

Medical Educators' Response to Changes in Medical Education due to COVID-19

I Re Lee^{1,*}, Hanna Jung^{1,*}, Yewon Lee², Hae Won Kim¹, Jae Il Shin³, Shinki An^{1,4}

¹Department of Medical Education, Yonsei University College of Medicine, Seoul; ²Eulji University School of Medicine, Daejeon; ³Department of Pediatrics, Yonsei University College of Medicine; ⁴Yonsei Institute for Global Health, Yonsei University Health System, Seoul, Korea

To analyze medical professors' evaluation of their online education experiences in an attempt to support faculty members and indicate the future direction of medical education. Faculty members who taught online in the first semester of 2020 at Yonsei University College of Medicine in South Korea were surveyed. The results of the survey were analyzed in June 2020. There were 88 respondents (35.1% of 251): 59 professors (67.0%), 16 associate professors (18.2%), and 13 assistant professors (14.8%). Their specialties lay in basic medicine (25.0%), clinical medicine (65.9%), and research and special purposes (9.1%). Sixteen participants (18.2%) had previous experience in online lectures; 23 (26.1%) reported that preparation time for online lectures was the same as before; 65 (73.9%) reported that the preparation time had increased; 38 (43.2%) faced difficulties in preparation and lecturing online, and among them 16 (42.1%) indicated inadequate interaction with students; 11 (28.9%) needed extra preparation time; and 11 (28.9%) attributed their difficulties to technical issues with the online platform. Participants' satisfaction with online lectures was low ($p < 0.001$). In the free response question on overall experience with online education, 38.3% mentioned the need for an instructional design that allows students to actively participate and interact with professors, 29.5% mentioned the need for the establishment of an information & communications technology system, and 17.0% mentioned the necessity of faculty development. To prepare for the current pandemic and more in the long term, an appropriate educational support system must be constructed, and a learner-centered instructional design that enables wider interactions and active learning is needed.

Keywords: COVID-19, Educators, Faculty-student interaction, Online lecture

Corresponding author

Shinki An
Department of Medical Education,
Yonsei University College of Medicine,
50-1 Yonsei-ro, Seodaemun-gu, Seoul
03722, Korea
Tel: +82-2-2228-2525
Fax: +82-2-364-5450
E-mail: anshinki@yuhs.ac
<https://orcid.org/0000-0002-9822-7961>

Jae Il Shin
Department of Pediatrics, Yonsei
University College of Medicine, 50-1
Yonsei-ro, Seodaemun-gu, Seoul
03722, Korea
Tel: +82-2-2228-2073
E-mail: shinji@yuhs.ac
<https://orcid.org/0000-0003-2326-1820>

*These authors contributed equally to this work

Received: September 28, 2021

1st revised: October 15, 2021

Accepted: October 18, 2021

INTRODUCTION

The coronavirus disease 2019 (COVID-19) outbreak adversely affected all social sectors worldwide, including economy, healthcare, and education. Its high infectivity necessitated measures such as social distancing, quarantine, and travel restrictions in every country, bringing almost all face-to-face activities to a standstill. The education system witnessed utter confusion because schools were not prepared to suddenly provide a remote learning environment either at the beginning or in the middle of a semester. Medical education faced greater limitations, as lab work and clinical practice are essential curriculum components. However, with a worsening pandemic and in efforts to somehow continue educational activities, schools began announcing new curriculum guidelines [1,2]. On March 17, 2020 the Association of American Medical Colleges issued guidelines recommending that, for the first time in American history, all

clinical rotations be discontinued. Additionally, many medical schools announced cancellation of in-person classes, small group activities, and clinical practice and converted all preclinical education to online classes [2-4]. The Yonsei University College of Medicine (YUCM) in South Korea, following the guidelines issued by the government and the Yonsei University, began online classes on March 16, 2020 for preclinical students and resumed clinical practice on March 19, 2020, which had been discontinued for 4 weeks because of the pandemic.

