Canadian Medical Education Journal

Reviews, Theoretical Papers, and Meta-Analyses

Zoomification of medical education: can the rapid online educational responses to COVID-19 prepare us for another educational disruption? A scoping review

La zoomification de l'enseignement médical : les solutions virtuelles précipitées lors de la COVID-19 peuvent-elles nous préparer pour une prochaine perturbation dans l'enseignement? La zoomification de l'enseignement médical : les solutions virtuelles précipitées lors de la COVID-19 peuvent-elles nous préparer pour une prochaine perturbation dans l'enseignement? Revue exploratoire.

David Rojas,[1] Jayul Tailor,[2] Karine Fournier,[3] Jeffrey JH Cheung,[4] Cristian Rangel[3]

[1]Temerty Faculty of Medicine, University of Toronto, Ontario, Canada; [2]University of Medicine and Health Science, St Kitts and Nevis; [3]University of Ottawa, Ontario, Canada [4]University of Illinois at Chicago, Illinois, USA

Correspondence to: David Rojas; email: david.rojasgualdron@gmail.com

Edited by: Doug Archibald (senior section editor); Marcel D'Eon (editor-in-chief)

Published ahead of issue: May 8, 2023; published: Nov 8, 2023; CMEJ 2023, 14(5) Available at https://doi.org/10.36834/cmej.74697

Abstract

Introduction: In response to the COVID-19 pandemic, educators have increasingly shifted delivery of medical education to online/distance learning. Given the rapid and heterogeneous nature of adaptations; it is unclear what interventions have been developed, which strategies and technologies have been leveraged, or, more importantly, the rationales given for designs. Capturing the content and skills that were shifted to online, the type of platforms used for the adaptations, as well as the pedagogies, theories, or conceptual frameworks used to inform the adapted educational deliveries can bolster continued improvement and sustainability of distance/online education while preparing medical education for future large-scale disruptions.

Methods: We conducted a scoping review to map the rapid medical educational interventions that have been adapted or transitioned to online between December 2019 and August 2020. We searched MEDLINE, EMBASE, Education Source, CINAHL, and Web of Science for articles pertaining to COVID-19, online (distance) learning, and education for medical students, residents, and staff. We included primary research articles and reports describing adaptations of previous educational content to online learning.

Results: From an initial 980 articles, we identified 208 studies for full-text screening and 100 articles for data extraction. The majority of the reported scholarship came from Western Countries and was published in clinical science journals. Cognitive content was the main type of content adapted (over psychomotor, or affective). More than half of the articles used a video-conferencing software as the platform to pivot their educational intervention into virtual. Unfortunately, most of the reported work did not disclose their rationale for choosing a platform. Of those that did, the majority chose technological solutions based on availability within their institutions. Similarly, most of the articles did not report the use of any pedagogy, theory, or framework to inform the educational adaptations.

Résumé

Introduction : En réponse à la pandémie de la COVID-19, l'enseignement médical a été progressivement déplacé vers l'espace virtuel. Compte tenu de la rapidité et de l'hétérogénéité des adaptations opérées, nous n'avons qu'une idée peu précise des activités éducatives élaborées, des stratégies et des technologies mobilisées et, plus important encore, des raisons avancées pour les motiver. Une meilleure connaissance du contenu et des compétences dont l'enseignement a été transféré en ligne, du type de plateformes utilisées pour le virage, ainsi que des pédagogies, des théories ou des cadres conceptuels utilisés pour guider les activités éducatives adaptées soutiendrait une amélioration continue et la pérennité de l'enseignement à distance, tout en préparant la formation médicale à de futures perturbations d'envergure.

Méthodes : Nous avons effectué une revue exploratoire pour recenser les activités éducatives en médecine qui ont été expéditivement adaptées ou transposées en ligne entre décembre 2019 et août 2020. Nous avons interrogé les bases de données MEDLINE, EMBASE, Education Source, CINAHL et Web of Science à la recherche d'articles portant sur la COVID-19, sur l'apprentissage en ligne (à distance) et sur la formation des étudiants en médecine, des résidents et du personnel enseignant. Nous avons inclus des articles de recherche originale et d'autres décrivant l'adaptation de contenus éducatifs à l'apprentissage en ligne.

Résultats : Des 980 articles trouvés, nous avons sélectionné 208 études pour un examen du texte intégral et 100 articles pour une extraction de données. La plupart des travaux provenaient de pays occidentaux et ont été publiés dans des revues médicales. Le type de contenu adapté était principalement cognitif, dans une moindre mesure psychomoteur ou affectif. Plus de la moitié des articles présentaient un logiciel de visioconférence comme plateforme utilisée pour transposer des activités éducatives en mode virtuel. Malheureusement, la plupart des études ne précisaient pas les raisons justifiant le choix de plateforme. Celles qui l'ont fait indiquaient majoritairement que les solutions technologiques avaient été choisies en fonction de leur disponibilité au sein de l'établissement. De la même manière, seulement une poignée d'articles font état de l'utilisation d'une pédagogie, d'une théorie ou d'un cadre pour guider les adaptations pédagogiques.

Introduction

As is well-known, the COVID-19 pandemic became a disruptive event that has impacted all areas of social life. The impact of this pandemic on education at large, and particularly on medical education, cannot be under-estimated. As recent scholarship has shown, most educational institutions pivoted their educational deliveries from classroom-based learning to virtual spaces, including replacing clinical placement based learning with alternate remote, asynchronous approaches.[1] By some accounts, 94% of student population was affected.[2] Certain mandated non-pharmaceutical interventions (NPI) to curb the spread of the virus (e.g., social distancing), changed the delivery of educational content and skill acquisition at all levels of medical training; making rapid distance models of education via digital platforms compulsory to address these challenges.[3-5]

In the face of widespread global COVID-19 morbidity and mortality, educationalists in the medical education continuum, were forced to re-design, develop, adapt and implement new educational interventions via online models.[2] Although in most cases these interventions were primarily online, some of them followed hybrid models of learning.[6-7] The use of hybrid models of education, such as flipped classrooms, or the use of digital technologies in medical education and residency are not new, having well-established best practices for content development and delivery.[8] However, the speed, scope and depth of changes prompted by the COVID-19 crisis was unparalleled. Consequently, educators and educational institutions had to rapidly pivot their content and delivery formats, including examinations, and evaluations to these new and adapted interventions.[9]

This scoping review aims to map the extent of rapid educational adaptations to on-line learning formats in medical education as a response to the first wave (March 2020 -September 2020) of NPI's public health policies for the COVID-19 pandemic. We focus on this particular moment in time as the reporting of these adaptations during the first months of the crisis likely informed the scholarship available for educators for further adaptations of educational programs from September 2020 onwards. We focused on rapid educational adaptations as we wanted to share the type of evidence available to pivot educational deliveries, should it be needed after the pandemic. Through this scoping review, we also aim to identify the theoretical frameworks and concepts that informed the selection of content and skills in these rapid educational adaptations, considering the ongoing epidemiological uncertainties of COVID-19 variants, and an emergent global awareness of the disruptive potential of infectious diseases, which may lead to new waves of educational and economic disruptions.

Responses to these types of crises may fuel further normalization of hybrid models of education with a high degree of technology-based delivery and interactions amongst educators, students, and institutions. As such, this scoping review presents the evidence available for the rapid adaptation to online educational interventions, which could help guide medical education for future technological and social disruptions.

Methods

This study followed the six-stage model for scoping reviews proposed by Arksey and O'Malley:[10] (i) Identifying research questions, (ii) Identifying relevant studies, (iii) Study selection, (iv) Charting the data, (v) Collating, summarizing, and reporting results, and (vi) consultation exercise (optional). The research team was interested in doing a final consultation with stakeholders in charge of the rapid pivot process of educational interventions. However, we decided not to engage in stage VI of Arksey and O'Malley's framework because of the time constraints and time limitations associated with delivering educational offerings in the middle of a global pandemic. Our consultation would have put more pressure on an already strained population.

The methodology was further guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis protocols extension for Scoping Reviews (PRISMA-ScR) framework.[11] The overall aim of this study was to map the rapid educational interventions that were adapted for, and/or transitioned to, online education during the first wave of the COVID-19 pandemic.

