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Co-evaluating a mobile educational tool artifact in Tanzanian Higher Education: Teachers' and students' perspectives on usability and user experience

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ABSTRACT

This study reports on Part 2 of a co-evaluation process of a mobile education tool (MET) prototype artifact known as CBEMET, at the College of Business Education (CBE) in Tanzania. A preliminary co-evaluation of CBEMET was done only by teachers and students of one campus. In this study, the design science research (DSR) framework combined with the four-cycle model of Information System (IS) DSR is employed. The participants included 40 teachers, 542 students and 8 managerial staff from the four campuses of the CBE alongside 1 official from the Tanzania Commission for Universities (TCU) and 2 officials from the National Council of Technical and Vocational Education and Training. Focus group discussions were held and questionnaires were administered. Thematic analysis is used for the qualitative data analysis, whereas for the quantitative data analysis reports on means, standard deviation, and correlations. The findings reveal that CBEMET was able to assist with practical problems for both teachers and students and that the participants found the tool useful for innovative teaching and learning. CBEMET was also found to be motivating to use and improved the learning, especially in supporting self-regulated learning (SRL). This work contributes towards empirical applications of the four-cycle DSR.

Keywords: *Co-evaluation, Mobile education tool prototype, DSR artifact evaluation, Usability and user experience (UX), Tanzania HEIs, Innovative teaching, and learning.*

INTRODUCTION

In this paper we discuss Part 2 of the CBEMET evaluation, a prototype co-designed and developed to assist with solutions to educational related problems at the College of Business Education (CBE), Tanzania. A preliminary evaluation was carried out involving academic members of staff and students of the Dar es Salaam campus of CBE (Mwandosya & Mbise, 2019). This paper reports on the full evaluation of CBEMET involving end-users from the four campuses of CBE, while considering the external environmental factors in the evaluation process.

Design science research (DSR) "…*seeks to create innovations that define the ideas, practices, technical capabilities, and products through which the analysis, design, implementation, management, and use of information systems can be effectively and efficiently accomplished…*" (Hevner, et al., 2004, p. 76). In DSR, artifacts are categorized into four types: *constructs* (terms, notations, and concepts for formulation problems and their solutions), *models* (representations of

possible solutions to practical problems), *methods* (prescriptive knowledge by defining guidelines and processes of how to solve problems and achieve goals), and *instantiations* (working systems that can be used in practice) (Johannesson & Perjons, 2014, pp. 29-30). The need to evaluate artifacts, such as mobile-related education tools or prototypes is emphasized by several researchers, such as, Brandtner, Helfert, Auinger & Gaubinger (2016), who asserted that the evaluation of designed artifacts is of crucial importance in any DSR project. The authors presented a multi-media, web-based DSR evaluation approach in the form of a survey, enriched with multimedia content. To put more weight on the best way to evaluate artifacts in DSR, Sonnenberg and Brocke (2012) pointed to the importance of knowing the objectives of the evaluation from the start to be able to define and determine whether to evaluate an artifact design process or to evaluate the artifact design product (Sonnenberg & Brocke, 2012). In addition, Greenberg and Buxton (2007) argued that the evaluation of a designed application can be harmful if wrongfully applied, therefore careful planning and implementation of evaluation procedures is needed (Greenberg & Buxton, 2007).

In the design and development of information systems and computer science artifacts, the DSR framework has been widely used (Kolog & Suero Montero, 2018; Oyelere, et al., 2017; Gomera, et al., 2017; Kapinga, et al., 2017). Hevner, et al., (2004) noted that artifacts thus developed are innovative in nature, and therefore the evaluation of their effectiveness in providing innovations, in our case in the education sector, is necessary. We argue that since mobile education artifacts can be installed in mobile devices, they have the potential to enhance teaching and learning anywhere, anytime, thus can improve the innovation ability of teachers and students and at the same time improve the quality of education offered. To assert their innovation capability, it is therefore necessary to evaluate them thoroughly (Xie & Parsons, 2009). According to Lagsten (2011), one major reason for conducting evaluations of information systems is to take actions based on the results of the evaluation in enhancing the current practices (Lagsten, 2011).

Higher education institutions (HEIs) in Tanzania, have increasingly been using learning management systems (LMS) and mobile learning systems (MLS) along with traditional face-to-face teaching and learning. As a result, LMS and MLS are being applied as mobile learning artifacts (instantiations) to solve the challenges of education in Tanzania (Mtega, et al., 2012; Mtebe & Kondoro, 2016; Shemahonge & Mtebe, 2018). The LMSs and MLSs accessed and used by both teachers and students through their mobile phones, especially smartphones, have been shown to facilitate the flexible exchange and access to a variety of educational resources for both the teachers and students (Kafyulilo, 2014; Kivunja, 2015; Mtebe & Kondoro, 2016; Mtega, et al., 2012). However, in the Tanzanian context, little is known on the detailed explanation about the evaluation of the mobile education application artifacts. This study, therefore, was designed to evaluate a mobile education tool prototype known as CBEMET which has been used as an MLS artifact by both teachers and students at CBE, along with normal face-to-face teaching and learning pedagogy (Mwandosya, et al., 2019). CBEMET was previously evaluated in a study conducted at the Dar es Salaam campus (Mwandosya & Mbise, 2019) and further improvements were made towards a second round of evaluation, which is presented in this study.

In particular, this study focuses on answering the four research questions:

1. To what extent has the CBEMET tackled both teachers' and students' identified practical problems in terms of usability for innovative teaching and learning at CBE?
2. What are the teachers' and students' user experience (UX) in using the *CBEMET* for improving innovative teaching and learning at CBE?
3. What are the views of the management team in instituting mobile learning pedagogy at the CBE?
4. What is the impact of the CBEMET on its external environment outside its application environment?

