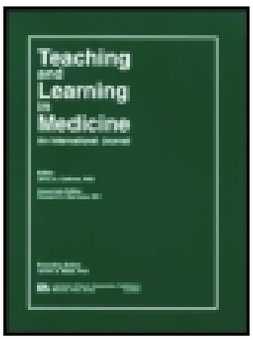

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Changing Medical Education, Overnight: The Curricular Response to COVID-19 of Nine Medical Schools

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ABSTRACT

Issue: Calls to change medical education have been frequent, persistent, and generally limited to alterations in content or structural re-organization. Self-imposed barriers have prevented adoption of more radical pedagogical approaches, so recent predictions of the 'inevitability' of medical education transitioning to online delivery seemed unlikely. Then in March 2020 the COVID-19 pandemic forced medical schools to overcome established barriers overnight and make the most rapid curricular shift in medical education's history. We share the collated reports of nine medical schools and postulate how recent responses may influence future medical education. *Evidence:* While extraneous pandemic-related factors make it impossible to scientifically distinguish the impact of the curricular changes, some themes emerged. The rapid transition to online delivery was made possible by all schools having learning management systems and key electronic resources already blended into their curricula; we were closer to online delivery than anticipated. Student engagement with online delivery varied with different pedagogies used and the importance of social learning and interaction along with autonomy in learning were apparent. These are factors known to enhance online learning, and the student-centered modalities (e.g. problem-based learning) that included them appeared to be more engaging. Assumptions that the new online environment would be easily adopted and embraced by 'technophilic' students did not always hold true. Achieving true distance medical education will take longer than this 'overnight' response, but adhering to best practices for online education may open a new realm of possibilities. *Implications:* While this experience did not confirm that online medical education is really 'inevitable,' it revealed that it is *possible*. Thoughtfully blending more online components into a medical curriculum will allow us to take advantage of this environment's strengths such as efficiency and the ability to support asynchronous and autonomous learning that engage and foster intrinsic learning in our students. While maintaining aspects of social interaction, online learning could enhance pre-clinical medical education by allowing integration and collaboration among classes of medical students, other health professionals, and even between medical schools. What remains to be seen is whether COVID-19 provided the experience, vision and courage for medical education to change, or whether the old barriers will rise again when the pandemic is over.

KEYWORDS
Online education; undergraduate medical education; COVID-19

Introduction

In 1988, Bloom noted that despite all the changes in medical practice over the previous half-century, medical education had changed little, referring to "a history of reform without change." [1] Calls for change in medical education continue to be numerous, persistent,[2–5] and mostly unanswered as barriers to change limit progress.[2,6] But a sudden, radical shift in medical education occurred in March 2020 when COVID-19 caused dramatic increases in hospitalizations and

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deaths across the globe. As a result of the pandemic, every educational institution began to consider how best to ensure the safety of their community and 90% of US medical schools abruptly halted on-campus teaching and removed medical students from clinical care.[7] Medical education, however, could not be paused as the students left campus, even though the pandemic affected every aspect of medical education from Medical College Admission Test administration to graduation requirements and residency programs.[8–13] Medical educators across the country were challenged with common goals: keep the curriculum going, keep the students on track, and keep them safe.[14] Responses to the disruption brought about by COVID-19 gave rise to innovation in many aspects of medical education.

In April 2020, a group of nine schools from the U.S. and U.K. shared reports on their curricular responses to the cessation of on-campus classes, determined common themes, highlighted differences and assessed potential consequences, some anticipated and some unexpected. The reports showed how each school made monumental shifts in curricular delivery at a pace never previously seen in medical education. We report these findings here and speculate on the ramifications for post-COVID-19 medical education. Although numerous COVID-related educational articles have been published since the outbreak, we believe this is the first collective report to discuss how the pandemic revealed some of the educational priorities of today's medical students and envision how these revelations might springboard medical education into real change.

The schools

The nine schools, with particular attention to their class size and curricular structure, are described in Table 1. All schools had a significant active-learning component to their pre-clerkship curriculum. The main distinguishing feature between the schools was class size, ranging from 42 to 280 per class. The schools were invited to participate at the end of March, 2020 as a sample of convenience through professional connections and with the help of the then president of the International Association of Medical Science Educators (IAMSE; see acknowledgements). Representatives from each school (the authors) reported details of their immediate curricular response to campus closures in a standard format. The initial reports were collated and a thematic analysis was performed. A summary report was distributed to all authors for collective editing and approval at the beginning of June. The findings are therefore limited to academic year, 2019-2020.