Identifying the research questions

The research questions guiding this study were: 1) What are the characteristics of the preliminary online adaptations of medical education in response to COVID-19? 2) What are the characteristics of the delivery format used (e.g., podcast, lectures, video conferencing, synchronous or asynchronous)? 3) What educational pedagogies, theories, or conceptual frameworks (adapted or not adapted) informed the approach used in the adaptations?

Identifying relevant studies

The literature search was performed by an information specialist (KF) in August 2020 across five databases: Medline MEDLINE(R) ALL (OvidSP), Embase (OvidSP), CINAHL (EBSCOHost), Education Source (EBSCOHost), and Web of Science. Studies were identified using a combination of each of the databases' unique subject headings and keywords, when applicable. Main concepts searched were "e-learning", "medical education" and "COVID-19," but multiple variations of these concepts were used in the search strategy, see Appendix A for the Medline search strategy. To be included in the results, articles must have been published in English or Spanish in a peer-reviewed journal between December 2019 and August 2020. This timeframe was used to capture articles pertaining broadly to the "First Wave" of the COVID-19 pandemic, acknowledging that the exact timing, epidemiological progression, and societal response to the pandemic varied significantly across global and regional geography. We focused on articles from the "first wave" as this was the evidence available for educators to design their educational deliveries from September 2020 onwards. A total of 884 articles were identified and exported into Covidence software (Veritas Health Innovation Ltd.) for management and screening by the study team.

Relevant studies were identified through a two-stage process of title and abstract screening, followed by the full-text review of articles. Overall inclusion criteria were framed by (i) Population, (ii) Concept, (iii) Context and (iv) Evidence Source. (i) Population: Studies referring to education for medical students, residents, or medical school faculty, (ii) Concept: Educational adaptations described must have involved online, distance, or web-based learning, (iii) Context: Interventions or prescriptions must have described adaptations of pre-existing educational content only, and (iv) Evidence Sources: original research articles, including innovation papers, that described specific online adaptations of an educational intervention due to COVID-19 were included.

Study selection

After the removal of duplicate references, 827 articles were identified for title and abstract screening (completed by CR and JC). We followed a team-screening process. Inclusion discrepancies among the two initial reviewers were resolved by consensus and, where necessary, the addition of a third reviewer (DR). In the second stage of review, 230 full-text articles were divided among four reviewers (CR, JC, DR, and JT). Each full-text article was screened by two reviewers and any inclusion discrepancies were resolved by consensus among the full team. During full-text review, commentary articles, systematic review articles, and articles that referred only to clinical practice implications were excluded from the final sample. See Figure 1 for a diagram of the study flow.

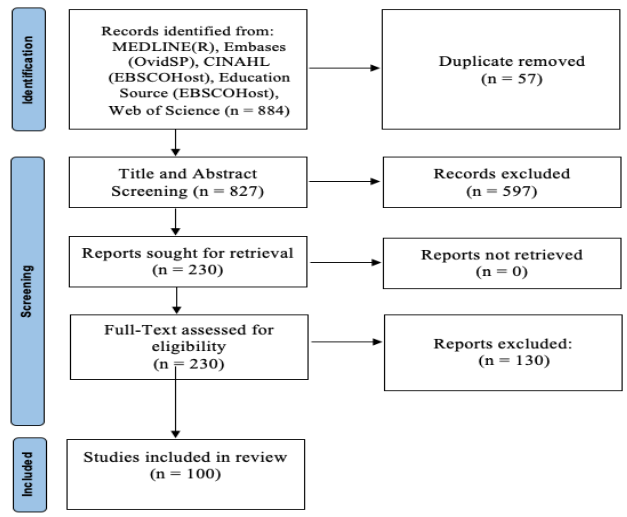

Figure 1. Diagram of study flow through different phases of the review

Charting the data

Data charting was completed using a Google Sheets template to allow for collaboration between team members. The data charting form was created by initially identifying variables that would help address our research questions. Specifically, we focused on the characteristics of the online adaptations such as type of journal in which it was published (e.g., medical education, or clinical journal), area of medicine for the adaptation (e.g., basic science or clinical science), and type of content that was adapted (e.g., cognitive, new knowledge and understanding; psychomotor, technical skills; or affective content, keeping students connected during NPI implementation). Furthermore, we captured the format used to deliver the educational adaptations (Podcast, Videos, Video conference platform), and whether it was reported that any educational pedagogy or framework informed the adaptation to online deliveries (i.e., instructional design). Following practices used in previous scoping review protocols,[12,13] we also collected publication year, geographical location where the research was produced, type of population addressed (e.g., Medical Student, Resident, Fellows), although these variables did not directly align with the research questions.

Each of the articles was dual extracted in successive passes. First data extraction pass was completed by one reviewer (JT) assessing each full-text article for key variables of interest outlined before. Once completed, a second reviewer (JC) did the same process with all articles. Any contradictions or incongruencies in the extracted data were resolved by a third reviewer (DR or CR).

As an iterative process, while charting the data, the team identified the opportunity to capture the rationale for choice of online learning platform(s). We were interested in highlighting whether the decisions were made based on convenience of having access, the platform usability, or any other potential variable. We brought in a new RA whose focus was to go through all the articles extracting this variable. The new RA was trained by a member of the research team (JT) whose supported a dual extraction process for 20% of the articles. The new RA extracted the "rationale of choice" from the remaining articles.

Last, we did not conduct a critical appraisal of the identified articles, as our goal was to identify the types of evidence available, and how educational adaptations were being conducted in Medicine.

Collating, summarizing, and reporting the results

Through the data charting, the research team also defined the list of values for each of the variables extracted. To do so, a member of the research team (JT) had the first pass through the data suggesting potential values for each variable. JC, CR, and DR (who are formally trained health professions education scientists) confirmed or suggested refinements based on the research questions, or the language more relevant within the medical education field. Additional key values were collapsed into general categories for simplified analysis by MI and JT, including article place of origin grouped by continent, and area of medicine for adaptation (Clinical) grouped into 'Surgical' and 'Non-Surgical' specialties. Charted data was exported into Microsoft Excel for descriptive analysis of the final sample, including frequencies, percentages, and cross-tabulations.

Results

The full-text review stage yielded a final sample of 100 articles for data extraction, charting and analysis. See Appendix C for all articles extracted in the final analysis.

Geographical participation

Our sampled articles show that most of the reported scholarship came from Western countries. Data shows that most articles during the first wave of the pandemic was dominated by North American authors with 62%, followed by Asian and European authors with 18% and 13% respectively. The remaining 7% was represented by authors located in Australia and New Zealand, Africa, and Latin America (see Appendix B, Table D-1).

Distribution of content in Clinical Journals vis-à-vis Med Ed Journals

Our sample of selected articles reveals that the majority (60%) of educational adaptations during the first wave of the COVID-19 pandemic were reported in clinical journals, while 39% were reported in medical education journals (see Appendix B, Table D-2).

Interventions: area of medicine addressed in the adaptation.

We report the *area of medicine addressed in the adaption* in two levels. The first level (higher) was whether the educational intervention aimed to deliver ***basic science content, or clinical science.*** Our data shows that 78% of our sample was focused on clinical sciences while only 14% of the sample targeted basic sciences (see Appendix B, Table D-3).

The second level of analysis was focused on the clinical science articles only, which were further categorized as surgical and non-surgical using definitions from the American College of Surgeons.[a,14] In our sample, only 30.8% of the articles belonged to surgical specialties, while 69.2% referred to non-surgical specialties (see Appendix B).

Population targeted

From the articles reviewed, the majority of the articles referred to interventions tailored for residents (39%). Furthermore, 38% of the articles referred to work oriented towards medical students, while 10% of the articles reviewed referred to interventions for faculty, and a similar proportion for fellows (13%) (see Appendix B, Table D-4).

[a]Fourteen specialties are considered surgical: cardiothoracic surgery, colon and rectal surgery, general surgery, gynecology and obstetrics, gynecologic oncology, neurological surgery, ophthalmic surgery, oral and maxillofacial surgery, orthopaedic surgery, otorhinolaryngology, pediatric surgery, plastic and maxillofacial surgery, urology, and vascular surgery.