LITERATURE REVIEW

Related work

In higher education institutions (HEIs) in Africa and in different parts of the world, there has been ongoing development, usage, and evaluation of mobile education-related tools that are used to aid delivery of educational services (Oyelere, et al., 2017; Sun & Kantor, 2006; Traxler & Kukulska-Hulme, 2005). The evaluation of these education tools checks if the intended goals when setting up the tools have been attained or not. For example, the intended goal in the design and development of *MobileEdu* as a mobile learning application in a Nigerian university, was to help students improve learning computer science courses using mobile devices. The evaluation of *MobileEdu* was done in a real-life learning setting involving 142 third-year undergraduate students where a comparison of the performance of two groups was made. In the real-life setting in the evaluation of *MobileEdu*, examination results of the control group and the experimental group of students indicated the usefulness of *MobileEdu* in the learning of computer science courses (Oyelere, et al., 2017). In a study by Järvelä, Näykki, Laru, & Luokkanen (2007), a mobile lecture interaction *(MLI)* tool that was designed for regulating and supporting students' thinking and participation in lectures was successfully evaluated. Its evaluation by the students revealed that *M.L.I.* had succeeded in transforming their learning by supporting the engagement of the students during lectures (Järvelä, et al., 2007).

An educational tool known as *MedAid* developed by Ferrer, Hodges. & Bonnardent, (2013) was intended to help provide learning resources for personnel in a disaster or emergency. *MedAid,* which was accessed through mobile devices, was evaluated and was found to be practical and effective in providing training when coupled with media such as videos, texts, and sound. Another mobile education tool known as *MOLT,* a window-based program for teaching new technical English Language words to 1st year undergraduate students, was developed to support their normal English Language lectures (Cavus & Ibrahim, 2009). The evaluation of *MOLT* was carried out with the students and the results proved to be positive for effectively supporting them. The pre and post evaluation results showed that before using MOLT system there were lower success rates (M = 24.68, SD = 12.44), than after using the MOLT system (M = 89.77, SD = 7.18). A study conducted in Ghana by Kolog and Suero Montero (2018) reported on the development and evaluation of an automated e-Counselling system - *EmoTect* - for emotion and sentiment analysis. Most of the participants, mainly scholars and councilors, agreed that the EmoTect had captured all the requirements they had proposed. Our present study focuses on the second round of co-evaluation of the CBEMET mobile education tool based on both usability and user experience (UX) using the Change and Impact Cycle of the four-cycle IS DSR.

Usability and User Experience (UX)

Studies have reported mixed comments and observations on students' and teachers' user experience, of sharing online education-related content such as, teaching notes, assignments, specialized training videos, and PowerPoint slide, (Tijani, 2016; Tijani, et al., 2020). These findings prompted us to deeply investigate the usability and user experience of the CBEMET. Usability and user experience (UX) are two terms that can easily be confused to mean the same though they are different (Interaction Design Foundation, 2009). A product with good usability might not necessarily generate positive experiences or satisfaction, while bad usability can break a good product. Hence, good usability is insufficient to create a good experience. Accordingly, good usability does not guarantee good UX, and it depends on the total interactive experiences of a user with a product or system in meeting user needs and expectations.

UX is said to be a concept that is central to interactive designs emphasizing how a product behaves and is used by people in the real world (Foley, 2007). The term *user experience* was initially

popularized by Norman (1998), but has gone beyond the normal considerations of usability like the ease of use, ease of learning, and proceeds to consider the positive aspect in using the products or services, for example through questionnaires from (Saket, et al., 2016; Hinderks, et al., 2019). It even goes further, to maximizing the usage of the product, for example aspects of joy, happiness, or engagement (Petrie & Bevan, 2009). A study by Kissinger (2013), explained the mobile e-reader and the way it had been used through social learning to realize effective students' learning process. Our study reports on the evaluation of CBEMET in terms of both usability and UX.

Evaluation of CBEMET considering the Impact and Change Cycle of DSR Framework

In Tanzania, HEIs are regulated by two bodies instituted by the government. The Tanzania Commission for Universities (TCU) regulates universities (HEIs), and the National Accreditation Council for Technical Education (NACTE) which regulates the colleges and other tertiary level institutions (HEIs). CBE is one of the colleges regulated by NACTE in terms of admission of students, curriculum design, teaching and learning facilities and examination regulations. In 2014, the government through its Education and Training Policy (United Republic of Tanzania, 2014) directed all HEIs to embark on technology-aided facilities in their teaching and learning mission. Following this, NACTE instructed HEIs under their control to embark on the use of mobile learning pedagogy in their colleges which include the use of mobile education tools.

The design and development of CBEMET were geared to solve educational-related practical problems at CBE, therefore teachers' and students' participation in the co-design and co-evaluation of this artifact was key. The process followed the systematic approach of the DSR framework which includes 5 steps, *explicate problem*, *define requirements, design and develop artifact, demonstrate artifact,* and *evaluate artifact* Johannesson & Perjons (2014). The DSR process can also be conceptualized as four interconnected cycles: the *change and impact*, the *relevance*, *design*, and *rigor* cycles (Drechsler & Hevner, 2016) which is a modified version of the *three-cycle view* (Hevner, 2007).

In the *change and impact cycle*, there is a consideration of the dynamic nature of IS DSR artifacts in the wider external environment in which they trigger the development of artifacts in the application area of the artifact. The *relevance cycle* is where the practical problems, requirements specifications, and acceptance criteria are identified in the application environment of the artifact. The *design cycle* corresponds to the DSR process where the artifact is designed, developed, and evaluated. The *rigor cycle* connects the DSR process and knowledge base. The *change and impact cycle* captures, the volatile environment where the effect of the innovative designs described in this study is looked at in the external environment outside of the application environment where the artifact is developed, in this case, CBE as an HEI is the application environment area.

