Original Study

ANNALS OF SURGERY

OPEN

An Online, Modular Curriculum Enhances Surgical Education and Improves Learning Outcomes in East, Central, and Southern Africa: *A Mixed-Methods Study*

Andrea S. Parker, MD, FACS, FCS(ECSA),*†‡ Bruce C. Steffes, MD, MBA, MA, FACS, FWACS, FCS(ECSA), FICS,‡§ Katherine Hill, MD, MS,‖ Niraj Bachheta, MSc,‡ Deirdre Mangaoang, MBA,¶ Michael Mwachiro, MBChB, MPH, FCS(ECSA),*‡ Laura Torbeck, PhD,# Russell E. White, MD, MPH, FACS, FCS(ECSA),*†‡ Abebe Bekele, MD, FCS(ECSA), FACS,‡**†† and Robert K. Parker, MD, MPH, FACS, FCS(ECSA)*†

Objective: We aimed to determine the impact of a standardized curriculum on learning outcomes for surgical trainees in East, Central, and Southern Africa (ECSA).

Background: As surgical education expands throughout ECSA, there is a recognized need for a standardized curriculum. We previously described the design of a novel, large-scale, flipped-classroom, surgical curriculum for trainees in ECSA.

Methods: In January 2020, the first year of curricular content for trainees of the College of Surgeons of ECSA was released, containing 11 monthly thematic topics, each with 2 to 5 weekly modular subtopics. We aimed to evaluate 3 outcomes utilizing data sources incorporated into the curriculum structure. Learner engagement was assessed by the number of trainees completing curriculum topics. User experience was evaluated using quantitative and qualitative feedback responses to embedded surveys for each content week. Curriculum impact on trainee examination performance was assessed by comparing certification examination scores stratified by the number of curricular topics each trainee completed.

Results: Two hundred seventy-one trainees (96%) in 17 countries accessed at least 1 weekly module. Trainees completed a median of 9 topics (interquartile range: 6–10). The feedback survey response rate was 92% (5742/6233). Quantitative and qualitative responses were positive in overall module value (93.7% + 2.6%), amount of learning experienced (97.9% + 1.4%), confidence in achieving learning objectives (97.1% + 2.4%), and ease of use of the module (77.6% + 5.98%). Topic-related certification examination performance improved significantly with increased completion of thematic topics.

Conclusions: A standardized surgical curriculum in ECSA demonstrated excellent trainee usage, positive feedback, and improved examination scores.

Keywords: educational outcomes, global surgery, mixed-methods analysis, qualitative analysis, sub-Saharan Africa, surgical curriculum, surgical education

*From the *Department of Surgery, Tenwek Hospital, Bomet, Kenya; †Department of Surgery, Alpert Medical School of Brown University, Providence, RI; ‡College of Surgeons of East, Central, and Southern Africa, Arusha, Tanzania; §Pan-African Academy of Christian Surgeons, Palatine, IL; ‖Department of Surgery, University of Pittsburgh Medical Center, Pittsburgh, PA; ¶Institute of Global Surgery, Royal College of Surgeons in Ireland, Dublin, Ireland; #Department of Surgery, Indiana University School of Medicine, Indianapolis, IN; **University of Global Health Equity, Kigali, Rwanda; and ††Department of Surgery, Addis Ababa University, Addis Ababa, Ethiopia.*

Disclosure: The authors declare that they have nothing to disclose.

Data: Supporting data underlying this article may be available upon request to the corresponding author.

All authors listed in this manuscript meet the criteria for authorship under Annals of Surgery guidelines. As this manuscript assesses outcomes of a multinational, large-scale curriculum development project, there are several important contributors. All authors have given final approval of the version to be submitted. A.S.P. made substantial contributions to the conception and design of this study, the collection, analysis, and interpretation of data, and to writing the manuscript. B.C.S. made substantial contributions to the acquisition of data related to the examination scores and assessment of module- and non–module-related questions and has critically revised the manuscript. K.H. made substantial contributions to the conception and design this study, specifically relating to the acquisition of user feedback. She was instrumental in the analysis and interpretation of data and has critically revised the manuscript. D.M. and N.B. made substantial contributions to the acquisition of data relating to trainee engagement and tracking of learner participation and have critically revised the manuscript. M.M. and A.B., as members of the COSECSA examinations committee, substantially contributed to acquisition of examination data and analysis and interpretation of that data and have critically revised the manuscript. L.T. has made substantial contributions to the analysis and interpretation of all sources of data and has critically revised the manuscript. R.E.W., as the chair of the COSECSA education committee, made substantial contributions to the conception and design of this study and has critically reviewed the manuscript. R.K.P. has substantially contributed to the conception and design of this study, the collection, analysis, and interpretation of data, and was substantial in writing and critical revision of the manuscript.

