
3- Guide virtual encounters.	--	100 50%	100 50%	--	2.5	.00	high
4- Social media platform (like tweeter-Instagram).	96 48%	78 39%	12 6%	14 7%	3.68	.50	Very high
5- Use of Blackboard or Microsoft Teams	125 62.5%	60 30%	5 2.5%	-	3.56	.83	Very high
6- Multimedia-enhanced content.	102 51%	75 37.5%	15 7.5%	8 4%	3.67	.54	Very high
7- video lectures (YouTube)	102 51%	75 37.5%	14 7%	5 2.5%	3.78	.46	Very high
8- lectures podcast	96 48%	78 39%	12 6%	14 7%	3.68	.52	Very high
9- Active discussion	95 47.5%	65 32.5%	34 17%	5 2.5%	3.77	.35	Very high
10- Flipped classroom	25 12.5%	73 36.5%	28 14%	74 37%	3.44	.19	Very high
11- Web-based viewer hosted in the cloud	105 52.5%	75 37.5%	14 7%	5 2.5%	3.91	.34	Very high
12- Digital library of learning resources.	105 52.5%	75 37.5%	14 7%	5 2.5%	4	.01	Very high
13- Using WhatsApp Messenger to communicate with the students in real-time.	105 52.5%	75 37.5%	14 7%	5 2.5%	3.70	.36	**Very high**
14- Repository of learning	25 12.5%	73 36.5%	28 14%	74 37%	3.00	.91	**High**

Table 5 demonstrated that the medical needs of teaching staff in educational technology were met to a significant extent, with approval rates ranging from 74.7% to 97.3%. Reflecting complete agreement on those requirements. The scenario that prompted faculty staff to teach remotely, which they had not previously been officially trained on, maybe the cause of these training demands, while there are some initiatives in this direction through electronic training platforms and follow-up courses on YouTube. These needs also indicate faculty staff's interest in using distance education skills after the Corona pandemic in the field of medical education. This was confirmed by the study of Akers *et al.*[11]; Buabeng-Andoh and Totimeh[22]; Fu[23]; Zhang *et al.*[2]; Patil, *et al.*[10]; Tsang *et al.*[30].

To answer Q5: What are the most important proposed solutions for distance medical education from the teaching staff's perspectives? We calculated mean and standard deviations as shown in Table 6.

According to table 6, the teaching staff indicated that the proposed solutions for distance medical education are of so big priority: (No. 2, 6, 16, and 17). While the solutions to a high degree are (Nos. 1, 3, 4, 5, 8, 9, 10, 12, 13, 14, 15, 18, 19, and 20). While the solutions to a medium degree were (No. 7, 11).

Table 4: relative weight, mean and standard deviations for the medical students' Perspectives on educational technology that have the most influence

Item	Degree of influence				Mean	Std.	Total degree
	Very high	high	Medium	Not Influence			
1- Blogging and Vlogging (Creating video blogs).	15 7.5%	27 13.5%	81 40.5%	77 38.5%	2.33	.19	Medium
2- Collaborative writing or story-making.	22 11%	25 12.5%	113 56.5%	30 15%	2.01	.45	Medium
3- Content Production (word Processing, spreadsheets).	82 41%	30 15%	80 40%	8 4%	3.66	.82	**Very high**
4- Discussion forums or text-based chats.	110 55%	82 41%	8 4%	- 0%	3.76	.96	**Very high**
5- E-Portfolios.	54 27%	95 47.5%	28 14%	23 11.5%	3.22	.55	**High**
6- Video chatting and conferencing.	112 56%	85 42.5%	3 1.5%	- 0%	3.44	.10	**High**
7- Intelligent tutoring (online teaching and assessment tools, often subject-specific).	55 27.5%	100 50%	12 6%	31 15.5%	3.16	.76	**High**
8- Mapping (mind-mapping, using interactive maps and charts, etc).	13 6.5%	100 50%	27 13.5%	60 30%	3.15	.53	**high**
9- Multimedia presentations.	101 50.5%	78 39%	21 10.5%	- 0%	3.98	.88	**Very high**
10- Online drawing and drafting.	101 50.5%	78 39%	21 10.5%	- 0%	3.98	.88	**Very high**
11- Plagiarism checking (using anti-plagiarism tools that provide feedback to writers).	15 7.5%	42 21%	49 24.5%	94 47%	1.00	1.00	Not influence
12- Quizzes and surveys.	101 50.5%	78 39%	21 10.5%	- 0%	3.78	.44	**Very high**
13- Video creation and sharing.	101 50.5%	78 39%	21 10.5%	- 0%	3.78	.44	**Very high**
14- Virtual gallery walks (there are special sites and software for these).	36 18%	44 22%	44 22%	76 38%	1.01	.35	Not Influence
15- Virtual reality scenarios (sometimes requires special software).	36 18%	44 22%	44 22%	76 38%	1.33	1,23	Not Influence
16- Wiki building.	10 5%	70 35%	24 12%	96 48%	1	.99	Not Influence