The benefit of the *change and impact cycle* is that it distinguishes between the immediate artifact effects in the application environment from those effects it may have indirectly in the wider context. Furthermore, the *change and impact cycle* advocate that artifact effects are no longer considered only on their application environment but extends outside the environments. According to Drechsler & Hevner (2016), the trigger for artifact design and development in an application area originate from an outside environment that is dynamic in nature.

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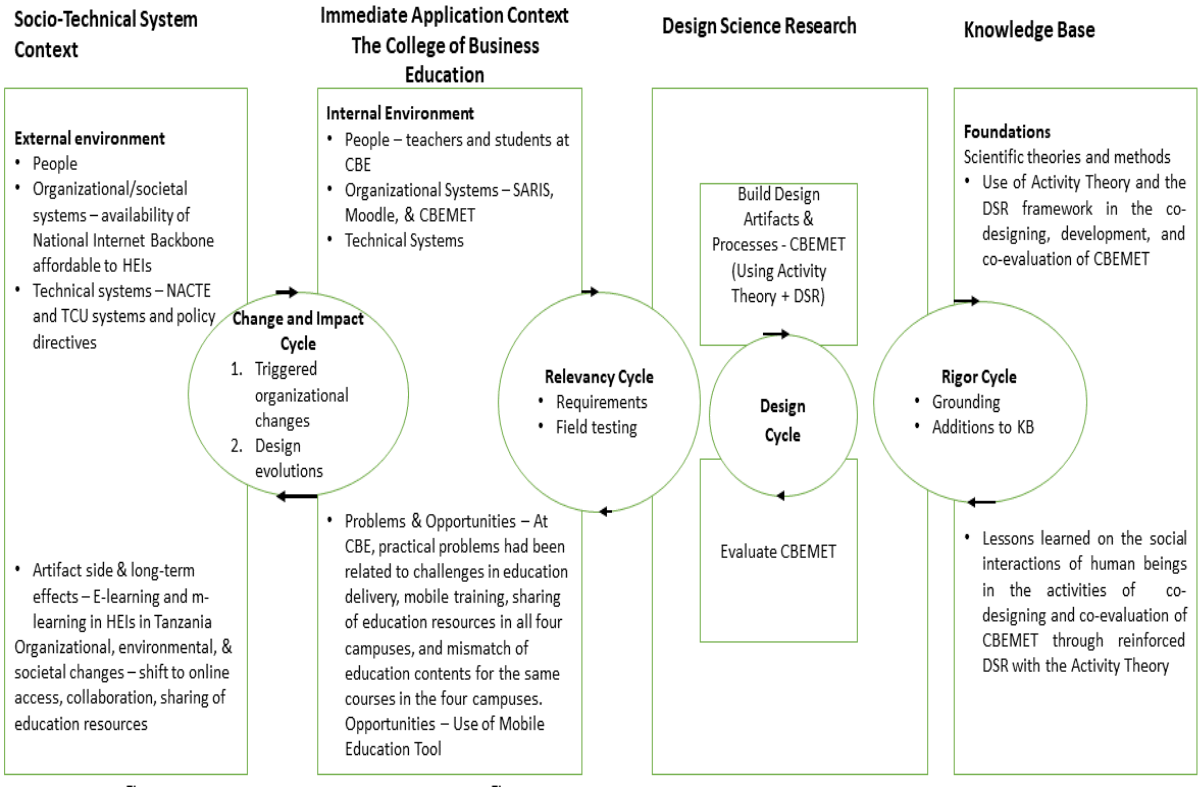

***Figure 1*:** CBEMET design science research cycles redrawn from (Drechsler & Hevner, 2016)

DSR Framework stages implementation

This study reports the activities conducted by both the teachers and students at CBE in co-evaluating an artifact – CBEMET – the fifth stage of DSR. According to Johannesson and Perjons (2014), the DSR project is composed of 5 stages as shown in Figure 2, the completed stages are shown in solid line boxes starting from 'Explicate Problem' to 'Demonstrate Artifact', the last stage of co-evaluation, that is, 'Evaluate Artifact', is shown in a solid bolded black line box.