Cross tabulation “Area of Medicine addressed in the adaptation” with “population targeted”

Cross tabulating the data of “*area of medicine addressed in the adaptation*” by “*population targeted”* (type of learner/trainee addressed), we noticed that for medical students, 34.1% of the reported work was not specific to surgical or non-surgical specialties. Analyzing *residents* and *medical students* together, the majority of the reported work referred to non-surgical specialties.

For faculty, although the number of articles referring to this population was small (n = 10), over half of the reported work was not specific to surgical or non-surgical specialties. Regarding fellows, the number of articles is also small (n = 15), and the majority of the work was non-surgical (66.7%).

What type of content was adapted online?

We analyzed our sample to determine the type of content that was addressed on the reported interventions.

In our sample, the majority of the reports were solely on cognitive areas (n = 84); whereas only five articles focused on affective content, and 8 on psychomotor skills (see Table 1).

Table 1. Sample content (i.e., cognitive, psychomotor, affective) distribution

Content	% of articles	# of articles
Cognitive	84%	84
Psychomotor	1%	1
Affective	1%	1
Unspecific	3%	3
Cognitive + Psychomotor	7%	7
Cognitive + Affective	4%	4
Psychomotor + Affection	0%	0

Digital platforms used as a delivery format

We analyzed what type of platforms were used to deliver educational experiences during the period of March to September 2020. Our data shows that 52% of the articles used Zoom, Microsoft Teams, or WebEx divided as follow: Webex (10 %), Zoom (86 %), Others (4%). There were a 16% of the articles that reported using the university supported Learning Management System, and a 12% that used a combination of the previously mentioned online platforms and social medical services such as WhatsApp, Facebook groups, Twitter, or Face Time. There was a 5% of the articles that used clinical APPs (Jabber App, Haiku, Canto, Doxymity, Telemedicine), while 4% used social networking platforms (YouTube, WhatsApp, Google Hangout) (see Table 2: Platform category, for further details).

Rationale of the platform selection

As part of the data charting process, the research team decided to extract whether the article reported their rationale for choosing a platform, and what type of rationale was offered. From our sample, 52% of the articles did not provide any rationale for the online platform chosen, making the lack of rationale the most common occurrence in the literature.

From those who reported a rationale, 15% of the articles reported functionality as the rationale:

> *Real-time display of presentation slides, ease of internet connectivity, ease of use on lap-tops and mobile phones, as well as the ability to record for subsequent playback.*[15]

Another 15% reported choosing the platform because it was approved by their institution and met the security requirements:

> *Easy interface, accessible outlets, collaborative platform, and its integrated, secure cloud systems used by our health care system.*[16]

Another 4% of articles reported choosing a platform based on public health regulations, that is, ‘social/physical distancing’ requirements. The remaining portion of the sample (7%) referred to popularity, or mixed rationales:

> *Work within what was available to us and our students.*[17]
>
> *Available to all at no cost, and easily found in the application list for Gmail users.*[18]

Table 2. Platform category

Platform category	% of articles	# of articles
Institutional/Clinical - Clinical/Virtual Care App (Jabber App, Haiku, Canto, WebEx, BlueJeans, Doxymity, Telemedicine)	5%	5
Institutional/Clinical - Course Management (Google Classroom, Virtual learning Environment, Canvas)	3%	3
Institutional/Clinical – Mixed	6%	6
Institutional/Clinical - Video Conference (Microsoft Team, WebEx, Google Form, Zoom)	52%	52
Institutional/Clinical – unspecified (University Website, Web-based technologies, Virtual Platform)	16%	16
Public – Other (Podcast)	2%	2

Public - Social Networking (YouTube, WhatsApp, Google Hangout)	4%	4
Mixed - Institutional & Public (Zoom/FaceTime, Facebook Group/Video Lecture, Zoom/Twitter/Google Sheet, Zoom/WhatsApp, Microsoft Team/Phone Call)	12%	12

Table 3. Rationale for platform use

Rationale for use	% of articles	# of articles
Mixed Rationale	7%	7
Approved/Compliant/Existing	15%	15
Availability/Popularity	5%	5
Public Health Reg/Maintain Education	4%	4
Unspecified	52%	52
Platform Functionality	15%	15
New Technology/Novel Platform Created	2%	2

Informing educational pedagogy/theory/framework for the adaptation: instructional design

The data shows that most of our sample did not outline or provide information regarding the instructional design model used to inform the interventions/adaptation (Table 3). From the articles that did provide a rationale, flipped classroom was the most common educational approach used (10%) (see Appendix B for descriptions, and Table 4 for the distribution of each design).

Table 4. Informing educational pedagogy/theory/framework for the adaptation: instructional Design

Instructional Design	% of articles	# of articles
Unspecified	74%	74
Blended learning theory	1%	1
Cognitive apprenticeship Model	2%	2
Social learning	1%	1
Blended Sync & A-sync model	1%	1
Peer-to-Peer Learning	2%	2
Constructivist Framework	1%	1
Kotter's change management model	1%	1
Government Provided Platform	1%	1
Flipped Classroom Model	10%	10

Discussion

Our results showed that most of the evidence available was developed in Western Countries. However, due to our inclusion criteria around language (only including articles in English and Spanish), these results were somewhat expected. We also captured the type of journal where the evidence was published, showing that the vast majority was reported in clinical science journals (instead of Medical Education journals). This finding is noteworthy as the style of reporting varies drastically between those two spaces. This variation made it difficult to identify and categorize basic and essential descriptors for a scoping review exercise, such as targeted populations, types, and content of interventions and planforms used to deliver the interventions in a systematic manner. Medical education journals provided a structure that facilitated rapid reporting of interventions in a legible manner, but even then, reporting was often incomplete. Because of the lack of specification, the information available in the selected articles was insufficient to categorize all the data captured across our search strategy. Our results also show that from those articles in a clinical science journal only 31% were from surgical specialities, which suggests that there might be some limitation(s) in adapting clinical educational deliveries to online learning.

Not surprisingly, we also noticed that most of the targeted population in the educational adaptations where medical students and residents (77%). These populations were completing a structured curriculum that needed to be adapted due to the NPIs, therefore, the context was adequate for doing scholarly work around the adaptation.

Interestingly, when cross-tabulating the data between "Area of Medicine for adaptation" and "Population targeted," results showed that the majority of the articles had focused on non-surgical specialties for residents and medical students, further reinforcing the existence of potential limitation(s) to pivot surgical-clinical educational deliveries.

Regarding the type of content that was adapted, our results show that the majority of the work focused on cognitive areas. This is worth highlighting as the heavy focus on clinical sciences found in our sample could have suggested a more even distribution among cognitive, psychomotor, and affective content. However, given the intrinsic limitations of online learning, it was somewhat expected that the majority of our sample would address cognitive content.

The analysis of the type of platforms being used showed that majority of the articles disclosed using a video-conference platform for the adaptation. Interestingly we also noticed that articles reported having used a combination between the institutionally supported platforms and social medica services, which triggered the question to determine if there was any rationale provided for the choice of platform used to adapt their educational deliveries. Unfortunately, our data shows that the majority of the articles reviewed did not provide any rationale for having chosen a platform to use, which limits the opportunities for other researchers in the field to replicate this work.

The last layer of analysis was to determine what kind of educational pedagogy/theory/framework were used to inform the online adaptations. Similarly, to the rationale for platform selection, the majority of the articles reviewed did not report having informed their adaptation work via any educational pedagogy theory of framework. However, it is important to highlight that for the remaining articles providing a rationale, we encountered a variety of educational models and frameworks suggesting that there is no one-size-fits-all solution when it comes to designing, selecting, and implementing educational adaptations in a time of crisis. The educational models and frameworks chosen were tailored to the content that was intended to be delivered and the targeted population.

What is concerning from these results is the lack of information reported in the COVID-19-related work, which does not align with best practices for reporting educational work. This threatens the reproducibility of these interventions, which in these scenarios should have been the main priority. As educational and hospital institutions are looking for guidance on how to prepare themselves for future academic year, the reported work offered little details to facilitate reproduction.

