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Enriching Performance of Mathematics in Secondary Schools Using Mobile Learning

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ABSTRACT

To date, there has been limited understanding of how mobile learning could positively motivate teaching and learning in secondary education in Tanzania. More precisely, such an understanding could contribute significantly towards rescuing the poor performance in Mathematics that has been a typical feature characterizing the subject in Tanzania over the years. This paper reports on a study that aimed at exploring the methodology that could be adopted in Mobile Learning in order to improve performance in Mathematics in secondary schools in Tanzania. A cohort research design which involved students and teachers sampled from 10 private and public secondary schools in Ilala Municipality in Dar es Salaam region, was conducted over a period of four months. Questionnaires and documentary review were used as the instruments of data collection. Data were analyzed using the Statistical Package for Social Sciences (SPSS) software. Results showed that the majority of participants accept the concept of using Mobile learning in education. The results also indicate that the use of technology had no adverse impact on the culture. Moreover, preliminary results on the mobile learning model showed that students' understanding of Mathematics considerably improved.

Key words: *M-learning; attitude; improving mathematics performance using M-Learning*

INTRODUCTION

The use of mobile learning in education has grown in recent years (Cabanban, 2013; Ellis, 2013; Skiba, 2011; Tan *et al*., 2007). Attesting to the fact of the increased prominence attached to use of mobile phones in teaching and learning, new words such as "enthusiasm mobile" have quite recently been added to the English lexicon. The phrase "enthusiasm mobile" refers to learning "while on the move" (Brown & Mbati, 2015). Additionally, mobile technology has become more pervasive in everyday life, and use and ownership have become more common among a wide range of ages groups due to its affordability (Baran, 2014; Mikre, 2011). For example, by making students' learning material available at hand, students who have similar experiences can relate them with their own points of view. Students are more ready to learn from others when they are involved in similar experiences (Zhang, *et al.,* 2006). However, research on the rationale for use of mobile learning technologies in education and particularly in Mathematics, have tended to be simplistic and grounded in people's beliefs and the mindset that mobile usage matters in enhancing teaching and learning. These simplistic assumptions have not been empirically subjected to scientific studies, which occasioned a need to carry out this study.

The Significance of Mathematics in Tanzania

Mathematics is the most widely used subject in the world. Every career uses Mathematics in some way. It is likely to be impossible for a country to be successful in science and technology without building a solid foundation of Mathematics in its educational system (Shao, 2014). Similarly, Mathematics has been described as a central part of the science applied in engineering and theoretical foundations of the world (Ferry, 2008). However, despite the paramount importance of Mathematics the current trend of performance in the subject at both levels of the education system in Tanzania has shown a decline (URT 2011; HAKIELIMU 2012). The problem is reported to be at the elementary levels of education (HAKIELIMU, 2012). Inferring from this scenario, one could argue that there is a need to improve Mathematical skills among students in Tanzania. Most certainly, one of the possible teaching and learning tools that could be used in the country to reverse the trend of poor performance in Mathematics is the use of mobile phones. Justification can be found in the fact that mobile phone penetration among students is very high. Thus, there is a need for investigating how these devices could be applied to enhance learning in the formal education sector.

Statistics from the Ministry of Education and Vocational Training of Tanzania (MOEVT) indicate that the Mathematics pass rate in the Form Four National Examinations (CSEE) in 2010 was 16.1% which was 1.7 percent less than the 17.8% the pass rate in 2009 (URT, 2011). The National Examination Council of Tanzania (NECTA) statistics on Standard VII National Examination in 2013 shows the pass rate in Mathematics was 27% as compared with English (33%) and Sciences (46%).

Similarly, the National Examination Council of Tanzania (NECTA) statistical data has shown a decline in students' performance in national examinations, which according to this study, resulted from low performance in mathematics at the primary and secondary school levels (TWAWEZA, 2013). The report by TWAWEZA (2013) shows that 34% of the secondary schools' students reported Mathematics to be the most difficult subject in their studies. Consequently, parents and teachers have been pointing fingers at each other, blaming one another as the source of the failure in Mathematics. Nonetheless, TWAWEZA (2013) linked the shortage of textbooks in secondary schools to the poor performance, suggesting that it contributed to the problem by 32%. The critical shortfall of teachers in rural areas and inconsistent teachers' classroom attendance were also some of the major challenges facing the education sector. The staggering number of students who perform poorly in Mathematics calls for a need for serious action to improve the situation. Indisputably, Mathematics has remained a subject that should be mastered in order to make it easier for students to learn other subjects. Thus, utilizing mobile technology in the classroom with the goal of improving learning is a viable area for exploration.