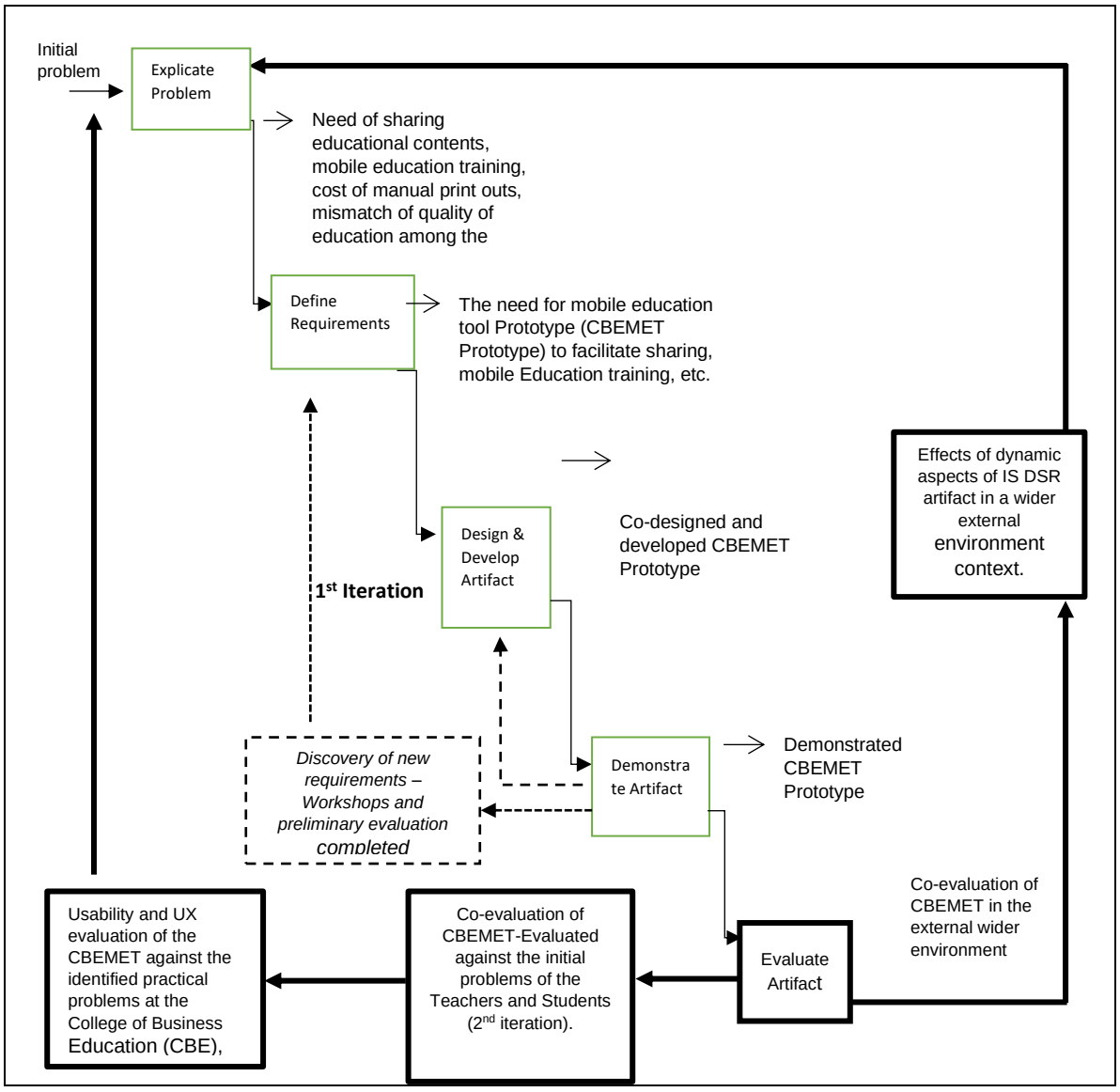

Figure 2: CBEMET co-evaluation process according to the DSR framework and the dynamic effects of the external wider context *(Johannesson & Perjons, 2014)*; *(Drechsler & Hevner, 2016)*.

The first four stages in the design and development of CBEMET have been accomplished as reported in earlier studies (Mwandosya & Suero Montero, 2017; Mwandosya, et al., 2019; Mwandosya & Mbise, 2019; Mwandosya, et al., 2019; Mwandosya, et al., 2020). It is worth noting that, during the co-design and development process of CBEMET, the demonstration and preliminary co-evaluation involved teachers and students of the Dar es Salaam campus only (Mwandosya, et al., 2020). In this study, students of the remaining campuses also participated in the co-evaluation exercise. The co-evaluation approach applied in this study involved two kinds of co-evaluation, first, the evaluation of CBEMET in the application context, that is, at CBE, and second, in the evaluation of the tool in the wider external environment to check whether the artifact

(CBEMET) had been in line with the directive from the National Council for Technical Education (NACTE) in the area of mobile learning, and the Tanzanian government Education and Training Policy of 2014. For all participants (teachers and students) the process started with a demonstration of the prototype (see Figure 3). Teachers, students, one Tanzanian Commission for Universities (TCU) official, and two NACTE officials who were serving as stakeholders were informed on how and what exactly to evaluate before the evaluation process itself had begun. This was necessary to prepare the teachers and students as effective co-evaluators of the CBEMET.

Figure 3: Demonstration of the CBEMET to students in a computer lab (left) and teachers in a board *room (right).*

RESEARCH METHODOLOGY

Evaluation Strategies

According to Johannesson & Perjons (2014), two different strategies can be used to evaluate an artifact, ex-ante, and ex-post evaluation. *Ex-ante evaluation* means that the artifact is evaluated without being used or even being fully developed, while *ex-post evaluation* requires the artifact to be employed. This study employed an ex-post evaluation strategy.

Participants

In the evaluation exercise, a total of forty (40) teachers were recruited for the focus group discussions. Out of forty teachers, sixteen (16) were from the Dar es Salaam campus and eight (8) from each of the remaining three campuses of Dodoma, Mwanza, and Mbeya respectively. The teachers were selected based on having attended a workshop held to facilitate the evaluation exercise, their readiness and willingness to participate, and also having participated in the earlier co-design and development of the CBEMET exercise (Mwandosya, et al., 2019). The participants were familiar with the initial stages of the CBEMET development process. 8 members of the management team was also involved as observers in the evaluation exercise. The inclusion of the management team's opinions in the study was purposely done to get their feelings on investment they had already approved to fund. A total of 542 randomly selected students from the four CBE campuses were also involved. Students had to possess experience in using computer technologies, for example, desktop, laptop, and mobile technologies, such as, PDAs, tablets, and smartphones. This was considered important since the application (CBEMET) is Web-based and therefore needed users who were familiar with the computer and mobile technologies and could

easily connect, access, download, share, and upload educational content. The distribution of students' participants by campus and gender is shown in Table 1 below.

