Advances in Medical Education and Practice

Dovepress
open access to scientific and medical research

Open Access Full Text Article

PERSPECTIVES

Implementation of Innovative Educational Technologies in Teaching of Anatomy and Basic Medical Sciences During the COVID-19 Pandemic in a Developing Country: The COVID-19 Silver Lining?

Joshua Owolabi[1]
Abebe Bekele[2]

[1]Department of Anatomy, Division of Basic Medical Sciences, School of Medicine, University of Global Health Equity, Butaro, Rwanda; [2]School of Medicine, University of Global Health Equity, Butaro, Rwanda

Video abstract

Point your SmartPhone at the code above. If you have a QR code reader the video abstract will appear. Or use: https://youtu.be/Il84OgnRUhw

Abstract: This article is a descriptive and reflective piece on the strategic adaptations that facilitated and enabled the teaching of anatomy and related basic medical sciences to medical students in an African medical school that never shut down during the COVID-19 induced lockdown of the year 2020. The article considers the roles of educational technology, innovations, media and how these were used to achieve learning objectives with optimal outcomes during the lockdown. Specific technologies and innovations including the Anatomage Table, Complete 3D Anatomy software, and the use of High-Fidelity Mannequin were deployed to facilitate effective teaching of anatomy and related basic medical sciences. This was aided by the robust use of a learning management system – Canvas, as well as internet facility for connection, videoconferencing, online sessions and online-based assessment in a strategically organised manner. This system was dynamic enough to respond to changes in COVID-19 related government policies including the lockdown and social distancing-related adjustments in the physical settings. The outcome was that the teaching of medical students did not stop, and optimal results were achieved. The article considers the roles of educational technology and innovations as well as the media and how these were used to achieve learning objectives with optimal outcomes during the lockdown. It is believed that this experiential piece would inspire and inform other medical schools on the benefit of building robustly dynamic medical school systems as well as the use of innovations in times of challenges. The article also considers both the limitations and benefits of technology in teaching anatomy. Very importantly, specific tools, innovations, and technologies were considered as used, and the information provided might be a guide for other potential users. Ultimately, the lesson learned would be of use to us and we believe we could also benefit many others.

Keywords: anatomy, basic medical sciences, medical education, COVID-19, Africa

Correspondence: Joshua Owolabi
Department of Anatomy, Division of Basic Medical Sciences, School of Medicine, University of Global Health Equity, Butaro, Rwanda
Tel +250 781164365
Email jowolabi@ughe.org

Background

The University of Global Health Equity [UGHE], located in Rwanda, East Africa, was one of the very few African institutions that was never shut down as a result of the global shutdown induced by the COVID-19 pandemic. The SARS-CoV-2 emerged as a novel virus, with an outbreak that was first reported in Wuhan, China, in late 2019

Received: 30 December 2020
Accepted: 7 April 2021
Published: 8 June 2021

and that eventually turned global. It soon turned into a -pandemic.[1] African states introduced lockdown measures in the first quarter of 2020 and almost all tertiary level academic institutions were closed. UGHE's strategic response was to take active steps and virtualise the teaching-learning activity within a short period of time. A major step towards achieving this was to leverage on an existing robust Learning Management System [LMS] and introduce resources. Adequate considerations were given to all essential factors to facilitate optimal learning experience for learners and best possible outcomes.[2] This essay describes these interventions, especially in terms of the use of robust e-learning strategies, including experiences and lessons learned.

Systematic Adjustment

The Canvas is a globally trusted LMS.[3–5] Prior to the COVID lock down, quality efforts had been put in place to use Canvas in a very robust manner to engage both the faculty and student, and without which it was impractical to teach in the school [Figure 1]. This robust use of the LMS and the experience with such a reliable LMS enabled the institution to migrate to the online or virtual learning environment, with strategic adjustments but without negative fallout. While the migration was universal as much as the institution was concerned, different components of the medical school system, especially the basic medical sciences division, were required to make specific adaptations based on their peculiarities that are associated with the contents and the delivery modes for these subjects following best practices and quality evidence. Online lectures were optimised for the best possible outcomes relative to programme.[6,7]

Systematic adjustment here refers to the strategic and methodical changes that constituted the process of visualizing the delivery of the basic medical sciences components of the medical education in UGHE. These adjustments are highlighted as follows:

1. Using the LMS as the platform for all learning materials.[8,9]
2. Prioritising the use of multimedia to enhance student learning experiences.[10]
3. Integrating all other resources including the library unto the LMS.
4. Integrating plugins in the form of social media and communication tools unto the LMS.
5. Sourcing, developing, organising and uploading learning material including media- audios, videos, illustrations, animations, etc., unto the LMS.

