Comparison of Online and Classroom-based Formats for Teaching Emergency Medicine to Medical Students in Uganda

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ABSTRACT

Objectives: Severe global shortages in the health care workforce sector have made improving access to essential emergency care challenging. The paucity of trained specialists in low- and middle-income countries translates to large swaths of the population receiving inadequate care. Efforts to expand emergency medicine (EM) education are similarly impeded by a lack of available and appropriate teaching faculty. The development of comprehensive, online medical education courses offers a potentially economical, scalable, and lasting solution for universities experiencing professional shortages.

Methods: An EM course addressing core concepts and patient management was developed for medical students enrolled at Makerere University College of Health Sciences in Kampala, Uganda. Material was presented to students in two comparable formats: online video modules and traditional classroom-based lectures. Following completion of the course, students were assessed for knowledge gains.

Results: Forty-two and 48 students enrolled and completed all testing in the online and classroom courses, respectively. Student knowledge gains were equivalent (classroom 25 ± 8.7% vs. online 23 ± 6.5%, p = 0.18), regardless of the method of course delivery.

Conclusions: A summative evaluation of Ugandan medical students demonstrated that online teaching modules are effectively equivalent and offer a viable alternative to traditional classroom-based lectures delivered by on-site, visiting faculty in their efficacy to teach expertise in EM. Web-based curriculum can help alleviate the burden on universities in developing nations struggling with a critical shortage of health care educators while simultaneously satisfying the growing community demand for access to emergency medical care. Future studies assessing the long-term retention of course material could gauge its incorporation into clinical practice.

As the gap in access to quality health care continues to widen for those in resource-challenged countries, building an adequate workforce capacity globally has become an increasingly pressing
international objective. In 2006, the World Health Organization estimated a deficit of over 4 million health care workers in 57 countries, with the greatest shortfalls in the developing nations spanning sub-Saharan Africa.\(^1\) That estimate is expected to magnify threefold by the year 2035, with a projected health worker shortage of upwards of 12.9 million.\(^2\) While many countries are increasing medical student enrollment in an effort to alleviate this deficit, a dearth of qualified teaching faculty exacerbates the problem.\(^3\) Additionally, a growing community-based need for access to emergency care has increased momentum to introduce emergency medical training in developing nations—thereby compounding the existing strain on educators, most of whom lack the knowledge base to instruct students on such a nascent specialty.\(^4,5\)

Web-based health education may provide a much-needed salve for the challenges faced by many low- and middle-income countries (LMICs). Online teaching tools offer students direct access to didactic and educational resources traditionally beyond their reach. Health care institutions themselves benefit, as online coursework may provide significant cost savings while also offering scalable, flexible, easily updatable, and reusable platforms that can be shared between multiple institutions.\(^6\) Previous research investigating the efficacy of online learning in developed countries has proven it academically equivalent to its conventional classroom-based counterpart and openly accepted by students.\(^7,8\) Similar research in LMICs has been encouraging, albeit limited. The use of Web-based learning in developing nations has predominantly focused on short, single, educational modules, rather than full-length courses.\(^9\) To our knowledge, no studies have examined the effectiveness of a comprehensive online medical course on emergency medicine (EM) in a developing nation, particularly in sub-Saharan Africa. With this in mind, we partnered with Makerere University College of Health Sciences in Kampala, Uganda, to investigate the efficacy of utilizing online medical education as a means of addressing this severe deficit and introducing EM to its students.

**METHODS**

**Educational Design and Delivery**

Board-certified EM physicians from Stanford School of Medicine developed a novel course covering core concepts in the recognition and treatment of patients with life-threatening emergencies, emphasizing the management of the undifferentiated patient. The course consisted of 20 modules, utilized a chief complaint-based approach, and focused on knowledge essential for the practice of EM. The content was presented in English (an official Ugandan language) by Stanford and guest faculty in 10- to 15-minutes video modules viewable on mobile platforms. Permission was obtained from Warner Bros. Entertainment Inc. for the inclusion of clips from the television drama “ER” used as case studies to discuss diagnosis and management of patients.

The content for both educational modes—online and classroom-based—was identical. The online course was conducted over 10 weeks during the spring of 2014. Students could access the online content from any Internet-connected source, including the university’s intranet server and computer lab. The classroom-based course was taught by visiting faculty as an intensive, weeklong seminar on the Makerere University campus in August 2014. This project was reviewed by the Stanford Institutional Review Board and determined to be exempt.

**Setting and Population**

Preclinical and clinical students at Makerere University College of Health Sciences who enrolled in the study were divided into two cohorts based on their availability. To limit selection bias, students did not choose the method of course delivery and the courses did not run concurrently.

**Evaluation and Analysis**

All students were evaluated before and after course completion to assess familiarity with the presented material. The study’s primary outcome was knowledge gain, defined by the difference between pre- and post-test scores. Tests included 40 multiple-choice (MCQ) and 40 free-response questions, written by board-certified EM faculty members and reviewed for content validity, clarity, and accuracy by a separate EM faculty member. The free-response questions assessed complex knowledge and clinical decision making, supporting their increased weighting as compared to MCQs (MCQ = 40 points; free-response = 80 points; total examination = 120 points). A predefined scoring rubric standardized grading of the free-response questions as full (2 points), partial (1 point), or no (0 points) credit, with scores for ambiguous answers reached by faculty consensus. Five faculty graders were blinded to the students’ name and cohort (online vs. classroom),
with each grader scoring the same set of questions on all examinations. Pre- and posttest questions addressed similar content without overlapping or repeating questions between the tests. Tests were identical for both cohorts.