Themes in curricular responses

We have focused our discussion on the pre-clinical components of medical education for two reasons. Firstly, the prospect of significant changes in basic science teaching in medical education is a current and controversial topic of conversation;[15] the pandemic response could offer insight into the impacts of such changes. Secondly, post-COVID clinical curricula seem unlikely to shift away from the clerkship model as 1) all schools had difficulty replacing in-person clinical rotations; and 2) the AAMC reversed its initial recommendation to withdraw medical students from the clinical environment[16] because of their importance to the future of the profession.

The shift to remote delivery: Not easy, but quick

Unsurprisingly, the need to immediately avoid in-person contact resulted in all schools transitioning to remote delivery of their curricula. What was surprising was the speed with which this was achieved. Urgency and necessity overwhelmed barriers to medical curricular change that had held since P.C. Anderson described them fifty years ago[17] (i.e., excessive traditionalism, faculty resistance and division, lack of leadership). More specifically, obstacles that had supposedly prevented medical education from moving online, such as time constraints, poor technical skills, lack of institutional support, and negative attitudes [18] were overcome in a matter of days.

Just prior to the pandemic, Ezekiel Emanual forecasted that pre-clinical education was 'inevitably' going to transition online by 2025.[15] His prediction had a mixed reception, but the incredibly quick conversion to a new form of delivery was made possible by an already established reliance on online learning management systems and the movement to flipped classroom instruction, which resulted in the creation of on-line study/preparatory material;[19] these key online elements were already blended into their curricula. Even though several commercial vendors offered free access to their medical education resources, all nine schools already had their own content and resources and used them instead. This material included recordings of previous lectures, voice-over-PowerPoints or videos formerly used as preparatory or supplementary material, or new material that was rapidly generated

Table 1. Nine schools shared reports of their curricular responses to the COVID-19 pandemic and consequent cessation of on-campus activities.

School	Location	Class Size	Sector	Primary Teaching Modality
Virginia Tech Carilion School of Medicine	VA, USA	42	Public	PBL
Zucker School of Medicine at Hofstra/Northwell	NY, USA	100	Private	PBL
Geisinger Commonwealth School of Medicine	PA, USA	107	Private	CBL & LIC
Larner College of Medicine, University of Vermont	VT, USA	124	Public	PBL, TBL, CBL
Harvard Medical School	MA, USA	165	Private	CBCL
Case Western Reserve University School of Medicine	OH, USA	184	Private	PBL
Tulane University School of Medicine	LA, USA	190	Private	Active Lecture
University of Texas Medical Branch School of Medicine	TX, USA	230	Public	PBL
School of Medicine, University of Leeds	United Kingdom	240-280	Public	Active Lecture

Relevant details of each school are shown. PBL, Problem Based Learning; CBL, Case Based Learning; Longitudinal Integrated Curriculum; TBL, Team Based learning; CBCL, Case Based Collaborative Learning.

for the move to virtual delivery. Re-purposing these resources allowed most basic science curricula to stay on schedule, either by replacing planned class time with these resources, or by maintaining the resources as preparatory materials for online facilitated learning sessions. All schools transitioned active small-group teaching to video-conferencing forums and collaborative virtual workspaces in which students interacted with each other and faculty.[20]

Delivery modalities and student engagement

Engagement in the new virtual learning process was mixed, with some schools finding students appearing less engaged online than with the pre-COVID on-campus format. With reflection, some online delivery methods and elements appeared to promote student engagement better than others.

'Live' not 'previously recorded'

The remote delivery of either 'live' or 'previously recorded' classes varied across the nine schools. The two forms of delivery are equally effective learning paradigms[21–23] but students at two schools (Virginia Tech Carilion and Case Western Reserve) requested 'live' online lectures within a few days of receiving 'previously recorded' online classes. Given the trend of poor class attendance in pre-COVID on-campus classes[24] this request was surprising but nonetheless granted. Should we have been surprised? Although reportedly effective, a recorded online delivery is less engaging than an on-campus class,[22] and it may be that the lack of an 'in-person' component and social connection also reduces online engagement; one of the major factors for medical students to attend on-campus classes is for social learning and interaction with peers.[25] Level of engagement and personal connection can be improved by implementing facets of online social presence[26] that influence a learner's sense of connection to other learners and educators. Improving a sense of connection might not have a significant impact on performance of highly motivated learners, but it may positively impact their satisfaction.

Interaction and autonomy

Factors that promote engagement, social presence, and autonomy in an online environment have been well described for online learning[27] but are only recently coming into the consciousness of medical educators due to this shift to remote learning.[28] Research has demonstrated that online education is most successful and engaging when learners have 1) some autonomy; 2) there is a specified purpose to an activity; and 3) there is interaction with peers or educators.[27] Therefore, it should come as no surprise that curricular elements such as Problem-Based Learning (PBL) and other forms of active small-group learning that retained these characteristics were more successful when moved online.