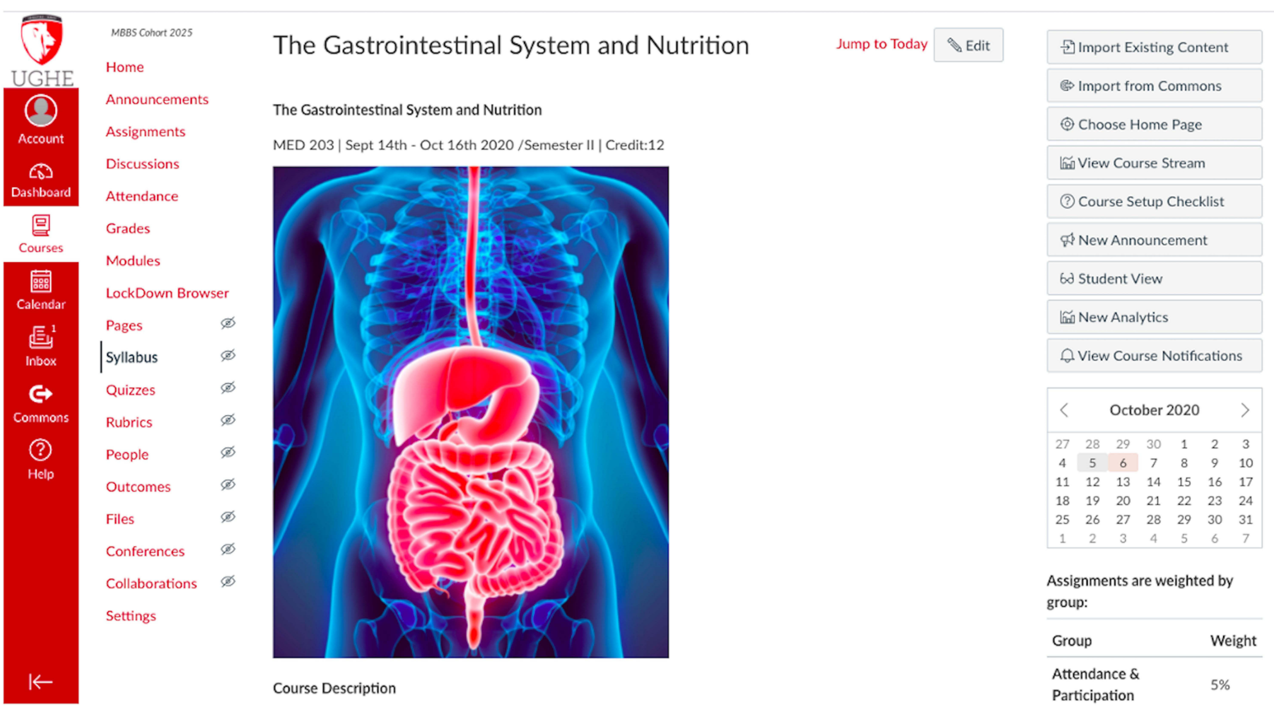

Figure 1 UGHE Canvas page illustrating the use of the LMS to integrate media and technology with all other learning materials to provide infrastructure for virtual learning.
Notes: Original figure captured from UGHE Canvas Guide; 2020. Creative Commons (https://creativecommons.org/licenses/by-nc-sa/4.0/).

6. Acquiring skills and developing proficiencies in the use of the various media to facilitate and enhance learning.
7. Training and e-training of faculty and students.

