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Building workforce capacity for effective use of health information systems: Evaluation of a blended eLearning course in Namibia and Tanzania

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Abstract

Background: Electronic health information systems (HIS) are critical components of national health systems, and have been identified as a key element in the development and strengthening of health systems globally. Novel approaches are needed to effectively and efficiently train health

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Authors' contributions

KR performed all data analysis, performed data visualization, wrote the original draft of the manuscript, and was responsible for review and editing of the final manuscript.

NP supervised and participated in project conception, project implementation, data curation, data analysis, funding acquisition, development of analytic methodology, project administration, data validation, data visualization, and manuscript writing, review, and editing.

JR designed the original in-person course and data collection associated with implementation of the in-person course.

DJ, PK, DP, MS, JCK, HLK, BL, and NGM contributed to participant recruitment, data collection, and interpretation of the data.

JA, JR, MH, XS, HT, and NP contributed to the development of the protocol.

BL contributed to protocol development, sampling frame for Tanzania participants, recruitment, administration of the pilot, data collection, and reviewing and editing the manuscript.

All authors read and approved the final manuscript. NP takes responsibility for the paper as a whole.

Declaration of Competing Interest

The authors declare that they have no competing interests with respect to the research, authorship, and publication of this article.

care workers on the use of HIS. One such approach is the use of digital eLearning programs, either alone or blended with face-to-face learning activities.

Methods: We developed a novel blended eLearning course based on an in-person HIS training package previously developed by the United States Centers for Disease Control and Prevention. We then conducted a pilot implementation of the eLearning course in Namibia and Tanzania.

Results: The blended eLearning pilot program enrolled 131 people, 72 (55%) from Namibia and 59 (45%) from Tanzania. The majority of enrollees were female (n = 88, 67%) and were nurses (n = 66, 50%). Of the 131 people who participated in the in-person orientation, 95 (73%) completed some or all of the eLearning modules. Across all three modules, the mean score on the post-test was significantly greater than on the pre-test ($p < 0.001$). When comparing results from previous in-person workshops and the blended eLearning course, we found that participants experienced strong learning gains in both, although learning gains were somewhat greater in the in-person course. Blended eLearning course participants reported good to very good satisfaction with the overall content of the course and with the eLearning modules (3.5 and 3.6 out of 5-point Likert scale). We estimate that the total cost per participant is 2.2–3.4 times greater for the in-person course (estimated cost USD $980) than for the blended eLearning course (estimated cost USD $287-$437).

Conclusion: A blended eLearning course is an effective method with which to train healthcare workers in the basic features of HIS, and the cost is up to 3.4 times less expensive than for an in-person course with similar content.

Keywords

Health information systems (HIS); eLearning; Health workforce education; Global health

1. Introduction

Health information systems (HIS) have been identified as a key area of focus in the development and strengthening of health systems globally [1,2]. High-quality data are essential to disease prevention and treatment, policy development, resource planning, and accountability [3,4]. Having reliable, valid, timely, and relevant data depends upon robust HIS tools, as well as personnel with skills to manage and use these systems. As the cost of information and communications technology has declined, novel information technology (IT) tools present both great opportunities for improving HIS and potential complexities. There is substantial need for health-sector personnel in low- and middle-income countries with the skills to define functional and technical requirements for HIS, design or select scalable and effective information systems, strengthen data quality and completeness, and provide data security. Innovative technical solutions can partially meet these needs, but the success of any solution depends upon the development of in-country human capacity to manage and use those systems.

Given the rapid pace of adoption of digital HIS worldwide, it is essential to prepare personnel at all levels of the health system to integrate these systems into their daily work. Novel approaches are needed to effectively and efficiently train these health care workers on core HIS concepts. One such approach is the use of digital eLearning programs, either alone

or through blended eLearning programs, which integrate face-to-face and digital learning activities. Studies have demonstrated that eLearning outcomes have similar performance to traditional face-to-face instruction programs [5–7]. Additionally, eLearning programs have been used effectively to train health care workers in resource-limited settings [8,9]. However, the use of eLearning specific to HIS has not yet been widely used for training health care workers in resource-limited settings.