To stimulate interaction, the optimal "classroom" size for e-learning is about 16 students,[29] which is much closer to the small group sizes used by our schools (4-17 students). When University of Texas Medical Branch and Case Western Reserve gave more autonomy to students for managing and running online PBL sessions, the engagement was reportedly higher than in previous on-campus sessions. Second, the impact of social presence was illustrated by the higher level of engagement in small-group online sessions where student-student and student-educator interaction was intrinsic to the educational format. The form of interaction and duration of sessions also affected engagement; Larner College of Medicine (University of Vermont) students were more engaged when their cameras were expected to be on and sessions were limited to less than 1.5 hours. Longer sessions or having to attend multiple sessions of video-conferences per day is more tiring than the same schedule experienced in

person.[30,31] The similarities and differences in what was achieved in the pandemic-instigated rush to online learning and what is practiced in established e-learning are worth considering and using as the foundation for future planning.

Similarities and differences to online education

Having been recently and appropriately described as being performed under the "*tyranny of the urgent,*"[32] the COVID-19 transition online is unlikely to be representative of a permanent, planned, and purposefully designed online pre-clinical curriculum. Optimal online learning design is not achievable in only a few days and is dependent on faculty development, appropriate resources, and delivery methods that are explicitly focused on online learning and purposefully organized and accessible.[33] Therefore, the decision to integrate online learning into medical education should involve a well-devised plan that considers curricular structure and required resources as well as content development, management, and standardization.[34]

Faculty development

At the onset of campus closures, faculty development was rapidly implemented and occurred despite faculty having numerous additional responsibilities necessary to establishing an online curriculum. Faculty development initially involved ensuring competency with the associated technology, which is normally secondary to establishing understanding of issues of quality and student learning online.[35] The nuanced differences between planning online and face-to-face sessions are numerous, and lack of appreciation of these issues can negatively impact the learning environment. Since the onset of the pandemic, faculty development has been ongoing and establishing skills to teach online may positively affect educators' face-to-face teaching and be a catalyst for change in the classroom.[36]

Resources

The transition to the online environment also illustrated a disparity in access to high-speed internet at home. Special arrangements had to be made for some students, and Harvard Medical School, Larner College of Medicine, and Leeds University School of Medicine are consequently now considering financial and technical support to ensure all students can use quality internet access. While some students relied on campus access for internet, others needed to be on campus to have a quiet space for learning that was not available in their home environment. Another possible stressor was the 'intrusion' of classmates and faculty 'virtually' walking into the student's private physical space during video-conferencing and gaining insights into their personal lives and socioeconomic situation.[37,38]

Delivery

One of the cardinal rules of distance education is, 'Do not take what you do in the classroom and expect the same outcomes.'[27] Despite this warning, that is largely what many programs did. All of our schools already had produced much of the content that could be remotely distributed, but neglected the need to adapt how content was made available and used to enhance learning.[39] Established use of learning management systems (LMS) made content distribution easier; however, most programs do not use the LMS to its fullest extent and likely relied upon it primarily as a filing system vs. a delivery platform. Programs continued to focus on delivering the same content, instead of focusing on achieving the same outcome, potentially increasing the extraneous cognitive learning load.[40] Better use of new internally developed resources or commercial material purposefully designed for online delivery may have been warranted.

Students' adaptation

While the material, educational goals, and delivery were often the same, the environment was unfamiliar. One of the key elements to student success and satisfaction in online education is student preparedness and awareness of expectations.[27] Students generally lacked preparation for this transition and without preparing and coaching the students about the new environment, we may also have increased their anxiety regarding expectations. Coupled with this challenge, our expectation was that the 'technophilic' generation of students would have the necessary technical savvy to be as engaged online as during on-campus sessions. These assumptions may have been misplaced as the online transition and introduction of unfamiliar software caused challenges for some students.[41]

Issues and responses specific to the COVID-19 pandemic

While the pandemic presented the stimulus to transition online, it also presented many confounding factors to assess the transition's impact. Extraneous pandemic-related factors not only affected students and faculty, but also the content delivered and how it was assessed. These extraneous factors thereby made comparative data scarce and a more scientifically rigorous interpretation impossible at this time.

