PERSPECTIVE

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Educational leadership in the time of a pandemic: Lessons from two institutions

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Abstract

Over the course of a few weeks in March, COVID-19 upended the daily lives of Americans. Academic Medical Centers became a center-point for the response to the virus. Leaders within academic medical centers faced twin challenges of responding to the needs of the patients we serve while managing radical changes within their own institutions, including the educational mission. In this article, we describe some key themes identified and lessons learned as educational leaders during this time. We draw from the experiences of two institutions- one public and one private. These lessons learned fall into the broad categories of leadership decision-making and communication and included the importance of principled decision-making, a connected leadership team, and effective communication both within leadership and to the broader institutional community. The consequences of these responses resulted in a renewed recognition for us as educational leaders of the interdependence of our tripartite academic fates, the importance of academic medical centers as anchor institutions and advocates for our community, and the resilience and ingenuity of our students. We provide examples of these lessons and themes and make recommendations for how to approach educational decision-making in the "new normal" of living with COVID-19 for the immediate future.

KEYWORDS

academic medicine, communication, COVID-19, decision-making, education, leadership

1 | INTRODUCTION

The disruptions to daily life brought by the emergence of SARS-CoV-2 as a global pandemic are unprecedented in modern times. Over the course of a few weeks in March, life in the US changed with unimaginable speed and scope, paralleling earlier experiences across the globe. For many regions of the country, academic medical centers (AMCs) formed a center-point for the response to the virus and the havoc that has followed in its wake. Nothing in memory casts the critical importance of AMCs' missions in starker relief: caring for the sick and preventing avoidable harm, educating the public, and medical learners as faculty educate themselves and each other, and generating and interpreting new knowledge. While the pandemic amplified the urgency of each mission area, it simultaneously swept away standard operating procedures. Face-to-face communication vanished, taking with it most standard routines and protocols. Leaders within AMCs faced the twin challenges of responding to unprecedented community needs while managing radical changes within

their own organizations and across all missions. Within medical education, these radical changes began for both of our institutions in early March (Table 1-Timeline of Events at One Institution). As community-based spread of COVID-19 became apparent in each of our cities, we discontinued in-person classroom based activity, shifting rapidly to online learning. In early March, the Association for American Medical Colleges (AAMC) released a statement encouraging medical schools to remove medical students from the care of patients with known or suspected COVID-19 and raising concerns about the ethical implications of allowing students into the clinical environment at all given the many unknowns of the pandemic.[1] Over the course of a few days, multiple decisions needed to be made, communicated, implemented, and managed. Aspects of leadership decision-making and communication greatly affected our ability to address these challenges. Moreover, it caused us to reflect on the critical importance of AMCs in providing a way forward in crisis. In this perspective, we outline our key lessons learned as educational leaders at two different academic medical centers, one public and one private, but with similar experiences and timelines, and how we believe these lessons should influence

decision-making going forward in the pandemic as we live with COVID-19 and resume our critical missions.

2 | LEADERSHIP DECISION-MAKING AND COMMUNICATION

2.1 | The importance of principled decision-making

When conditions require rapid decisions in the absence of evidence, clarifying and articulating the principles that should guide decision-making is critical. "Operational tempo"—the speed and intensity of actions relative to the speed and intensity of emerging events—is a common concept in the military and among organizations designed to respond to emergent conditions.[2] With notable pockets of exception, this is not a familiar concept for AMC's which are built to foster the deliberative, systematic processes that build evidence and certainty. Even in our Emergency Departments and ICU's, where a brisk "ops tempo" is common, we study our choices and seek to systematize them. We learned that