SDC *Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.annalsofsurgery.com).*

Reprints: Andrea S. Parker, MD, FACS, FCS(ECSA), Department of Surgery, Tenwek Hospital, PO Box 39, Bomet 20400, Kenya. Email: andrea_fisher@brown.edu.

Annals of Surgery Open (2022) 1:e140

Received: 10 November 2021; Accepted 20 January 2022

Published online 2 March 2022

DOI: 10.1097/AS9.0000000000000140

INTRODUCTION

Surgical education is a vital component of expanding access to surgical care in low- and middle-income countries (LMICs)[1–4] as increasing the surgical workforce remains a key intervention priority for sub-Saharan Africa.[3] Tailored curricular activities have been determined to be a necessary part of improving surgical education in LMICs like those in East, Central, and Southern Africa (ECSA).[5–10] Despite this recognition, there has been a lack of standardized surgical curricula for training programs in this region.[6, 11] Standardized medical and surgical curricula have previously been shown to increase uniformity of knowledge,[12] ensure necessary content is covered without solely relying on case- and patient-based experiences within training,[13] and increase in-training examination scores.[12, 14] A context-relevant, standardized surgical curriculum was identified as a priority to address this gap and enhance surgical training programs in the ECSA region. In the preceding paper, we describe a standardized online curriculum designed and developed for trainees within the College of Surgeons of East, Central, and Southern Africa (COSECSA).[15] This study aimed to report outcomes following the first year of curriculum implementation as evaluated through trainee utilization, participant perceptions, and impact on certification examination performance.

METHODS

Setting, Curriculum Design, and Participants

COSECSA is a nonprofit professional body that fosters surgical education by providing postgraduate surgical training in the rural areas of the ECSA region.[16] It is the largest surgical training institution in sub-Saharan Africa and provides graduates with an internationally recognized surgical qualification. The Surgical Foundations in Basic Science curriculum is a 2-year, online, flipped-classroom surgical curriculum designed for first- and second-year surgical trainees (designated as trainees for Membership in the College of Surgeons or Membership of the College of Surgeon [MCS] trainees) of COSECSA. The curriculum is structured for trainees to independently complete a weekly web-based module, which includes learning objectives, a precontent multiple-choice assessment, topical content sections, and a postcontent multiple-choice assessment. In addition to written material, the modules incorporate interactive and multimedia components like videos and interactive images. Completing the module is intended to prepare trainees for a semistructured group tutorial time consisting of small group activities and discussions that aim to solidify the important themes and concepts.

In January 2020, the curriculum was released for use by trainees in 17 COSECSA member and affiliate countries. These were the COSECSA countries with enrolled MCS trainees at the time of the curriculum release and are listed in Supplemental File A http://links.lww.com/AOSO/A103. Though encouraged, the modular curriculum was not mandatory in the initial year of implementation, which was the timeframe for reporting our outcomes. The curriculum is organized by thematic topic, each composed of 2 to 5 subtopics. For each subtopic, instructional material is delivered via an online module, which learners complete independently over the course of 1 week in preparation for a group teaching session. The COSECSA institutional review board granted ethical approval for this study.

Study Design

Based on the curriculum design, outcomes were evaluated via 3 sources: uptake and utilization of the curriculum (termed engagement), qualitative and quantitative user responses (termed feedback), and certification examination performance data (termed examination).

Engagement

The outcome of engagement in the modules was determined by the number of thematic topics completed by trainees. Each trainee's participation in the weekly online content was tracked via the learning management system. Participants are required to achieve a score greater than 80% on a postcontent, multiple-choice question assessment to complete the module. After completion of all modular subtopics, the thematic topic is recorded as complete.

Feedback

To evaluate users' experiences with the online curriculum and investigate perceptions of learning related to the stated learning objectives, we reviewed user-reported feedback to perform content analysis. At the end of each week of content, participants were invited to take a brief anonymous survey about the learning experience via an embedded Google form (Google LLC). Feedback was solicited using several open- and closed-ended questions incorporating Likert scales and free-text responses.