Students' performance, engagement, and motivation were all likely to be affected by their environment. Some students were alone for weeks as their educational environment changed rapidly and radically from the familiar, while outside a global pandemic grew larger and closer. Beyond the threat of infection, the uncertainty of when rotations would be completed, whether board exams would be rescheduled or canceled, and changes in graduation requirements and ceremonies only heightened emotions. Confinement to the home and social isolation blurred the life/work divide, and morale of some students started to decline. Students' use of supportive services at Virginia Tech Carilion was estimated to have risen by 30% during the first online course. The pandemic reinforced the educational maxim that basic human needs should be addressed before academic needs (aka "Maslow before Bloom"[42]) Effective education also included concerns for the emotional needs of students and the impact of the pandemic on learning. While communication was increased with town hall meetings, briefings from frontline physicians (Zucker School of Medicine), and online social events (Geisinger Commonwealth School of Medicine and Harvard Medical School), small-group learning sessions offered an opportunity for students to talk to faculty informally and for faculty to gauge the wellbeing of individual students.

Some students reported their inability to join the workforce as qualified physicians and fight COVID-19 as a point of frustration. Instead, students became trained COVID-19 contact tracers, secured personal protective equipment, and engaged in the surrounding community. This effort was formalized and expanded in Zucker School of Medicine's innovative service learning curriculum focused on practical action to address the pandemic surrounding the school. Harvard Medical School students designed a COVID-19 curriculum that has been used in countries around the world. Students at Larner College of Medicine created The Medical Student COVID-19 Action Network website[43] to collect and share volunteer opportunities for medical students across the U.S.

Modifications had to be made to assessment structures that confound the interpretation of the impact of curricular changes on student performance. The eight U.S. schools had little choice other than to maintain their assessment schedule in order for students to progress. This resulted in significant changes in the form, sources, and delivery of exam questions. To avoid students traveling, exams were mostly delivered remotely and sometimes unproctored. The form of assessment in some cases had to be modified for remote delivery. At some schools, exams and assessment were a focus of student anxiety so some assessment was converted to formative or students were allowed to take exams multiple times. Conversely, remote delivery of exams at Larner College of Medicine was well received by students as it decreased stress and improved autonomy by allowing them to identify a comfortable location to take the exam. Unrestricted by USMLE timelines, the University of Leeds School of Medicine in the U.K. was able to delay first-year assessments until the second-year. These changes make it impossible to interpret the impact of online education on student performance, however they do afford us a glimpse of what opportunities that could lie ahead.

The opportunities

The transition online has been implemented at all levels of education and has been heralded as an opportunity to make permanent changes to K-12 and undergraduate education.[44,45] Likewise, it has presented medical education with many insights and possibilities. The blending of more online learning into medical curriculum should not be seen as the phasing out of our roles as educators, but rather a change in our role. Nor should online learning be considered a lowering of educational standards or an inevitable slide toward a homogenous, standard medical education. Instead, increasing online learning in medical education could be viewed as playing to the strengths of the modern medical student and be an opportunity to increase inclusion and open new doors of innovation.

Changing role of medical educators

When the pandemic is over, what will be the motivation for faculty to maintain or develop the new paradigm we find ourselves in today and not go 'back-to-normal'? Before the pandemic, our

traditional roles as transmitters of information[46] was effectively being transferred to extra-curricular resources and our classrooms were emptying.[24] The pandemic has allowed us to experience new roles as educator coaches, facilitators, and role models.[46] This transition of roles was not considered by Emanual's forecast that we might be replaced by online resources.[15] Instead, these new roles will be a major component of the predicted shift in medical education away from information transmission and toward facilitated, active learning[19] with a new emphasis on educational research; a paradigm shift that has been completed in Vermont's lecture-free curriculum.

Our recent experience has shown that adding true online learning to curricula will require substantial faculty development in instructional design, running online sessions, and generation of specific online resources aligned and tailored to curricular components.[47] Development of these resources is a critical component of a blended curriculum and can be a substantial amount of work. However, development of materials can be given tangible credit as publishing these resources in peer-reviewed repositories (e.g. MedEdPortal) can be considered scholarship and allow us to fulfill our faculty role as a scholar;[46] submitting such publications have been incorporated into the faculty development program at Virginia Tech Carilion.

Our role as 'assessor'[46] will also be challenged. Our developed resources will have to help medical students learn numerous highly complex concepts and our assessment of their learning must be authentic, determining the depth and contextual transfer of knowledge, problem-solving abilities, and adaptive expertise.[48–50] Developing this authenticity will go beyond simple text-based measures of ability[51] and will challenge us to match innovations in our online educating with creativity in our assessment. Facing this challenge scientifically will be another opportunity for scholarship.