To address the pressing HIS educational needs of the health workforce in resource-limited settings, a partnership was formed between the International Training and Education Center for Health (I-TECH) at the University of Washington and the US Centers for Disease Control and Prevention (CDC) to conduct a pilot program using blended eLearning. The project was supported by the United States (US) President's Emergency Plan for AIDS Relief (PEPFAR), with a goal of strengthening use of data systems in PEPFAR-supported projects globally. In this paper, we describe the eLearning course and the results of pilot testing in Namibia and Tanzania.

2. Materials and methods

2.1. Program design

In 2009, a group-based, in-person HIS training package was developed by CDC. The goal of the 4.5-day course was to "expand the capacity of health care professionals in PEPFAR countries to strengthen and effectively implement HIS by increasing access and availability to training on core HIS concepts." The target audience included individuals involved in design, deployment, and use of electronic HIS in PEPFAR partner countries, and the majority of course participants represented the national, provincial, and district levels of the health system in these countries.

While the course was successful, costs and resource requirements related to its in-person format limited scalability. To address this challenge, we developed a novel course based on the content of the original training package using an eLearning approach, with a similar target audience. The eLearning modules were conceived to be publicly available and usable through either a blended eLearning format or a self-paced, completely digital eLearning format (http://globalhealthworkforce.org/index.html). We then conducted an evaluation of a pilot implementation of the eLearning course to ensure that the resources matched needs; were understandable, usable, and useful; and contributed to quality improvement of future HIS eLearning resources.

For the pilot evaluation, we used a blended eLearning format consisting of a half-day, face-to-face introductory group session and the digital course content that could be accessed either online or through an application pre-installed on tablet devices. We used a blended e-Learning format, rather than a completely digital one, because learners' familiarity with e-Learning applications could not be established prior to piloting. During the face-to-face introduction, we provided background information, introduced learning objectives, described strategies for self-directed learning, distributed tablets, and oriented users to the tablet and eLearning application. Participants then returned to their place of work and had up to 4 weeks to individually complete the modules. The course contained three narrated modules

(Table 1), each with participatory exercises as well as pre- and post-tests. Each module required approximately one hour to complete, and included both audio and text options (Fig. 1). Participants completed the blended eLearning pilot program between April and June 2016.

The program targeted health care workers (including clinical staff, data clerks, data managers, pharmacy staff, and laboratory staff) and national, regional, and district-level administrators within select regions of Namibia and Tanzania. Participants were solicited by leadership at the Namibia Ministry of Health and Social Services and the Tanzania Ministry of Health, Community Development, Gender, Elderly and Children (75 potential participants per country).

We administered pre-tests prior to viewing the modules and post-tests at the conclusion of each module. Pre- and post-tests used 10 identical, multiple-choice questions. Additionally, participants completed a course evaluation for each module, collecting feedback on the usefulness, clarity, and perceived knowledge transfer of each eLearning module using 3- and 5-point Likert scales, as well as free text responses.

2.2. Program assessment

The primary evaluation outcome was knowledge gain resulting from the completion of the blended eLearning course, measured by differences in post-test and pre-test scores. Secondary outcomes included achievement of a 70% passing score and participant satisfaction with eLearning module content, format, and delivery.

We collected participant demographics using the Training System Management and Reporting Tool (TrainSMART; I-TECH, Seattle, WA). For participants using the online course format, data from the pre- and post-tests and participant evaluations were stored on the website used to host the modules (http://globalhealthworkforce.org), with only an individual's project identification number recorded. For participants using the offline tablet application, these data were stored on the tablets using Open Data Kit (ODK; University of Washington, Seattle, WA), an open-source, password-protected software tool that allowed data to be saved on the tablets when offline, then uploaded to a password-protected server at the conclusion of the program.