Different mobile learning technologies are used in different places within the country. One example of the mobile technology in use for children with special needs is *Proloquo2go*, an assistive technology app available on iTunes. Students with autism spectrum disorders and others who experience difficulties in speaking can use the app's library of symbols and text-to-speech conversion to communicate easily and naturally with others. This type of assistive app helps with broadening students' horizons both in and out of the classroom (Johnson, et al, 2012). Another technology is the Mob Math adopted from the Caribbean for learning algebraic Mathematics. The system consists of a mobile phone, a server and an Internet connection. It connects the server that sends data to each student based on their usage. The system has several learning strategies, game-based learning, and personalization to support the learning process (Kaloo & Mohan, 2012).

Mobile learning in Mathematics is supported by a variety of devices and technologies that facilitate the delivery of documents, multimedia, notifications, news, assignments, quizzes and

educational courseware, all contributing to Mobile learning. These include: Smart phones including iPhone, Android and Blackberry, Laptops, Tablets including the iPad, Android devices, Kindle, iPod, Personal media players such as the iPod, and Gaming devices such as Xbox 360. Mobile phone technology has been repeatedly recognized as potentially an important channel for diversifying education to increase competitiveness in the Tanzanian workforce, in an increasingly globalized future (URT 2016). However, different studies show that many mobile learning approaches require users to stay online, or have pre-loaded materials. This research was intended to investigate the possibilities associated with mobile learning that allows the user to access the learning materials, download them and stay offline while learning, and the possibility of sharing the learning materials among the learners. This will enable students and teachers to have collaborative learning activities in different contexts.

Mobile Technologies in Education

Globally, there are numerous applications of mobile technologies in education. These include, the *Teacher Mate System* (TMS) from the United States (Teale, 2009) and the *MOBIlearn* project in Europe (Chambo et al. 2013), Likewise, in the Caribbean, mobile learning was used to teach Mathematics to secondary schools students (Kalloo & Mohan 2012). Similarly, in Niger, the project *ABC* in which adult students are taught how to use mobile phones as part of a literacy and numeracy project, showed a substantial increase in numeracy exam scores (Aker, Christopher, & Lybbert, 2011).

The concept of mobile learning is now getting attention in Sub Saharan African countries. For example, *Dr Math*, a mobile learning project in South Africa built in mobile social network *Mxit* installed on mobile phone. This allowed for access to a tutor from the University of Pretoria to assist students with Mathematics homework (Sibanyoni & Alexander, 2017). *Dr. Math* allows students to complete tutorials, homework, and testing during out of school hours, and allows teachers to support students and monitor their progress (Sibanyoni & Alexander, 2017). Other mobile project initiatives in South Africa include *MoMath* (to support Math education) and *Hadeda* which support language learning. A UNESCO working paper on mobile learning shows that the educational objective of improving Math performance through mobile technology is being achieved. The results indicate that the use of the mobile devices increased retention and motivation and there were improvements in students' end of term tests scores (UNESCO, 2012).

Traces of mobile learning initiatives in East Africa began as a project through *MPrep* and *Bridge It* in Kenya and Tanzania, respectively. *MPrep* is an SMS based quizzing and tutoring platform. A 2013 report indicated that there were 10,000 subscribers across 400 schools in Kenya (infoDev, 2013). As an initial impact, studies have revealed that *MPrep* helps individual students to improve their scores in English, Mathematics, Kiswahili and Science. *MPrep* makes it possible for teachers to deliver quality education, draw students' attention, and monitor their performance in detail, even remotely. Technologically, *MPrep* offers students tutorials and quizzes via SMS on every single topic from class seven to eight. Ageng'o (2012) noted that the system served 5000 students on simple mobile phones over 100 schools across every region of Kenya.

In Tanzania, the mobile learning initiative projects started with the *Bridge It* project, with the goal of increasing educational achievement in Mathematics, Science and Life Skills among students at primary school level, through the innovative use of cell phones and television technology (Chambo, *et al.,* 2013). The project enables students to gain a better understanding of the material taught by being able to visualize instead of simply listening to a theoretical explanation. However, its implementation encountered some challenges such as unavailability of electric power by the time of use and self-study not being utilized.

The good practice being demonstrated by Twiga Hosting Limited (THL, 2018) has resulted in a role model for mobile learning. THL uses a Tablet known as the *thl Tab* (Figure 1) with secondary school learning materials that allow students to learn using ICT. The e-school, *tHL 2.0 Revised edition* available at the Google play store, encourage students to focus on academic material rather than unethical information through its parental control functions.

Figure 1**:** *M-Learning Devices* (Source: http://thlpc.com/)

STATEMENT OF THE PROBLEM

According to Kemp (2018), more than a quarter of the African population (425 million of 1272 million) has access to the Internet. While this represents a significant opportunity, it also brings great challenges and responsibilities. While literacy has decreased at a low rate, technology use has increased at a higher rate. Figure 2 below shows various uses of technology in relation to the global population. Mobile users are recorded at 39% of the population while the Internet user was 53% (Kemp, 2018).