Use of Videos

Educational videos are generally useful, and they have been considered of good value in medical education.[11,12] Educational videos might help address the problem of cognitive load when, for instance due to long hours of didactic teaching in the online environment. Furthermore, UGHE adopted Flipped Class and other pedagogies, such as the Team Based Learning [TBL], and the Case-Based Collaborative Learning [CBCL]. Flipped classroom has shown evidence to improve learning outcomes, not just in terms of student performance as measured through assessment but also in terms of competency and internalisation of information with the benefit of facilitating continuing learning better.[13,14]

The use of educational videos therefore became quite important as a vital educational resource and was based on the need to have a collection of resources of various types. It is however usually a challenge to ensure that appropriate quality videos are used to help students learn and to optimise their learning experiences. To this end, we mostly engaged in the use of professionally produced videos that were commercially available. We used the Osmosis videos[15,16] and ScholarRx videos.[17] In addition to these, videos produced by subject teachers themselves could be used, as well as videos that were freely available on the internet, such as videos from the Khan Academy[11,18] and videos shared with us from partners institutions (Stanford and UC Davis). Faculty members were required to review and approve the videos before use. In line with best practices, it was considered important for teachers to make these videos available on the learning management system [LMS] through specific links. In addition to these, faculty members were required to write brief notes on the objectives of the video as well as the key concepts and sometimes generate questions for reflective practice. Educational videos allowed for flexibility, especially to choose whether a class might be synchronous or asynchronous.

Use of Audios

Audio materials in medical education are often best used in addition to illustrations or photographic representations in such a way that learners can see the illustrations and listen to the audios and in an attempt to explain the illustrations or information.[19] Audios were integrated into the PowerPoint presentations at strategic points and at specific times. For example, using the audio recording tool on the PowerPoint presentation of the Microsoft application could produce recorded voicing that provided further explanations to diagrammatic, and pictorial information or text. This was also somewhat under the control of students and could be optional as one might choose not to play a particular audio if the student is satisfied with the text, diagrammatic or photographic illustrations. Generally, and based on the available evidence, such audios were expected to be relatively short – typically less than 5 minutes in most instances. This is to ensure that learners remained engaged as they considered other information that would be provided. Audios could just be teacher's voice over already prepared PowerPoint slides or illustrations. Alternatively, suitable audio presentations can be integrated into such PowerPoint presentations and/or illustrations.

Use of Computer-Based Educational Programs and Technology

Computer educational programs were also used to support the transition from the predominantly didactic mode of delivery to the predominantly virtual mode of delivery. The Complete 3D Anatomy educational program by Elsevier [Figure 2] was used for the teaching of functional Anatomy and some aspects of physiology. The voice recording features enable the creation of videos by combining the dynamic 3D representations and creations to create video lectures that can be linked to the learning management system or shared with a group of learners directly through the programmes platform. In addition to the new dimension to enhancing learning that the use of the 3D software offers; it offers the kinesthetic advantage based on the VARK theory of learning.[20–22]

Anatomage Table [Figure 3] was also used. It is a software-enabled technology and innovation that is being used for the purpose of teaching anatomy and physiology, including certain aspects of histology and embryology, comparative anatomy and pathology. The Anatomage Table is a commercial product of the Anatomage company in the USA It could serve diverse purposes depending on the need of the student and a proficiency of the user. These uses may include but not limited to virtual dissection, virtual 3D atlas, teaching aids,