2.3. Statistical analysis

We used descriptive statistics to characterize module completion and pre- and post-test scores. We used the paired *t*-test for comparison of mean pre- and post-test scores and the Chi-2 test for equality of proportions of participants with passing scores. We performed multivariable regression analysis to identify predictors of the difference between pre- and post-test results, with adjustment for pre-test scores, module, eLearning modality, country, profession, and sex. The model for score as a continuous outcome used generalized estimating equations (GEE) with identity link, Gaussian family, and robust variances, while the model for the binary outcome of passing used a GEE model with log link and Poisson family with a similar set of covariates.

Using linear regression models, we compared post-test scores and change in pre-test and post-test scores between eLearning program participants and participants in the original classroom workshops conducted in Namibia (2012; N = 16), South Africa (2010, 2011, 2012; N = 56), Swaziland (2013; N = 30), Nigeria (2012; N = 18), and CDC US (2013; N = 13). These data were limited to a set of 10 questions used in both the workshop and blended eLearning tests, and the models were adjusted for pre-test scores.

To explore costs of course delivery, we calculated cost per participant for delivering the online and tablet-based forms of the blended eLearning course in Namibia, and compared this to a theoretical cost per participant for delivering an in-person workshop-based course similar to the original in-person course. These cost estimates reflected ITECH's perspective as a technical assistance partner, and did not include costs for course development nor time costs for course participants.

Analyses were performed with Stata version 14.1 (StataCorp, College Station, TX). All statistical testing was two-sided, and a p-value of < 0.05 was considered statistically significant.

3. Results

A total of 131 people enrolled in the blended eLearning pilot program, 72 (55%) from Namibia and 59 (45%) from Tanzania (Table 2). The majority were female ($n = 88$, 67%) and were nurses ($n = 65$, 50%). Of the 131 people who participated in the in-person orientation, 95 (73%) completed some or all of the eLearning modules. The proportion of enrollees who completed some or all of the eLearning modules did not differ significantly by country ($p = 0.27$), cadre ($p = 0.27$), or sex ($p = 0.36$). Nearly half of all program participants completed the post-test for all three eLearning modules ($n = 60$, 46%). Among those who completed some or all of the eLearning modules, 77 out of 95 did so using a tablet (81%), while 18 did so using online access to the modules (19%); all online users were in Namibia.

On average, participants' scores on the eLearning module post-tests were higher than on the pre-tests for each of the three modules ($p < 0.001$; Fig. 2). The mean difference in post-test score relative to pre-test score was +1.74 points (95% CI, 1.31–2.17) for module 1, +1.37 points (95% CI, 0.82–1.92) for module 2, and +1.85 points (95% CI, 1.36–2.33) for module 3. Overall, scores on module 2 were slightly lower than for modules 1 and 3.

Across all three modules, more people passed the post-test compared to the pre-test, at the 70% passing threshold. Of those who failed the pre-test for module 1, 73% moved from non-passing to passing scores on the post-test. Of those who failed the pre-test for module 2, 39% passed the post-test, and of those who failed the pre-test for module 3, 67% passed the post-test. The opposite result of moving from passing to non-passing from pre- to post-test was rare (0, 3, and 2 cases for modules 1, 2, and 3, respectively). The difference in passing rate for the pre-test and post-test was statistically significant only for module 1. Only 22 (17%) of all 131 eLearning course enrollees completed and passed the post-test for all three

modules. Passing rates did not vary significantly by country ($p = 0.55$), sex ($p = 0.52$), or cadre (0.63).