The main challenge associated with the newly issued guidelines was the inevitable transition from in-person classes to remote learning based on an online educational platform. Although various teaching methods using information & communications technology (ICT) have already been developed and are considered one of the representative changes of the Fourth Industrial Revolution in education [5-7], the actual integration of ICT-based remote learning into the educational curriculum was

delayed [8–10]. There are several reasons for this delay. Most professors prefer in-person lectures as they do not appreciate the changes to their teaching methods due to the introduction of ICT and consider it burdensome to prepare a new set of online lectures [11]. More fundamentally, many professors feel that ICT-based teaching conflicts with their teaching paradigm: for them, education is defined by face-to-face teaching. Moreover, professors tend to adhere to the conventional way of teaching because the results have been satisfactory. However, the newly issued policies required professors to teach remotely, thus preventing them from lecturing according to their preferences. As ICT-based remote learning became a requirement rather than an option, medical schools and the board had to offer a way for professors to conduct lectures online. However, the available time for a systematic transition into online learning was too short. Additionally, the students, staff, and faculty were all inexperienced in online education. The professors faced considerable difficulties as they had to abandon their lecture styles and quickly adapt to new teaching methods.

In this background, we decided to investigate the experiences of medical school faculty affected by the COVID-19 pandemic. The purpose of this study is to examine the perceptions of faculty who have taught classes by investigating online teaching experiences, satisfaction with online lectures, and intention to use the online education platform in the future. Previously published studies investigated the changes in medical education due to the pandemic from the students' perspective based on their experiences of remote learning [1,2]; Few studies explored the online education experiences of the medical faculty [11,12], but were limited by the number of professors surveyed and the subject they taught online [11]. Others broadened the subjects of their survey to both the professors and the students, highlighting the changes in the environment brought by the COVID-19 pandemic rather than focusing on the perspectives of the medical educators [12]. We believe that this is the first study to explore the changes in the medical educational environment brought by the pandemic from an educator's point of view. In this way, this study serves as an essential resource in seeking novel ways to support faculty members in using ICT-based learning and provide future direction to medical education.

METHODS

1. Study population

This study was conducted at YUCM in South Korea. A total of 300 professors who conducted online lectures at YUCM in the first semester of 2020 (from March to June) for medical students in Years 1-4 were considered eligible for the study. We surveyed professors who conducted online lectures that were a part of the regular curriculum; those who conducted small-scale online lectures in clinical practice courses were excluded. The survey, conducted in June 2020, included a total of 251 faculty members, after excluding outside lecturers.

2. Survey design and implementation

The survey was designed to investigate the experience of the faculty members in terms of the transition to an online curriculum. We developed the survey questions together with relevant faculty in the YUCM and the medical school's Vice-Dean for Education. To collect participants' demographic information, the survey asked for their professorial titles and specialties. The survey included questions about prior online lecturing experience, lecture types, time spent in preparing the lectures, difficulties in lecture preparation and in online lecturing, satisfaction with online lectures, and intention to use the online education platform in the future. Satisfaction with online lectures and difficulties in preparing lectures for online classes and in online lecturing were evaluated using a Likert scale (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree). Finally, open-ended questions were asked reasons for the increase in time, reasons for the difficulties in lecture preparation and the overall online teaching experience. Participants were informed about the survey via email and it was administered online through Google Forms. The survey was administered online through Google Forms. The time required for survey completion was approximately 5 minutes. The purpose of the study was stated on the first page of the survey.

3. Statistical analysis

The general characteristics of the participants were analyzed using descriptive statistics. Continuous variables were presented as mean and standard deviations and compared using the independent t-test or Mann-Whitney U-test. Categorical variables were presented as frequencies and percentages and

compared using the chi-square test or Fisher's exact test, as appropriate. Spearman's correlation analysis was used to study the relationships between lecture preparation hours, difficulties in preparation and lecturing, and satisfaction with online lectures. Data were statistically analyzed using IBM SPSS for Windows ver. 25.0 (IBM Corp., Armonk, NY, USA). P-values less than 0.05 were considered statistically significant. Open-ended responses were coded by two independent authors for thematic contents. Discrepancies in themes were reviewed by authors until a consensus was reached.

4. Ethical considerations

The survey was conducted anonymously to protect the information of the study participants. It was stated clearly both in the email and the survey that the responses would not be used for purposes other than research. Only those who agreed to participate in the study were asked to take the survey. The responses were collected on a Google Forms spreadsheet and stored in an encrypted, portable storage device. The Yonsei University Health System Institutional Review Board (IRB approval no., Y-2020-0082) approved the study.

