

Online Assignments at Kilimanjaro Christian Medical University College during the COVID-19 Pandemic

G. J. M. Stienen^{1,2,*}, G. Ibrahim³, H. Luzinge³, A. K. Mteta^{3,4}, L. Msuya^{3,5}, J. A. Bartlett⁶

¹Department of Physiology, Kilimanjaro Christian Medical University College, Moshi, Tanzania

²Department of Physiology, Amsterdam UMC, Vrije Universiteit, Amsterdam Cardiovascular Sciences, Amsterdam, the Netherlands

³Kilimanjaro Christian Medical University College, Moshi, Tanzania

⁴Department of Urology, Kilimanjaro Christian Medical Center, Moshi, Tanzania

⁵Department of Pediatrics, Kilimanjaro Christian Medical Center, Moshi, Tanzania

⁶Duke Global Health Institute, Duke University, Durham, NC, USA

Biophysics may be regarded as one of the major “languages” in physiology, in particular, in relation to physiologic mechanisms and models. These mechanistic aspects are considered to be difficult for medical students, in general, and in sub-Saharan Africa, in particular. During the coronavirus disease 2019 (COVID-19) closure of the Kilimanjaro Christian University Medical College (KCMUCo) from 18 March 2020 to 1 June 2020, most of the 199 first-year medical students (MD1; undergraduates) returned to their home villages. To facilitate self-study during this period, a weekly assignment-based e-learning module (~10 to 15 essay questions) was developed for the physiology course by using the learning management system (LEO; DaVinci Education, Durham, NC). This system was developed at Duke University School of Medicine and introduced at KCMUCo in 2011 (1, 2). Although concerned with the basics of physiology, the module included biophysical elements of respiration, the nervous system, digestion, and the endocrine system.

In response to the COVID-19 pandemic, medical education faculty quickly transitioned the entire preclerkship curriculum to online formats that included content in the basic sciences, health systems sciences, and even in behavioral sciences (3). The assignment-based teaching module is in line with this trend and hence could become one of the cornerstones of the preclerkship curriculum in the 21st century. Here, we provide an outline of the assignment-based module developed at KCMUCo and discuss the results of the first evaluation during the 2019 to 2020 academic year. In the discussion of the assignments, biophysical elements are highlighted, because students and medical staff usually find them difficult to handle. Online assignments have a particular advantage in this respect because the student can be guided at his or her own pace through the biophysical aspects of physiologic mechanisms.

In most medical curricula in high-income countries, biophysics is incorporated within physiology and cell biology courses or in organ-

“*” corresponding author

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centered modules. In our assignments within the physiology course, attention was given, for instance, to mechanistic aspects of alveolar ventilation, neural networks, motor programs for body motion, memory traces, astigmatism in vision, the discrete nature of pixels, and voxels in modern imaging (e.g., nuclear magnetic resonance, positron emission tomography, and singlet oxygen triplet energy transfer), wave frequency in electroencephalograms, voluntary and involuntary phases of food transport, and endocrine feedback loops. Exposure to mechanistic thinking already during the first year of the medical curriculum increases the awareness of the importance of biophysics and mathematics in evidence-based and patient-tailored medicine. This is particularly relevant in sub-Saharan Africa, where medical practice, to a large extent, is culturally governed by the elderly generation of health professionals.

Description of the assignments

(Note that an expanded version of this section may be found in the Supplemental Material.)

Online assignments

On a weekly basis, the online assignments were given to the MD1 mostly staying in their home villages in Tanzania. Students were asked to submit the answers to the assignment questions via LEO. Thereafter, the model answers to the questions and the scoring key were made available. A novel aspect of the assignment module was self-grading. Students were asked to compare answers with the model answers and to calculate and upload scores in LEO. The answers and scores of 10 (randomly chosen) students were checked to verify the grading process and to see if there were common gaps in the knowledge that needed further attention. Care was taken to reduce the size of the files to facilitate transfer of the content to (and from) the students because Internet connections in Tanzania generally are slow. This also reduced the associated costs for students that are, in relative terms, high. Ethical approval was granted by the Research Ethics Committee of the Kilimanjaro Christian Medical University College (2503).

The subjects of the assignments were as follows: nervous system, gastrointestinal tract, metabolism, and glutamate and ego. The study material of these assignments included lecture slides related to these subjects, relevant chapters in *Guyton and Hall Textbook of Medical Physiology* (4), and a review paper (5). An example of the assignments, including model answer and scoring key, can be found in the Supplemental Material.

The number of students who uploaded the answers of the assignments during the college closure gradually declined from 158 (assignment 1) to 12 (assignment 7). The overall response, i.e., the average number of students (\pm standard error of the mean [SE]), was 125 ± 15 (63% \pm 7% of the student population). The number of students who participated in assignment 8, which could be done as a group, was 89 (12 groups and 21 individuals). The average scores of the first 7 assignments (\pm SE) were very good: 80.8 ± 1.8 (on a scale from 0 to 100). The number of students who individually uploaded the scores of the assignments gradually declined from 158 (assignment 1) to 12 (assignment 7); the average (\pm SE) was 72 ± 19 ($n = 7$).