This could explain the teaching experience during the Corona epidemic by shifting to remote education, which improved the teaching staff's skills and provided them with a variety of experiences linked to digital teaching skills, as well as knowing how to support them. Despite the presence of numerous hurdles, previous data indicate that there are favorable developments in medical education remote education. There is a trend toward reformulating the presentation of medical training courses, with e-learning playing a critical role. This was confirmed by the study of Khalifa *et al*., [24]; Bakker and Wagner[34]; Hodges[27]; Sindiani *et al*.[25]; Murphy[7].

The previous findings highlight a number of significant insights gained during the COVID-19 pandemic pertaining to medical education and the utilization of educational technology.

Table 5: Relative weight, mean and standard deviations for the medical staff needs in terms of educational technology

Item	Degree of nee				Mean	Std.	Total Degree of need
	Very high	**high**	**Medium**	**no need**			
1- pedagogical instruction on the use of online technology in education to support teaching and learning on social media platforms.	66 88%	4 5.3%	5 6.7%	-	3.97	.34	**Very high**
2- Multimedia-enhanced content.	60 80%	5 6.7%	4 5.3%	1 1.3%	3.67	.54	**Very high**
3- New curriculum design	63 84%	7 9.3%	5 6.7%	-	3.77	.43	**Very high**
4- Videoconferencing	60 80%	2 2.7%	3 4%	-	3.65	.42	**Very high**
5- How to design flipped-classroom	56 74.7%	5 6.7%	10 13.3%	4 5.3%	3.71	.65	**Very high**
6- How to design online learning assignments	73 97.3%	2 2.7%	-	-	4	.01	**Very high**

Table 6: Relative weight, mean and standard deviations for the most important proposed solutions for distance medical education

Solutions	Degree of important				Mean	Std.	Total Degree of important
	Very high	**high**	**Medium**	**Not important**			
1-Improved educator skills.	16 21.3%	50 66.7%	6 8%	3 4%	3.21	.09	Big
2- Incentives and rewards for the time spent developing and delivering online content.	25 33.3%	25 33.3%	25 33.3%	-	4	.00	Very high
3- Improved institutional strategies.	25 33.3%	40 53.3%	7 9.3%	3 4%	3.08	.43	high
4- Support and a positive attitude among all those involved in the creation and distribution of online content.	17 22.7%	48 64%	10 13.3%	-	3.11	.49	high
5- Use Learning Management Systems (LMS) like Blackboard and Zoom.	10 13.3%	45 60%	20 26.7%	-	3.00	.98	high
6- The educator's good e-learning skills.	55 73.3%	20 26.7%	-	-	3.76	.66	**Very high**
7- Instructional design.	12 16%	15 20%	45 60%	3 4%	2.05	.50	Medium
8- Blended learning	15 20%	30 40%	16 21.3%	9 12%	3.22	.29	high
9- Additional training in online technology-based learning pedagogy is utilized to improve teaching and learning.	10 13.3%	46 61.3%	16 21.3%	3 4%	3.17	.73	high
10- Telemedicine video visits	11 14.7%	43 75.3%	18 24%	3 4%	3.13	.33	high