RESULTS

Of the 251 professors invited to participate, 88 (35.1%) responded: 59 professors (67.0%), 16 associate professors (18.2%), and 13 assistant professors (14.8%) (Table 1). Twenty-two (25.0%) had specialization in basic medicine, 58

Table 1. Information about participants

Characteristic	No. (%)
Professorial titles	
Professor	59 (67.0)
Associate professor	16 (18.2)
Assistant professor	13 (14.8)
Specialty	
Basic sciences	22 (25.0)
Clinical sciences	58 (65.9)
Research and special purposes	8 (9.1)
Prior online lecturing experience	
Yes	16 (18.2)
No	72 (81.9)
Lecture type	
Live lectures only	34 (38.6)
Pre-recorded lectures + live lectures	22 (25.0)
Pre-recorded lectures only	32 (36.4)

Table 2. Participant responses to increase in lesson preparation time

Questions	No. (%)
Did you spend more time preparing online lectures than before?	88 (100.0)
Yes	65 (73.9)
>300%	10 (11.4)
200%–300%	4 (4.5)
100%–200%	15 (17.1)
50%–100%	13 (14.8)
<50%	23 (26.1)
No	23 (26.1)
If yes, what were the reasons? ^{a1}	98 (100.0)
Extra time required for pre-recording lectures	45 (45.9)
Extra time to revise content and format lecture slides	40 (40.8)
Extra time to revise assessments (exams)	8 (8.2)
Extra time using the online platform	5 (5.1)

^{a1}Multiple responses allowed.

Table 3. Participant responses to difficulties in preparing online lectures, satisfaction with online teaching, and future online lecture intention

Questions	No. (%)
Did you find it more difficult preparing online lectures and in lecturing online than before? ^{a1}	88 (100.0)
Yes	38 (43.2)
No	19 (21.6)
No difference	31 (35.2)
If yes, what were the reasons for the difficulties?	38 (100.0)
Lack of interaction with students	16 (42.1)
Time required to pre-record lectures	11 (28.9)
Technical issues using the online latform	11 (28.9)
Were you more satisfied with the online lectures than before? ^{a1}	88 (100.0)
Yes	29 (33.0)
No	27 (30.7)
No difference	32 (36.3)
Do you intend to use the online education platform in the future?	88 (100.0)
Yes	46 (52.3)
No	42 (47.7)

^{a1}Yes (strongly agree, agree), no (strongly disagree, disagree), and no difference (neutral).

(65.9%) in clinical medicine, and 8 (9.1%) in research and special purposes. Sixteen (18.2%) had previous experience in conducting online lectures and 72 (81.8%) had no experience. Regarding lecture type, 34 (38.6%) conducted only live lectures, 32 (36.4%) used only pre-recorded lectures, and 22 (25.0%) used both.

1. Difficulties in preparation of online lectures and in online lecturing

Regarding changes in the time spent on preparing lectures, 23 (26.1%) reported no changes, and 65 (73.9%) reported that their lecture preparation time had increased (Table 2). Among the latter, 10 (11.4%) answered that the preparation time had increased by more than 300%. Reasons for the increase in time included extra time spent on pre-recording lectures (45, 69.2%), revising the content and format of lecture slides (40, 61.5%), revising assessment methods, such as exams (8, 12.3%), and familiarizing oneself with the online program (11, 28.9%).

Out of 88 respondents, 38 (43.2%) reported having experienced difficulties in lecture preparation and in online lecturing. Reasons for the difficulties included lack of interaction with students (16, 42%), extra time required to pre-record lectures (11, 28.9%), and technical issues with the online program (11, 28.9%) (Table 3).

2. Satisfaction with online lectures

A total of 29 participants (33.0%) indicated satisfaction with online lectures and 27 (30.7%) indicated dissatisfaction. In the comparative analysis of satisfaction with online lectures and related factors, there was no statistical significance in terms of lecture hours, lecture preparation hours, specialty, prior experiences in online lecturing, and lecture type. The only statistically significant factor was difficulty in lecture preparation and in online lecturing ($p < 0.001$): with higher scores for lecture preparation and online lecturing, the satisfaction score tended to be lower (Table 4). Spearman’s correlation analysis showed that as lecture preparation time increased, difficulties with the lecture preparation process increased, and as difficulties in the lecture preparation process increased, satisfaction with online lectures decreased (Table 5).