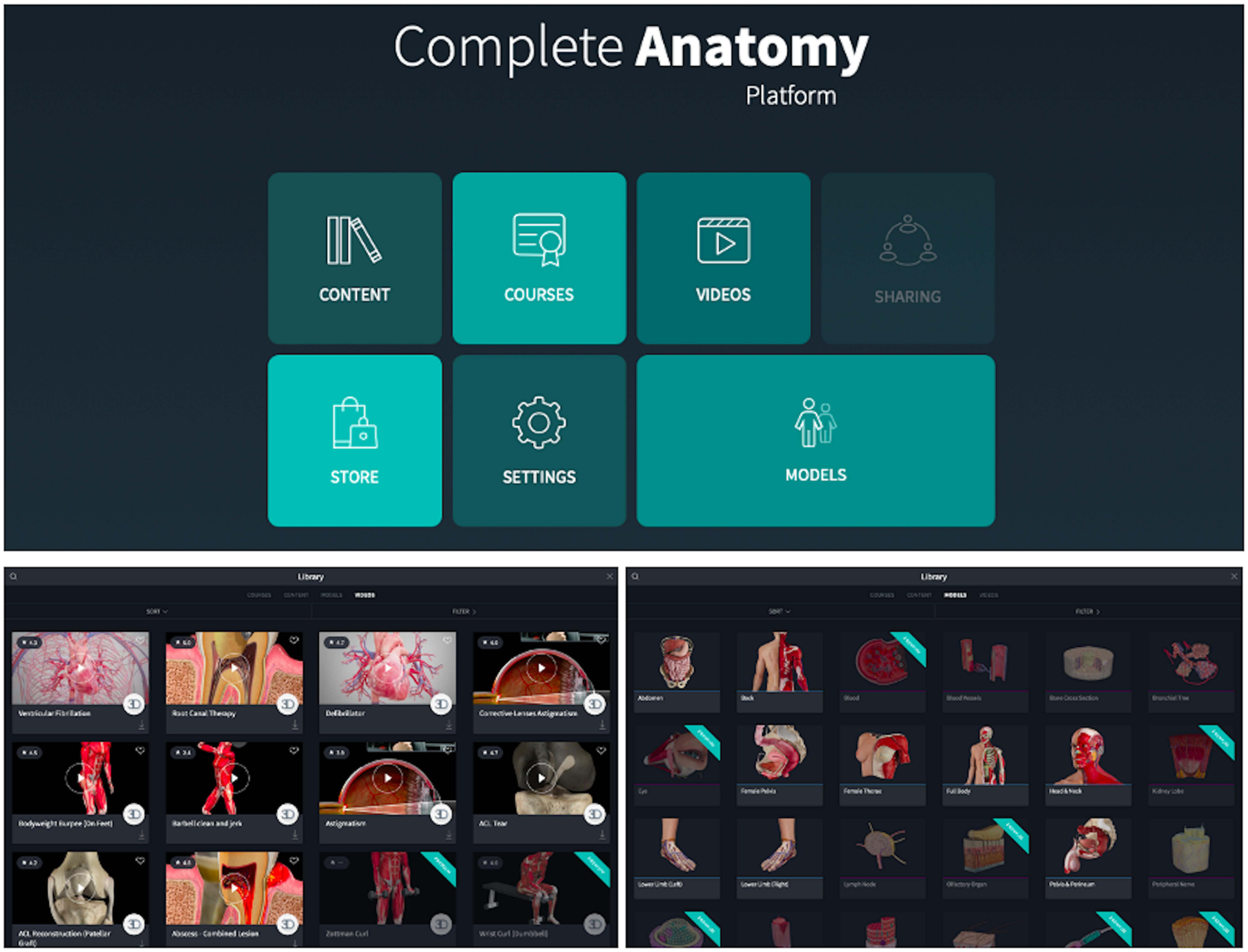

Figure 2 The Complete 3D Anatomy Interface. The all-in-one platform allows for the creation of content from course materials which include videos [self-made and ready-made], 3D human body models and the resources from the platform online store. On this platform, videos, audio, simulations and animations can all be created and integrated and made available to learners who also link with the platform or through the LMS.
Note: Original figure captured from Complete 3D Anatomy, 2020, @3D4Medical.

Figure 3 The Anatomage Table 7 for Anatomical dissection, physiological/functional simulation, demonstration and teaching facility.

virtual simulator of the human body structures and functions.[23] High fidelity mannequins were also used to complement other resources as described.

Simulations

UGHE has an integrated curriculum. The integration is described as both horizontal across the Basic Medical Sciences disciplines and vertical across the Basic Medical Sciences, Laboratory Medical Sciences, and Clinical Sciences with carefully determined structure and instructional methods. One way of achieving effective integration in modern medical curricula is Medical Simulation. Simulation links basic sciences and clinical medicine. UGHE has a simulation facility [Figure 4], run by experts, educators, and physicians. High-fidelity mannequins were used in the simulation facility.