Using multivariable regression, we found that neither the eLearning format nor participant characteristics such as gender, country of origin, and profession were associated with knowledge gain as assessed by difference in post-test and pre-test scores (Table 3). Participants with higher knowledge of module content on the pre-tests were less likely to gain significant new knowledge ($p < 0.001$). Module content was also significantly related to knowledge gain, with lower levels of score improvement in modules 2 and 3 relative to module 1 ($p < 0.001$ and $p = 0.02$ respectively).

We calculated pre-test and post-test scores for the participants of the blended eLearning course using only the ten questions that were used for pre- and post-test assessment for the CDC in-person module on “Introduction to HIS.” We found that there was no significant difference in the pre-test scores when comparing the eLearning course participants to the in-person course participants (Table 4). However, the in-person course participants had higher post-test scores, raising their scores by 0.69 points more than the eLearning course participants.

Of participants who completed the final blended eLearning course evaluation, respondents reported good to very good satisfaction with the overall content of the course and with the eLearning modules (3.5 and 3.6 out of 5-point Likert scale). Respondents reported that they were somewhat to fully able to use eLearning technology to learn about the foundations of HIS (2.5 out of a 3-point Likert scale) and to identify the competencies needed by health care workers to effectively use HIS (2.3 out of a 3-point Likert scale).

We estimated the costs associated with the in-person course, and compared these to observed costs for the eLearning pilot project in Namibia (Table 5). We assumed 20 participants in each course, and assumed that one international trainer traveled to Namibia for both the in-person and the blended eLearning course. The results demonstrate a cost per participant, which was 2.2–3.4 times greater for the in-person course than for the blended eLearning course ($980 vs. $287–437), and a cost per passing participant which was 2–3 times greater ($1042 vs $342–521).

4. Discussion

In this pilot evaluation of a blended eLearning course, we demonstrated an innovative approach to improving health workforce capacity to manage and utilize HIS – a critical component of strengthening health systems globally. The course was successful in improving knowledge related to HIS among participants in a variety of health professions in Namibia and Tanzania, and learning gains were not significantly impacted by gender, profession, country of residence, or media (tablet vs. online access to course material). When comparing results from previous in-person workshops developed by CDC and the blended eLearning course, we found that participants experienced strong learning gains in both, although learning gains were somewhat greater in the in-person course. Blended eLearning course participants gave positive feedback about the course structure, as well as

their knowledge of HIS competencies at the end of the training. Additionally, we estimate that the total cost per participant is up to 3.4-times less expensive for the blended eLearning course than for an in-person course with similar content.

We found a highly significant increase in mean post-test score relative to mean pre-test score in all three eLearning modules, in addition to a trend towards higher passing rates (with a 70% passing threshold) on post-tests relative to pre-tests. Although these results are encouraging, it is important to note the relatively select nature and small size of the pilot implementation, which may limit translation of these results if the course were implemented on a broader scale. While a wide variety of health professionals were represented among the course participants, this pilot implementation did not include health data personnel from the district or provincial levels – key groups to include in future HIS training. The blended eLearning course participants were selected by their supervisors for participation, perhaps influencing their motivation to complete the required work. It is unclear how much time participants were allotted for completion of the eLearning modules within their usual workday, or whether they received any support from their colleagues or supervisors in the completion of the modules. Further evaluation of the conditions for achieving successful learning gains in different contexts and with different types of participants would be helpful.

Although there were strong learning gains among participants of both this blended eLearning pilot evaluation and the comparison in-person course previously conducted by CDC, in-person course participants did have significantly greater gains, compared to the eLearning participants. There may be true learning benefits to face-to-face instruction that are diminished with eLearning courses. Additional possible reasons for the disparity in learning gains may be the different profile of course participants. In-person course participants were leaders at the national, provincial, and district levels of their countries, and English was the primary language for many of these participants, whereas eLearning course participants were primarily facility-level health care workers and many were not native English speakers. Additionally, participants in an in-person course benefit from the presence of a trainer who could clarify difficult or unfamiliar terms. It is possible that differences in education, language, familiarity with pre- / post-course testing, or other participant factors – rather than learning modality – may explain the differences observed.