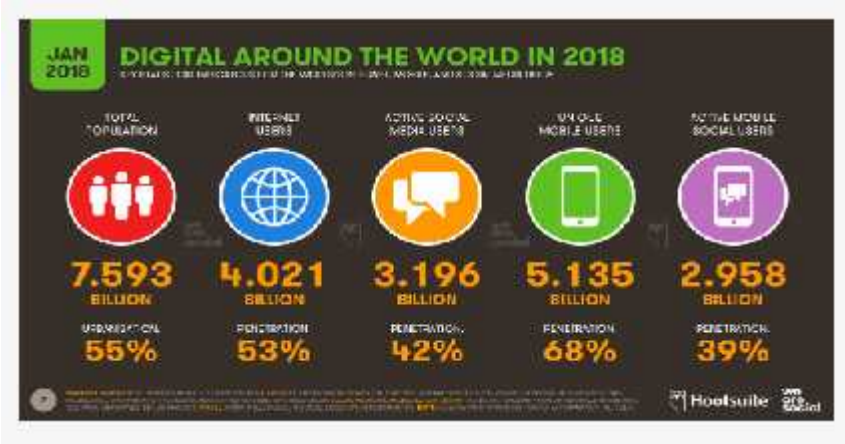

Figure 2: *Digital around the world.* Source: (Kemp, 2018)

In 2018, the world experienced a high increase in the ownership and use of technology tools. The number of Internet users in 2018 was approximately 4.021 billion (Figure 2), representing an increase of 7% per annum. The number of mobile phone users in 2018 was almost 5.135 billion, at 4% increase per annum. Kemp (2018) noted that it is not just the number of people using the technology that had increased but also the amount of time people spent on the technology that had gone up over the 12 month period**.**

Mobile phone use in Tanzania has been growing rapidly (Kafyulilo 2013). PCT (2016) reported that the number of mobile subscribers in Tanzania reached 40.17 million by 2016, which was almost equal to the size of the country's population. At the same time, the number of Internet users was 17.26 million in 2015 while the mobile money usage was about 18.08 million. TCRA (2017) showed that the number of mobile technology users had increased over the five years prior. In 2017, the number of mobile technology users recorded was about three times more than the statistics recorded in 2012 (Figure 3, TCRA, 2017).

Type of Service	2012	2013	2014	2015	2016	2017
Fixed Wireless	777,461	1,056,940	1,913,062	662,892	1,216,393	3,468,188
Mobile Wireless	6,031,323	7,498,873	11,390,031	16,280,343	18,014,358	19,006,223
Fixed Wired	712,095	761,606	984,198	319,636	629,474	520,698
Total	7,520,878	9,312,272	14,217,311	17,263,623	19,860,225	22,995,109

Figure 3: *Estimated number of users by technology type (Source: TCRA 2017)*

A significant investment in mobile infrastructure has been made, to provide the content and resources related to the integration of mobile devices in the learning environment globally (Johnson, Smith, Willis, Levine, & Haywood, 2012). Despite the opportunities that mobile learning has brought about, there are several technical challenges that influence its use for educational purposes. Some of these challenges include: device variability which makes it difficult to implement learning modules across the diverse number of mobile devices (Elias, 2011); broadband accessibility - despite the improvements in the area of mobile broadband, connectivity, access has remained expensive or even unavailable in some regions, and integration between the hardware and software on the device is still a challenge (Bidin & Ziden 2013). Moreover, limited memory storage and RAM as well as small screen sizes with poor resolution, color and contrast, may lead students accidentally selecting functions they do not need, including deleting important documents.

Nevertheless, as mobile phones become more accessible and affordable (Mikre, 2011), it is important to examine how their features and functionalities can be tailored to educational purposes in mathematics. Overall, there has been a noticeable increase in poor performance in science subjects in basic education which progressively trims down the number of engineers and scientists in higher learning institutions in Tanzania (Chambo, *et al.,* 2013). Despite the advancement of ICT, technology oriented learning in enhancing education remains a challenge in developing countries (Kisanga & Ireson, 2015; Cabanban, 2013; Ndume, Tilya, & Twaakyondo, 2008). Little is known on how mobile learning can be used as a tool to enhance students' learning in science subjects without violating the national ethics. The future of mobile learning mainly features in the arts and social sciences and is hardly found in mathematics.

While there are some limiting factors for the penetration of M-learning, Parry (2011) is of the opinion that ethically, teachers have the responsibility to teach students how to use this technology to acquire knowledge, instead of googling and ensure that students end up on the right side of the digital divide. The field of mobile learning in Tanzania is still in its infancy (Alhajri, 2016; Isaacs, 2012), and while the use of mobile technology is increasing widely at the individual level, its importance in the Tanzanian education context is only slowly being realized.