High Fidelity Simulation is an educational technology and pedagogy that uses sophisticated manikins in simulated patient environments. It is also known as a human patient

Figure 4 Medical education simulation facility setup at the UGHE.

simulator or high-fidelity simulators. This method engages computerized systems to control full-body manikins that are programmed to give realistic physiologic responses to learners' actions [Figure 4]. As such, these manikins can demonstrate physiological and pathophysiological processes normally, and in response to interventions, making them highly useful to teach complex phenomena and to integrate several dimensions of basic medical sciences in single sessions. The manikins can breathe and talk, sleep-and-wake up, for instance, they are also capable of delivering babies, bleeding, and making vomitus. They can be used to learn and manipulate almost all major vital and physiological signs, such as the pulse, heartbeat, ECG among others. All these features allowed for a better presentation of structures, functions, symptoms and medical skills to learners.[24]

Further Thoughts and Recommendations

It is very clear that the teaching of Anatomy and related basic medical sciences to medical and allied health students could be improved with strategic adaptations, and the use of technology and media [Figure 5]. The COVID-19 pandemic has simply provided insight into the roles and benefits of technology and innovation as well as their creative uses. It is now almost certain that the continual integration of technology into medical education is essential in order to improve learning outcomes and address the cognitive load that might be associated with the volume of basic medical science content in medical education and training.[25] While certain traditional pedagogical practices are almost synonymous with the teaching of Anatomy, of which cadaveric dissection is one, it would be impractical to imagine the stoppage of medical education globally should the pandemic last for several months with limited cadaveric dissections. Hence, technology remains a reliable means of ensuring that students do not suffer from deficits that are created by the inability to adapt and embrace available benefits that technology might offer. We, therefore, join a number of authors in their advocacy for the use of technology and creative adaptations to ensure proper teaching of Anatomy despite the constraints

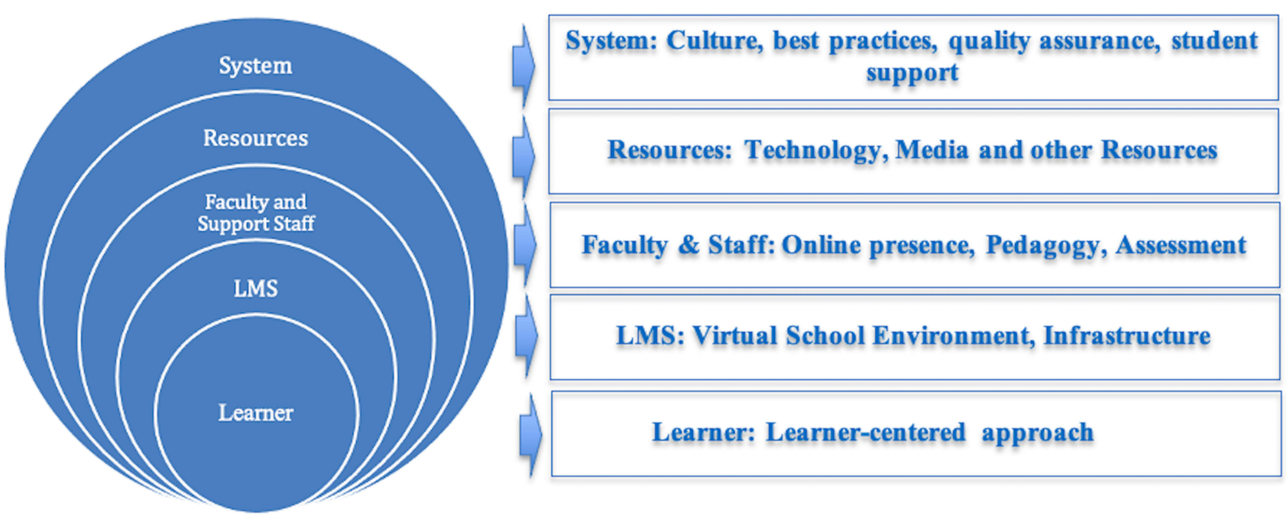

Figure 5 An illustration of the adaptations and integrations that enabled the optimal use of media towards virtualising the school during the COVID-19.

that have been caused by the COVID-19 pandemic[26] It is also evident, for example, in the United Kingdom that such adaptations are being made and with evidence of successes.[27]

It is important to state that despite the huge benefits offered by the adoption of technology and the adaptations that enabled continuous teaching with optimal results during the COVID-19 lockdown as discussed, there were a number of limitations that we identified. These limitations included learning methods that were impractical. While they might not absolutely stop teaching and learning activities, it would become important specifically to address them in order to specifically address their implications and mitigate their effects.