Examination

To determine the effectiveness of the curriculum, we evaluated the association between completion of the curriculum and certification examination scores. For the first 2 years, trainees are enrolled in the MCS surgical training program.[11] At the completion of MCS training, trainees take a written summative certification examination, successful completion of which qualifies them for an objective structured clinical examination. Passage of these examinations allows the trainee to continue with further training. The validated, standardized written examination consists of 120 multiple-choice questions on topics related to the general practice and basic principles of surgery and serves as a proxy for attaining sufficient surgical knowledge. The multiple-choice questions on the 2020 examination were reviewed by three authors (RKP, ASP, BCS) to determine, a priori, which questions were related to thematic topics covered in the first year of the Surgical Foundations in Basic Science curriculum. Those questions that assessed information covered in the curriculum were designated module-related questions; questions that assessed information not covered in the curriculum were designated nonmodule questions.

Analysis and Assessment of Curriculum Outcomes

Engagement

Participation was analyzed to identify the total number of trainees completing each thematic topic, which required completing all subtopics. Due to a technical error with uploading the Anesthesia and Perioperative care modules, the number of participants for this one topic could not be obtained.

Evaluation of Feedback

Based on the mixed-methods study design, we performed quantitative survey analysis and qualitative content analysis of the feedback responses provided by the trainees. For ease, we utilized a convergent survey design,[17] eliciting quantitative and qualitative feedback from all users. The feedback text was analyzed separately and integrated during interpretation. Closed-ended questions were dichotomized to determine reported percentages of learning, confidence, value, and ease of use. Qualitative source material was reviewed in its entirety. Due to the volume of responses, autocoding was used to initially identify themes for each open-ended question[18] using NVivo 12 Plus software (QSR International), which facilitates the analysis of large amounts of free-text data. Proceeding forward, the text was explored and further coded to develop emerging themes

and subthemes with an inductive approach by two investigators (RKP, ASP) until saturation was reached. Representative comments for each subtheme were extracted.[19]

Examination Performance

Examinees who took the 2020 MCS certification examination were stratified into groups based on the number of completed thematic topics (0–3, 4–6, or >6) available at the time of the examination. Examination performance, as measured by average score, was compared using these groups. To better understand the direct impact of the curriculum, we assessed performance on individual questions relevant to the topics covered in the curriculum (36 questions), comparing examinees who did and did not complete the modular content specific to these questions. We also evaluated performance on the non–module-related questions (84 questions) to control and account for a trainee's baseline medical knowledge and ability to navigate multiple-choice examinations. Quantitative analysis was conducted using Stata version 16 (Stata Corp). Pearson's χ^2 test was used for categorical data, and analysis of variance was used for continuous outcomes. A multiple linear regression model was created. The outcome was examination scores on modular curriculum topics, and the exposure was the number of thematic topics completed within the curriculum, controlling for performance on non–curriculum-related questions. A P value of <0.05 was considered statistically significant.

RESULTS

Engagement

In 2020, 283 trainees were granted access to the material in 17 countries. 271 trainees (96%) accessed at least 1 weekly module. Among the 10 topics with available data, trainees completed a median of 9 thematic topics (interquartile range: 6–10). Trainees who participated in the weekly modules achieved a passing score on the postmodule assessment 91% of the time (6233 passing scores out of 6870 assessments). Table 1 displays the number of trainees who completed the available topics.

Feedback

Feedback was provided 5978 times via the weekly postmodule surveys, corresponding to an approximate 92% response rate (5742/6233, excluding the anesthesia modules). The response rates for each thematic topic are shown in Table 2. Average responses were positive in: overall value of the module (93.7% ± 2.6%), amount of learning experienced for the objectives (97.9% ± 1.4%), confidence in achieving the learning objectives (97.1% ± 2.4%), and ease of use of the module (77.6% ± 5.98%). The levels of value, learning, and confidence are graphically presented by thematic topic in Figure 1. Qualitative analysis revealed themes and subthemes of the free-text responses as displayed in Table 3.

Examination

At the time of the written membership examination in September 2020, 8 thematic topics had been introduced. The ninth topic (Burns) became available in September but was not widely utilized as the examination was the first week of September. One-hundred twenty-two candidates took the written certification examination. Among examinees, 120 (98%) participated in at least 1 weekly module. The average examination scores by topics completed are exhibited in Table 4, and further performance on specific topic questions

TABLE 1.