This study therefore explored the likelihood of adopting mobile learning to facilitate the learning of Mathematics in secondary schools in Ilala district in Tanzania. The study is further guided by four research questions:

Q1: Can mobile learning improve performance in Mathematics subject?
Q2: Are students and teachers in secondary schools having access to ICT devices?
Q3: What are the factors affecting the use of ICT in teaching and learning?
Q4: What are teachers' attitudes towards mobile learning?

METHODOLOGY

Characteristics of respondents

The study involved students and teachers from 10 private and public secondary schools in Ilala District. The purposive sampling technique was deployed in this study. All schools were purposively selected because they teach Mathematics and some use technology based education such as e-Learning, computer based learning as well as web based learning.

To address the possible poor response rate, questionnaires were randomly distributed to 790 students and 210 teachers available on site. However, only 545 students and 140 teachers returned the questionnaires (Table 1). Since not all respondents were able to answer all items in full, the authors performed a quality check for each item and the analysis reports the items based on the final quality check.

Table1*: Sample size*

S/N	Occupation	No. of Questionnaire Distributed	No. of Questionnaire Received	Percentage
1	Students	790	545	68.9%
2	Teachers	210	140	66.7%
Total		1000	685	68.5%

Research Design

A cohort research design was used for the study which was conducted over a period of four months. Students and teachers from 10 private and public secondary schools in Ilala Municipality and two groups of students participated in the research. The two groups were united by the fact that they all studied Mathematics. Sub groups were then selected comprising students from Form 1 to Form 6 who were studying ICT. The researchers used a quantitative framework, to study the

cohorts for statistical differences within specialized subgroups that were at the same or similar level of Mathematics learning relevant to the research problem being investigated.

Data were collected using closed-ended questionnaires. For students, the questionnaires were administered in the classroom during their free time. Teachers were left to fill questionnaires on their own time, to give them freedom to express the reality about mobile learning in education. The instrument was designed to capture three scale levels; Agree, Neutral/Moderate and Disagree. Finally, the data were analyzed statistically using SPSS. Secondary data were obtained from the records available at the Education Department at Ilala Municipal Council, Dar es Salaam. The data included the Secondary Education Strategy, Education ICT Policy and the Education ICT Strategic Plan.

Ethical issues such as informed consent, anonymity and confidentiality were observed during and after the data collection processes. Participants were informed about the right to withdraw from the study at any stage of the data collection. In addition, research permits were obtained from the Ilala Municipal Council, Dar es Salaam.

Reliability Test

In order to measure reliability of the items a Cronbach's alpha test was used. The results of the reliability test are presented in Table 2. The resulting α, coefficient of reliability ranged from $0.8542 \leq \sim \leq 0.8635$. The summary of the reliability test data shows that Average Inter item Covariance was **0.0693035**, the number of items in the scale were 38, of which 34 were positive while 4 were negative framed questions. The scale reliability coefficient was 0.8635 indicating a good measure of the concept.

Table 2*: Reliability test*

Item	Obs Sign	Item test correlation	item-rest correlation	Average Inter item covariance	alpha
Allow to use personal computer	43 +	0.1985	0.1557	0.0719698	0.8636
Allow to use personal Mobile	43 +	0.2449	0.2101	0.0718276	0.8628
Using ICT to prepare Lesson Plan	43 +	0.6318	0.6042	0.0686492	0.857
Using computer in Class Teaching In front of Students	43 +	0.4847	0.4475	0.0695754	0.8591
IS participation in ICT Training compulsory to teach in your school	43 +	0.3352	0.2926	0.0708017	0.8615
Have you attended introductory course in basic computer	43 +	0.7334	0.7142	0.0683607	0.856
Have you attended advance course in basic	43 +	0.4737	0.4385	0.0698606	0.8594

computer application					
have you attended course in Internet	43 +	0.4295	0.3975	0.0705506	0.8604
Do You Own Equipment Specific for ICT Training	43 +	0.3937	0.3582	0.0706371	0.8608
Course on Pedagogical Use of ICT in teaching	43 +	0.3636	0.3272	0.0708516	0.8612
Subject Specific Training	43 +	0.4057	0.3687	0.0704309	0.8605
Course on Multimedia	43 +	0.4224	0.3852	0.0702538	0.8602
Participate on Online Community/Blogs	43 +	0.4810	0.4455	0.0697533	0.8593
ICT Training provided by ICT Staff	43 +	0.7760	0.7565	0.0672666	0.8542
Others Professional development	43 +	0.4755	0.438	0.0696569	0.8593
Does Your school Provide Address to Teacher	43 +	0.1651	0.1292	0.0723356	0.8638
Does Your school Provide Address to Students	43 +	0.3710	0.3314	0.0706113	0.861
Does Your school Provide Address to Others Staffs	43 -	0.2296	0.1881	0.0717536	0.8631
Service Computer using ICT /Technology coordinator	43 -	0.2033	0.1586	0.0718958	0.8636
Do You use any Electronic Register in your school?	43 +	0.3914	0.3539	0.0705381	0.8607
Do you use any Content Management System in your school?	43 +	0.3075	0.2626	0.0709688	0.862
Do your school Library Connected in Internet	43 +	0.2561	0.21	0.071402	0.8629
Service Computer From Outside the School	43 +	0.6292	0.5852	0.0664951	0.8549
In sufficient Number of Internet -connected computer	43 +	0.7615	0.7179	0.0623148	0.8493
Insufficient Number of internet -Connected Computer	43 +	0.3082	0.2406	0.0701865	0.863
Insufficient Internet Bandwidth or speed	43 +	0.5228	0.4559	0.0666031	0.8577
Insufficient Number of Laptop	43 +	0.6749	0.6199	0.0638296	0.8526
School Computer is Out	43	0.7476	0.7036	0.0628536	0.85

