Association Between E-learning System Usage and Medical Student Academic Performance at the Kilimanjaro Christian Medical University College in Moshi, Tanzania

Margaret Murray[1], Glory Ibrahim[2], Chrispina Tarimo[2], Lawrence Park[3], Gabriel Msuka[2], Gibson Kapanda[2], Ahaz Kulanga[2], Charles Muiruri[3], John Bartlett[3]

Corresponding author: Dr Margaret Murray margaretmurray88@gmail.com
Institution: 1. Eastern Virginia Medical School, 2. Kilimanjaro Christian Medical University College, 3. Duke University Global Health Institute
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Abstract

Introduction: In Tanzania medical schools have increased their enrollment to train more students. At the Kilimanjaro Christian Medical University College (KCMUCo) the faculty adopted an electronic learning system to deliver downloadable course materials to students. This study aimed to analyze the association between the student’s use of course materials and final grade in courses between 2011 and 2016.

Methods: A retrospective analysis examined the association between the downloaded materials and grade of medical students from 2011-2016 at KCMUCo. Linear regressions were used to assess the association between (1) downloaded materials and grades and (2) sociodemographic variables and grades.

Results: Of the 1,527 students, the distributions of grades were approximately normal from 2011-2016. There was a weak but significant association between grade and downloaded materials \( \beta=0.03; p<0.0001 \). The number of downloads peaked in 2012 but declined in subsequent years. The majority of students downloaded less than 10 materials on the course website from 2011-2016.

Conclusion: Downloaded materials had a weak effect on student grades. The distribution of materials on social media may have compromised the ability to observe associations with final grades. The e-learning environment is dynamic and rapid technological changes may compromise the value of individual interventions.
Keywords: electronic learning systems, e-learning systems; international medical education; downloadable material

Introduction

In 2014 Tanzania had 0.022 physicians per 1,000 population, one of the lowest ratios worldwide (World Health Organization, 2017). Tanzania must increase their health workforce in order to address the national health disparities and meet their national medical needs. Currently there are seven medical schools in the country, but the number of graduates is not enough to close the patient-physician gap (Mills et al., 2011). In 2010 the Tanzanian government began to work on improving the coordination between the Ministries of Health and Education, the poor physical infrastructure, and the shortage of faculty in basic and clinical sciences (Mullan et al., 2011). They strongly encouraged expansion in class size across medical schools.

Medical schools have started to implement innovative, efficient methods to deliver educational resources to their growing study body. One example is the use of an electronic learning management system (e-learning system), which has enabled schools primarily in developed countries to provide unlimited access of educational course materials through electronic platforms (Frehywot et al., 2013). These course materials would not be available to all students without these types of platforms. However most Tanzanian schools have yet to adopt these systems due to financial and infrastructure constraints (Mtebe, 2015). Furthermore the impact of the e-learning systems in medical education remains inconclusive (Kotsiantis et al., 2013; Jo, Yoon and Kim, 2013; Mödritscher, Andergassen and Neumann, 2013). In order to increase the adoption of e-learning systems, Tanzanian schools have been encouraged to: increase awareness of mobile technology, expand access to e-learning through mobile devices, partner e-learning systems with social media to increase access, clarify policies on intellectual property rights and copyrights of e-learning materials, and strengthen internet speed within institutions to increase user access to educational technologies (Mtebe, 2015).

In 2011 Kilimanjaro Christian Medical University College (KCMUCo) introduced an e-learning system, known as the Learning Content Management System+ (LCMS+, Durham, North Carolina USA), which delivered the curriculum to a student body that doubled from 2011-2016 (Killewo et al., 2014). The introduction of this system was supported by a Medical Education Partnership Initiative (MEPI) Award, funded by President's Emergency Plan for AIDS Relief (PEPFAR) and the United States National Institutes of Health (NIH) (Mtebe, 2015). The system provided medical students access to course content, such as Microsoft power point presentations, readings, discussion board posts, and assignments. Students were able to access the system while on and off the KCMUCo campus wireless network. The system was populated with the KCMUCo medical school curriculum to deliver the content to all medical students simultaneously. Students accepted the e-learning system quickly, although the faculty were slower to adopt it (Muiruri et al., 2014). A 2015 LCMS+ report showed that 82% of students reported that LCMS+ helped them analyze content effectively (Lim et al., 2015).