Statement					Mean	SD	Level
11- Students were given remote access to a critical component of the daily routine.	11 14.7%	9 12%	49 65.3%	6 8%	2.22	.20	Medium
12- new medical curriculum structure that allows students to participate with physicians and residents via remote microscopy	16 21.3%	50 66.7%	5 6.7%	4 5.3%	3.29	.56	high
13- Providing equitable access to and participation in novel learning methods is a crucial element of curriculum design.	8 10.7%	52 69.3%	13 17.3%	2 2.7%	3.49	.46	high
14- using coaching and mentoring, regulated conversations on Mobile Apps for updates, and troubleshooting, and e-resources.	7 9.3%	51 68%	9 12%	7 9.3%	3.32	.44	high
15- Provided the opportunity to join an e-course book club.	15 20%	35 46.7%	15 20%	10 13.3%	3.49	.70	high
16- Inviting students to conduct independent research on selected topics available in the digital library.	30 40%	30 40%	10 13.3%	5 6.7%	3.53	.23	Very high
17- Strengthen interprofessional communication.	30 40%	30 40%	15 20%	-	3.50	.01	Very high
18- Use small-group interactive sessions.	25 33.3%	50 66.7%	-	-	3.14	.54	high
19- Advise students to participate in a dimly lit environment to increase their perception of imaging findings.	20 26.7%	30 40%	15 20%	10 13.3%	3.00	.11	high
20- Developed solutions to Internet connectivity issues.	10 13.3%	50 66.7%	10 13.3%	5 6.7%	3.41	.54	high

The aforementioned lessons possess the potential to be implemented in order to strengthen medical education in subsequent periods and bolster readiness for comparable situations. Several important lessons and their possible applications can be identified.

1. The significance of online learning has been underscored by the pandemic, as it has compelled a transition towards digital platforms to ensure the uninterrupted provision of education in times of crisis. The integration of online learning technologies into medical education courses, especially in non-pandemic circumstances, offers the potential for enhanced flexibility and accessibility.

2. The necessity of interactive virtual platforms: It has been observed that conventional lecture-based instructional approaches are comparatively less efficacious when employed in virtual environments. Interactive virtual platforms, such as video conferencing systems equipped with features such as breakout rooms and real-time feedback mechanisms, have demonstrated higher levels of engagement and effectiveness. The application of this lesson entails the integration of interactive components into virtual medical education platforms in order to augment student engagement and active involvement.

3. The significance of educators' flexibility to novel technologies and instructional approaches was underscored by the pandemic. It is imperative for educators to have comprehensive training in order to properly utilize educational technology, hence facilitating smooth transitions between in-person and online teaching modalities. It is imperative for educational institutions to offer professional

development opportunities to instructors in order to augment their proficiency in technology.

4. The study underscored the significance of collaborative learning options, such as virtual group discussions or case-based learning, in fostering student engagement and cultivating critical thinking abilities. It is recommended that institutions integrate collaborative learning opportunities into their online medical education programs in order to facilitate peer-to-peer engagement.

5. The study emphasized the necessity for novel assessment methodologies that may be executed in a remote setting, such as online quizzes or simulations, in order to proficiently evaluate students' knowledge and skills. Educational institutions want to consider investigating alternative assessment methods that align with remote learning environments, all the while ensuring accurate evaluation of students' competencies.

6. Equity considerations: The COVID-19 epidemic has brought to light preexisting inequities in technology access and internet connectivity, which have had a detrimental impact on students' capacity to engage effectively in remote education. In order to mitigate equity issues, institutions should proactively allocate essential resources, such as electronic devices and internet connectivity, to students who may encounter obstacles.