Both study cohorts experienced a withdrawal of students following course commencement. The classroom-based group also experienced the late enrollment of students following administration of the pretest. Therefore, due to fluctuating enrollment in both groups, paired t-test analysis was performed for only the subset of students completing both pre- and posttests. As a basis for comparison, independent t-tests were used to compare all pretests to all posttests. Mixed analysis of variance compared knowledge gain between online and classroom groups, using all test takers. Demographics, attitudes, and experience levels between the two groups were compared using chi-square tests for categorical variables and Wilcoxon rank-sum tests for continuous variables. All data analysis was conducted via STATA Version 13.

RESULTS

Initial enrollment in the online and classroom-based courses was 77 and 80 students, respectively. There was a 36.4% (n = 28) attrition rate from the online group. In the classroom group, a comparable number of students left the course (n = 18, 22.5%) as joined throughout its duration (n = 21, 26.3%). No statistically significant difference in sex, clinical experience, or prior exposure to online courses was noted between the cohorts enrolled in each course (p < 0.01; see Data Supplement S1, available as supporting information in the online version of this paper, which is available at http://onlinelibrary.wiley.com/doi/10.1002/aet2.10066/full). More than 97% of students, regardless of group, reported being comfortable with English, rating their language proficiency as “good” or “very good.” Of enrolled students, 42 and 48 students completed both pre- and posttesting in the online and classroom courses, respectively. Knowledge gain was statistically significant across all examination sections for both online and classroom-based groups (p < 0.001; see Data Supplement S2, available as supporting information in the online version of this paper, which is available at http://onlinelibrary.wiley.com/doi/10.1002/aet2.10066/full). Students demonstrated equivalent knowledge gain in the free-response section and total examination score (p = 0.32 and p = 0.18, respectively; Figure 1). However, the classroom-based group did demonstrate a greater knowledge gain on the MCQ section compared to the online cohort (p = 0.03).

DISCUSSION

Our study definitively demonstrates that a comprehensive, online course covering the fundamentals of EM offers a successful and viable alternative to time-intensive classroom-based seminars taught by visiting instructors. Incorporating Web-based coursework within the established, conventional curriculum can help alleviate the burden on universities in developing nations struggling with critical shortages of EM-trained educators. Such training will also ultimately help satiate the growing global demand for access to emergency medical care.

Analysis indicated no significant differences in knowledge gain between the online and classroom-based cohorts, suggesting that both methods of instruction provide equivalent learning. However, notable differences in attrition between the two platforms were observed. The classroom-based approach, offered during a school break, exhibited greater completion than the online course, offered during the academic year. The increased accompanying workload and protracted online format may have contributed to the increased attrition rate among this cohort. However, given that students completing the entire course experienced comparable success, incorporating the course into the standard, required curriculum for subsequent students would negate this issue.

The Web-based course is a promising option for the delivery of a basic EM curriculum in LMICs; however, we did not assess the longitudinal retention of the material. Follow-up studies to evaluate material retention and its incorporation into patient care, as well as the sustainability of the online program, would be beneficial. Comparative cost and time investment analyses of developing a novel online course that can be reused and shared, compared to sending teams of visiting educators year after year, would enable more informed decision making. Such analyses will determine if the higher upfront costs and time demands of developing an original online program (e.g., lecture preparation, filming, Web hosting, translation) merit both the expense—given its adaptability and long-term usability—and the time...
investiture—reducing the need for visiting faculty.\textsuperscript{6,10} As global health priorities increasingly refocus efforts to address major shortages in the health care labor force, it is vital that the means of delivering essential emergency care training throughout the developing world is not only innovative and effective, but also economical and efficient.

**LIMITATIONS**

Courses were capped at 80 students due to logistic limitations of the classroom setting. The difference in the timing of the two course offerings may have impacted attrition rates and the delayed posttesting of the online group (3 months) versus the classroom cohort (immediately) may have impacted measured knowledge gains on the MCQs. The high attrition rates may limit the power to detect differences between groups or identify participants failing to adapt to or who are unmotivated by the online learning format.

**CONCLUSIONS**

A complete online course covering the fundamentals of emergency medicine offers a successful and viable alternative to intense, classroom-based programs taught by visiting instructors. Web-based curriculum can help alleviate the burden on universities in developing nations struggling with a critical shortage of health care educators while simultaneously satisfying the growing community demand for access to emergency medical care.

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Supporting Information

The following supporting information is available in the online version of this paper available at http://onlinelibrary.wiley.com/doi/10.1002/aet2.10066/full

Data Supplement S1. Demographics and pre-course characteristics of Ugandan medical students participating in either a traditional classroom or online course on emergency medicine, Kampala, Uganda 2014.

Data Supplement S2. Comparison of test results among Ugandan medical students participating in either a traditional classroom or online course on emergency medicine, Kampala, Uganda 2014.