Table 1: *Distribution of students by campus and gender*

Campus		**Frequency**	**Percent**	**Cumulative Percent**
	Dar es Salaam	143	26.4	26.4
	Dodoma	159	29.3	55.7
	Mwanza	120	22.1	77.9
	Mbeya	120	22.1	100.0
	Total	542	99.9	
Total (%)			**100.0**	
Gender				
Male		326	60.1	60.1
Female		216	39.9	100.0
Total		542	100	
Total (%)			**100.0**	

The CBE Dodoma campus reported the largest number of participating students. Dodoma is the newly established capital city of Tanzania attracting more government officials to the city. Therefore, there has been an increase in the population of people in Dodoma which has as well triggered an increase in the number of students attending the CBE Dodoma Campus. Also, among the CBE campuses, Dodoma Campus staff and students were highly motivated to participate in research activities as compared to other campuses. The reason behind the Dodoma campus staff motivation is that they have agreed to put more effort in both research as well as teaching and learning activities. This kind of agreement and concentration has served to make the campus in Dodoma the leading one in terms of quality and number of paper publications in reputable journals among the four campuses.

Table 2: *Students' experience in the use of mobile-related applications*

	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
1 - 3 years	224	41.1	41.3	41.3
4 - 6 years	191	35.0	35.2	76.6
7 - 9 years	105	19.3	19.4	95.9
10 years and above	22	4.05	4.1	100
Total	542	99.4	100.0	
Total (%)		**100.0**		

The number of male students who participated in the study was 326 (60.1%), and female students were 216 (39.9%). On the experience of using computers and mobile technologies, as shown in Table 2 above, most of the students had the experience of between 1-3 years (41.3%), followed by those with experience of 4-6 year (35.2%), 7-9 years (19.3%), and lastly, those with experience of 10 years and above (4.05%).

The CBEMET, as a web-based application, is accessed by any device that is connected to the Internet through passwords and usernames. The students as participants were asked to report the devices they use or will use in accessing the application, and most of them indicated use of smartphones and tablets (47.2% and 24.2% respectively) with others using Laptops (14.7%), PDAs (10.1%), and desktop computers (3.3%). The larger number of participants using smartphones implies that students will have access to the application anytime and anywhere. In Tanzania, mobile network companies offer a discount on the Internet bundles for students providing them with affordable rates for them to access educational materials among other things. Therefore, students at CBE and other HEIs are beneficiaries of such discount arrangements since most of them have smartphones. In addition, mobile network operators offer affordable smartphones with Internet connection to students and society at large to increase their customer bases.

Table 3: *Distribution of devices used by teachers and students to access the CBEMET.*

	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Smartphone	257	47.2	47.4	47.4
Tablet	132	24.2	24.4	71.8
PDA	55	10.1	10.1	81.9
Laptop	80	14.7	14.8	96.7
Desktop computer	18	3.3	3.3	100.0
Total	542	99.4	100.0	
Total (%)		**100.0**		

Data collection

Data were collected from a total of forty (40) teachers who were recruited for the focus group discussions. A total of 800 survey questionnaires were distributed to randomly selected students from the four campuses from whom only 542 (67.75%) completed questionnaires were returned. Babbie (2004), asserts that a response rate of 50% is acceptable for further analysis where 60% is good, and 70% is very good. A response rate of 67.75% was therefore considered adequate for this study.

Focus Group Discussions (FGDs)

The FGDs were done on all four campuses. The FGDs were focused on answering research questions 1, 3, and 4. Four groups of 8 students from each campus were formed for the FGD (randomly selected from the 542 students previously mentioned). All 40 participating teachers were also involved in FGDs, in groups of 8 teachers (5 groups in total). The purpose of the FGDs was to gain insights into the feelings of teachers and students about the CBEMET, and the views of the management team for the investment in the mobile technology infrastructure to enable mobile

learning. Also, the FGDs were geared to obtain rich, qualitative information, and insightful feedback to support and enrich what the questionnaires could not capture. The FGDs in all campuses took from one to three hours. This is in line with the reported literature as according to van Eewijk & Angehrn (2017), who noted the duration of focus group discussion should range from one hour to several hours. The researchers assumed the role of a moderator, facilitated the discussion, and only intervened occasionally to clarify issues. Otherwise, the researchers let the discussion flow freely for teachers to explain their experience in using the CBEMET followed by the students. Furthermore, the management team of the CBE was also involved in the FGD separately and they formed their own group. Upon participants' consent, the researchers recorded the entirety of the FGDs conducted. The recorded data was later transcribed, analyzed by two experts who are members of the academic department and the details were shared again among the teachers and students in all campuses for clarity and rectifications.

Questionnaires

A questionnaire to address research question 2 was prepared and distributed to 40 teachers and 542 students through the *CBEMET*. It was prior agreed that ability to access and download the questionnaire was one of the criteria to evaluate the prototype. The questionnaire was designed to obtain information from teachers specifically on the usability and experience they have gained in using the *CBEMET* in tackling their practical problems and from students on how the *CBEMET* has tackled their practical problems in terms of enabling them to share educational resources, enabling innovative learning among them, and collaboration of education matters or projects through *'live cha*t' among them online to enhance their learning. The questionnaire was designed differently but with some similar items for teachers and students and adapted validated items from Harpur & de Villiers (2015). Regarding students, the questionnaires had three parts: *Demographic*, *Usability* (Mobile Learning Features, Contextual Factors [Pragmatic], User-centricity [Pragmatic]), Flexibility, and Interactivity), and *User Experience* (UX) (Emotional Issues, Contextual Factors [Hedonic], User-centricity Factors [Hedonic], Social Values, Needs, Appeal, and Satisfaction).