Completion of Modular Curriculum Content by Thematic Topic

Thematic Topics	Released in 2020	Weekly Subtopic Modules	Trainees Who Completed the Topic*	Percentage Completing Topic†
Statistics & Research Methods	January	2	238	84.1
Oncology	February	3	229	80.9
Wound Healing	March	4	229	80.9
Fluids & Electrolytes	April	4	246	86.9
Systemic Response to Injury	May	3	237	83.7
Shock	June	4	218	77.0
Hemostasis	July	3	191	67.5
Trauma	August	5	165	58.3
Burns	September	3	166	58.7
Surgical Infections	October	2	164	58.0
Anesthesia and Perioperative Considerations‡	November	2	—	—

*Completion as documented on December 31, 2020.

†As information on attrition at individual training programs was not tracked, we used the number of trainees who were given initial access as the denominator (N = 283).

‡Anesthesia and Perioperative Considerations was the 11th topic, but results were not recorded due to technical error.

TABLE 2.

Response Rates for Feedback by Thematic Topic

Thematic Topics	Number of Weekly Modules	Number of Passing Scores	Number of Feedback Surveys Completed	Response Rate (%)
Statistics & Research Methods	2	404	383	94.8
Oncology	3	648	588	90.7
Wound Healing	4	892	767	86.0
Fluids & Electrolytes	4	824	783	95.0
Systemic Response to Injury	3	582	565	97.1
Shock	4	696	679	97.6
Hemostasis	3	573	534	93.2
Trauma	5	825	791	95.9
Burns	3	471	467	99.2
Surgical Infections	2	318	228	71.7
Anesthesia and Perioperative Considerations*	2	-	255	-

*Anesthesia and Perioperative Considerations was the eleventh topic, but results were not recorded due to technical error.