Blended eLearning course participants and supervisors within the national ministries of health for Tanzania and Namibia provided insights on the utility of the eLearning resources for future HIS eLearning education. Tanzania, for example, currently uses an online web portal as part of its HIS to provide health data, visualization, and health program indicators at the national and regional level. The Tanzania Ministry of Health, Community Development, Gender, Elderly and Children is planning to move to eHealth systems in over 7000 health facilities across the country. This creates a significant opportunity to educate facility-level health workers on the use and maintenance of HIS, including issues of data quality. In order to optimize performance of this or similar blended eLearning HIS courses in the future, pilot participants recommended increasing the amount of time to complete the course materials, translating materials into local languages, distributing some or all of the course material in hard copy, or offering a second in-person session at the end of the course to facilitate discussion of key material. Pilot evaluation participants also recommended

increasing use of personal smartphones to access the eLearning modules via the internet, rather than use of tablet devices with pre-installed software.

As this was a blended eLearning course, with an in-person introductory session plus digital course content, there are important implications for future adaptation. For example, the format of the course could be changed to add more face-to-face learning time versus less – or none at all – to adjust to different needs of learners as well as different budgets. Although we have demonstrated success of this course, it is unclear whether an exclusively eLearning course model (without any face-to-face component) or a self-study model would be equally effective.

There continue to be innovations in distance education targeting the health workforce, with new programs made available since the time of this study. It is critical that these programs consider the specific HIS educational needs of low- and middle-income countries, particularly in Africa. These settings differ from high-income settings not only in having limited availability of health informatics training, but also in fundamental differences in their HIS ecosystems, such as greater reliance on offline, mobile, and open-source tools or early-stage HIS policy and governance environments. Additionally, in order to meet these education needs in a timely and efficient manner, programs should emphasize eLearning over in-person courses where possible. Future research is needed to assess the comparative effectiveness of these programs. Lastly, all educational programs focused on HIS, including the course presented here and the related modules available at http://globalhealthworkforce.org/index.html, will need to be continually updated in order to remain current. Future work must include expansion and optimization of the current modules, and targeted dissemination to support uptake in appropriate settings.

5. Conclusions

In summary, we have developed an innovative, blended eLearning course to build health workforce capacity for the implementation of HIS. In robust analysis of our pilot implementation with 131 enrollees from Tanzania and Namibia, we found strong learning gains based on pre- and post-tests. Comparison of our blended eLearning course to a similar in-person course demonstrated similar, though modestly reduced, knowledge transfer at a much-reduced cost. As leaders of health systems and nongovernmental agencies work to develop the human resources to improve healthcare delivery, access to effective, affordable tools to train health workforce members is critical. This pilot evaluation demonstrates an example of one such approach for the delivery of HIS-related training – a critical skillset at all levels of health systems. This novel training program could play an important role in building health workforce ability to utilize and maintain electronic HIS, ultimately improving health through better information and a stronger health workforce.

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The findings and conclusions in this paper are those of the authors and do not necessarily represent those of the Centers for Disease Control and Prevention.

Abbreviations:

HIS	electronic health information systems
IT	information technology
EMRs	electronic medical records
I-TECH	International Training and Education Center for Health
CDC	United States Centers for Disease Control and Prevention
PEPFAR	United States President's Emergency Plan for AIDS Relief
ODK	Open Data Kit Software
GEE	generalized estimating equations

References

[1]. World Health Organization, Everybody's Business: Strengthening Health Systems to Improve Health Outcomes: WHO's Framework for Action, (2007).