Ethical Considerations

All participants in the study were given information about their rights in the research. The information included, the right to freely provide information and the surety of anonymity; understanding of the COVID-19 pandemic situation as participants were assured of measures like wearing of masks, social distancing, and use of sanitizers during FGDs, participants were also told that in case they felt participating in the evaluation exercise will threaten their well-being then they are free to withdraw; to freely seek more information and clarity about the study at the time they get stuck; and that the information they provide is solely for the research purposes and not otherwise.

Data Analysis

Thematic analysis was used to analyze the qualitative data. The content of the transcribed focus group discussions in each campus was coded and analyzed by prominent themes. The themes were classified as *students' motivation and engagement with the* CBEMET; *collaborative learning patterns*; *self-regulated learning; learning preferences;* and *teachers' engagement with students in using the* CBEMET (sharing educational materials, upload and download of quizzes, assignments, and examinations). Data obtained from the questionnaires were analyzed using the Statistical Package for Social Sciences (SPSS) and descriptive analysis to find the means, correlations, and standard deviations. Initially, before the evaluation exercise was conducted on each campus, workshops were held to ensure every detail about the evaluation was as clear as possible. Finally, another round of workshops was held on each campus after the evaluation exercise had been completed to finalize and clear issues that were confusing during analysis. The TCU and NACTE

officials were present in this final workshop to countercheck *mobile learning* directives to see how the CBEMET satisfies them. The results of the evaluation and analysis are discussed in the following section.

FINDINGS

This section reports on the findings in accordance with the research questions, for example, the focus group discussions (FGDs) were held to answer research questions 1, 3, and 4 while questionnaires ware used to answer research question 2. The findings are detailed below.

Usability Co-Evaluation

In response to research question 1, "*To what extent has the* CBEMET *tackled both teachers and students identified practical problems in terms of usability for innovative teaching and learning at CBE?"* evaluation of the usability of the prototype was measured using both FGDs (teachers and students) and questionnaires (students) on the mobile learning features (see Table 4).

Table 4: *Summary of focus group discussions of teachers and students in the co-evaluation process*

Usability and UX aspect	Focus group discussion responses
Mobile learning features - Usability	Participants found that the CBEMET can support mobile learning - **Teachers**
	Participants enjoyed self-regulated learning and peer-discussions in the "Live Chart" they use in CBEMET - **Students**
	Participants found interesting when testing different icons, they suggested during the co-designing stage of the CBEMET – **Teachers** and **Students**
	Participants found sharing of educational materials through the CBEMET helpful and innovative – **Teachers** and **Students**
	Participants found uploading and downloading of educational materials very interesting and innovative – **Teachers** and **Students**
Emotional issues - UX	Participants found attending lessons using the CBEMET as motivating and fun – **Students**
	Participants found the CBEMET enjoyable to use – **Teachers** and **Students**
	Participants observed that the CBEMET as new technology is an acceptable form of learning – **Students**
	Participants found the CBEMET encouraging to learn difficult subjects - **Students**

Teachers and students at CBE found that CBEMET had solved their initial practical problems. The evidence obtained from the co-evaluation exercise of teachers and students indicated support for the prototype in mobile learning, self-regulated learning for students, and sharing of educational materials among teachers and students. The students' responses on the questionnaire items (Likert scale of 1-7) regarding the usability of the prototype are summarized in Table 5 below.

Table 5: *Usability analysis of selected items related to mobile learning features - Students' Perspective*

Usability aspect	Evaluated items	Mean score	Standard Deviation
Mobile learning features	The CBEMET has adequate facilities and capabilities to support mobile learning	4.9	2.5
	The interface of the application through mobile devices does not hamper working with, through different available options	5.2	1.7
	Uploading and downloading of educational materials are feasible and achievable	5.6	1.3
	The CBEMET as an application is used well for mobile learning	5.5	2.5
Contextual factors (pragmatic)	Before handheld device knowledge and exposure make the task of learning, access, and sharing of educational materials easy.	5.3	3.1
	Students' and teachers' characteristics and needs have been considered as part of the exercise	5.6	3.0
	When working with the application it is as if I am in a normal class interacting with learning materials and with my colleagues	5.1	1.7

Table 6: *Correlations between variables*

	Mobile Features	Contextual usability	User-Centric usability	Flexibility usability	Interactivity usability
Mobile Features	------				
Contextual usability	.117**	------			
User Centric usability	.170**	.332**	------		
Flexibility usability	.149**	.138**	.212**	------	
Interactivity usability	.195**	.213**	.429**	.272**	------
Usability	.525**	.586**	.657**	.657**	.628**

** Correlation is significant at the 0.01 level (2-tailed).

The correlation scores of the variables as shown in Table 6, were mostly positive, indicating that they were affecting each other positively.

User Experience Co-Evaluation

The user experience was mainly considered for the students in response to research question 2. Responses obtained from students on all four campuses on the question are provided in Table 7.

Table 7: *Summary of the students' responses to UX questions (Likert scale of 1-7 was used)*

User experience (UX) aspect	Evaluated items	Mean Score	Standard Deviation
Emotional issues	Lessons using CBEMET are motivating and fun	5.3	1.6
	CBEMET encourages participation with a long time trying to process the lessons	4.9	1.9
	The experience of using CBEMET is enjoyable	5.2	1.7
	It is a new technology, yet it is interesting and an acceptable form of learning	5.4	1.5
	This way of learning the "fundamentals of computer applications" subject through CBEMET is encouraging	5.1	1.6

As shown in Table 8 below, the correlation between variables was generally positive except for emotional UX and appeal UX, contextual UX and social values UX, user centric UX and appeal UX, needs UX and appeal UX, appeal UX and satisfaction UX, and finally, emotional UX, and Satisfaction UX.