A survey was conducted among the students by using Google Forms (Google Docs Editor software, Google, Dublin, Ireland) to obtain feedback about the level of effort and the contribution to learning, to assess the hours per week spent by the students on the assignments, and to obtain suggestions for improvement. The survey was filled in by 83 of 199 students (i.e., by 42%). Details of the results of the survey are shown in the Supplemental Material. The level of active student participation was rather high in comparison to the time allocated for individual study during the second semester of the study of medicine at KCMUCo. Moreover, note that the majority of the students were very positive about the level of effort and the contribution to learning.

Asynchronous assignments

After the closure period, students returned to the college, and online revision sessions were organized via Zoom (Zoom Video Communications, Inc., San Jose, CA) to review the study material covered by the assignments. Students without or with poor Internet facilities during closure of the college now also had access to the assignments, model answers, and histograms of the scores. The results of the subsequent, midsemester 2 exam were very similar to those of the cohort of students during the previous academic year. This suggests that the combination of online and asynchronous assignments were equally or even more effective compared with teaching during the previous academic year.

Future perspectives

During the last decade, academic online teaching has advanced at a tremendous pace. The COVID-19 pandemic has given a further boost to online teaching. It can be expected that the methods to perform online teaching will be refined in the near future further and may even become a cornerstone of university training. Sub-Saharan countries, including Tanzania, face specific challenges in this respect because of limited Internet facilities and the relatively high costs (6).

Our online assignment-based teaching module proved to be very suited for a large group of students from KCMUCo in Moshi, Tanzania, an environment with poor Internet access. It allowed individual feedback of student performance and quality assurance. One particular benefit was that the teaching module promoted interaction between students mainly residing in rural areas in sub-Saharan Africa.

The integrated nature of the essay questions did not make it possible to distinguish specifically between learning performance of the students regarding the biophysical and physiologic elements within the assignments. However, the mechanistic insight provided was highly appreciated by the students, in particular, since teaching before the MD1 entered college more frequently exposed them to fact recollection rather than to mechanistic thinking. From other components of the regular pre-COVID-19 physiology course, such as student presentations, where attention was paid to clinical applications, it became apparent that Tanzanian students, even when challenged to act otherwise, mostly chose “safe” options and preferred to present textbook material (often found via the Internet). In contrast, the assignments sparked discussions on the importance of biophysical mechanisms and models within modern evidence-based and patient-tailored medicine.

The format of this assignment-based e-learning module was tailored for its use during the closure of the college during the COVID-19 pandemic in sub-Saharan Africa. Novel aspects included the self-grading option, quality assurance of the grading process, and the possibility to identify in a timely manner common gaps in knowledge. The module stimulated active learning (i.e., it stimulated the students to actively process and apply new information). Moreover, it provided insight and feedback on the acquisition of knowledge and allowed student interaction. Individual and group assignments are essential elements in academic training. The results of this pilot study suggest that the format of the assignments used is very well suited to treat biophysical processes and models and could be used as a valuable tool to promote mechanistic thinking in online teaching in sub-Saharan Africa and in general.

SUPPLEMENTAL MATERIAL

Supplemental material includes assignment descriptions, an assignment with model answers and scoring key, and survey results; it is available at: <https://doi.org/10.35459/tbp.2021.000194.s1>.

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REFERENCES

1. Killewo, L., E. Lisasi, G. Kapanda, D. Tibyampansha, G. Ibrahim, A. Kulanga, C. Muiruri, N. Fadhili, D. Wiener, A. Wood, E. Kessi, K. Mteta, M. Ntabaye, and J. Bartlett. 2014. Introduction of a learning management system at the Kilimanjaro Christian Medical University College. *Afr J Health Prof Educ* 6:37–40.
2. Lisasi, E., A. Kulanga, C. Muiruri, L. Killewo, N. Fadhili, L. Mimano, G. Kapanda, D. Tibyampansha, G. Ibrahim, M. Nyindo, K. Mteta, E. Kessi, M. Ntabaye, and J. Bartlett. 2014. Modernizing and transforming medical education at the Kilimanjaro Christian Medical University College. *Acad Med* 89:560–564. <https://doi.org/10.1097/ACM.0000000000000327>.
3. Rose, S. 2020. Medical student education in the time of COVID-19. *JAMA* 323:2131–2132. <https://doi.org/10.1001/jama.2020.5227>.
4. Hall, J. A. 2016. *Guyton and Hall Textbook of Medical Physiology*. 13th edition. Elsevier, Philadelphia.
5. Mason, N. L., K. P. C. Kuypers, F. Müller, J. Reckweg, D. H. Y. Tse, S. W. Toennes, N. R. P. W. Hutten, J. F. A. Jansen, P. Stiers, A. Feilding, and J. G. Ramaekers. 2020. Me, myself, bye: regional alterations in glutamate and the experience of ego dissolution with psilocybin. *Neuropsychopharmacology* 45:2003–2011. <https://doi.org/10.1038/s41386-020-0718-8>.
6. Ibrahim, G., H. Luzinga, and G. Kapanda. 2020. Teaching and learning experiences in medical education during the COVID-19 pandemic: the case of Kilimanjaro Christian Medical University College (KCMUCo), Tanzania. *J Learn Dev* 7:433–446.