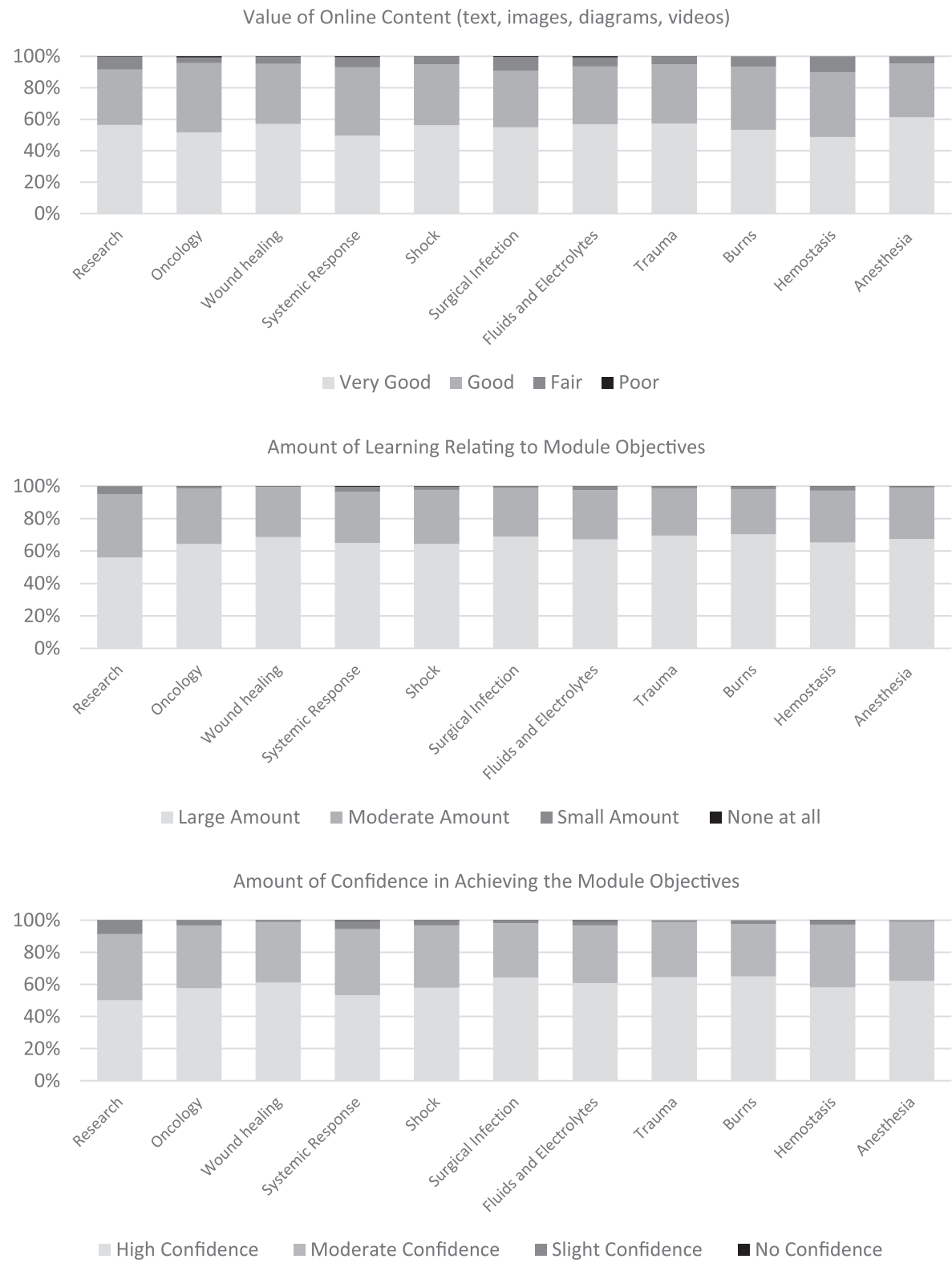

FIGURE 1. Quantitative feedback by thematic topic regarding overall value of the module, amount of learning experienced, and confidence in achieving objectives.

is detailed in Table 5. The multiple linear regression model was calculated to establish the effect on modular curriculum-related examination scores by the number of modules completed, controlling for the examinees' performance on questions not related to curricular topics. A significant regression equation ($F[2,119] = 42.1$, $P < 0.001$ with an r^2 of 0.41) demonstrated examination scores on module-related questions were equal to $9.2 + 0.61 \times$ (number of topics completed) $+ 0.27 \times$ (performance on nonmodule examinations). Examinees' scores on the module-related questions increased by 0.61 points for every topic completed, a significant predictor ($P < 0.001$).

TABLE 3.

Qualitative Analysis of the Feedback Provided by Participants After Weekly Module Completion

Theme	Subtheme	Representative Comments
List any components of the module that were particularly helpful		
Everything or all	1. Appreciation	"All"
	2. Satisfaction	"All components were very useful"
Topic-specific content	1. Explanation of particular concepts within topic	"Management and classification of pelvic and extremity fracture were very helpful" (Trauma)
	2. Practical examples with content application	"[Comparison of] the changes in metabolism between the fed state, the fasted state, and states of stressed illness." (Systemic response to injury)
		"Critically assessing literature, types of studies, hypothesis testing." (Research)
Examples and scenarios	1. Clinical connections	"Healing in specific type of tissues and their clinical correlation"
	2. Summarized content	"Clear examples. Simple language"
		"The clinical application of different forms of shock"
Multimedia components	1. Video	"Good knowledge checks lead to better understanding."
	2. Reading materials	"Video tutorials are impressive"
	3. Diagrams, interactive activities, and illustrations	"Interactive approach to learning"
	4. Knowledge checks	
Any suggestions on how to improve this module		
Desire for more content	1. More videos	"More studies quoted and possible links to download those papers."
	2. More diagrams, illustrations, and interactive content	"More videos and links to guidelines and papers would be much welcome."
	3. More practice opportunities such as knowledge checks and multiple-choice questions	"More questions after reading assignments"
		"Give a short summary of video tutorial on all subject"
Internet functionality	1. Access to offline or downloadable content	"To provide a downloadable module for offline use"
		"Make videos downloadable"
No suggestions or encouragement	1. Desire for continued use	"Excellent work. Well summarized"
	2. Approval of methods	"Good module. Good pictures and questions. I would keep as is."
		"Module is well structured"
		"Keep it up!"
Technical challenges or issues you encountered while using the online module		
Network connectivity	1. Internet reliability	"Kept losing my progress, likely due to poor internet connection"
	2. Failure to save progress	"Due to internet interruption, video took a lot more time to load."
	3. Failure to load content	
No challenges	1. Ease of use	"No issues or technical challenges"
	2. Encouragement to continue with the teaching method	"I appreciate this way of teaching and learning"

TABLE 4.