TABLE 1 Timeline of events at one institution

Date	Label
28-Feb	Evaluation of Tech Readiness for School Administration & Students Begins
29-Feb	Leadership Communication Structure Developed & Announced
6-Mar	Dedicated COVID−19 Website for All School Communications
7-Mar	Discussions Begin on Broad Policy Implementation for Travel, Events
9-Mar	Cancellation of University Sponsored Travel, Study Abroad, Visitors, University Events Begins
10-Mar	Launch of Regular Meetings with Program Leads
11-Mar	Move to Online Instruction for Classroom Based Activities Begins with Plan for Implementation April 6
12-Mar	First Town Halls Begin
12-Mar	Preparation for Possible Need to Cancel Clinical Rotations Begins
13-Mar	ACGME Guidelines for Programs Released; AAMC & LCME Guidelines Released
13-Mar	Student-led Response to COVID−19 Launches
15-Mar	First Evidence of Local Community Spread of COVID−19 & Announcement for All Classes to Move Online
16-Mar	Move of Administrative Operations to Virtual Begins
17-Mar	Updated Guidance from AAMC on Student Clinical Participation
17-Mar	Beginning of Elective Procedures and Office Visit Cancellation to Accommodate Surge in Inpatients
20-Mar	Clinical Rotations for 3rd Year Students and Non-Essential 4th Year Rotations Cancelled
23-Mar	Local Stay At Home Issue Ordered & Clinical Students Begin Virtual Electives
27-Mar	Online Learning Resources Launched for Residents, Fellows & Faculty in Event of Redeployment
31-Mar	Daily Newsletter Launched for all Faculty, Staff & Trainees
18-May	Clinical Year Students Begin Non-Direct Patient Care Clerkship Activities in Simulation Center, Virtual Lectures and NBME Subject Exams
15-Jun	Shortened & Altered Clinical Clerkships for 3rd Year Student Begin in Clinical Setting
3-Aug	Rising 3rd Years Begin Clerkship Year with Shortened Clerkships
17-Aug	Preclinical Courses Resume with Combination of Online and In-Person Activities

rapidly establishing and broadcasting the principles that should guide decision-making in the face of rapid operations tempo is a best practice. Similarly, gathering ongoing feedback on those decisions from the stakeholders impacted and engaging them in decision-making when possible is critical to staying an effective course.

In the early hours of the pandemic, safety quickly emerged as a foundational principle. Establishing the best means to ensure the safety of our patients, faculty, staff, and learners emerged as the fundamental imperative—acting on that principle has been an iterative, ongoing process. As community spread of COVID-19 entered our respective communities, we made rapid decisions to move to online learning for classroom-based activities. This was critical because the means of spread and mechanism by which to ensure safety in large group environments was not yet clear. In the case of the clinical environment, caring for our patients cannot be separated from caring for ourselves. The availability of personal protective equipment (PPE) and the impact of practice decisions on the supply of PPE has proved critical to safety, and has guided the flow of patients, providers, staff, and learners through our practices and services. This led to early exclusion of both medical students and residents from care of COVID-19 suspected or confirmed patients early in the pandemic. A lack of available PPE meant we need to limit the number of people who cared for patients and the logical choice, since learners must be supervised, is to have faculty care for these patients. However, early evidence that COVID-19 causes more severe disease and mortality in older and chronically ill populations also resulted in exclusion or restriction of some faculty from the clinical environment. Of critical importance were the protocols for occupational and student health to ensure screening, care and infection control guidance for faculty, staff, and students alike.[3]

While achieving educational objectives initially took a pause as we addressed safety concerns, advancing these objectives remained and remains a guiding principle for our decision-making.[3–5] Preparing learners to advance to further training or practice and to assure their readiness to do so is a core mission. During this unprecedented time, our educators were charged with finding creative, effective methods to educate our students under less than ideal conditions while assuring the safety of our learners, faculty, staff and patients in the learning process. At both of our institutions, the inability to meet the core learning objectives of the required clinical curriculum ultimately led to a decision to remove learners from those environments. Specifically, necessary decisions to cancel elective and semi-elective procedures in order to ensure adequate access to ventilators, critical care beds, and hospital beds, led to an inability to meet core objectives in both the surgery and the obstetrics and gynecology clerkships very quickly. As fewer and fewer other elective admissions occurred, both because of shifts in patient care needs and

decisions made by the patients themselves, other services were impacted. This had implications not only for medical student education, but also for resident education, leading us to shift groups of residents to the emergency department, critical care units, and home-based work. To meet the educational needs of our medical students, we rapidly developed online platforms for case-based learning, engaged in distance standardized patient and simulation activities, and rapidly revised the clerkship schedules and lengths to ensure we could meet the core learning objectives.[1,6] For residents, we implemented telehealth, home-based chart review rotations for quality improvement, and online case-based learning to prepare for potential redeployment if needed. Throughout we engaged the learners to understand the impact of these changes. They not only provided critical feedback but also suggestions for changes. Examples of changes that resulted from their feedback included adding regular synchronous sessions to classroom-based education to ensure effective engagement with the faculty; changes to the way coursework and assignments were presented; flexibility in exam schedules to address internet issues and opportunities for clinical engagement in areas not previously explored.