Limitations of teaching during the COVID era:

1. Dissection of cadaver – this was limited due to COVID-19 lockdown and social distancing measure.
2. Laboratory hands on training: social distancing measures made many laboratory hands-on sessions impractical.
3. Onsite histology and embryology experiments: this was also limited due to lockdowns and social distancing measures.

Recommendations

1. Investment in technology might better help institutions to adapt to new or alternative models of learning in times of emergencies and constraints, such as the one caused by the COVI-19 situation.

2. Adopting multiple learning methods and adopting dynamic approaches such as blended learning might help for ease of adaptation.

3. Using evidence-based methods to facilitate learning and teaching would make institutions resilient in terms of achieving their curricular learning objectives.

4. Educating medical educators and helping them to use diverse pedagogical methods would help institutions to be more resilient in times of challenge.

Conclusion

We believed that a number of factors were responsible for the effective adaptations that facilitated the effective delivery of Anatomy sessions. This included the robust use of a reliable LMS, the robust use of Anatomy and medical education innovations including the Complete 3D software, media – audio and video recording of sessions, animations, high fidelity simulations, video conferencing, while all these were combined with well-timed online synchronous learning. The adaptations yielded a dynamic and unconventional mode of delivery that was neither purely synchronous nor totally asynchronous. Noting that anatomy is a peculiar basic medical science because of its importance to medical education and relatively practical aspects, these adaptations allowed for successful delivery with minimal limitations. This might provide insight into what Anatomy educators and other departments might do to creatively adapt systems to meet their needs in similar situations.

We would describe our experiences with these adaptations as being challenging, exciting, rewarding and fulfilling. The institution has successfully completed an academic session without any interruption or disruption despite all limitations and problems that had come with the COVID-19 pandemic. It was challenging because it required both teachers and learners to adapt to the new normal and to keep learning on how best to be involved in the activities of teaching and learning. It was fulfilling because it has been successful. It was rewarding because there is evidence for success. Clearly, there are several lessons to learn, including how to optimise the use of media, technology and the innovations. These lessons will be taken forward towards improving learning and teaching activities in the future.

Disclosure

The authors reported no conflicts of interest for this work.

References

1. Lai CC, Shih TP, Ko WC, et al. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and coronavirus disease-2019 (COVID-19): the epidemic and the challenges. *Int J Antimicrob Agents*. 2020;55(3):105924. doi:10.1016/j.ijantimicag.2020.105924
2. Owolabi JO. Virtualising the School During COVID-19 and Beyond in Africa: infrastructure, Pedagogy, Resources, Assessment, Quality Assurance, Student Support System, Technology, Culture and Best Practices. *Adv Med Educ Pract*. 2020;11:755–759. doi:10.2147/AMEP.S272205
3. Coates H, James R, Baldwin G. A critical examination of the effects of learning management systems on university teaching and learning. *Tertiary Educ Manage*. 2005;11(1):19–36. doi:10.1080/13583883.2005.9967137
4. Endozo AN, Oluyinka SA, Daenos RG. Teachers' Experiences towards Usage of Learning Management System: CANVAS. Publication: ICETC2019: Proceedings of the 2019 11th International Conference on Education Technology and Computers; 2019. 91–95. doi:10.1145/3369255.3369257.