of date	+				
Lack of adequate Skill of Teacher	43 +	0.7140	0.6646	0.0632726	0.8512
Insufficient technical Support	43 +	0.6612	0.6086	0.0645696	0.8532
Lack of adequate Content/material for teaching	43 +	0.5355	0.4721	0.066599	0.8572
Most parent not in fever of Using ICT	43 +	0.6108	0.5592	0.0660237	0.855
Most teacher not In fever of using ICT in school	43 +	0.4226	0.358	0.0686135	0.8603
Lack of Interest of teachers	43 -	0.0795	0.0021	0.0731255	0.8693
No Unclear Benefits of using ICT for Teaching	43 +	0.0455	-0.0545	0.074104	0.8746
Using ICT in School is Not a Goal	43 -	0.0003	-0.0972	0.074819	0.8755
Teachers Education	43 +	0.1577	0.1011	0.0721527	0.8651
Secondary Schools	43 +	0.3814	0.2837	0.0680207	0.8646
Test scale				**0.0693035**	**0.8635**

RESULTS AND DISCUSSION

Teachers' and Students' Basic Characteristics

The study collected data from 140 teachers and 545 students. Gender representation of the respondents in Table 3 below, shows that among teachers, females accounted for 67 (43%) whereas 73 (52%) were males. In the category of students, 307 (56%) of the respondents were females and 238 (44%) were males. The higher proportion of female students to males is likely attributable to the fact that three schools out of ten were girls' schools, whereas the rest combined both females and males.

Since not all respondents were able to answer all items in full, following a quality check for each item and review of the analysis reports, **the researchers decided to report on the responses of teachers only. The results for research questions 1 to 4 are shown below.**

Table 3: *Basic characteristics of teachers and students*

S/N	School	No. of Respondents					
		Teachers			Students		
		Male	Female	Total	Male	Female	Total
1	S1	6	10	16	87	90	177
2	S2	4	2	6	39	22	61
3	S3	9	3	12	34	15	49
4	S4	8	6	14	0	50	50
5	S5	4	16	20	0	15	15
6	S6	8	3	11	34	25	59
7	S7	14	10	24	0	50	50
8	S8	8	6	14	20	0	20
9	S9	8	5	13	14	25	39
10	S10	4	6	10	10	15	25
	Total	**73**	**67**	**140**	**238**	**307**	**545**
Percent		52%	48%	100%	44%	56%	100%

Using mobile learning for improving performance in education

Q1: Can mobile learning improve performance in Mathematics subject?

The first research question sought to explore whether mobile learning could improve performance in Mathematics. Participants – students and teachers - were requested to express their degree of agreement with each item on a three-point scale: *Agree, Neutral (Neither Agree nor Disagree) and Disagree* [Table 4]. Only 458 participants responded, and their responses are summarized in Table 4.

The results in Table 4 below show that the majority of respondents (83%) accepted that using Mobile learning in continuing education would enhance teaching and learning. They believed that better performance and high grades could be attained by using Mobile Learning (83.6%). Results also negate the assertion that that increased use of ICT/Mobile learning (38.20%) would add more problems related to forged certificates. Furthermore, results also indicate that culture was not negatively correlated to the use of technology (34.30%). However, the majority of participants reported that a controlled use of Technology in lower schools is required. Parry (2011) noted that educators need to learn how to embrace Mobile devices both inside and outside the classroom. Tablets preloaded with games, theories, and content could be a preference for lower school students. However, in regard to managing ethical and culture issues, the literature shows that

teachers can download video through their mobile phones and present them to students through a TV set available in the classroom (Kafyulilo, 2013; Kafyulilo, Moses, & Rugambuka, 2012).