Educational heterogeneity and unique medical school experiences

There may be concerns that increasing the online components might result in an 'industrial' approach[52] to medical education with a centralized, single mode of delivery. This *Fordist* approach to online learning (akin to Ford's production lines producing a single model of car via single method) is by no means the only model.[27] Other approaches with high levels of innovation, variation, and product (*post-Fordist* approaches) can be adopted that are decentralized. Post-Fordism would maintain the role of the faculty member as a skilled curriculum developer (along with the other roles described above)[46] while assuring the heterogeneity and branding of each medical school.

There may also be concerns that incorporation of more online learning is juxta-posed to the transition from teacher- to student-centered medical education. At its inception, online learning was video-based and mimicked the lecture-based environment. This was also the case for many of the resources we used in the pandemic response, such as voice-over-PowerPoints; students listened and took notes. The internet and online resources negate this original TV-style approach and student-centered elements can and should be incorporated[53] (given more time for faculty and resource development). Use of these elements and along with the capacity for asynchronous delivery and student autonomy gives the online learning environment the potential to be the pinnacle of student-centered education.

Meeting the modern medical student online

Above, we described students' responses to the pandemic-related changes we made, including mixed engagement and coping with technical hurdles and insufficient resources. Inclusion of online learning should therefore ensure students have sufficient internet connectivity, technical savvy, and understanding of online learning. Nevertheless, we should also dovetail this work with a growing understanding of how today's medical student interacts with the content, their peers, and the educator.

The efficiency of learning is important to medical students given the volume of material they must cover. Online learning provides that efficiency[54] and is a factor that draws students to external electronic resources and interactions outside the lecture hall. Familiar material within electronic resources can be skipped and unfamiliar material can be repeated, whereas a 50-minute lecture has to be experienced at a pedestrian pace of 1x speed. External resources can be improved upon by providing in-house resources that are peer-reviewed, better aligned with learning objectives and assessment and still allow efficient use of time.

Interactivity with peers and educators appeared to be an important component to our students' engagement. The impact of peer-peer learning is well established and it can be adapted to the online environment

with development of interactive skills;[55] likewise interaction with educators remains an important contributor to learning online.[56] The importance of interaction and social learning are elements that were not considered in Emanual's forecast but we suggest they are essential to generate the experience that the modern medical student seeks.

Student autonomy, perhaps the greatest asset of online learning, is also a major element of student-centered learning and it promotes intrinsic motivation.[57] We saw a glimpse of this when students at two schools became more engaged when given more choice in how they ran their PBL groups. Moving away from the prescribed schedule and allowing some degree of choice would allow students to relate their learning to personal values and goals and leverage their established skills. While medical students have a set educational destination, they maybe more engaged and intrinsically motivated[58] if they can determine (to some extent) how they reach it. A goal of blending more online learning should therefore to be to introduce more autonomy, while ensuring students meet expected outcomes and are not demotivated by too many choices.[59]

New doors of innovation

As we consider introducing more online learning into our curriculum it is worth considering the innovations could be made when freed from the constraints of time and physical space. Online learning's ability to allow asynchronous learning and assessment would let students leverage previously honed skills and spend more time on unfamiliar material.

With constraints on room sizes and locations removed, online learning can enhance collaborative learning, allowing different classes to learn together in the same virtual space and engage in near-peer learning/teaching; not only could content be vertically integrated, but the students could be as well. The logistics of interprofessional education might also be simplified if students from different health professions could meet online. It would also allow us to group medical students together by their interests, not just within their school, as collaborative or shared courses could be established.

Our recent movement toward online education also gave us opportunity to think about new content priorities. During the pandemic, apropos courses on the history of pandemics and telemedicine were developed and clinical interview skills were taught online in the context of telemedicine. Asynchronous clinical electives in pathology and radiology (neither requiring patient contact) were generated and helped students fulfill graduation requirements. While necessity was the mother of these inventions, maintaining this momentum and perpetuating this progress depends solely on us.

Summary

The changes that were implemented in March 2020 provided glimpses into how medical curriculum and the role of medical educators might evolve over the rest of the 21st century. While the pandemic-related data will be too noisy to make scientific, robust decisions, the insights we have gained should give us confidence and motivation to try novel learning methods and approach them scientifically.

The importance of social interaction and social learning in medical education makes Emanuel's prophecy unlikely. Although online 'lecture-style' videos might students help pass board exams, it seems unlikely to us that students will be satisfied, effectively engaged and able to achieve deep learning with these sources alone. Our brick-and-mortar lecture halls were already empty. Integrating more active, online learning can help us harness its strengths of efficiency and student autonomy to promote engagement and intrinsic motivation to learn in our students. If we blend more online learning into our curricula, we must appreciate that our roles as educators are not diminished, but they are different and faculty might embrace these new roles to engage and inspire curiosity in our students.

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