2.2 | A connected leadership team

Communication between leaders of the academic enterprise is crucial for effective functioning.[7–9] Never is it more important for a leadership team to communicate effectively and efficiently than in a crisis. Situational awareness of other members of the team, their roles, and the events unfolding in their mission areas can be of critical importance.[10] The COVID-19 pandemic erected a number of challenges to effective communication and situational awareness between team members. The move to shelter-in-place orders removed the efficiency and clarity of in-person communication just as the required pace of decision-making and management sped up within each of our academic missions. To address this threat, at one of our institutions, the Dean met each morning (in person but appropriately socially distanced) with his senior mission leaders in clinical care, education, research, administration, and public health. The meetings lasted 30 minutes and served as a form of academic incident command center. This time allowed us to communicate information to each other about our daily priorities and ask questions about how various decisions might affect the other missions. As an example, at this daily briefing, the clinical leader provided information about the timing of elective surgery cancellation, providing ample time and foreknowledge for the education leader to make decisions about when the educational learning objectives of the surgical clerkship would be compromised to an extent that removing the learners

from the environment would be necessary. Similarly, this meeting spurred critical conversations about effective strategies for managing house staff and the broader physician redeployment strategy of the school as hospitalized COVID cases rose. Although it is not necessary for such a meeting to occur in person, the in-person nature of this meeting facilitated unstructured conversations that allowed for a more nuanced understanding of the situation each of us was facing.

2.3 | Organized, coordinated, and cascading communication

While internal communication between leaders may have been effective, communicating to the rest of our stakeholders was often problematic, particularly at the beginning of the pandemic. In the decentralized structure of many AMCs, including our own, it was difficult to communicate critical decisions to everyone who needed or wanted to know. Email-based communication was the initial attempt at spreading information, resulting in flooded inboxes. Websites with new and updated policies and procedures became important repositories, but were difficult to maintain across units within the medical school and across the hospital and medical school. Individuals within the clinical environment relied on word of mouth, often spreading misinformation. Those outside of clinical environments communicated via social media and other platforms, again often misrepresenting the "on the ground" situation. Communication teams struggled to get important information out to faculty, staff, and learners in a timely and effective manner.

In addition to streamlining and coordinating communication, our institutions developed a distributed communication strategy. For critical clinical information, this involved distribution through and by department chairs and division chiefs. This allowed information to be tailored to the audience. For educational information, it involved distribution though program directors and educational administration. To facilitate transparency and address common questions, at one institution, we developed regular cascading remote meetings with key stakeholders. The Dean and his leadership team met weekly or more frequently with the Department Chairs to review critical changes and foreshadow potential next steps, gain input and refine strategies. In turn, Department Chairs and Division Chiefs held regular town halls with faculty to review current state and answer the many questions that arose. They also distilled key emails and sent out regular digests to ensure the most important information was captured and targeted to their faculty, housestaff, and staff. Questions and issues that emerged were fed back to senior leadership to inform further decision-making. The feedback and engagement

of "on the ground" stakeholders proved critical throughout the response.

In education, this involved regular town halls with educational leaders at all levels including administrators, course and clerkship directors, program directors, and staff to update on the situation and address key questions, policy needs, and challenges. It also included bi-weekly meetings with students of each class individually with the undergraduate administration. We chose to meet with classes separately because their issues were different and each required unique approaches and conversations. At the residency level, we meet weekly with program directors providing best practices, and encouraged program directors to meet regularly with residents and fellows. We also had intermittent all GME town halls with residents and fellows to address central concerns. These town halls proved critical in dispelling myths, identifying issues senior leadership were not aware of and providing transparency in a time of confusion and crisis. Again regular digest emails of the most important information became a valuable mechanism to distribute information to faculty and learners.