Performance on Certification Examination Stratified by the Number of Topics Completed

Factor	Overall	Completed 0–3 Topics	Completed 4–6 Topics	Completed >6 Topics	*P*
Number of candidates	122	11	24	87	
Passed examination, N (%)	105 (86)	6 (55)	21 (88)	78 (90)	0.006
Examination score on module-related questions (N = 36), average score (SD); (% correct)	25.7 (4.0); (71)	20.6 (5.0); (57)	25.5 (3.0); (71)	26.4 (3.6); (73)	<0.001
Examination score on non–module questions (N = 84), average score (SD); (% correct)	46.4 (7.3); (55)	41.9 (5.8); (50)	45.2 (7.1); (54)	47.3 (7.4); (56)	0.05
Overall examination score (N = 120), average score (SD); (% correct)	72.1 (10.1); (60)	62.5 (10.1); (52)	70.7 (8.9); (59)	73.7 (9.8); (61)	0.002

TABLE 5.

Performance on Module-Related Questions Among Examinees by Completion of the Thematic Topic

Module	Number of Examinees Who Completed Topic*	Percentage of Examinees Who Completed Topic	Number of Examination Questions on Topic	Overall Average Correct	Completed Topic	Did Not Complete Topic	*P*
Statistics & Research Methods	111	91.0	2	1.61	1.63	1.45	0.3
Oncology	107	87.7	2	1.17	1.21	0.93	0.1
Wound Healing	107	87.7	7	5.02	5.19	3.87	0.0002
Fluids & Electrolytes	116	95.1	4	2.37	2.41	1.67	0.03
Systemic Response to Injury	109	89.3	5	3.64	3.74	2.85	0.0008
Shock	106	86.9	4	3.55	3.67	2.75	<0.0001
Hemostasis	84	68.9	2	1.27	1.37	1.05	0.01
Trauma	73	59.8	7	5	4.92	5.12	0.3

*Completion as of September 2020 at the time of the examination.

DISCUSSION

A quality surgical curriculum is an essential component of effective surgical training programs,[20, 21] increasingly recognized as necessary to developing surgical education in LMICs.[8–10] Online curricula are an integral part of surgical training in high-income countries,[22] and blended learning instructional designs like the flipped classroom have been shown to improve trainee performance.[23] Covering a large, heterogeneous area and involving nearly 300 trainees in 17 countries, the results of this study demonstrate that an online, modular surgical curriculum can be successfully implemented in sub-Saharan Africa, as indicated by the high utilization of the curriculum.

The mixed-methods approach allows for parallel analysis of quantitative and qualitative aspects of student perceptions of the curriculum, which is an important strength of this study. A large majority of participants (92%) responded to the feedback surveys. This excellent response rate ensures that we understand most trainees' experience with the curriculum, thus increasing the validity of our findings. Trainee perceptions of the content were favorable toward the value of the weekly modules, the learning that occurred, and the confidence that resulted from their use. Qualitative analysis showed a strong desire for more content, especially multimedia and interactive content like videos, multiple-choice questions, and clinical scenarios. Our data were consistent with other conclusions supporting the effectiveness of incorporating active learning tools within surgical curricula.[24]

In addition to largely positive trainee perceptions, we show the objective effectiveness of the curriculum based on the results of the summative COSECSA certification examination, which is used to assess trainees' medical knowledge and determine their ability to progress through training.[25] Trainees who completed the modular curriculum topics demonstrated significant improvement on written examination performance, with scores proportionate to their degree of completion of the curriculum. This finding holds true even when controlling for trainee baseline medical knowledge and aptitude with standardized testing. Participation in the modular curriculum thus represents an effective learning strategy. Passing certification examinations is a marker of surgeon quality and professionalism,[26] and a curriculum that improves passage rates is an important contribution to surgical education and quality.

While meaningful in its scope, this study is limited in that it reviews a single year of data. Evaluating trends in the use of the curriculum would better characterize potential chronologic shifts in curriculum uptake. Further, while we designed the curriculum as a flipped-classroom structure, we were not able to put into place a formal way to monitor the institutional performance of the group tutorial session. Based on informal feedback from trainees and faculty, the group tutorial time is occurring at many institutions. However, there is likely variable application of this practice, especially in programs with fewer faculty. This limits assessment as to whether true blended learning is consistently being employed. It is also possible that the presence of more engaged faculty increases both the use of the modules and examination scores. However, the impact of faculty engagement was not addressed in this study. Finally, we recognize that the anonymous nature of the survey and resultant lack of demographic data collected represents a potential limitation of the study. The primary goal of the survey is to evaluate the curriculum's effectiveness and impact and obtain feedback for improvements in future iterations. Thus, to maximize feedback responsiveness and decrease social desirability bias, we opted to maintain anonymity for survey respondents.