3. Intention to conduct online lectures in the future

Regarding the intention to conduct online lectures in the future, 46 (52.3%) were willing to continue lectures online, and 42 (47.7%) were unwilling to adopt this method in the future (Table 3). In the comparative analysis of the intention to conduct online lectures in the future and the following related factors, no

Table 4. Comparative analysis of satisfaction with online lectures and related factors

Variable	Satisfied (N=29)	Not satisfied (N=27)	p-value
Lecture hours ^{a)}	13.10 ± 20.09	6.07 ± 8.59	0.168
Lecture preparation hours ^{a)}	1.59 ± 1.45	1.89 ± 1.81	0.656
Difficulties in preparation and in online lecturing ^{a)}	2.69 ± 1.00	3.93 ± 0.78	<0.001
Specialty			0.280
Non-clinical	13 (61.9)	8 (38.1)	
Clinical	16 (45.7)	19 (54.3)	
Prior experience in online lecturing			0.532
Yes	8 (61.5)	5 (38.5)	
No	21 (48.8)	22 (51.2)	
Lecture type			0.370
Live lectures only	23 (56.1)	18 (43.9)	
Pre-recorded lectures only	6 (40.0)	9 (60.0)	

Values are presented as mean ± standard deviation or number (%), unless otherwise stated.

^{a)}By Mann-Whitney U-test.

Table 5. Correlation among lecture preparation hours, difficulties in preparation, and satisfaction

Variable	Lecture preparation time	Difficulties in lecture preparation and in online lecturing	Satisfaction
Lecture preparation time	1		
Difficulties in lecture preparation and in online lecturing	0.275 (0.009)	1	
Satisfaction	-0.085 (0.430)	-0.548 (<0.001)	1

Value are presented as coefficient of correlation (p-value).

Table 6. Comparative analysis of participants' intention to conduct online lectures in the future and related factors

Variable	I will (N=46)	I will not (N=42)	p-value
Lecture hours ^{a)}	9.47 ± 11.99	7.57 ± 16.71	0.199
Lecture preparation hours ^{a)}	1.78 ± 1.58	1.86 ± 1.72	0.959
Difficulties in preparation and in lecturing ^{a)}	3.11 ± 0.97	3.45 ± 0.89	0.131
Satisfaction ^{a)}	3.43 ± 0.94	2.55 ± 0.89	<0.001
Specialty			1.000
Non-clinical	16 (44.8)	14 (29.6)	
Clinical	14 (55.2)	28 (70.4)	
Prior experience in online lecturing			0.055
Yes	12 (27.6)	4 (18.5)	
No	34 (72.4)	38 (81.5)	
Lecture type			0.659
Live lectures only	28 (79.3)	28 (66.7)	
Pre-recorded lectures only	18 (20.7)	14 (33.3)	

Values are presented as mean ± standard deviation or number (%), unless otherwise stated.

^{a)}By Mann-Whitney U-test.

Table 7. Participant responses to reasons for intending to use or not use the online education platform in the future

Reasons	No. (%)
I will use an online education platform	46 (100.0)
Expansion of time and space for learning via ICT	16 (34.8)
Flipped learning & rewatching of the lecture	16 (34.8)
Students prefer online lectures	8 (17.4)
Blended learning (online+in-person classes)	6 (13.0)
Improved interaction with and participation of students	4 (8.7)
Current trend in medical education	4 (8.7)
Improved lecture quality	3 (6.5)
No comment	2 (4.3)
I will not use an online education platform	42 (100.0)
Shortage of interactions with students	31 (73.8)
Prefer to in-person lectures	6 (14.3)
Technical issues using the online platform	4 (9.5)
No comment	1 (2.4)

ICT, information & communications technology.