[2]. AbouZahr C, Boerma T, Health information systems: the foundations of public health, Bull. World Health Organ. 83 (2005) 578–583. [PubMed: 16184276]

[3]. Nash D, Elul B, Rabkin M, Tun M, Saito S, Becker M, Nuwagaba-biribonwoha H, Strategies for more effective monitoring and evaluation systems in HIV programmatic scale-up in resource-limited settings: implications for health systems strengthening, J. Acquir. Immune Defic. Syndr 52 (2009) S58–62. [PubMed: 19858942]

[4]. AbouZahr C, Adjei S, Kanchanachitra C, From data to policy: good practices and cautionary tales, Lancet 369 (2007) 1039–1046. [PubMed: 17382830]

[5]. Cook DA, Levinson AJ, Garside S, Dupras D, Erwin PJ, Montori VM, Internet-based learning in the health professions: a meta-analysis, JAMA 300 (2008) 1181–1196. [PubMed: 18780847]

[6]. George PP, Papachristou N, Belisario JM, Wang W, Wark PA, Cotic Z,Rasmussen K, Sluiter R, Riboli-Sasco E, Tudor Car L, Musulanov EM, Molina JA, Heng BH, Zhang Y, Wheeler EL, Al Shorbaji N, Majeed A, Car J, Online eLearning for undergraduates in health professions: a systematic review of the impact on knowledge, skills, attitudes and satisfaction, J. Glob. Health 4 (2014), 10.7189/jogh.04.010406.

[7]. Rasmussen K, Belisario JM, Wark PA, Molina JA, Lee Loong S, Cotic Z,Papachristou N, Riboli-Sasco E, Tudor Car L, Musulanov EM, Kunz H, Zhang Y, George PP, Heng BH, Wheeler EL, Al Shorbaji N, Svab I, Atun R, Majeed A,Car J, Offline eLearning for undergraduates in health professions: a systematic review of the impact on knowledge, skills, attitudes and satisfaction, J. Glob. Health 4 (2014), 10.7189/jogh.04.010406.

[8]. Frehywot S, Vovides Y, Talib Z, Mikhail N, Ross H, Wohltjen H, Bedada S,Korhumel K, Koumare AK, Scott J, E-learning in medical education in resource constrained low- and middle-income countries, Hum. Resour. Health 11 (2013), 10.1186/1478-4491-11-4.

[9]. Chang AY, Ghose S, Littman-Quinn R, Anolik RB, Kyer A, Mazhani L,Seymour AK, Kovarik CL, Use of mobile learning by resident physicians in Botswana, Telemed. J. E 18 (2012) 11–13, 10.1089/tmj.2011.0050.

Summary Table

What was already known

- Health information systems (HIS) are a critical component of health systems globally
- An in-person course has previously been successfully used to train health care workers from low-resource settings in the principles and use of HIS
- eLearning courses can have similar performance to traditional face-to-face instruction programs, and have been successfully used in low-resource settings
- It is unknown whether HIS eLearning courses are effective in low-resource settings

What this study added to our knowledge

- A blended eLearning course can be successfully used to improve knowledge related to HIS among participants in a variety of health professions in low-resource settings
- The total estimated cost per participant is up 3.4-times less expensive for a blended eLearning course than for an in-person course with similar content