Table 4: *Responses on the use of Mobile Learning in education*

Question item	**N= 458**	**Disagree**	**Neutral**	**Agree**
Q1	Will lead to more students continuing with education	50 (10.90)	27(5.90)	381(83.20)
Q2	Will lead to better performance if used with traditional learning	79(17.20)	42(9.20)	337(73.60)
Q3	Will help students get high grades at the end of their studies	49(10.70)	26(5.70)	383(83.60)
Q4	Will add more problems to forged certificate	175(38.20)	86(18.80)	197(43)
Q5	Is the best way to increase enrolment in education	67(14.60)	34(7.40)	357(77.90)
Q6	Will effect negatively our culture of assessing information	157(34.30)	88(19.20)	213(46.50)
Q7	Will understand the concept of mobile learning	53(11.60)	22(4.80)	383(83.60)

The findings in regard to attaining a higher grade in Mathematics using mobile learning in secondary schools are consistent with the findings reported by da Costa & Lopes (2016) that technology resources based on a variety of approaches that complement traditional methods, enrich and widen the spectrum of conditions necessary to acquire and develop knowledge. Technology use has been proven to provide an opportunity for changes aimed at meeting students' learning demand and has manifested itself in a shift in focus from teacher–centered practice to student-centered learning. Mobile technology has accelerated the pace of learning even more. However, Dias (2013) maintains that the context of digital technology requires a different paradigm relevant for the teaching and learning process.

Accessibility to ICT Devices in education

Q2: Are students and teachers in secondary schools having access to ICT devices?

The second research question aimed at finding out if students and teachers could use ICT devices in the classroom (such as mobile phones, laptops or desktop machines) in schools. The sub question items were used to find out if teachers had attended relevant courses that equip them with skills for preparation of lessons using ICT tools. Out of 140 returned questionnaires among teachers, only 43 responses provided data relevant to this question.

Participants were requested to respond either *yes* or *no* to each sub-question. Generally, the findings indicated that, in some schools, students had been allowed to use ICT while in some classes they were not. The reason given is that some classes have to seat for national ICT courses. In addition, some schools were already registered to take ICT courses while others were not. The research results also indicated that 32.56% of teachers use laptops or personal computers at school. It was also noted that some schools were pre-installed with computers and

some students were allowed to access these computers. It was further noted that 67.44% of teachers use computers and the internet to prepare their lessons. Findings also indicated that 76.71% of teachers had attended basic computers literate courses but only 32.56% attended advanced courses in ICT. Moreover, only 20.93% of teachers attended an Internet training course and only 32.00% attended multimedia courses. In general, the results show that accessibility of computer devices in the selected secondary schools is still low.

Table 5: *Accessibility of ICT equipment (Responses from teachers)*

	Questions (N=43)	Yes		No	
		N	%	N	%
Q1	Are student allowed to use personal laptop?	14	32.56%	29	67.44%
Q2	Are students allowed to use personal mobile?	8	18.60%	35	81.40%
Q3	Do you use computer and internet for the preparation of lesson?	29	67.44%	14	32.56%
Q4	Are students using computer?	21	48.84%	22	51.16%
Q5	Have you attended introduction Course in basic computer?	33	76.71%	10	23.26%
Q6	Have you attended advance course in computer application?	14	32.56%	29	67.44%
Q7	Have you attended a course in the internet?	9	20.93%	34	79.07%
Q8	Have you attended equipment specific training?	11	25.58%	32	74.42%
Q9	Have you attended any course in the use of ICT?	11	25.58%	32	74.42%
Q10	Have you attended subject specific courses in computer?	13	30.23%	30	69.77%
Q11	Have you attended course in multimedia course	14	32.00%	29	67.44%
Q12	Have you participated in an online community training such as blog?	15	34.88%	28	65.12%

Most secondary school teachers do not have access to ICT facilities for teaching, though they privately use Internet services via social media such as WhatsApp, Instagram, Facebook and Twitter. The research results revealed that the willingness to the adopt and use ICT tools in schools had a positive impact regardless of the fact that they were not well equipped with ICT tools and that they lacked adequate content material for teaching. The results suggest that more effort from the Ministry of Education may be needed both in terms of awareness creation and equipment support, especially at the infants' level, hoping that in future those schools will reach a level of self-sustainability.

Factors Affecting the Use of ICT in Teaching and Learning

Q3: What are the factors affecting the use of ICT in teaching and learning?

The third research question aimed at exploring the factors that affect the use of ICT in teaching and learning. Approximately 18.10% of the 43 respondents indicated that insufficient technical support for teachers hinders the use of ICT in learning and teaching. On the other hand, 23.26% responded that the available school computers were out of date. Further, 2.33% responded that most parents and teachers were not in favor of using ICT in schools. Moreover, 20.93% of the participants responded that there was insufficient Internet bandwidth for use. Regarding the item "No or unclear-benefits to use ICT on teaching and learning", 18.60% said not at all, and 55.81% said there was little or unclear benefit to use ICT in teaching and learning. However, the findings shown in Table 6 display an interesting pattern. The majority of respondents selected neutral in their responses to all questions, implying that either they were truly not sure of the appropriate answers or they were deliberately unhelpful.