Table 8. Open-ended questions about the overall online education experience (N=81)

Comments by professors	No. (%)
Need to promote students' interaction and participation (instructional design for pre-, in-, post-class activity, student participation monitoring system, feedback system)	31 (38.3)
Need to improve the ICT system for online education (equipment for web-based communication, IT infrastructure, studio, IT-equipped lecturing place, programs, supporting persons, etc.)	26 (32.1)
Need for faculty development for online education	15 (18.5)
Need to roll back to in-person lectures	4 (4.9)
Need more experience in online teaching	4 (4.9)
Need for policies to support online education	1 (1.2)

ICT, information & communications technology; IT, information technology.

statistical significance difference was observed: lecture hours, lecture preparation hours, difficulties in lecture preparation and in online lecturing, specialty, prior experience in online lecturing, and lecture type (Table 6). The only statistically significant factor

was satisfaction with online lectures ($p < 0.001$): when satisfaction was high, more participants expressed their intention to conduct online lectures in the future.

Among the 46 who were willing to continue online lectures

in the future, 16 (34.8%) reported that ICT-based online lectures allow expansion in time and space for learning, 16 (34.8%) reported that recorded online lectures allow students to repeat watching the materials and faculties to apply new teaching methods, and 8 (17.4%) reported that students' preference for online lectures made them want to continue online lecturing (Table 7).

On the other hand, 42 participants who did not want to use online lectures in the future cited the lack of interaction with students as the main reason (31, 73.8%) and either noted that they prefer in-person lectures (6, 14.3%) or that it is difficult to use the program (4, 9.5%).

Considering the responses to open-ended questions about the overall online education experience, 31 (38.3%) mentioned the need for an instructional design to enhance student interaction and participation, 26 (32.1%) mentioned the need to improve the ICT system for online education, and 15 (18.5%) mentioned the need for faculty development for online education (Table 8).

DISCUSSION

The pandemic made medical schools worldwide to switch from in-person to online education within a short period of time [13–15]. Particularly, in South Korea, the outbreak coincided with the beginning of a new school year in March 2020. This posed new challenges for the faculty, students, and staff in beginning a new year with a redesigned curriculum for all grades. The distribution of the specialties (17.1% basic medicine, 70.9% clinical medicine, 12% other) of the faculty members currently enrolled in the YUCM was very similar to that of the professors who responded to the questionnaire (25.0% basic medicine, 65.9% clinical medicine, 9.1% research and special purposes), which proposes that this study used representative samples.

Only 18.2% of the participants had previous online lecture experience. This revealed that, although ICT-based education has been spotlighted, its actual usage by the faculty in their lectures remained low. This suggested that approximately 80% of the faculty must have been challenged by the forced transition to remote learning as they did not have prior experience in online education. Therefore, the responses of those who had no prior online lecturing experience could provide a meaningful assessment for ICT-based education.

Regarding lecture preparation time during COVID-19, more than 70% of professors said that it had increased. This suggested that online lecture preparation takes longer than in-person lectures, which can heighten pressure on lecturers. Participants responded that having to pre-record lectures was the main reason for the increase in preparation time.

It was found that increase in lecture preparation time was also closely related to satisfaction with online lectures. When the lecture preparation time increased, the difficulty in preparing and lecturing increased, and when difficulty increased, the satisfaction level with the lecture decreased. Therefore, to increase the satisfaction of professors with online lectures, support must be provided to reduce the time required to produce pre-recorded lectures. As a specific means to this end, training can be provided in infrastructure utilization and human resources. Additionally, many professors complained of difficulties in using the equipment and the program built into ICT-based education. This result is consistent with those of previous studies, which state the inadequacy of technological facilities as one of the main challenges faced by faculty in the process of developing and implementing online lectures during remote learning [8,9,16–18]. Therefore, to revitalize ICT-based education, faculty development and human resources must be provided for easier and continued use of infrastructure by the professors [19–21].

Professors have been in need of a teaching design that allows active interaction with their students when using an online platform for teaching. In fact, the main difficulty pointed out in conducting online lectures was the inability to read students' reactions. Further, the prime reason for not wanting to continue future online lectures was the insufficient interaction with students. Moreover, the participants indicated that to successfully continue online education, a systematic program that monitors students' participation and development of an instructional design to increase interaction with the students are needed.