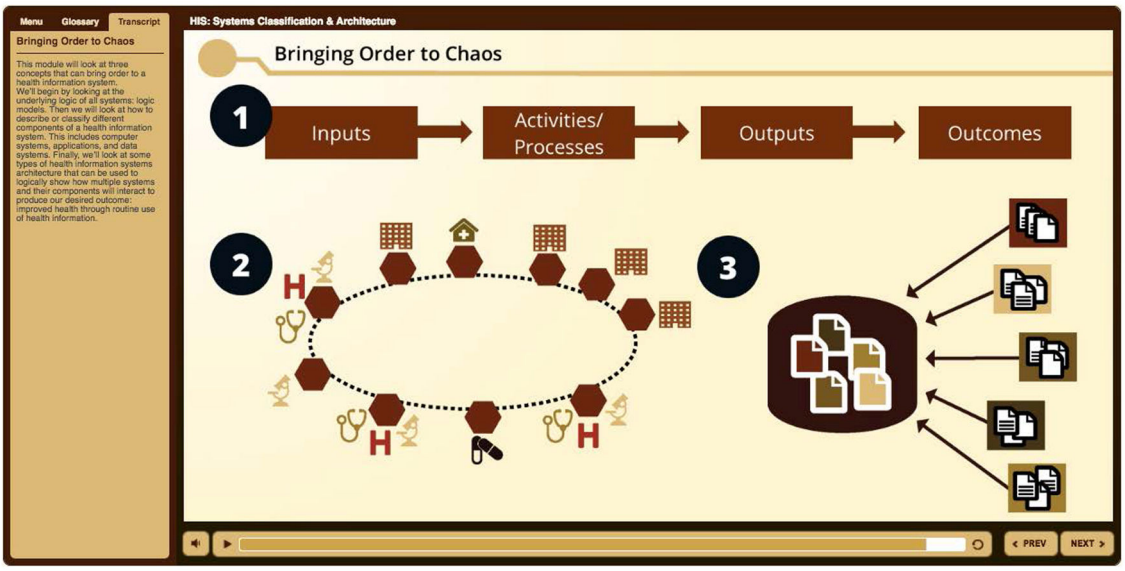

Fig. 1.

The transcript tab allows learners to read along with the narration.

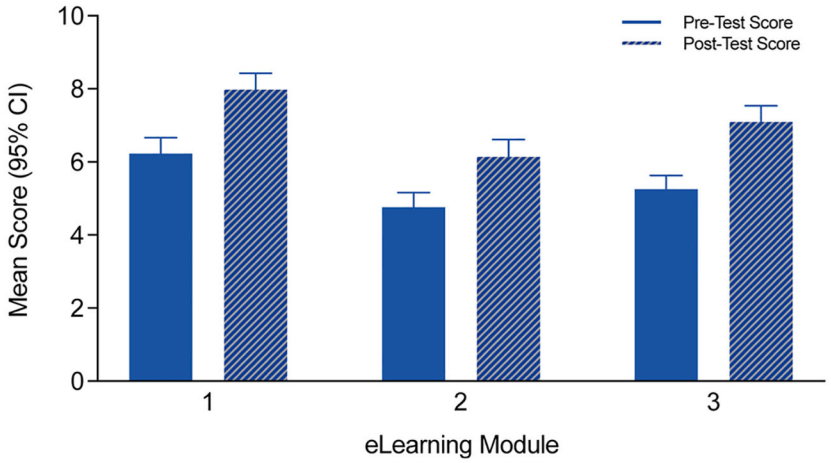

Fig. 2.

Change in knowledge by module, Namibia and Tanzania combined. Seventy-three people took both the pre- and post-test for eLearning module 1, 68 people for module 2, and 65 people for module 3. The p-value for the paired t-test for the difference in mean score on the pre- and post-test for each module was < 0.001.

Table 1

eLearning module content.

Module	Objectives
Module 1: Introduction to HIS: Information Use, Technology, and Terminology	• Explain the difference between information literacy, computer literacy, and information system literacy • Define key information system terms • Identify the components of a HIS
Module 2: Health Information Systems: Classification and Architecture	• Describe the logic underlying HIS • Describe information system classifications and architectures
Module 3: Data Management Concepts	• Define data management concepts • Describe components of the data management process

Table 2

Participant characteristics, Namibia and Tanzania.