Limitations

The main limitation of this work was the time in which the review was being conducted. The research team did not anticipate the multiple subsequent COVID waves, which limited the opportunity to complete this work at a much earlier time. We also acknowledge that the multiple pandemic associated responsibilities might have prevented educators and researchers from publishing their educational adaptations. The data presented here might present only a portion of the work that was done. Last, we realized that rapid educational adaptations might need a different guiding framework around how to report them. The lack of a standardized framework for reporting rapid adaptations created some challenges when defining the values that each of the extracted variables could take.

Conclusion

Our data revealed that there were several limitations in the reporting across all interventions captured by our methodological strategy. As shown here, essential information, such as the specific characteristics of populations targeted by the interventions, their total numbers, adjustments to the content of specific areas - cognitive, skills or affective content, and the evaluation of learning outcomes were under-reported, and at times fully absent from the reports. Equally concerning was the absence of clearly identifiable concepts and theoretical frameworks to ground the interventions in terms of content and format of delivery. While most of the reports contained explanation regarding the rationale for selecting digital platforms and other tools, the explanations were mostly focused on the features of the tools (e.g., interactive features, video-conferencing capabilities). In other words, they failed to provide the necessary grounding of the theoretical underpinnings between education and digital technologies.[17,18] It is possible that providing the list of features of the technological tools utilized to deliver education was perceived to suffice as an explanation for the decisions made to design the educational adaptations. However, without careful consideration of the effects that the format of delivery has on the curricular design and content of the educational interventions, the listing of the technological features is insufficient to allow others to replicate this work. Authors must report their conceptual apparatus, their conceptual and methodological assumptions and the basic information that describes educational interventions. Only then, we can build robust educational models that build on the pragmatic content that busy clinical educators and other develop at time.

It is for this reason that we suggest that journals in the field develop clear guidelines for reporting rapid pragmatic interventions where explicit questions help the authors identify: 1) theoretical bodies informing their applied work; 2) the rationales that inform their methodological choices; 3) clear details on the curricular design in terms of content, the format of delivery and the epistemological connections between the former and the latter; and 4) details for reproducibility utilizing PICO or other reporting frameworks. Of course, the poor reporting that took place during the timeline analyzed here was caused by the need to socialize ideas rapidly in a fast-evolving crisis – more than the need to advance complex and replicable interventions. Having said that, there were a handful of completed reports published in high-ranking medical education journals. It appears that, in these cases, the journals produced a reporting framework with guided sections for authors that may have facilitated the identification of some elements of PICO (Population, Intervention, Comparison and Outcomes) in the interventions reported.

Nowadays, when selecting a technological solution to deliver educational experiences, educators are presented with balancing a compromise between availability and engagement. In the past, there was a lack of availability of technological solutions due to the schedule nature of the educational opportunities. Currently, there is wide access to technologically supported educational material, however the trade-off is on how to best engage and captivate the audience, which tends to replicate the old-trades of theatre-based teaching. Thus, it is as important as it was before to comprehensively report the decision-making process that drives educational interventions. Only this way will we be able to identify best practices in this new modality.

Conflicts of Interest: There are no conflict of interest to report. None of the authors has any financial link to any of the educational platforms used for online learning.

Funding: There was no funding associated with this project. The work was conducted during the research protected time of the authors of this paper.

Acknowledgements: We want to acknowledge Dr. Robert Paul for his financial contribution to this project in the form of RA capacity, and Mitch Irving (the RA) for his diligent work on this project.

References

1. Gordon M, Patricio M, Horne L, et al. Developments in medical education in response to the COVID-19 pandemic: a rapid BEME systematic review: BEME Guide No. 63. *Med teach*. 2020 Nov 1;42(11):1202-15. https://doi.org/10.1080/0142159X.2020.1807484
2. United Nations. *Policy brief: education during COVID-19 and beyond.* New York: United Nations; 2020 Aug. Available from: https://www.un.org/development/desa/dspd/wp-content/uploads/sites/22/2020/08/sg_policy_brief_covid-19_and_education_august_2020.pdf [Accessed on Jun 15, 2021].
3. Byrnes KG, Kiely PA, Dunne CP, McDermott KW, Coffey JC. Communication, collaboration and contagion: “virtualisation” of anatomy during COVID-19*.* *Clin Anat*. 2021 Jan;34(1):82-9. https://doi.org/10.1002/ca.23649
4. Figueroa F, Figueroa D, Calvo-Mena R, Narvaez F, Medina N, Prieto J. Orthopedic surgery residents’ perception of online education in their programs during the COVID-19 pandemic: should it be maintained after the crisis*?. Acta Orthop*. 2020 Sep 2;91(5):543-6. https://doi.org/10.1080/17453674.2020.1776461
5. Gupta MP, Sridhar J, Wykoff CC, Yonekawa Y. Ophthalmology conferences in the coronavirus disease 2019 era. *Curr Opin Ophthalmol*. 2020 Sep 1;31(5):396-402. https://doi.org/10.1097/ICU.0000000000000688
6. Schwarzkopf R, Maher NA, Slover JD, Strauss EJ, Bosco JA, Zuckerman JD. The response of an orthopedic department and specialty hospital at the epicenter of a pandemic: the NYU Langone health experience. *J arthroplasty*. 2020 Jul 1;35(7):S3-5. https://doi.org/10.1016/j.arth.2020.04.041
7. Shahrvini BB, Coffey CS, MacDonald BB, Lander SL. Pre-clinical remote undergraduate medical education during the COVID-19 pandemic: a survey study. *Res Squ.* 2020 Jun 10:rs-3. https://doi.org/10.21203/rs.3.rs-33870/v1
8. Srinivasan DK. Medical students' perceptions and an anatomy teacher's personal experience using an e-learning platform for tutorials during the COVID-19 crisis*. Anat Sci Educ*. 2020 May;13(3):318-9. https://doi.org/10.1002/ase.1970
9. James HK, Pattison GT. Disruption to surgical training during Covid-19 in the United States, United Kingdom, Canada, and Australasia: a rapid review of impact and mitigation efforts*. J Surg Educ*. 2021 Jan 1;78(1):308-14. https://doi.org/10.1016/j.jsurg.2020.06.020
10. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Metho*. 2005 Feb 1;8(1):19-32. https://doi.org/10.1080/1364557032000119616
11. Tricco AC, Lillie E, Zarin W, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation*. Ann Intern Med. 2018* Oct 2;169(7):467-73. https://doi.org/10.7326/M18-0850
12. Halas G, Schultz AS, Rothney J, et al. A scoping review protocol to map the research foci trends in tobacco control over the last decade. *BMJ Open* 2015;5:e006643 https://doi.org/10.1136/bmjopen-2014-006643.
13. Kastner M, Tricco AC, Soobiah C, et al. What is the most appropriate knowledge synthesis method to conduct a review? Protocol for a scoping review. *BMC Med Res Methodol* 2012;12:114 10.1186/1471-2288-12-114
14. American College of Surgeons. *What are the surgical specialties?* American College of Surgeons. 2021. Available from: https://www.facs.org/education/resources/medical-students/faq/specialties [Accessed Nov 9, 2020].
15. Lee JS, Chan JJ, Ithnin F, Goy RW, Sng BL. Resilience of the restructured obstetric anaesthesia training programme during the COVID-19 outbreak in Singapore*. Int J Obstet Anesth*. 2020 Aug;43:89. https://doi.org/10.1016/j.ijoa.2020.04.002
16. 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):2635-8. https://doi.org/10.1016/j.jacc.2020.04.015
17. Guerandel A, McCarthy N, McCarthy J, Mulligan D, Lane A, Malone K. An approach to teaching psychiatry to medical students in the time of Covid-19. *Ir J Psychol Med*. 2021 Dec;38(4):293-9. https://doi.org/10.1017/ipm.2020.87
18. Moszkowicz D, Duboc H, Dubertret C, Roux D, Bretagnol F. Daily medical education for confined students during coronavirus disease 2019 pandemic: a simple videoconference solution. *Clin Anat*. 2020 Sep;33(6):927-8. https://doi.org/10.1002/ca.23601

Appendix A. MEDLINE Search strategy

Search performed originally June 22, 2020 and updated August 31st, 2020

MEDLINE(R) ALL (Ovid, 1946 to June 16, 2020)