At universities, faculty-student interaction is key to the growth and development of students and positively impacts their abilities, including their cognition [22,23]. However, in online classes, two-way communication between the instructor and the students is significantly limited compared with in-person classes. Some previous studies reported that the absence of interaction in the former negatively impacts students' adjustment to college life by making it difficult to ask questions and weakening the sense of belonging within the medical community [2,21]. Therefore, it

is critical that an environment in which the instructor and students can actively interact and provide bidirectional feedback be provided even during remote learning [24]. Professors' real-time feedback during class to the students' responses may encourage more student participation, as the asynchronous communication environment presented immense challenges to the students learning remotely [9]. Therefore, it remains a task for medical schools to ensure smooth faculty-student interactions to guide student participation in online classrooms [25].

The COVID-19 pandemic demanded an online transition that was so abrupt that not enough time could be devoted to designing a curriculum that enabled high student-faculty interaction appropriate for remote learning; lectures online remained passive and were focused on delivering the required information included in the medical curriculum. Therefore, we must explore ways to increase student participation using methods such as flipped learning and team-based learning. Furthermore, there is a need for faculty development so that professors can design these teaching methods and incorporate them in lectures.

Lastly, among professors with high lecture satisfaction, the proportion of those who expressed their intention to conduct online lectures in the future was significantly higher. Therefore, it is necessary to identify factors that can increase lecture satisfaction so that professors voluntarily participate in ICT-based education. Previous studies mentioned that, although initially the professors resisted online remote learning, an attitude of positivity and gradual reception was observed when adequate infrastructure, appropriate program support for instructors, and time to familiarize with the facilities were provided [21]. Therefore, sufficient technology, resources, time, and human resources that meet their needs should be provided to improve their experience with online education.

1. Limitations

This study has some limitations. First, the responses were from faculty members of a single medical school, affecting the generalizability of results. Second, the survey response rate was not high; therefore, the survey results may be biased. Third, to ensure anonymity, some demographic factors were not included. Hence, the responses according to participants' age and gender could not be analyzed. Finally, this study focused on the initial period of the COVID-19 outbreak-related changes in medical education and corresponding responses by the faculty.

Considering that medical schools have been adopting various measures to introduce a more effective online education since the outbreak, many faculty members may have become more familiar with online education, and their perceptions of it may also have changed.

2. Conclusion

Medical schools have devised and adjusted to the alternatives to their original ways of teaching since the COVID-19 outbreak. However, the possibility of interruptions in medical education in the future due to COVID-19 variants as well as new infectious disease outbreaks cannot be ruled out. Therefore, it is critical to build a long-term educational system at the university level to effectively respond to such events. Additionally, a learner-centered instructional design that promotes a wide range of interactions and active learning is required. This should be preceded by faculty development. Further, it is necessary to consider a plan to establish an easily accessible infrastructure for ICT-based education.

AUTHORS' CONTRIBUTIONS

SA and JIS designed the study. IRL and HJ collected the data and IRL, HJ, and SA did the analysis. IRL, HJ, HWK, YL, SA, and JIS wrote the first draft of the manuscript. All authors had full access to all the study data. All authors reviewed, wrote and approved the final version.

REFERENCES

1. 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;21(1):14.
2. Shahrivini B, Baxter SL, Coffey CS, MacDonald BV, Lander L. Pre-clinical remote undergraduate medical education during the COVID-19 pandemic: a survey study. *BMC Med Educ.* 2021;21(1):13.
3. Ferrel MN, Ryan JJ. The impact of COVID-19 on medical education. *Cureus.* 2020;12(3):e7492.
4. Newman NA, Lattouf OM. Coalition for medical education: a call to action: a proposition to adapt clinical medical education to meet the needs of students and other healthcare learners during COVID-19. *J Card Surg.* 2020;35(6):1174-75.
5. Tsekeris C. Surviving and thriving in the Fourth Industrial Revolution: digital skills for education and society. *Homo Virtualis.* 2019;2(1):34-42.
6. Reaves J. 21st-century skills and the Fourth Industrial Revolution: a critical future role for online education. *Int J Innov Online Educ.*