Characteristic	Namibia N = 72	Tanzania N = 59	Total N= 131
Gender, *n* (%)			
Female	58 (81)	30 (51)	88 (67)
Male	14 (19)	29 (49)	43 (33)
Profession, *n* (%)			
Nurse	48 (67)	17 (29)	65 (50)
Physician	3 (4)	26 (44)	29 (22)
Pharmacist	4 (6)	0 (0)	4 (3)
Advanced-Practice Provider	0 (0)	1 (2)	1 (1)
Social Worker	0 (0)	1 (2)	1 (1)
Community Health Worker	1 (1)	0 (0)	1 (1)
Dentist	0 (0)	1 (2)	1 (1)
Other	16 (22)	13 (22)	29 (22)
Program Completion, *n* (%)			
In-Person Orientation Only	17 (24)	19 (32)	36 (27)
Orientation + Some eLearning[a]	19 (26)	16 (27)	35 (27)
Orientation + All eLearning[b]	36 (50)	24 (41)	60 (46)
eLearning Format, *n* (%)[c]			
Tablet	37 (67)	40 (100)	77 (81)
Online	18 (33)	0 (0)	18 (19)

[a]Participation in some eLearning defined by completion of the pre-test for at least one module.

[b]Participation in all eLearning defined by completion of the post-test for all three modules.

[c]Of participants who completed some or all eLearning.

Table 3

Adjusted analysis of change in pre-test and post-test scores by participant characteristic, Namibia and Tanzania combined.

Characteristic	Coefficient (95% CI)	P-value
Gender		
Female (ref)	–	–
Male	0.31 (−0.52 – 1.14)	0.47
Country of Origin		
Namibia (ref)	–	–
Tanzania	0.51 (−0.20 – 1.22)	0.16
Profession		
Nurse (ref)	–	–
Physician	0.11 (−0.97 – 1.19)	0.84
Other	0.34 (−0.39 – 1.07)	0.37
eLearning Format		
Tablet (ref)	–	–
Online	0.44 (−0.46 – 1.33)	0.34
Pre-test Score[a]	−0.66 (−0.80 to −0.52)	< **0.001**
Module		
Module 1 (ref)	–	–
Module 2	−1.33 (−1.83 to −0.82)	< **0.001**
Module 3	−0.60 (−1.10 to −0.11)	**0.02**

Analysis performed using GEE model with Gaussian family and identity link with robust variances. Each characteristic assessed while controlling for all other listed characteristics. The coefficient represents the difference in the change score from pre-test to post-test, relative to the reference value for each category.

[a]For every one point increase in pre-test score, the expected gain in points from the pre-test to post-test decreases by 0.66 points. As an example, a participant with a pre-test score of 8 would be expected to have a 0.66-point smaller increase in score on the post-test relative to a participant with a pre-test score of 7.

Table 4

Pre- and post-test performance for eLearning and in-person courses, Namibia and Tanzania combined.

	eLearning Course N = 61	In-Person Course N = 108	P-value
Pre-test score, mean	6.02	6.34	0.24
Post-test score, mean	8.13	9.14	**< 0.0001**[a]
Change in score from pre- to post-test, mean	+ 2.11	+ 2.80	**< 0.0001**[a]

Analysis performed using 10 shared questions from the eLearning and in-person courses, with each question awarded 1 possible point. P-values calculated using linear regression with outcome of score and exposure of type of course.

[a]Linear regression models adjusted for pre-test score.

Table 5

Sample costs of training for in-person versus blended eLearning course in Namibia.

Parameter	In-person course	Online course	Tablet-based course
Number of participants	20	20	20
International trainer airfare	$1500	$1500	$1500
International trainer per diem	$1694	$726	$726
Transportation to training facility	$300	$300	$300
Facility cost	$4000	$800	$800
Participant per diem	$12,100	$2420	$2420
Tablets			$3000
Total	$19,594	$5746	$8746
Cost per participant	**$980**	**$287**	**$437**
Post-test pass rate[a]	0.94	0.84	0.84
Cost per passing participant	**$**1042	**$342**	**$521**

All costs in US dollars.

[a]Pass rate based on achieving a passing score of ≥ 7 of 10 possible points on post-test using only the 10 questions that were used for assessment for the CDC in-person module on “Introduction to HIS,” assuming that all participants take the post-test.