Despite high uptake and overwhelmingly positive quantitative and qualitative feedback, we found technical challenges to be the greatest source of negative feedback. Within LMICs, internet connectivity due to low bandwidth is a commonly cited challenge for lack of uptake.[27, 28] Yet, our study shows that despite issues related to internet functionality, uptake of the curriculum was excellent. Somewhat paradoxically, there was a strong desire for more multimedia content. Other studies have similarly shown good utilization of web-based curricula in our region.[27, 29, 30] Many trainees in our region report using the internet for learning opportunities during the coronavirus disease 2019 (COVID-19) pandemic,[31] and there is a desire by trainees to have access to educational content via distance learning, specifically basic science modules.[28] While the implementation of our curriculum was independent of the COVID-19 pandemic, it is possible that the pandemic impacted utilization. Numerous comments expressed a desire for the content to be made available offline for those training institutions with poor internet functionality. This potential concern was anticipated in the curriculum design, and the decision was made to make the content available to COSECSA program directors in an offline format. With the implementation of the curriculum, the content was made available in a fully functional HTML web format on USB flash drives and for download from a Google drive (Google LLC). Program directors had access to offline content, but trainees were unaware of this and expressed their desire for it. This reveals a communication gap that we hope to correct. While the nature of this miscommunication is not fully understood, we anticipate that a better presentation of information regarding these available offline versions will help to alleviate the frustration expressed by participants when they encounter bandwidth or connectivity issues.

Surgical education in LMICs remains a vital endeavor with tremendous opportunities, including that of curriculum development. With the completion of the curriculum for the MCS trainees this year, we anticipate several future directions for this project. With the knowledge gained from the analysis of the qualitative feedback, we plan to begin updates and revisions to the content. Consistent with the feedback received, we plan to increase the multimedia content within the modules and hope to collaborate with those creating such content for educational purposes. Finally, we anticipate beginning the design and development of a standardized surgical curriculum for senior trainees pursuing general surgery training through COSECSA.

Online, modular surgical curriculum is effective in the ECSA region based on trainee use, perceptions, and performance. With increasing internet use and availability in sub-Saharan Africa, web-based content delivery is ideal for addressing the perceived need for standardized surgical curriculum in the region.[9] The flipped-classroom instructional design with the incorporation of active learning techniques applies current best educational practices to this surgical curriculum. Further, online content helps supplement the gaps in education within various disciplines of surgery[32] and creates context specificity. The successful implementation of a standardized surgical curriculum is a crucial step in advancing global surgical education and closing the surgical access gap.

REFERENCES

1. Meara JG, Leather AJ, Hagander L, et al. Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development. *Lancet*. 2015;386:569–624.
2. Binda C, Zivkovic I, Duffy D, et al. Evaluation of interventions addressing timely access to surgical care in low-income and Low-Middle-Income countries as outlined by the Lancet Commission 2030 global surgery goals: a systematic review. *World J Surg*. 2021;45: 2386–2397.
3. Luboga S, Macfarlane SB, von Schreeb J, et al; Bellagio Essential Surgery Group (BESG). Increasing access to surgical services in sub-saharan Africa: priorities for national and international agencies recommended by the Bellagio Essential Surgery Group. *PLoS Med*. 2009;6:e1000200.
4. Rickard J. Systematic review of postgraduate surgical education in low- and middle-income countries. *World J Surg*. 2016;40:1324–1335.
5. Galukande M, Luboga S, Elobu E. Challenges facing surgical training in the Great Lakes region in sub-Saharan Africa: a review article. *East Central African J Surg*. 2013;18:3–11.