1. coronavirus/ or betacoronavirus/ or coronavirus infections/
2. (nCoV* or 2019nCoV or 19nCoV or COVID19* or COVID-19* or COVID or SARS-COV-2 or SARSCOV-2 or SARSCOV2 or Severe Acute Respiratory Syndrome Coronavirus 2 or Severe Acute Respiratory Syndrome Corona Virus 2).ti,ab,kf,nm,ot,ox,rx,px.
3. ((new or novel or "19" or "2019" or Wuhan or Hubei or China or Chinese) adj3 (coronavirus* or corona virus* or betacoronavirus* or CoV or HCoV)).ti,ab,kf,ot.
4. ((coronavirus* or corona virus* or betacoronavirus*) adj3 (pandemic* or epidemic* or outbreak* or crisis*)).ti,ab,kf,ot.
5. ((Wuhan or Hubei) adj5 pneumonia).ti,ab,kf,ot.
6. or/1-5
7. exp Education, Medical/
8. Students, Medical/
9. ((medical* or medicine? or clinical*) adj2 (educat* or train* or student* or curricul*)).ti,ab,kf.
10. (resident? or fellow* or intern?).ti,ab,kf.
11. (UGME* or PGME*).ti,ab,kf.
12. exp Physicians/
13. Faculty, Medical/
14. exp Medical Staff/ or personnel, hospital/
15. (general practitioner* or clinician* or physician* or doctor*).ti,ab,kf.
16. (surgeon* or psychiatrist* or radiologist* or obstetrician* or gyn?ecologist* or an?esthesiologist* or dermatologist* or oncologist* or rheumatologist* or neurologist* or pathologist* or p?ediatrician* or cardiologist* or urologist* or geriatrician* or gerontologist*).ti,ab,kf.
17. ((medical* or clinical* or healthcare* or health-care*) adj1 (staff* or personnel* or professional* or practitioner* or worker*)).ti,ab,kf.
18. or/7-17
19. Education, Distance/
20. Computer-Assisted Instruction/
21. (e-education* or e-instruction* or elearning or e-learning or e-train* or e-curricul* or e-program* or m-learn*or telecourse* or tele-course*).ti,ab,kf.
22. ((online* or virtual* or internet* or web* or distanc* or computer* or electronic* or remote* or mobile*) adj3 (class or classes or classroom* or class-room* or course* or learn* or teach* or educat* or training or curricul* or instruction* or tutorial* or seminar* or workshop* or work-shop*)).ti,ab,kf.
23. webinar*.ti,ab,kf.
24. videoconferencing/ or webcasts as topic/
25. webcast/
26. (videoconferenc* or video conferenc* or webcast* or web cast* or audioconferenc* or audio conferenc* or podcast* or videocast* or video cast* or webcast* or web cast*).ti,ab,kf.
27. or/19-26
28. 6 and 18 and 27
29. limit 28 to yr="2019 -Current"

Results: 143 references retrieved

August: **359** references retrieved

Appendix B. Additional Tables

Table A. Distribution of surgical specialties

Surgical (Specific Field)	Total # of articles	Total out of 100 articles	Clinical Science out of 78 articles
Plastic Surgery	2	2.00%	2.56%
Orthopedics	3	3.00%	3.85%
Surgery	9	9.00%	11.54%
Head & Neck Surgery	1	1.00%	1.28%
Dermatology surgery	1	1.00%	1.28%
Neurosurgery	2	2.00%	2.56%
Anesthesiology	2	2.00%	2.56%
Cardiothoracic	1	1.00%	1.28%
Emergency Medicine	3	3.00%	3.85%
Sum	24	24.00%	30.77%

Table B. Distribution of non-surgical specialties

Non-Surgical (Specific field)	Total # of articles	Total out of 100 articles	Clinical Science out of 78 articles
Neurology	7	7.00%	8.97%
Cardiology	1	1.00%	1.28%
Dermatology	5	5.00%	6.41%
Otolaryngology	2	2.00%	2.56%
Clinical Science	8	8.00%	10.26%
Paediatric	3	3.00%	3.85%
Anatomy	1	1.00%	1.28%
Oncology	2	2.00%	2.56%
Allergy and Immunology	1	1.00%	1.28%
Geriatric Psychiatry	2	2.00%	2.56%
Geriatrics	2	2.00%	2.56%
Radiology	6	6.00%	7.69%
Psychiatry	3	3.00%	3.85%
Ophthalmology	1	1.00%	1.28%
Primary Care	1	1.00%	1.28%
Internal Medicine	1	1.00%	1.28%
Endocrinology	1	1.00%	1.28%
Pathology	2	2.00%	2.56%
Regenerative Medicine	1	1.00%	1.28%
Infectious Diseases	1	1.00%	1.28%
Gastroenterology	1	1.00%	1.28%
Radiation Oncology	1	1.00%	1.28%
Histopathology	1	1.00%	1.28%
Sum	54	54.00%	69.23%

Table C. Models of educational interventions and definitions

Type of Model	Definition
Kotter's Change Management Model	Design to: "(a) create urgency; (b) form a guiding coalition; (c) create a vision; (d) communicate the vision; (e) remove obstacles; (f) create short-term wins; (g) build on the change, and (h) institutionalise new approaches" Bloom's taxonomy & active learning also mentioned
Constructive Framework Model	Built upon faculty members' existing facilitation and teaching skills and highlighted their transferability
Peer-to-Peer Model	Mimic face-to-face workshop by using Zoom with breakout rooms
Flipped Classroom Model	Enabled a mix of asynchronous and synchronous learning because learners could complete parts of the curriculum at their own pace (based on their own understanding or because of scheduling constraints)
Cognitive Apprenticeship Model	Modelled a short presentation on how to write high quality MCQs, then used coaching, and scaffolding, then 'articulation' and 'exploration' steps for learners to create their own MCQs.

Table D-1. Geographical distribution of the sample.

Countries of Origin	Percent of Total Sample	# of articles
North America	62%	62
South America	2%	2
Europe	13%	13
Australia/Oceania	3%	3
Asia	18%	18
Africa	2%	2

Table D-2. Journal types

Journal Types	Percent of Total Sample	# of articles
Clinical	60%	60
Medical Education	39%	39
Other	1%	1

Table D-3. Area of Medicine

Areas of Medicine	Percent of Total Sample	# of articles
Basic Science	14%	14
Clinical Science	78%	78
Unspecified	8%	8

Table D-4. Population targeted in the sample.

Population	Percent of Total Sample	# of articles
Undergraduate	38%	38
Residents	39%	39
Fellows	13%	13
Faculty	10%	10
Number of participants	Percent of Total Sample	# of articles
Reported	42%	42
Did not report	58%	58