3 | REFLECTIONS ON EDUCATION AS A CORE MISSION OF AN ACADEMIC MEDICAL CENTER

3.1 | The interdependence of our fates

As the size and scope of AMC's have grown, mission compartmentalization and balkanization has been an unfortunate and periodic side effect.[11] Investigators may feel disconnected from the clinical missions that help fund their work and which their discoveries ultimately serve. Educators struggle with the constraints they face in optimally teaching their learners, like the steady creep of content and the growth of clinical service requirements. Clinical care, the financial engine for the enterprise, faces ongoing pressures for productivity in a competitive world where the demands of financial performance and growing consumer expectations come at a cost of relationships, reflection and time for teaching and scholarship. However, the importance and interdependence of the tripartite mission may have never been clearer than in the last several months- an important lesson going forward.[12]

The sudden deceleration in clinical operations produced waves that have rocked our research and educational enterprises. Funds for discretionary purposes dried up instantly, halting recruitments and plans for strategic new initiatives. To reduce density on campus, non-essential research was halted. Essential research was generally classified as that related to COVID-19 and that which would be completely lost if not continued at a decelerated pace. Patients, the substrate of clinical learning, were suddenly in short

supply and for those who were present, physical contact remained limited to only those necessary for care. Removal of learners from non-clinical environments, including labs, changed the work of students, houseofficers, and faculty overnight.

But these changes also resulted in a wonderful story of resilience and reinforcement of the importance of the work we do as AMCs. Never in human history has medical science moved so quickly. Therapies and new clinical pathways were developed and tested with astonishing speed. Basic science innovations are rapidly unraveling the virus' secrets, resulting in new ways of detecting, tracking, and understanding the illness as well as identifying promising new targets to treat and control it. Our institutions are creating and testing vaccines, developing and testing therapeutics, and creating and implementing novel testing strategies. At one of our institutions, an animal model for COVID was rapidly developed and used to trial multiple therapeutic and vaccine candidates. A vaccine candidate has emerged from this work that is currently under study. New testing strategies were developed by our research labs and operationalized by clinical and research teams allowing for surveillance and diagnostic testing strategies to be developed and to support both state and local testing needs. Both of our institutions participated in therapeutic and vaccine trials that have contributed to current best practices and vaccine opportunities. Throughout the pandemic, faculty at AMCs across the world have been gathering and distributing critical information about Covid-19's course and collaborating across centers in instituting best practices—both critically important when evidence is limited. Similarly, policies and procedures for workplace safety, testing, and management have been freely shared in a collaborative, cross-institution support network.

In education, we engaged locally and nationally with teams of collaborators and colleagues to develop comprehensive new plans for online education, alternatives to clinical care, and new schedules for our clinical care environments. We have collaborated to identify best practices to support our learners and stand up virtual interviewing and medical school and residency and fellowship program selection in an online, socially distanced world. Never has the educational community worked closer together to solve truly complex problems and make rapid decisions in support of our learners. These decisions ranged from ACGME suspension of non-critical review processes, to suspension of Step-2 Clinical Skills, to creation and implementation of novel test delivery for USMLE Step 1 and Step 2, to creating novel LCME review processes, to decisions to move all medical school and residency interviews online and suspend unnecessary away rotations. Each of these were difficult decisions made possible only through collaboration across medical schools, between medical school and residency program leadership, and

through the facilitation and support of the national organizations that support and accredit our educational programs.

3.2 | Advocacy and the anchor institution

As anchor institutions in our respective communities, members of our faculty serve as critical experts and advocates at the local, regional, and national level. Locally, members of our infectious disease, infection prevention, and occupational health teams advocated for rigorous infection prevention and educated our students, housestaff, faculty and staff, as well as the public about best practices. They continually updated us as information became available and served as thought leaders and champions for effective policies and procedures. Faculty, school and health system leaders allied with our Departments of Public Health to build data management tools, address public health challenges, and provide resources including testing and PPE when resources were limited. Our leadership met weekly (and sometimes almost daily) with local and state governments to advocate for and create policies and guidelines that support best practices and sensible strategies for both stay-at-home and return-to-work. Our institutions broadly engaged with public health efforts to develop community education strategies, test vulnerable populations, assess supplies, and develop plans for PPE distribution and to study the impact of our interventions. This work proved critical for our community and also greatly influences our learners.