Table 8: *Correlation between UX variables*

	Emotional UX	Contextual UX	User-Centric UX	Social Values UX	Needs UX	Appeal UX	Satisfaction UX
Emotional UX	-------						
Contextual UX	.369**	------					
User Centric UX	.252**	.237**	------				
Social Values UX	.165**	-0.022	.358**	------			
Needs UX	.129**	.377**	.337**	.129**	------		
Appeal UX	-0.08	-.158**	0.016	.253**	-0.008	------	
Satisfaction UX	0.017	.176**	.142**	.161**	.294**	0.081	------
UX	.441**	.490**	.641**	.593**	.615**	.359**	.513**
** Correlation is significant at the 0.01 level (2-tailed).							

Teachers' and Management team's views

The responses from the focus group discussions with the teachers and management team indicate that the management team focused on the return on investment (ROI) of the technology infrastructure already in place, while the focus of teachers was based on the quality of education. The themes identified in the FGD responses were Cost, Quality Education, and Affiliations. During the discussions, members of the management team agreed that the investment in the mobile technology infrastructure has paid off as demonstrated in the words of a member of the management team below.

> "*We jointly agree that at a certain moment we were reluctant to invest much in this technology, but currently we have seen how it has paid to invest*".

The members of the management team appreciated investment in mobile learning, noting as follows:

> "*The investment in mobile learning has paid off*"
>
> "*The investment has helped to continue with some classes during the COVID-19 pandemic that faced the whole world, also, we have improved the quality of our education through mobile education tools.*"

On the quality of education, one of the participant teachers noted:

> "*This kind of investment and change in the mindset to embrace technology has been a key factor for us being nominated for the best institution award in 2017*".

Representative responses from the management team and the teachers are presented in Table 9 below.

Table 9: *Statements from the FGD responses*

Themes	Statements
Cost	*"The cost incurred in the implementation of mobile technology infrastructure is paying off significantly" –* ***Management Team***
Quality education	*CBE as one of the higher education institutions in Tanzania is now recognized as one of the best institutions in Tanzania. We won the best institution award in Tanzania in 2017" –* ***Teachers***
Affiliations	*"We have affiliations with some renowned universities in the world, for example, we are affiliated with the University of Eastern Finland, Stockholm University, Dalian University in China, Chengdu University in China" –* ***Management Team***
Impact and change Cycle of DSR	*"We have been applauded by NACTE by implementing artifact for innovative teaching and learning through CBEMET and initiating e-learning and mobile education CBE". –* ***Teachers***

DISCUSSION

The purpose of this study was to evaluate the extent to which CBEMET confirms the earlier identified user requirements and assess the users' perceptions of usability and user experience focusing on the four research questions.

Usability of the Prototype for innovative teaching and learning at CBE

Research Question 1: *To what extent has the CBEMET tackled both teachers and students identified practical problems in terms of usability for innovative teaching and learning at CBE?*

Among the criteria evaluated in the usability of CBEMET were the mobile learning features which relate to solving the identified practical problems facing teachers and students at CBE. During the demonstration and initial evaluation of CBEMET (Mwandosya., Suero Montero, Mbise, & Oyelere, 2020) new requirements were found that included those of students as well, that were to be jointly co-evaluated in the final 2nd co-evaluation of the CBEMET (see). The final co-evaluation, in this case, included students in the process. According to findings from the second iteration of the co-design and development of the CBEMET, students preferred among other functionalities, the possibility of "*Live Chat*" (see Figure 4) to enhance their self-regulated learning, and this requirement and others were met.

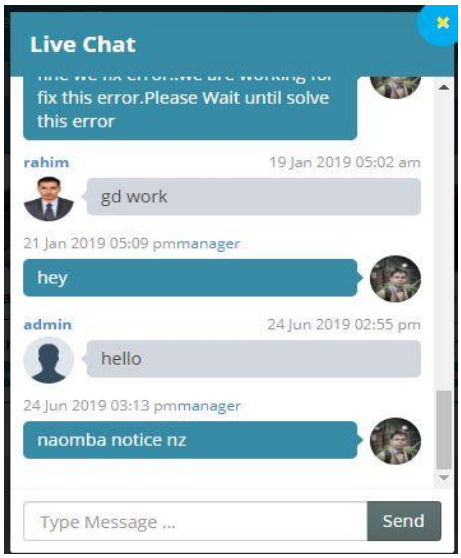

Figure 2: The students' Live Chat through the interface

One of the usability aspects of the students' questionnaire was "*The CBEMET has adequate facilities and capabilities to support mobile learning"*, and the mean score for this statement was 4.9 which was on the higher side of the Likert scale of "Agree". The uploading and downloading of educational materials to be shared among teachers and between teachers and students, was one of the strongest usability checks whether CBEMET meets the requirements or not. The findings from the questionnaire to students reveal that the statement "*Uploading and downloading of educational materials are feasible and achievable*" had a mean score of 5.6, indicating that students agreed that the prototype can perform both teachers' uploading and downloading for the students.

However, in Tanzania the constant availability of Internet and electricity power is not guaranteed and can be a hindrance to the successful utilization of the prototype CBEMET. A study by Kihoza et al., (2016), noted that one of the many challenges in the implementation of web-based applications is the availability of reliable Internet infrastructure and reliable electricity. This contextual reality is expected to have a negative effect on the functionality of CBEMET. Proper planning on the working of Internet infrastructure and constant electricity power are cornerstones to improve the learning in the higher education context. Hence, the working of the prototype will only be as expected whenever the infrastructure is running, which might limit its "any time" access. This finding is similar to that in a study conducted in the Nigerian University context where Internet access hindered the mobile application *MobileEdu* continuous deployment (Oyelere, et al., 2017).