5. Marachi R, Quill L. The case of Canvas: longitudinal datafication through learning management systems. *Teach Higher Educ*. 2020;25:4:418–434. doi:10.1080/13562517.2020.1739641
6. Tang B, Coret A, Qureshi A, Barron H, Ayala AP, Law M. Online Lectures in Undergraduate Medical Education: scoping Review. *JMIR Med Educ*. 2018;4(1):e11. doi:10.2196/mededu.9091
7. Khurana MP. Learning under lockdown. *BMJ*. 2020;369:m1283. doi:10.1136/bmj.m1283
8. Back DA, Behringer F, Haberstroh N, Ehlers JP, Sostmann K, Peters H. Learning management system and e-learning tools: an experience of medical students' usage and expectations. *Int j Med Educ*. 2016;7:267–273. doi:10.5116/ijme.57a5.f0f5
9. Tibyampansha D, Ibrahim G, Kapanda G, et al. Implementation of a Learning Management System for Medical Students: a Case Study of Kilimanjaro Christian Medical University College. *MedEdPublish*. 2017;6(1):50. doi:10.15694/mep.2017.000050
10. Mayer RE. Multimedia learning. *Psychol Learn Motiv*. 2002;41:85–139.
11. Jang HW, Kim KJ. Use of online clinical videos for clinical skills training for medical students: benefits and challenges. *BMC Med Educ*. 2014;14:56. doi:10.1186/1472-6920-14-56
12. Dong C, Goh PS. Twelve tips for the effective use of videos in medical education. *Med Teach*. 2015;37(2):140–145. doi:10.3109/0142159X.2014.943709
13. Hurtubise L, Hall E, Sheridan L, Han H. The Flipped Classroom in Medical Education: engaging Students to Build Competency. *J Med Educ Curricular Dev*. 2015;2:35–43. doi:10.4137/JMECD.S23895
14. Hew KF, Lo CK. Flipped classroom improves student learning in health professions education: a meta-analysis. *BMC Med Educ*. 2018;18(1):38. doi:10.1186/s12909-018-1144-z
15. Haynes MR, Gaglani SM, Wilcox MV, Mitchell T, DeLeon V, Goldberg H. Learning through Osmosis: a collaborative platform for medical education. *Innovations Global Med Health Educ*. 2014;2014(1):2. doi:10.5339/igmhe.2014.2
16. Guven T, Geraci C, Green J, et al. Learning through Osmosis: a global Wikipedia editing course for medical students. *MedEdPublish*. 2020;9(1):109. doi:10.15694/mep.2020.000109.1
17. Le TT, Prober CG. A proposal for a shared medical school curricular ecosystem. *Acad Med*. 2018;93:1125–1128. doi:10.1097/ACM.0000000000002194
18. Prober CG, Khan S. Medical Education Reimagined. *Acad Med*. 2013;88(10):1407–1410. doi:10.1097/ACM.0b013e3182a368bd
19. Couto BD, Zaro M, Musacchio C, Moraes A, da Cunha A. Audio and Video Media in Teacher Training: deterritorialization in Education. *Creative Educ*. 2016;7:1056–1068. doi:10.4236/ce.2016.77110
20. Othmana N, Amiruddinb MH. International Conference on Learner Diversity Different Perspectives of Learning Styles from VARK Model. *Procedia Soc Behav Sci*. 2010;7(C):652–660. doi:10.1016/j.sbspro.2010.10.088
21. Bhagat A, Vyas R, Singh T. Students awareness of learning styles and their perceptions to a mixed method approach for learning. *Int j Applied Basic Med Res*. 2015;5(Suppl 1):S58–S65. doi:10.4103/2229-516X.162281
22. Mozaffari HR, Janatolmakan M, Sharifi R, Ghandinejad F, Andayeshgar B, Khatony A. The Relationship Between the VARK Learning Styles and Academic Achievement in Dental Students. *Adv Med Educ Pract*. 2020;11:15–19. doi:10.2147/AMEP.S235002
23. García MJ, Dankloff MC, Aguado HS. Possibilities for the use of Anatomage (the Anatomical Real Body-Size Table) for Teaching and Learning Anatomy with the Students. *Biomed J Sci Tech Res*. 2018;4(4):94.
24. Lewis R, Strachan A, Smith MM. Is high fidelity simulation the most effective method for the development of non-technical skills in nursing? A review of the current evidence. *Open Nurs J*. 2012;6:82–89. doi:10.2174/1874434601206010082
25. Gaur U, Majumder MAA, Sa B, Sarkar S, Williams A, Singh K. Challenges and Opportunities of Preclinical Medical Education: COVID-19 Crisis and Beyond. *SN Compr Clin Med*. 2020;2:1992–1997. doi:10.1007/s42399-020-00528
26. Saverino D. Teaching Anatomy at the Time of COVID-19. *Clin Anatomy*. 2020;23616. doi:10.1002/ca.23616
27. Longhurst GJ, Stone DM, Dulohery K, Scully D, Campbell T, Smith CF. Strength, Weakness, Opportunity, Threat (SWOT) Analysis of the Adaptations to Anatomical Education in the United Kingdom and Republic of Ireland in Response to the Covid-19 Pandemic. *Anat Sci Educ*. 2020;13(3):301–311. doi:10.1002/ase.1967