- 2019;3(1):1-21.
7. Van Laar E, Van Deursen AJ, Van Dijk JA, De Haan J. The relation between 21st-century skills and digital skills: a systematic literature review. *Comput Humn Behav.* 2017;72:577-88.
 8. O'Doherty D, Dromey M, Loughheed J, Hannigan A, Last J, McGrath D. Barriers and solutions to online learning in medical education: an integrative review. *BMC Med Educ.* 2018;18(1):130.
 9. Dyrbye L, Cumyn A, Day H, Heflin M. A qualitative study of physicians' experiences with online learning in a masters degree program: benefits, challenges, and proposed solutions. *Med Teach.* 2009;31(2):e40-6.
 10. Bury R, Martin L, Roberts S. Achieving change through mutual development: supported online learning and the evolving roles of health and information professionals. *Health Info Libr J.* 2006;23 Suppl 1:22-31.
 11. Pather N, Blyth P, Chapman JA, Dayal MR, Flack NA, Fogg QA, et al. Forced disruption of anatomy education in Australia and New Zealand: an acute response to the COVID-19 pandemic. *Anat Sci Educ.* 2020;13(3):284-300.
 12. Gupta S, Dabas A, Swarnim S, Mishra D. Medical education during COVID-19 associated lockdown: faculty and students' perspective. *Med J Armed Forces India.* 2021;77(Suppl 1):S79-84.
 13. Consorti F, Kanter SL, Basili S, Ho MJ. A SWOT analysis of Italian medical curricular adaptations to the COVID-19 pandemic: a nationwide survey of medical school leaders. *Med Teach.* 2021;43(5):546-53.
 14. Singh K, Srivastav S, Bhardwaj A, Dixit A, Misra S. Medical education during the COVID-19 pandemic: a single institution experience. *Indian Pediatr.* 2020;57(7):678-9.
 15. Wang C, Xie A, Wang W, Wu H. Association between medical students' prior experiences and perceptions of formal online education developed in response to COVID-19: a cross-sectional study in China. *BMJ Open.* 2020;10(10):e041886.
 16. Vogelsang M, Rockenbauch K, Wrigge H, Heinke W, Hempel G. Medical education for "Generation Z": everything online?!: an analysis of Internet-based media use by teachers in medicine. *GMS J Med Educ.* 2018;35(2):Doc21.
 17. Rajab MH, Gazal AM, Alkattan K. Challenges to online medical education during the COVID-19 pandemic. *Cureus.* 2020;12(7):e8966.
 18. Muflih S, Abuhammad S, Karasneh R, Al-Azzam S, Alzoubi KH, Muflih M. Online education for undergraduate health professional education during the COVID-19 pandemic: attitudes, barriers, and ethical issues. *Res Sq [Preprint].* 2020 Jul 16 [Epub]. <https://doi.org/10.21203/rs.3.rs-42336/v1>.
 19. O'Doherty D, Loughheed J, Hannigan A, Last J, Dromey M, O'Tuathaigh C, et al. Internet skills of medical faculty and students: is there a difference? *BMC Med Educ.* 2019;19(1):39.
 20. Childs S, Blenkinsopp E, Hall A, Walton G. Effective e-learning for health professionals and students: barriers and their solutions: a systematic review of the literature: findings from the HeXL project. *Health Info Libr J.* 2005;22 Suppl 2:20-32.
 21. Hayat AA, Keshavarzi MH, Zare S, Bazrafcan L, Rezaee R, Faghihi SA, et al. Challenges and opportunities from the COVID-19 pandemic in medical education: a qualitative study. *BMC Med Educ.* 2021;21(1):247.
 22. Astin AW. *What matters in college?: four critical years revisited.* San Francisco (CA): Jossey-Bass; 1993.
 23. Pascarella ET, Terenzini PT. *How college affects students: a third decade of research.* San Francisco (CA): Jossey-Bass; 2005.
 24. Wong G, Greenhalgh T, Pawson R. *Internet-based medical education: a realist review of what works, for whom and in what circumstances.* *BMC Med Educ.* 2010;10:12.
 25. Lucas G, Cao G, Waltemeyer S, Mandernach BJ, Hammond HG. The value of instructor interactivity in the online classroom. *J Empower Teach Excell.* 2021;5(1):3.