Table 6: *Factors that affect the use of ICT in teaching and learning*

	Factor /obstacles using ICT at School	**Disagree**		**Neutral**		**Agree**	
		N	**%**	**N**	**%**	**N**	**%**
1	Insufficient number of computers	9	18.60%	27	62.79%	8	18.65%
2	Insufficient number of Internet connected computer	6	13.95%	35	81.40%	2	4.65%
3	Insufficient internet bandwidth in speed	9	20.93%	29	67.45%	5	11.63%
4	Insufficient number of laptops	4	9.30%	26	60.47%	13	30.23%
5	School computers out date	5	11.63%	28	65.12%	10	23.26%
6	Lack of adequate skill of teachers	6	13.95%	28	65.11%	9	20.95%
7	Insufficient technical support for teachers	5	11.63%	30	69.76%	8	18.10%
8	A lack of adequate contents material for teaching	10	23.26%	31	72.10%	2	4.65%
9	Most parents not in favor of using ICT in school	9	20.98%	33	76.75%	1	2.33%
10	Most teachers not in favor of using ICT in school	8	18.60%	34	79.07%	1	2.33%
11	Teachers lacking internet	9	20.93%	31	72.09%	3	6.98%
12	No or unclear-benefits to use ICT on teaching and learning	8	18.60%	24	55.81%	11	25.58%
13	Using ICT in school is not our goal	8	18.60%	25	58.14%	10	23.26%

Findings revealed by the study provide a picture of the factors affecting the use of ICT in teaching and learning. Most of the factors have also been explored in several studies (Ndume, *et al.,*2008; Sanga, *et al.,* 2013; Kisanga and Ireson, 2015). These studies show that an insufficient number of computers/laptops in primary schools in Tanzania has been a dominating factor and this can be attributed to financial constraints and lack of a maintenance culture in the society. For example, in some of the selected schools, the study found that even the few available ICT equipment were not functioning well. One of the reasons raised was lack of proper maintenance. Another interesting finding that could hinder the use of ICT devices in education is that most of the teachers selected the neutral category for their response, indicating the possibility of mixed feelings about using ICT in schools. This result can imply that some control measures/strategies need to be in place to ensure that students are truly using ICT for education purposes and not otherwise.

The attitude of teachers towards mobile learning

Q4: What are teachers' attitudes towards mobile learning?

The fourth research question sought to explore teachers' attitude towards mobile learning. When asked about their feelings and the feelings of others about mobile learning, the majority of the 54 teachers that answered the question (66.70%) responded positively, implying they were aware of mobile learning and would use it. However, 27.8% of the respondents expressed reservation towards the use of mobile technology in learning. The researchers are of the view that the respondents doubt could decrease with an increase in the awareness of mobile learning. Generally, teachers showed positive attitudes when they were asked about their students' feeling towards mobile learning. About 52% responded positively to this question. Table 7 shows the summary of the results on different questions in relation to teachers' attitudes towards mobile learning.

Table 7: *Teachers' attitude towards Mobile learning*

Question Item	**(N=54)**	**Low**	**Moderate**	**High**
Q1	How would you rank your feeling and of other people you know about Mobile learning	3 (5.60%)	15 (27.80%)	36 (66.70%)
Q2	My feeling toward Mobile learning	2 (3.70%)	9 (16.70%)	43 (79.60%)
Q3	My thought about other people's feeling towards mobile learning	4 (7.40%)	20 (37.00%)	30 (55.60%)
Q4	My thought about my students' feeling towards mobile learning	4 (7.40%)	22 (40.70%)	28 (51.90%)

Consistent with Kisanga's (2016) finding, our findings reported in Table 7 revealed that about 80% of the teachers had high attitudes towards mobile learning, whereas only 4% had low attitudes. The high attitude level indicated by the majority of teachers could be attributed to their experience in using mobile phones. Data retrieved from secondary sources shows that the majority of people (including teachers) in Tanzania own mobile phones (TCRA, 2017). Few teachers showed uncertainty/low feelings toward mobile learning. The finding may likely be

attributed to lack of proper policy/measures of using mobile phones in secondary schools in Tanzania.

A Prototyped Model

To achieve the objective of enriching learning and performance in mathematics in secondary schools, a mobile learning model and a prototype tool which is a web mobile application system has been developed. Two research theories were considered in the design: Social constructivist theory and activity theory supported by another study done by Norman (1999) which emphasized the device, learner, and social aspects as the key factors to be considered in designing mobile learning. Thus, the design focused on easy access to technology, connectivity, integration, ownership as well as institutional support. The system was developed in the Eclipse integrated development environment (IDE) using the Android software development kit (Android SDK Tools). The application is targeted at any Android mobile device running at least Android 2.2, which corresponds to API level 8 up to the latest Android SDK Version. At the time of writing this report, Android 9 (Android Pie) API level 19 was the latest Android SDK Version in use.