3.3 | The resilience and ingenuity of students

Although our students were not on the front lines of patient care for the pandemic, they have made considerable contributions in collaboration with our institutional and local community. Early in the course of the pandemic, our students, like that of other institutions,[13] organized and developed a working group to identify potential strategies to help during the COVID pandemic. Under the supervision of faculty, they developed a leadership team and several sub-teams to work on areas of need. The products of these efforts are ample and include developing an online tool for faculty and residents to request childcare and for learners across all health professions to volunteer to provide it. They created best practices including limiting the number of people providing childcare and ensuring alignment with LCME rules around services for supervisors. Students worked with colleagues in the engineering school to make face shields when they became scarce and later, collaborated with industry to build these in mass. They supported just-in-time education on Covid-19 for community providers by helping to staff a Project ECHO—providing

background research and collating resources for community participants. They created support and thank you videos for our faculty, housestaff, and allied health providers. Students reached out to our community partners. They delivered food to homebound elders and at-risk individuals and developed educational materials for non-English speaking populations. They sewed cloth masks, created PPE kits for homeless and under-resourced populations, and served as contact tracers for our city and county departments of public health. Throughout the last many months, we have been inspired by both their creativity and ability to get things done despite the immense stressors of their constantly changing environment.

3.4 | Principled decision-making-returning to the "new normal"

As we have progressively returned to our tripartite mission of clinical care, research, and education in the "new normal" with COVID-19 firmly a part of all we do, the principles that guided us in our early decisions must remain at the forefront.

In education, we will need to ensure the safety of our learners in the classroom, the labs, and the clinical environment. This means making hard decisions about using online learning in place of large group classroom-based activities and effective social distancing during necessary in-person activities, such as clinical skills training. We were fortunate at both of our institutions to have some infrastructure to support online learning for lecture-based education. However, like most schools, effective active learning in the online environment is far from assured. A great deal of work remains to develop the necessary IT infrastructure, technological support, and faculty expertise to do it effectively.[14,15] Resources for online instruction are only part of this resource challenge as our medical schools, residencies, and fellowships move to fully online interviewing and recruiting. For both of our schools, we have made decisions to do all lecture-based activity online, but have added small group, socially distanced activities when meeting the learning objectives requires it-such as is necessary for clinical skills training and lab-based activity. We are closely monitoring for any evidence of spread of disease within the classroom and thus far have not found any. All interviews for both medical school and residency are being done virtually and travel continues to be suspended.

Our new clinical environment presents its own slate of challenges including ensuring our hospital partners have appropriate plans for PPE supplies and our learners are appropriately trained in effective infection prevention strategies. Both of our institutions are dedicated to having students remain in the clinical environment going forward and begin supervised care of patients with COVID-19. It seems likely that this illness will be around for at least several years, and

they will need to understand how to care for patients with it. We have instituted focused training in appropriate use of PPE, infection control and prevention, and strict protocols for symptom screening, COVID testing, and contact tracing.

Finally, the state of the local healthcare system and its ability to meet the educational objectives and support the safety of all involved must be constantly monitored. Over the next year to 18 months, we are all anticipating surges of COVID that will affect our ability to teach students and train residents and fellows. As COVID-19 cases again begin to rise in the community and changes are made to procedural schedules to ensure adequacy of hospital and ICU beds and equipment, the ability to meet core learning objectives may again be jeopardized. We have learned that we can supplement traditional clinical learning with simulation and case-based learning, which can reduce necessary clinical time, but not eliminate it. The challenges of navigating the changes in the clinical environment have proven the most challenging. Maintaining communication amongst leaders, closely monitoring our clinical and community environments, and maintaining open lines of communication with our learners, course directors, program directors, and faculty will be of critical importance.

In addition to managing educational priorities, we are working hard to determine best practices for how to provide personal and professional support for our students, housestaff, faculty, and staff. COVID is affecting professional identity formation and wellbeing[16,17] and yet the best response to this reality is far from clear. We have been calling on our learners, student affairs units, and psychiatry, psychology and human resources colleagues to identify imaginative new approaches. Based on their suggestions, we have recently implemented a peer support team, online groups, and continued frequent town halls, as well as enhanced interaction between faculty and students in remote education. In addition, we anticipate increased demand for health services including mental health as we continue our education mission amidst this crisis.

A number of allied efforts are assisting with the educational challenges we face. The AAMC has facilitated the formation of several educational leader communities. These communities in turn, have engaged with key national organizations like NBME, ACGME, and ERAS and have shared emerging best practices. Their survey of COVID response practices informs a regularly updated dashboard that is broadly available to members of the AAMC. Dr. Ed, program director, and other educational list serves have provided ideas, resources, and support for educators. Educational journals are providing rapid turnaround on COVID-related articles. These resources and others will help us to develop new strategies where needed to meet our educational objectives in constrained environments and timelines. Whatever strategies an individual school chooses will need to be flexible, aligned with the resources and strengths of the institution, and consistent with the values of the school and faculty who will need to teach it.