Appendix C. Articles extracted for final analysis

1.	Agarwal S, Sabadia S, Abou-Fayssal N, Kurzweil A, Balcer LJ, Galetta SL. Training in neurology: flexibility and adaptability of a neurology training program at the epicenter of COVID-19. *Neurology*. 2020; 94(24), e2608–e2614. https://doi.org/10.1212/wnl.0000000000009675
2.	Aghakhani K, Shalbafan M. What COVID-19 outbreak in Iran teaches us about virtual medical education. *Med Educ Online*. 2020;25(1), 1770567. https://doi.org/10.1080/10872981.2020.1770567
3.	AlGaeed M, Grewal M, Richardson PK, Leon Guerrero CR. COVID-19: neurology residents' perspective. *J Clin Neurosci*. 2020;78, 452–453. https://doi.org/10.1016/j.jocn.2020.05.032
4.	Ali SR, Dobbs TD, Whitaker IS. Webinars in plastic and reconstructive surgery training: a review of the current landscape during the COVID-19 pandemic. *J Plast Reconstr Aesthet Surg*. 2020;73(7), 1357–1404. https://doi.org/10.1016/j.bjps.2020.05.038
5.	Almarzooq ZI, Lopes M, Kochar A. Virtual learning during the COVID-19 pandemic. *J Am Coll Cardiol*. 2020;75(20), 2635–2638. https://doi.org/10.1016/j.jacc.2020.04.015
6.	Ashrafzadeh S, Imadojemu SE, Vleugels RA, Buzney EA. Strategies for effective medical student education in dermatology during the COVID-19 pandemic. *J Am Acad Dermatol*. 2020;84(1), e33–e34. https://doi.org/10.1016/j.jaad.2020.08.068
7.	Bandi F, Karligkiotis A, Mellia J, et al. Strategies to overcome limitations in otolaryngology residency training during the COVID-19 pandemic. *Eur Arch Otorhinolaryngol*. 2020;277(12), 3503–3506. https://doi.org/10.1007/s00405-020-06228-9
8.	Bari A. Dermatology residency training in COVID-19 pandemic: transition from traditional to online teaching. *J Coll Physicians Surg Pak*. 2020;*30*(Supp2), S63–S66. https://doi.org/10.29271/jcpsp.2020.Supp1.S63.
9.	Bhargava S. Online classes for medical students during COVID-19 pandemic: through the eyes of the teaching faculty. *J Res Med Dent Sci*. 2020;8(4), 189–192.
10.	Bhashyam AR, Dyer GSM. "Virtual" boot camp: orthopaedic intern education in the time of COVID-19 and beyond. *J Am Acad Orthop Surg*. 2020;28(17), e735–e743. https://doi.org/10.5435/jaaos-d-20-00559
11.	Birch E, de Wolf M. A novel approach to medical school examinations during the COVID-19 pandemic. *Med Educ Online*. 2020;25(1), 1785680. https://doi.org/10.1080/10872981.2020.1785680
12.	Bryan DS, Benjamin AJ, Schneider AB, Milner R, Matthews JB, Roggin KK. Nimble, together: a training program's response to the COVID-19 pandemic. *Ann Surg*. 20202;*272*(2), e142–e143. https://doi.org/10.1097/sla.0000000000003994
13.	Burns R, Wenger J. A remotely conducted paediatric bootcamp for fourth-year medical students. *Med Ed.* 2020;54(7), 668–669. https://doi.org/10.1111/medu.14187
14.	Chao TN, Frost AS, Brody RM, et al. Creation of an interactive virtual surgical rotation for undergraduate medical education during the COVID-19 pandemic. *J Surg Educ.* 2020;78(1), 346–350. https://doi.org/10.1016/j.jsurg.2020.06.039
15.	Chick RC, Clifton GT, Peace KM, et al. Using technology to maintain the education of residents during the COVID-19 pandemic. *J Surg Educ*. 2020;77(4), 729–732. https://doi.org/10.1016/j.jsurg.2020.03.018
16.	Choudhury N, Shoushtari A. Training oncologists in the time of COVID-19. *J Oncol*. 2020;*25*(7), 546–547. https://doi.org/10.1634/theoncologist.2020-0373
17.	Chua A, Mendoza MJ, Ando M, et al. Changing the landscape of medical oncology training at the national university hospital in the philippines during the coronavirus disease 2019 (COVID-19) pandemic. *J Cancer Educ*. 2020. https://doi.org/10.1007/s13187-020-01786-2
18.	Co M, Chu K. Distant surgical teaching during COVID -19 - a pilot study on final year medical students. *Surg Pract*. 2020;24(3), 105–109. https://doi.org/10.1111/1744-1633.12436
19.	Codispoti CD, Bandi S, Moy JN, Mahdavinia M. Running a virtual allergy division and training program in the time of COVID-19 pandemic. *J Allergy Clin Immunol*. 2020;*145*(5), 1357–1359. https://doi.org/10.1016/j.jaci.2020.03.018
20.	Collier S. A geriatric psychiatry virtual rotation during COVID-19. *Am J Geriatr Psychiatry*, 2020;28(8), 891. https://doi.org/10.1016/j.jagp.2020.05.010
21.	Conroy ML, Garcia-Pittman EC, Ali H, Lehmann SW, Yarns BC. The COVID-19 AAGP online trainee curriculum: development and method of initial evaluation. *Am J Geriatr Psychiatry*. 2020;28(9), 1004–1008. https://doi.org/10.1016/j.jagp.2020.06.003
22.	Duggan MC, Goroncy A, Christmas C, Chippendale R. Staying afloat in the COVID -19 storm: GERIAtrics Fellows Learning Online And Together (GERI-A-FLOAT). *J Am Geriatr Soc.* 2020;68(10). https://doi.org/10.1111/jgs.16755
23.	Durfee SM, Goldenson RP, Gill RR, Rincon SP, Flower E, Avery LL. Medical student education roadblock due to COVID-19: virtual radiology core clerkship to the rescue. *Acad Radiol*. 2020;27(10), 1461–1466. https://doi.org/10.1016/j.acra.2020.07.020
24.	Durrani, M. Debate style lecturing to engage and enrich resident education virtually. *Med Educ*. 2020;54(10), 955–956. https://doi.org/10.1111/medu.14217

25. Dutta AK, Goswami K, Murugaiyan S, et al. The transition from objectively structured practical examination (OSPE) to electronic OSPE in the era of COVID-19. *Biochem Mol Biol Educ*. 2020;48(5), 488–489. https://doi.org/10.1002/bmb.21410
26. Edwards JA, Breitman I, Kovatch I, et al. Lessons learned at a COVID-19 designated hospital. *Amer J Surg.* 2020;221(1), 62–64. https://doi.org/10.1016/j.amjsurg.2020.07.029
27. Eltayar AN, Eldesoky NI, Khalifa H, Rashed S. Online faculty development using cognitive apprenticeship in response to COVID-19. *Med Educ*. 2020;*54*(7), 665–666. https://doi.org/10.1111/medu.14190
28. Figueroa F, Figueroa D, Calvo-Mena R, Narvaez F, Medina N, Prieto J. Orthopedic surgery residents' perception of online education in their programs during the COVID-19 pandemic: should it be maintained after the crisis? *Acta Orthopaedica*. 2020;91(5), 543–546. https://doi.org/10.1080/17453674.2020.1776461
29. Gaber DA, Shehata MH, Amin HAA. Online team-based learning sessions as interactive methodologies during the pandemic. *Med Educ*. 2020;54(7), 666-667. https://doi.org/10.1111/medu.14198
30. García-Lozano J, Cuellar-Barboza A, Garza-Rodríguez V, Vázquez-Martínez O, Ocampo-Candiani J. Dermatologic surgery training during the COVID-19 era. *J Eur Acad Dermatol Venereol*. 2020;34(8). https://doi.org/10.1111/jdv.16621
31. Gawad N, Towaij C, Stuleanu T, Garcia-Ochoa C, Williams LJ. Prioritizing resident and patient safety while maintaining educational value: emergency restructuring of a Canadian surgical residency program during COVID19. *Can J Surg*. 2020;63(3), E302–E305. https://doi.org/10.1503/cjs.006120
32. Geha R, Dhaliwal G. Pilot virtual clerkship curriculum during the COVID-19 pandemic: podcasts, peers and problem-solving. *Med Educ*. 2020;54(9), 855–856. https://doi.org/10.1111/medu.14246
33. Gomez E, Azadi J, Magid D. Innovation born in isolation: rapid transformation of an in-person medical student radiology elective to a remote learning experience during the COVID-19 pandemic. *Acad Radiol*. 2020;27(9), 1285–1290. https://doi.org/10.1016/j.acra.2020.06.001
34. Graffeo CS, Elder BD, van Gompel JJ, Daniels DJ. Digitally decentralised mock oral board examination for neurological surgery trainees. *Med Educ*, 2020;*54*(9), 854–855. https://doi.org/10.1111/medu.14270
35. Guerandel A, McCarthy N, McCarthy J, Mulligan D, Lane A, Malone K. An approach to teaching psychiatry to medical students in the time of COVID-19. *Ir. J. Psychol. Med.* 2020;1–7. https://doi.org/10.1017/ipm.2020.87
36. Hannon P, Lappe K, Griffin C, Roussel D, Colbert-Getz J. An objective structured clinical examination: from examination room to Zoom breakout room. *Med Educ*. 2020;54(9), 861. https://doi.org/10.1111/medu.14241
37. Hodgson JC, Hagan P. Medical education adaptations during a pandemic: transitioning to virtual student support. *Med Educ*. 2020;54(7), 662–663. https://doi.org/10.1111/medu.14177
38. Hughes B, Stallard J, West C. The use of Whatsapp® as a way to deliver plastic surgery teaching during the COVID-19 pandemic. *J Plast Reconstr Aesthet Surg*. 2020;73(7), e1–e2. https://doi.org/10.1016/j.bjps.2020.05.034
39. Jack MM, Gattozzi DA, Camarata PJ, Shah KJ. Live-streaming surgery for medical student education - educational solutions in neurosurgery during the COVID-19 pandemic. *J Surg Educ*. 2020;78(1), 99–103. https://doi.org/10.1016/j.jsurg.2020.07.005
40. Kanneganti A, Sia CH, Ashokka B, Ooi SBS. Continuing medical education during a pandemic: an academic institution's experience. *Postgrad Med J*, 2020;96(1137), 384–386. https://doi.org/10.1136/postgradmedj-2020-137840
41. Kelley SR, Mathis KL, Dozois EJ. Colorectal surgery training and the COVID pandemic. *Clin Teach.* 2020;17(4), 413–414. https://doi.org/10.1111/tct.13202
42. Kent F, George J, Lindley J, Brock T. Virtual workshops to preserve interprofessional collaboration when physical distancing. *Med Educ*, 2020;54(7), 661–662. https://doi.org/10.1111/medu.14179
43. Kim RH, Brinster NK, Meehan SA. Dermatopathology education during the COVID-19 pandemic: virtual simulation of the multiheaded microscope. *J Am Acad Dermatol*. 2020;83(3), e243–e244. https://doi.org/10.1016/j.jaad.2020.05.127
44. Landa-Ramírez E, Domínguez-Vieyra NA, Hernández-Nuñez ME, Díaz-Vásquez LP, Santana-García IA. Psychological support during COVID-19 death notifications: clinical experiences from a hospital in Mexico. *Psychol Trauma.* 2020;12(5), 518–520. https://doi.org/10.1037/tra0000679
45. Lawrence K, Hanley K, Adams J, Sartori DJ, Greene R, Zabar S. Building telemedicine capacity for trainees during the novel coronavirus outbreak: a case study and lessons learned. *J Gen Intern Med*. 2020;35(9), 2675–2679. https://doi.org/10.1007/s11606-020-05979-9
46. Lee J, Chan J, Ithnin F, Goy R, Sng B. Resilience of the restructured obstetric anaesthesia training programme during the COVID-19 outbreak in Singapore. *Int J Obstet Anesth*. 2020;43, 89–90. https://doi.org/10.1016/j.ijoa.2020.04.002
47. Lee YM, Park H, Pyun SB, Yoon YW. Enforced format change to medical education webinar during the coronavirus disease 2019 pandemic. *Korean J Med Educ*. 2020;32(2), 101–102. https://doi.org/10.3946/kjme.2020.158
48. Lewis EE, Taylor LJ, Hermsen JL, McCarthy DP, Fiedler AG. Cardiothoracic education in the time of COVID-19: how I teach it. *Ann Thoracic Surg*. 2020;110(2), 362–363. https://doi.org/10.1016/j.athoracsur.2020.04.002