The majority of first- and second-year students felt that content was well organized, effectively presented, and useful for learning purposes. They reported that the uploaded material contributed to their understanding of course content and instructors organized presentations of course materials in an effective manner (Lim et al., 2015). Additionally the KCMUCo administration facilitated four mandatory LCMS+ orientation sessions for students at the beginning of the year for an hour each. The staff also conducted follow-up sessions two or three times during the student’s first year, depending on each student’s understanding of LCMS+. Throughout the year the staff offered two sessions on LCMS+ per semester to the students, sent out video tutorials and guide manuals, and performed individual counseling sessions upon request. The purpose of these sessions was to teach students how to use the LCMS+ effectively to enhance their educational experience.
Despite increasing acceptability, it remained unknown whether a student’s use of the system affected their academic performance. This study aimed to measure how student use of available resources on the e-learning system affected their academic performance. The other aim of the study was to measure the association between student sociodemographic variables [sex, age, service history, and pre-enrollment exam score] and their final grade.

**Methods**

The study was conducted between May and August 2016 at KCMUCo in Moshi, Tanzania. KCMUCo is a constituent college of Tumaini University Makumira and resides at the foot of Mt. Kilimanjaro, affiliated with the Good Samaritan Foundation.

The target population was KCMUCo first- and second-year medical students from 2011-2016 taking courses in biochemistry, anatomy, physiology, community health, pharmacology, parasitology, and microbiology. The inclusion criteria were those students who had completed either their first or second year in medical school and had access to the LCMS+. Six students, who dropped out during the academic year or did not receive a grade in a course, were excluded. Seventy-three students who did not have complete sociodemographic data, including the Advanced Certificate of Secondary Education Examination [ACSEE], birthdate, sex, or service history, were also excluded. The ACSEE is the national standardized exam students must take before entering medical school. The exam had a maximum score of 15 and encompassed the following subjects: biology, chemistry, and physics.

Data was collected from three primary sources: LCMS+ website, academic records, and the university student registry. Students downloaded course materials, such as power points, course outlines, documents, assignments, visual recordings, and faculty posts, from the LCMS+ website for their courses. The names of the students who downloaded each document were recorded during the study and saved on excel files. The final course grades of students were recorded in the academic records office at KCMUCo. The grade was based on computer-administered tests. The ACSEE scores were also obtained from the academic records office as a hard copy and were transcribed into an electronic version. The transcribed scores were double-checked by an outside source and the transcription process had less than a 10% error rate. The sociodemographic variables, including sex, age, and service history, were obtained from the university student registry. All study procedures were approved by the ethical review boards at the Tanzania National Institute of Medical Research, the KCMUCo Research Ethics Committee, and Duke Health System Institutional Review Board.

The primary measure was the number of downloaded materials per student in each course. Available course materials were power points, readings, course outlines, assignments, and faculty posts on course discussion boards. Initially the names of students who downloaded power points in a first-year course were recorded. The total frequency of downloaded power points for one student represented the total number of power points the student downloaded during their first-year. The other course materials were measured and summarized similarly. These calculations were done identically for both first- and second-year students.

The total number of downloaded materials were calculated for each student in every course. The frequencies of the different downloaded materials in a course were matched with the final grade in that respective course by student name. The frequencies of the different materials were summed together to generate total downloads in a course in a given year. Linear regression models were created to assess the association between the course downloads and grade. To analyze the association between sociodemographic variables and grade, the mean grade was calculated according
to either sex, age, service history per year, and ACSEE scores.

A Wilcoxon rank sum was used to assess differences between sociodemographic variables and grade. Statistical significance was determined at p-values at <0.05. Data analysis for this study was generated using SAS software 9.4 [SAS Institute Inc. 2016. SAS System for Windows, Fifth Edition. Cary, NC, USA: SAS Institute Inc.], Tableau Software [Tableau Software Inc. 2015. Tableau Public. Seattle, WA, USA: Tableau Software Inc.], Microsoft Excel 2010 [Microsoft Office Professionals Plus. 2016. Microsoft Excel 2016. Santa Rosa, CA, USA: Microsoft Corporation.]

Results/Analysis

We analyzed 1527 first- and second-year medical students, representing 5,205 student-course-years. From 2011-2016 the class size increased from 111 to 259 students. First-year students had a mean age of approximately 22 years, were predominantly of male gender, and did not participate in service before medical school [Table 1].