The events of the last year are without modern precedent. We are all watching history unfold around us. Through this fog of uncertainty, some clarity has emerged. Our community is remarkably resilient. Our interdependent, tripartite academic mission is our strength. An effective leadership team with open and clear communication and an effective, organized, and cascading communication strategy are critical ingredients. Finally this: optimism is an evidence-based response. In the face of unprecedented challenges, our academic medical community has learned, adapted, and innovated at a pace not seen in human history to promote the health and well-being of our patients, faculty, staff, and learners while ensuring the effective training of the next generation of physicians. As academic leaders and faculty we are role modeling critical behaviors for our learners and we are demonstrating to them exactly how important the work we do is. This generation of learners will no doubt be influenced by these experiences, and it is our belief that they will have developed remarkable resilience and a renewed passion for their future careers as physicians.

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REFERENCES

1. Alison Whelan M, AAMC Chief Medical Education Officer; Geoffrey Young, PhD, AAMC Senior, Director of Student Affairs and Programs; Veronica M. Catanese M, MBA, AAMC Senior, Director of Accreditation Services; Co-Secretary L. Medical Students and Patients with COVID-19: Education and Safety Considerations. AAMC; 2020.
2. Operational Tempo. (Accessed 9/27/2020, 2020, at https://www.nwcg.gov/committee/6mfs/operational-tempo.).
3. Important Guidance for Medical Students on Clinical Rotations During the Coronavirus (COVID-19) Outbreak. AAMC, 2020. (Accessed 9/27/2020, 2020, at https://www.aamc.org/news-insights/press-releases/important-guidance-medical-students-clinical-rotations-during-coronavirus-covid-19-outbreak)
4. Goldenberg MN, Hersh DC, Wilkins KM, Schwartz ML. Suspending medical student clerkships due to COVID-19. *Med Sci Educ*. 2020;3:1-4.
5. Menon A, Klein EJ, Kollars K, Kleinhenz ALW. Medical students are not essential workers: examining institutional responsibility during the COVID-19 pandemic. *Acad Med*. 2020;95:1149-1151.
6. Barbara Barzansky P, MHPE, Cantanese VM. LCME Update on Medical Students, Patients, and COVID-19: Approaches to the Clinical Curriculum. AAMC; 2020.
7. Butler C. Five steps to organisational resilience: being adaptive and flexible during both normal operations and times of disruption. *J Bus Contin Emer Plan*. 2018;12:103-112.
8. Chalwin RP, Flabouris A. Utility and assessment of non-technical skills for rapid response systems and medical emergency teams. *Intern Med J*. 2013;43:962-969.
9. St. Pierre M. *Crisis Management in Acute Care Settings: Human Factors and Team Psychology in A High Stakes Environment*, 2nd edn. Berlin: Springer; 2011.
10. Glick JA, Barbara JA. Moving from situational awareness to decisions during disaster response: transition to decision making. *J Emerg Manag*. 2013;11:423-432.
11. Pellegrini VD Jr, Guzick DS, Wilson DE, Evarts CM. Governance of academic health centers and systems: a conceptual framework for analysis. *Acad Med*. 2019;94:12-16.
12. Skorton D.To address COVID-19 and future pandemics, we must answer fundamental questions. AAMC Insights: AAMC; 2020.
13. Long N, Wolpaw DR, Boothe D, et al. Contributions of health professions students to health system needs during the COVID-19 pandemic: potential strategies and process for U.S. Medical Schools. *Acad Med*. 2020;95(11):1679-1686.
14. Ruiz JG, Mintzer MJ, Leipzig RM. The impact of E-learning in medical education. *Acad Med*. 2006;81:207-212.
15. Van Nuland SE, Hall E, Langley NR. STEM crisis teaching: curriculum design with e-learning tools. *FASEB BioAdv*. 2020;2(11):631-637.
16. Choi B, Jegatheeswaran L, Minocha A, Alhilani M, Nakhoul M, Mutengesa E. The impact of the COVID-19 pandemic on final year medical students in the United Kingdom: a national survey. *BMC Med Educ*. 2020;20:206.
17. Meo SA, Abukhalaf AA, Alomar AA, Sattar K, Klonoff DC. COVID-19 pandemic: impact of quarantine on medical students' mental well-being and learning behaviors. *Pak J Med Sci*. 2020;36:S43-S48.