49. Looi JC, Bonner D, Maguire P, et al. Flattening the curve of COVID-19 for medical education in psychiatry and addiction medicine. *Australas Psychiatry*. 2020;29(1), 31–34. https://doi.org/10.1177/1039856220946647
50. Lubarsky S. Movie night! An entertaining online educational method for introducing students to common presentations in neurology. *Med Educ*. 2020;54(9), 856–857. https://doi.org/10.1111/medu.14218
51. Matalon SA, Souza DA, Gaviola GC, Silverman SG, Mayo-Smith WW, Lee LK. Trainee and attending perspectives on remote radiology readouts in the era of the COVID-19 pandemic. *Acad Radiol*. 2020;27(8), 1147–1153. https://doi.org/10.1016/j.acra.2020.05.019
52. McRoy C, Patel L, Gaddam DS, et al. Radiology education in the time of COVID-19: a novel distance learning workstation experience for residents. *Acad Radiol*. 2020;27(10), 1467–1474. https://doi.org/10.1016/j.acra.2020.08.001
53. Merali Z, Carayannopoulos KL, Lai A. All hands on deck: creation of an online internal medicine redeployment curriculum. *Med Educ*. 2020;54(10), 958–959. https://doi.org/10.1111/medu.14213
54. Moe J, Brookes C, Dyalram D, et al. Resident education in the time of a global pandemic: development of the collaborative OMS virtual interinstitutional didactic (COVID) program. *J Oral Maxillofac Surg*. 2020;78(8), 1224–1226. https://doi.org/10.1016/j.joms.2020.05.029
55. Monday LM, Gaynier A, Berschback M, et al. Outcomes of an online virtual boot camp to prepare fourth-year medical students for a successful transition to internship. *Cureus*. 2020;Published. https://doi.org/10.7759/cureus.8558
56. Mooney CJ, Peyre SE, Clark NS, Nofziger AC. Rapid transition to online assessment: practical steps and unanticipated advantages. *Med Educ*. 2020;54(9), 857–858. https://doi.org/10.1111/medu.14225
57. Morawo A, Sun C, Lowden M. Enhancing engagement during live virtual learning using interactive quizzes. *Med Educ*. 2020;54(12), 1188. https://doi.org/10.1111/medu.14253
58. Moszkowicz D, Duboc H, Dubertret C, Roux D, Bretagnol F. Daily medical education for confined students during coronavirus disease 2019 pandemic: a simple videoconference solution. *Clin Anat*. 2020;*33*(6), 927–928. https://doi.org/10.1002/ca.23601
59. Mulla ZD, Osland-Paton V, Rodriguez MA, Vazquez E, Kupesic Plavsic S. Novel coronavirus, novel faculty development programs: rapid transition to eLearning during the pandemic. *J Perinat Med.* 2020;48(5), 446–449. https://doi.org/10.1515/jpm-2020-0197
60. Murdock HM, Penner JC, Le S, Nematollahi S. Virtual morning report during COVID-19: a novel model for case-based teaching conferences. *Med Educ*. 2020;54(9), 851–852. https://doi.org/10.1111/medu.14226
61. Nadarajah VD, Er HM, Lilley P. Turning around a medical education conference: Ottawa 2020 in the time of COVID-19. *Med Educ*. 2020;54(8), 760–761. https://doi.org/10.1111/medu.14197
62. Newcomb AB, Duval M, Bachman SL, Mohess D, Dort J, Kapadia MR. Building rapport and earning the surgical patient's trust in the era of social distancing: teaching patient-centered communication during video conference encounters to medical students. *J Surg Educ*. 2020;78(1), 336–341. https://doi.org/10.1016/j.jsurg.2020.06.018
63. Obaid O, Zimmermann J, Ares G. Surgical residents in the battle against COVID-19. *J Surg Educ*. 2020;*78*(1), 332–335. https://doi.org/10.1016/j.jsurg.2020.07.018
64. O'Connell A, Tomaselli PJ, Stobart-Gallagher M. Effective use of virtual gamification during COVID-19 to deliver the ob-gyn core curriculum in an emergency medicine resident conference. *Cureus*. 2020;Published. https://doi.org/10.7759/cureus.8397
65. Oldenburg R, Marsch A. Optimizing teledermatology visits for dermatology resident education during the COVID-19 pandemic. *J Am Acad Dermatol*. 2020;82(6), e229. https://doi.org/10.1016/j.jaad.2020.03.097
66. Parisi MCR, Frutuoso L, Benevides SSN, et al. The challenges and benefits of online teaching about diabetes during the COVID-19 pandemic. *Diabetes Metab Syndr: Clin Res Rev*. 2020;*14*(4), 575–576. https://doi.org/10.1016/j.dsx.2020.04.043
67. Parker EU, Chang O, Koch L. Remote anatomic pathology medical student education in Washington State. *J Clin Pathol.* 2020;154(5), 585–591. https://doi.org/10.1093/ajcp/aqaa154
68. Patel PM, Tsui CL, Varma A, Levitt J. Remote learning for medical student-level dermatology during the COVID-19 pandemic. *JAAD.* 2020;83(6), e469–e470. https://doi.org/10.1016/j.jaad.2020.08.033
69. Pollom EL, Sandhu N, Frank J, et al. Continuing medical student education during the coronavirus disease 2019 (COVID-19) pandemic: development of a virtual radiation oncology clerkship. *Advances Rad Oncol.* 2020;5(4), 732–736. https://doi.org/10.1016/j.adro.2020.05.006
70. Prigoff J, Hunter M, Nowygrod, R. Medical student assessment in the time of COVID-19. *J Surg Educ*, 2020;78(2), 370–374. https://doi.org/10.1016/j.jsurg.2020.07.040
71. Rasouli JJ, Shin JH, Than KD, Gibbs WN, Baum GR, Baaj AA. Virtual spine: a novel, international teleconferencing program developed to increase the accessibility of spine education during the COVID-19 pandemic. *World Neurosurg*. 2020;140, e367–e372. https://doi.org/10.1016/j.wneu.2020.05.191
72. Recht MP, Fefferman NR, Bittman ME, et al. Preserving radiology resident education during the COVID-19 pandemic: the simulated daily readout. *Acad Radiol*. 2020;27(8), 1154–1161. https://doi.org/10.1016/j.acra.2020.05.021