In general, the research highlights the significance of efficiently utilizing educational technology in medical education both at times of crisis and in the long term. Through the application of acquired knowledge, institutions have the potential to improve the caliber, availability, and flexibility of medical education initiatives, all while ensuring readiness for forthcoming epidemics or comparable obstacles

Limitations

There are limitations to studies, and in this case, it was the use of a single data collection technique.

Due to the study's exclusive reliance on meta-analysis, the findings could not be confirmed by other techniques, such as independent measurements. In light of the devastating effects of the COVID-19 pandemic, these findings should be interpreted as an overview of online learning for medical education as a higher education alternative. As a result, the preliminary findings provide a robust framework for debate and discussion and a solid starting point for future in-depth research on the subject. Another significant disadvantage of our research is the tiny sample size.

Conclusions

Medical education is undergoing a paradigm revolution. This transition occurred in the aftermath of the Covid-19 crisis. Digital e-learning is being used by the international community to support the pandemic response in public health. The COVID-19 epidemic won't be the last major infectious illness to put learners at risk. Medical educators can use professional ethics in medicine to help students who will have leadership roles in future pandemic response and professional formation by providing them with strong conceptual tools that can be used as an ethical framework. That college must develop a clear strategy for utilizing institutional resources. Through a media relations relationship, this integration was leveraged to develop instructional videos. The pandemic's urgency has accelerated the development of a slew of new educational programs around the world, the vast majority of which make use of a range of digital tools. Such initiatives must act as a springboard for the future growth of evidence-based medical education.

During the Covid-19 Pandemic shutdown, medical students were reluctant to accept e-learning. According to current studies, instructional technology is on par with, if not better than, traditional learning approaches. These findings may give an incentive for policymakers to support its deployment carefully, notwithstanding the diversity of the studies. Furthermore, the findings indicated barriers to and options for using online learning in medical education among medical educators. The findings can be used to drive institutional and

educator practice in the establishment of new online learning opportunities.

During the COVID19 outbreak, we urge for research into peer mentoring for medical students using a social media platform. More student and teacher training, better-designed e-courses, increased engagement, motivation, and blended learning are all recommended. Governments and education providers must continue to promote educational information construction by providing standardized home-based teaching and learning equipment to teaching staff and students, conducting online teacher training, and funding academic research into online education, particularly education to assist students who have difficulty learning online.

For examination, open-book examinations and closed-book examinations can both contribute to a blended assessment program due to their complementary advantages. Changes enforced by this pandemic offer a vital opportunity to evaluate alternative medical education and assessment modes. Also, we should set up a well-established infrastructure to integrate online teaching correctly based on international experiences.

Strategies for the future include keeping up with the exposure of medical students, expanding access to it, and using remote learning as an extra or substitute educational method. Mobile technologies provide opportunistic learning, a beneficial learning approach that allows for continuing educational benefits during downtime.

The growth of online learning has been faced with new and unexpected obstacles as a result of the COVID-19 outbreak in the field of medical education. Medical schools should be ready to ensure a successful educational environment for medical students as the transition to online education poses significant challenges by emphasizing tech-based pedagogy, advising, motivating, inviting medical students' feedback, and supporting medical educators to adjust to the new reality. A key strategy for maintaining medical education continuity during the COVID-19 pandemic or any future pandemic is the adoption of online learning. More extensive research from throughout the world is needed to fully understand the impact of this historic era on every facet of medical education. Along with all the challenges it presented, this pandemic served as a reminder that one of humanity's strongest defenses against dangers is human collaboration through research. We might be more optimistic about the future of medicine if we used the same collaborative science in education, particularly in medical education.

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Ethical approval

All procedures performed in the study were following the ethical standards of the institutional research committee of scientific Research Dean of Hail University (IRB Log Number: RG-22007) and with the 1964 Helsinki declaration and its later amendments.

Informed consent

The consent was deemed not necessary, anyhow, we obtained it orally from all participants.

Conflict of interest

We have no conflicts of interest to disclose.
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Data availability

The raw data supporting the conclusion of this article will be available upon request to the corresponding author.

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