6. Rickard J, Ntirenganya F, Ntakiyiruta G, et al. Global health in the 21st century: equity in surgical training partnerships. *J Surg Educ*. 2019;76:9–13.
7. Talib Z, Narayan L, Harrod T. Postgraduate medical education in sub-Saharan Africa: a scoping review spanning 26 years and lessons learned. *J Grad Med Educ*. 2019;11(suppl 4):34–46.
8. Cameron BH, Rambaran M, Sharma DP, et al. The development of postgraduate surgical training in Guyana. *Canadian J Surg*. 2010; 53:11.
9. Krishnaswami S, Nwomeh BC, Ameh EA. The pediatric surgery workforce in low- and middle-income countries: problems and priorities. *Semin Pediatr Surg*. 2016;25:32–42.
10. Jayaram A, Pawlak N, Kahanu A, et al. Academic global surgery curricula: current status and a call for a more equitable approach. *J Surg Res*. 2021;267:732–744.
11. Kakande I, Mkandawire N, Thompson M. A review of surgical capacity and surgical education programmes in the COSECSA region. *East Central African J Surg*. 2011;16:6–34.
12. Lambert DR, Lurie SJ, Lyness JM, et al. Standardizing and personalizing science in medical education. *Acad Med*. 2010;85:356–362.
13. Smeds MR, Sheahan MG, Shames ML, et al. A modern appraisal of current vascular surgery education. *J Vasc Surg*. 2021;73:1430–1435.
14. Kelly DM, London DA, Siperstein A, et al. A structured educational curriculum including online training positively impacts American Board of Surgery In-Training Examination Scores. *J Surg Educ*. 2015;72:811–817.
15. Parker AS, Hill KA, Steffes BC, et al. Design of a novel online, modular, flipped-classroom surgical curriculum for East, Central, and Southern Africa. *Ann Surg Open*. 2022;1:e141.
16. COSECSA. College of Surgeons of East, Central, and Southern Africa 2021. Available at: https://www.cosecsa.org. Accessed September 21, 2021.
17. Fetters MD, Curry LA, Creswell JW. Achieving integration in mixed methods designs-principles and practices. *Health Serv Res*. 2013;48(6 pt 2):2134–2156.
18. Abd-Elrahman A, Andreu M, Abbott T. Using text data mining techniques for understanding free-style question answers in course evaluation forms. *Res High Educ J*. 2010;9:1.
19. Thomas DR. A general inductive approach for analyzing qualitative evaluation data. *Am J Evaluat*. 2006;27:237–246.
20. Debas HT, Bass BL, Brennan MF, et al; American Surgical Association Blue Ribbon Committee. American Surgical Association Blue Ribbon Committee Report on Surgical Education: 2004. *Ann Surg*. 2005;241:1–8.
21. Bell RH. Surgical council on resident education: a new organization devoted to graduate surgical education. *J Am Coll Surg*. 2007;204:341–346.
22. Jayakumar N, Brunckhorst O, Dasgupta P, et al. e-learning in surgical education: a systematic review. *J Surg Educ*. 2015;72:1145–1157.
23. Hew KF, Lo CK. Flipped classroom improves student learning in health professions education: a meta-analysis. *BMC Med Educ*. 2018;18:38.
24. Luc JGY, Antonoff MB. Active learning in medical education: application to the training of surgeons. *J Med Educ Curric Dev*. 2016;3:JMECD.S18929.
25. Han A, French J, Lipman J. Value of standardized testing in surgical training. *Surg Clin North Am*. 2021;101:679–691.
26. Kopp JP, Ibáñez B, Jones AT, et al. Association between American Board of Surgery initial certification and risk of receiving severe disciplinary actions against medical licenses. *JAMA Surg*. 2020;155:e200093.
27. Di Lu J, Cameron BH. The effectiveness and challenges of E-learning in surgical training in low-and middle-income countries: a systematic review. *Global Health Ann Rev*. 2020;1:59–62.
28. Mains EA, Blackmur JP, Dewhurst D, et al. Study on the feasibility of provision of distance learning programmes in surgery to Malawi. *Surgeon*. 2011;9:322–325.
29. Ekenze SO, Okafor CI, Ekenze OS, et al. The value of internet tools in undergraduate surgical education: perspective of medical students in a developing country. *World J Surg*. 2017;41:672–680.
30. Goldstein SD, Papandria D, Linden A, et al. A pilot comparison of standardized online surgical curricula for use in low- and middle-income countries. *JAMA Surg*. 2014;149:341–346.
31. Wanjara S, Parker RK, Cheruiyot D, et al. A cross-sectional survey investigating the impact of COVID-19 on surgery training at teaching hospitals accredited by the College of Surgeons of East, Central and Southern Africa. *East Central African J Surg*. 2021;26:49–58.
32. White RE, Parker RK. Delivery of subspecialty surgical care in low-resource settings. In: Park A, Price R, eds. *Global Surgery*. Springer, 2017:69–107.