73. Roberts, V, Malone, K, Moore, P, Russell-Webster, T, Caulfield, R. Peer teaching medical students during a pandemic. *Med Educ Online*. 2020;25(1), 1772014. https://doi.org/10.1080/10872981.2020.1772014

74. Robertson J, Ahlgren E, Rydberg F, Snygg-Martin U, Westin J, Studahl M. The virtual ward - the students' clinical education during the current pandemic. *Lakartidningen*. 2020;117(20077).

75. Rogers A, Lynch K, Toth H, Weisgerber M. Patient and family centered (tele)rounds: the use of video conferencing to maintain family and resident involvement in rounds. *Acad Peds*. 2020;20(6), 765–766. https://doi.org/10.1016/j.acap.2020.05.026

76. Rose C, Mott S, Alvarez A, Lin M. Physically distant, educationally connected: interactive conferencing in the era of COVID-19. *Med Educ*. 2020;54(8), 758–759. https://doi.org/10.1111/medu.14192

77. Roskvist, R, Eggleton, K, Goodyear-Smith, F. Provision of e-learning programmes to replace undergraduate medical students' clinical general practice attachments during COVID-19 stand-down. *Educ Prim Care*. 2020;31(4), 247–254. https://doi.org/10.1080/14739879.2020.1772123

78. Rotoli J, Bodkin R, Pereira J, et al. emergency medicine residency curricular innovations: creating a virtual emergency medicine didactic conference. *AEM Educ Training*. 2020;4(3), 270–274. https://doi.org/10.1002/aet2.10477

79. Roy H, Ray K, Saha S, Ghosal AK. A study on students' perceptions for online zoom-app based flipped class sessions on anatomy organised during the lockdown period of COVID-19 epoch. *J Clin Diagn Res*. 2020;Published. https://doi.org/10.7860/jcdr/2020/44869.13797

80. Roy SF, Cecchini MJ. Implementing a structured digital-based online pathology curriculum for trainees at the time of COVID-19. *J Clin Pathol*. 2020;*73*(8), 444. https://doi.org/10.1136/jclinpath-2020-206682

81. Sabharwal S, Ficke JR, LaPorte DM. How we do it: modified residency programming and adoption of remote didactic curriculum during the COVID-19 pandemic. *J Surg Educ*. 2020;77(5), 1033–1036. https://doi.org/10.1016/j.jsurg.2020.05.026

82. Sam, AH, Reid MD, Amin A. High-stakes, remote-access, open-book examinations. *Med Educ*. 2020;54(8), 767–768. https://doi.org/10.1111/medu.14247

83. Sandhaus Y, Kushnir T, Ashkenazi S. Electronic distance learning of pre-clinical studies during the COVID-19 pandemic: a preliminary study of medical student responses and potential future impact. *Isr Med Assoc J*. 2020;22(8).

84. Schwarzkopf R, Maher NA, Slover JD, Strauss EJ, Bosco JA, Zuckerman JD. The response of an orthopedic department and specialty hospital at the epicenter of a pandemic: the NYU Langone health experience. *J arthroplasty.* 2020 Jul 1;35(7):S3-5. https://doi.org/10.1016/j.arth.2020.04.041

85. Shahrvini BB, Coffey CS, MacDonald BB, Lander SL. Pre-clinical remote undergraduate medical education during the COVID-19 pandemic: a survey study. *Res Squ*. 2020 Jun 10:rs-3. https://doi.org/10.21203/rs.3.rs-33870/v1

86. Shih KC, Chan JC, Chen JY, Lai JS. Ophthalmic clinical skills teaching in the time of COVID-19: a crisis and opportunity. *Med Educ*, 2020;54(7), 663–664. https://doi.org/10.1111/medu.14189

87. Siddiqui UD, Aslanian HR. The new virtual reality: advanced endoscopy education in the COVID-19 era. *Dig Dis Sci*. 2020;65(7), 1888–1891. https://doi.org/10.1007/s10620-020-06386-0

88. Singh K, Srivastav S, Bhardwaj A, Dixit A, Misra S. Medical education during the COVID-19 pandemic: a single institution experience. *Indian Peds*. 2020;57(7), 678–679. https://doi.org/10.1007/s13312-020-1899-2

89. Srinivasan DK. Medical students' perceptions and an anatomy teacher's personal experience using an e-learning platform for tutorials during the COVID-19 crisis. *Anat Sci Educ*. 2020 May;13(3):318-9. https://doi.org/10.1002/ase.1970

90. Steehler AJ, Pettitt-Schieber B, Studer MB, Mahendran G, Pettitt BJ, Henriquez OA. Implementation and evaluation of a virtual elective in otolaryngology in the time of COVID-19. *Otolaryngol Head Neck Surg.* 2020;164(3), 556–561. https://doi.org/10.1177/0194599820951150

91. Tang, P. Y, New, L. M, Leow, W. Q. Zooming for cells: Tele-education of histopathology residents during the COVID-19 pandemic. *Proc. Singapore Healthc*. 2020;30(1), 71–75. https://doi.org/10.1177/2010105820944447

92. Thampy HK, Ramani S, McKimm J, Nadaraja VD. Virtual speed mentoring in challenging times. *Clinc Teach.* 2020;17(4), 430–432. https://doi.org/10.1111/tct.13216

93. Torres A, Domańska-Glonek E, Dzikowski W, Korulczyk J, Torres K. Transition to online is possible: solution for simulation-based teaching during the COVID-19 pandemic. *Med Educ*. 2020;54(9), 858–859. https://doi.org/10.1111/medu.14245

94. Tsang ACO, Lee PP, Chen JY, Leung GKK. From bedside to webside: a neurological clinical teaching experience. *Med Educ*. 2020;54(7), 660. https://doi.org/10.1111/medu.14175

95. Veerapen K, Wisener K, Doucet S, Amari E. A scaffolded structured approach for efficient transition to online small group teaching. *Med Educ*, 2020;54(8), 761–762. https://doi.org/10.1111/medu.14209

96. Virarkar M, Jensen C, Javadi S, Saleh M, Bhosale PR. Radiology education amid COVID-19 pandemic and possible solutions. *J Comput Assist Tomogr,* 2020;44(4), 472–478. https://doi.org/10.1097/rct.0000000000001061

97. Wyles SP, Meyer FB, Hayden R, Scarisbrick I, Terzic A. Digital regenerative medicine and surgery pedagogy for virtual learning in the time of COVID-19. *Regen Med*. 2020;Published. https://doi.org/10.2217/rme-2020-0106
98. Zeinali M, Almasi-Doghaee M, Haghi-Ashtiani B. Facing COVID-19, jumping from in-person training to virtual learning: a review on educational and clinical activities in a neurology department. *Basic Clin Neurosci*. 2020;151–154. https://doi.org/10.32598/bcn.11.covid19.910.2
99. Zhang Q, He YJ, Zhu YH, et al. The evaluation of online course of traditional Chinese medicine for medical bachelor, bachelor of surgery international students during the COVID-19 epidemic period. *Integr. Med. Re*. 2020;9(3), 100449. https://doi.org/10.1016/j.imr.2020.100449
100. Zuo L, Dillman D, Miller Juvé A. Learning at home during COVID-19: a multi-institutional virtual learning collaboration. *Med Educ*. 2020;54(7), 664–665. https://doi.org/10.1111/medu.14194