Table 1: Sociodemographic variables of first-year medical students from 2011 to 2016.

| Variable            | 2011-2012 | 2012-2013 | 2013-2014 | 2014-2015 | 2015-2016 | Sum |
|---------------------|-----------|-----------|-----------|-----------|-----------|-----|
| Age                 | N         | 113       | 138       | 147       | 131       | 269 | 798 |
|                     | Mean (µ)  | 2         | 21        | 21        | 21        | 23  | 22  |
|                     | Std Dev   | 5         | 3         | 2         | 3         | 3   | 3   |
|                     | Min.      | 18        | 17        | 19        | 18        | 20  | 17  |
|                     | Max.      | 37        | 35        | 33        | 36        | 46  | 46  |
|                     | Missing   | 32        | 18        | 10        | 38        | 3   | 101 |
| ACSEE score (0-15)  | N         | 144       | 152       | 142       | 151       | 253 | 842 |
|                     | Mean (µ)  | 6         | 6         | 7         | 9         | 10  | 8   |
|                     | Std Dev   | 2         | 2         | 2         | 2         | 3   | 3   |
|                     | Min.      | 2         | 2         | 0         | 2         | 0   | 0   |
|                     | Max.      | 14        | 15        | 14        | 13        | 15  | 15  |
|                     | Missing   | 1         | 4         | 15        | 18        | 19  | 57  |
| Sex (Missing=16)    | Male      | N         | 87        | 103       | 101       | 85  | 160 | 536 |
|                     |           | Percent   | 67        | 70        | 67        | 56  | 59  | 63  |
|                     | Female    | N         | 42        | 44        | 49        | 67  | 112 | 314 |
|                     |           | Percent   | 32        | 30        | 33        | 44  | 41  | 37  |
|                     |           | Missing   | 16        | 9         | 7         | 17  | 0   | 49  |
| Service History (Missing=16) | No | N | 111 | 137 | 147 | 143 | 259 | 797 |
|                     |           | Percent   | 86        | 93        | 98        | 94  | 95  | 94  |
|                     | Yes       | N         | 18        | 10        | 3         | 9   | 13  | 53  |
|                     |           | Percent   | 14        | 7         | 2         | 6   | 5   | 6   |
|                     |           | Missing   | 16        | 9         | 7         | 17  | 0   | 49  |
| Total Students      |           |           |           |           |           |     |     |

The average age of males was higher (µ=22.6) in comparison to females (µ=21.2) in the first-year classes from 2011-2015. The percentage of students who served decreased from 2011 [14%] to 2016 [4.8%], and had a higher mean age (µ=29.9 years) than students who did not serve (µ=21.5). From 2011-2016 the mean ACSEE score increased [µ=6.3 to 10.5]. The mean final grade in both first- and second-year cohorts decreased from 2011-2016,
Based on the distributions of the total student downloads, the majority of students downloaded less than 10 materials on the course websites from 2011-2016. For example, in 2011 21.1% of students did not download any documents and 66.7% of students downloaded 6 or less documents in all their courses. The numbers of downloads peaked in 2012, but from 2012-2016 the numbers of downloads decreased in each subsequent year (β= -28.4; p<0.0001). In 2015 82.9% of students did not download any materials and 95% of the students downloaded 15 or less documents in all their courses. From 2012 to 2016 an increasing number of students downloaded less than 10 downloads per year.

There was a slight positive association between total downloads and average final annual grade [β=0.03; p<0.0001] from 2011-2016. The linear regressions between the different types of downloaded materials (i.e. power points, assignments, readings, outlines and number of post views) and final grade from 2011-2016 demonstrated variable associations based on the type of document. However, most of the associations between each of the types of documents were null. Power points and readings appeared to be used more than assignments, outlines, and posts but faculty uploaded more power points and readings than any of the other types of documents in most every course.

Age was weakly associated with grade, although in 2012 grades decreased among older students. Age was not associated with downloads per year. From 2011-2016 the younger students appeared to download more than older students. However, the difference in downloads between younger and older students was small. Males and students who did not serve had higher grades than females and students who served. Males received higher grades than females in four out of the five years, and the difference between grades of males and females from 2011-2015 was significant (p=0.002). First-year students who did not serve received higher final grades than students who served except for 2015 to 2016. However, the difference between the grades of the total students who did not serve and those students who did serve was not significant (p=0.206). On average males downloaded more documents (µ =17.9) than females (µ=14.2), and this difference in number of downloads between males and females was significant (p=<0.0001). Students who did not serve averaged more downloads (µ =16.6) than those who served (µ=15.8). The difference in the number of downloads between those students who served and did not serve was not significant (p=0.42).