User experience with the CBEMET for innovative teaching and learning at CBE

Research Question 2: What are the teachers' and students' user experience (UX) in using the CBEMET for improving innovative teaching and learning at CBE?

Evaluation of a two-year users' experience of CBEMET from CBE teachers and students in all four campuses provided enough experience in the working of the prototype such that they could express their user experience in the usage of the prototype. Quantitative data obtained from the questionnaires indicated that statements concerning the user experience were related to

innovative teaching and learning. For example, "*Lessons using CBEMET are motivating and fun"* had a mean score of 5.4, indicating that students agreed that their experience of two years using CBEMET had improved the innovative teaching and learning at CBE.

However, during the FGD that included teachers and students as presented in Table 4, one of the innovative statements from the student participants was as follows:

> "*The participants found the sharing of educational materials through CBEMET helpful and innovative"*

Furthermore, all 5 statements found in different aspects of user experience in the students' questionnaire had a mean score of more than 5.0, indicating that all the statements of the UX have been agreed upon as true by students (see Table 5).

CBE Management views on the Mobile Learning Implementation and Impact on External Environment

Research Question 3: W*hat are the views of the management team in instituting mobile learning pedagogy at the CBE?*

The support of the management of the institutions plays a major role in the academic excellence of the concerned institutions. In response to the research question the management views on the implementation of CBEMET indicates that one of the biggest achievements of the College of Business Education was that it has been excelling among other institutions of higher education in Tanzania. According to Webometrics Ranking in 2018, CBE ranked 21st in the list of best Universities and Colleges in Tanzania. In 2019, CBE ranked 15th in the best Universities and Colleges in Tanzania, and it was also ranked 2nd in the best College in Tanzania after Nelson Mandela African Institute of Science & Technology (NM-AIST) (Wikipedia, 2020). Also, in the year 2016, CBE received an award as an outstanding institution in Tanzania. All these come from investments in technology and other College projects which reflect the quality of education services offered by the College. In general, all the management team members recognized the good return on investment. They attributed the investment to the raised quality of education at the College.

The benefits observed by the members of the management team can be linked to the initial practical problems that faced CBE as noted by the teachers. The problems of mismatch of education content among campuses were of great concern for the management of CBE (Mwandosya & Suero Montero, 2017).

CONCLUSION

This study presented the deployment of a DSR framework to co-evaluate CBEMET, a technology initiative developed in collaboration with teachers and students to assist with the sharing of education content for innovative teaching and learning in the Tanzanian higher education context at the College of Business Education. The co-evaluation was carried out to assess if the tool has tackled the identified problems of education delivery at CBE. Also, CBEMET was evaluated against its impact on the external environment factors; that is directives from NACTE on the investment of mobile technology by all HEIs including CBE.

The evaluation of the CBEMET has identified end-user satisfaction in the way that sharing of educational resources is experienced among teachers and students at CBE: first, among the teaching staff themselves; second, between teachers and students; and finally, among students in

all four campuses. Nevertheless, we are aware that other scholars Lwoga (2014) and Oyelere, et al., (2017) have identified challenges that teachers and students face when using web-based educational applications in emerging economies, including the high price of Internet bundles, affordability of purchasing a smartphone (some students), lack of enough experience of using smartphones for educational purposes (most students mainly use their phones for social media interactions, especially Instagram and Facebook), and poor cellular networks access (teachers and students). However, a key part of the reported success in sharing educational resources through CBEMET is that the participants in this study perceived that the challenges mentioned could be balanced out by the benefits that a mobile education tool offers when all the conditions are well met (Mwandosya & Suero Montero, 2017; Mwandosya, et al., 2019).

Therefore, in this study teachers and students at CBE reported that the use of CBEMET has minimized educational-related practical problems that had been persistently contributing to diminishing the quality of education at CBE. Notable examples are the problems of access to learning materials, that is, teachers used to provide learning materials by writing on the whiteboards or by providing a hardcopy of their teaching notes for students to pay to photocopy them. This way of getting notes had been a problem for students who did not have the resources to get copies in time. Now, the availability of CBEMET provides easy access to different learning materials, not only notes but also books, manuals, etc., online that can be accessed anywhere and at any time. An earlier study has shown that this kind of online access to learning materials enables the students to have a good level of critical thinking (Botha, et al., 2005).

CBEMET, in this regard, has facilitated innovative teaching and learning at CBE in the sense that, for learning to take place, it does not necessarily require both teachers and students to be in class, rather through the CBEMET they can share learning materials at any time even after class hours. The evaluation of the CBEMET has also shown that it has a positive impact as perceived by the management team. Members of the management team reported satisfaction with the investment they have made in mobile technology infrastructure and considered it to have a good return on investment. They have noted the impact of having mobile learning pedagogy, especially during the COVID-19 pandemic.

Future Work

The study has reported on the fifth stage of a DSR project, known as Evaluate Artifact. This stage determined how well the artifact can solve the explicated problem and to what extent it fulfills the requirements (Johannesson & Perjons, 2014). The first step concerning future research is to improve the CBEMET to be a full-fledged system to support other education-related activities not covered in this study, for example, online examination administration, and the comprehensive reporting mechanism thereof. Also, the future work should dwell on extending the functionalities of CBEMET so that it could share some of its information with other national education-related mobile tools, for example, NACTE systems, as a consideration for a wider external environment as stated by (Drechsler & Hevner, 2016). In this way, the same DSR method used in this research can be applied or modified by other HEIs in a bid to attain an innovation ecosystem in Tanzania.

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