Discussion

After the introduction of LCMS+ all medical students had access to course materials simultaneously. KCMUCo faculty hoped this expansion would facilitate student interaction and review of materials in order to enhance their understanding and academic performance. However, this study showed no significant association between students’ final grades and the different types of downloaded materials (i.e. power points, assignments, readings, outlines, and posts) between 2011-2016. Furthermore there was no association between total downloads and final grade with the exception of total downloads and final annual grade where a weak association was observed. These findings are more perplexing, considering that the pre-entry exam scores increased from 2011-2016, which suggests that KCMUCo was enrolling medical students with stronger academic performance and a recent LCMS+ report showed that the majority of students felt that the material on LCMS+ contributed to their understanding of the course content (Tibyampansha et al., 2017).

The null associations might be a result of the distribution of total downloads, which was skewed towards fewer total downloads. This observation suggests that students simply did not access materials available in LCMS+, which could explain the lack of association between downloads and final grades. It is possible that students could have shared the
educational files with other classmates via social media sites, such as WhatsApp, rather than downloading it directly from LCMS+. Anecdotes from students suggest that this process of file sharing was common. This type of activity could have resulted in the skewed distribution. Since some students did not have internet access off campus and the internet connection on campus was occasionally unreliable, sharing the documents with classmates would have allowed them access to the materials without having to use the online course website. Also these students may not have been accustomed to computer access at school or they were inexperienced with technology in an educational setting. However, medical students at KCMUCo in 2015 reported that electronic learning was useful and would help them learn materials more efficiently (Kisanga and Ireson, 2015). Another contributing factor might be that faculty were not using LCMS+ effectively to deliver materials to students, or perhaps faculty were not updating materials annually. Several studies in Tanzania have found that faculty at higher-learning-institutions have been resistant to the adoption of e-learning systems. This reluctance is due to the perception that e-learning systems are an additional workload, lack of computer knowledge, or a fear of adopting new technologies (Mtebe and Raisamo, 2014; Mtebe and Raisamo, 2014). However KCMUCo faculty did fully participate in posting course materials during our study period. These uncertainties call for more analysis of the data and other studies examining the effects of e-learning systems on student academic performance.

The association between age and downloads was weak and this finding might have been due to the concentration of younger students in each class. Students who served were older (29.9 years old) in comparison to students who did not serve (21.5 years old). Those students who served might have been less familiar with technology as their primary means of learning, as evidenced by their lower download frequency (15.8) in comparison to the download frequency of students who did not serve (16.6).

Male students and students who did not serve had higher grades on average in comparison to female students and students who served. These observations might have been because the majority of students in the study were male (63.1%) and had not served (93.8%). This gender difference aligns with the national trend of male dominance in the medical profession (Morley, Leach and Lugg, 2009; Exavery et al., 2013). However KCMUCo improved this inequality and increased the number of women in their incoming classes from 2011 [32.6%] to 2016 [41.2%].

Males had higher grades than females in four out of the five years, which was significant (p=0.002). Additionally female students only downloaded 14.2 materials in comparison to male students who downloaded on average 17.9 materials. Men and women used LCMS+ differently and men had better results due to their efforts. A 2012 paper showed that the gender gap in literacy in technology has disappeared in educational institutions, yet the percentage of woman in the technological workforce remains low in sub-Saharan African countries such as Kenya (Braennstroem, 2012).

It was also uncertain whether faculty made the tests simply based on lecture content, if they included content from materials posted on the LCMS+, or if those tests were changed on an annual basis to reflect the current LCMS+ material that year. We did not know how the final course grade was calculated each year and who determined the final grade. Student's socioeconomic background might have influenced their ACSEE score or final grade, although we did not evaluate that measure. Although students were granted access to tablets from the school and had internet access on campus, it was unknown whether all students had internet access to download these materials outside of campus. A 2015 review on LCMS+ showed that 62-73% of first- and second-year medical students reported difficulty accessing LCMS+ outside of campus (Lim et al., 2015).

Since e-learning systems offer a way to organize curricular content for a large number of students with a small
number of faculty and unlimited access to resources, they may offer a way to provide medical education effectively and cost-efficiently. However, computer access, internet bandwidth, and additional technology infrastructure for these e-learning systems is expensive and many schools do not have the money to afford them (Mtebe, 2015). Additionally, the incomplete and inadequate internet coverage limits medical student usage of e-learning systems in countries like Tanzania. Internet coverage must increase in the region before e-learning systems can be effective outside of a wireless classroom setting. In the KCMUCo study, the ability to demonstrate an association between downloaded materials and final grades may have been obscured by a second disruptive social media technology, based on student anecdotes. Given these difficulties, a more specific analytical approach may be needed since medical education includes both course work on e-learning systems and dynamic peer interactions in classrooms and hospitals. Future studies should concentrate on a student's performance in the electronic learning system and in a medical setting. Additionally, this study questions the implementation effectiveness of the electronic learning system and the system's impact on the academic performance of the students.

**Conclusion**

This study analyzed the association between the total downloaded materials and the final grade of first- and second-year medical students at KCMUCo in Moshi, Tanzania. Based on this analysis, the association between downloaded materials and grade was minimal. The number of downloads decreased over the five years with the majority of students downloading few materials, although they may have shared them through other mechanisms not captured in our analyses. A different and more specific analytical approach may be necessary to better understand how learning management systems can impact the student's academic performance given the limitations encountered in our study.

E-learning systems are beginning to emerge in professional schools in low- and middle-income countries. They are capable of delivering educational materials to a greater number of students, which is important in countries where there is an emphasis on training more providers. More research is necessary to discover the best way to incorporate e-learning systems into the medical curriculum because they have the potential to benefit the next generation of providers.

**Take Home Messages**

- There was a minimal association between the number of downloads per student and their final grade.
- The majority of students downloaded less than 10 downloads per year.
- Students may have obtained course materials other than downloading them from the school website.

**Notes On Contributors**

Margaret Murray, MD, MS holds a master's degree in global health from Duke University, USA, and a medical degree from Wake Forest University School of Medicine, USA. She currently is completing her medical training at Eastern Virginia Medical School, USA in family medicine.

Glory Ibrahim, MPH serves as the LMCS Specialist in the MEPI division, where she manages and oversees all the e-learning conducted via LCMS at KCMUC. She holds a Master of Public Health from the University of Glamorgan, UK.

Chrispina Tarimo holds a postgraduate degree in Monitoring and Evaluation from Cavendish University, Zambia. Currently she serves as the Program Assistant in the Monitoring and Evaluation division in the KCMC-MEPI.
department at KCMUC and monitors the activities, surveys, and progress of MEPI.

Gibson Kapanda, MSc, Bcom holds a master's of science and Bachelor of Commerce. He currently is the Data Manager and Statistician of the Monitoring and Evaluation division in the KCMC-MEPI department at KCMUC, where he oversees the data collection and analysis of the projects.

Lawrence Park, PhD holds a Doctoral Degree in epidemiology from University of North Carolina, USA, and master's degrees in computer science and electrical engineering from the Johns Hopkins School of Engineering, USA. Currently he is an associate professor in Medicine and Global Health at Duke University, USA.

Gabriel Msuka holds a Bachelor of Science in Information Technology from Tumaini University, Tanzania. He specializes in data communications and networking, database management and implementation, and e-learning, and currently serves as an ICT specialist on the KCMC-MEPI team.

Charles Muiruri, PhD, MPH holds a Masters of Public Health and Doctoral Degree in health policy and management from the University of North Carolina, USA. He is an assistant research professor of global health at Duke University, USA, and has held administrative positions in the KCMC-Duke Collaboration.

Ahaz Kulanga, MBA serves as the Vice Provost at KCMUC, where he manages administrative and financial issues. He coordinates interactions with the KCMC and MEPI faculty and oversees program activities within the KCMC-MEPI department. He also served as a senior administrator in the KCMC-Duke Collaboration for 6 years.

John Bartlett, MD is a Professor of Medicine, Global Health, and Nursing at Duke University Medical Center, USA, and Professor of Medicine at KCMC. He obtained a medical degree from the University of Virginia, USA. He is the co-director of the Duke University Africa Initiative and Center for AIDS Research.

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**Appendices**

**ABBREVIATIONS**

KCMUCo: Kilimanjaro Christian Medical University College  
MEPI: Medical Education Partnership Initiative  
LCMS+: Learning Content Management System plus  
ACSEE: Advanced Certificate of Secondary Education Examination  
PEPFAR: President’s Emergency Plan for AIDS Relief  
MD1: 1st year Medical Students  
MD2: 2nd year Medical Students

**Declarations**

The author has declared that there are no conflicts of interest.

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**Ethics Statement**

Duke University Health System IRB has determined that the following protocol meets the criteria for a declaration of exemption from further IRB review. The Tanzania National Institute of Medical Research certified that the research entitled: Association between an e-learning system and medical student test academic performance at the Kilimanjaro Christian Medical University College in Moshi (Kulanga A. et al.) has been granted ethical clearance to be conducted in Tanzania. The Kilimanjaro Christian Medical College Research Ethics and Review Committee approved the proposal of the study “Association between an e-learning system and medical student test academic performance at the Kilimanjaro Christian Medical University College in Moshi”.

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