All users of the system must register themselves into a system and some special users (teachers, and academic principals) can be registered by the system administrator to avoid distorting and manipulating their identity (using fake identities), especially when considering the sensitivity of the category itself. All the testing done on the client side of the application was carried out on an Android mobile device, the Samsung Galaxy Trend. The screen of the mobile phone was printed and saved to a file with the help of the DroidAtScreen software program. Figure 4 displays some simulation slides.

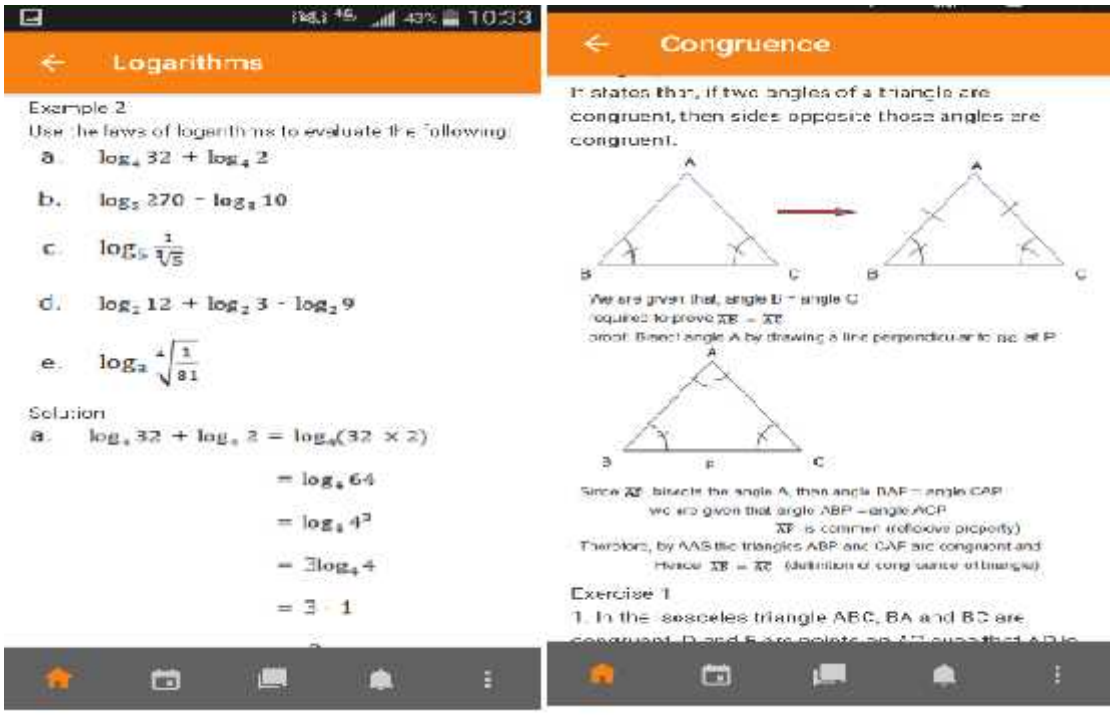

***Figure 4*:** *Simulated slides*

Several technologies and tools were used in the development of this system. They include: Android, Java, PHP, MySQL, JSON, phpMyAdmin and the Android mobile phone.

The results of the study suggest that while teachers would like to use mobile technologies to improve student learning in mathematics, teachers require face-to-face support to really change their behavior. No one is going to change a teacher's educational outlook or philosophy with a few text messages. The traditional methods of teaching Mathematics promise little in the learning of Mathematics. Based on the results of the present study, teachers should encourage the use of ICT to students so as to maximize its positive impact. The ICT has to be a key pivot in the production, transfer and use of knowledge (Swarts and Wachira, 2010).

CONCLUSION AND RECOMMENDATION

Results from the study have shown that there is a need for development and implementation of mobile learning for secondary schools in Tanzania. The effective use of Information and Communications Technology (ICT) in developing countries like Tanzania is crucial for supporting education and overcoming the challenges that are being encountered in the education sector. The poor performance in Mathematics has been a critical issue for some years in the different secondary schools in Tanzania. Mobile learning in the teaching and learning of Mathematics is practical, possible and viable.

From the research results, it can be concluded that mobile learning is needed in Ilala Municipal secondary schools and Tanzania at large. The role of government in establishing ICT facilities at schools cannot be ignored as participants noted that most schools have limited resources that cannot allow the establishment of ICT. The researchers recommend that schools should focus on self-sustainability by making the labs accessible. Tanzania and other developing economies cannot afford to push aside these issues. There is no better place than in schools where ICT should be embraced.

Therefore, we found that there is a need for more effort by the government through the Ministry of Education and Technology towards adoption of mobile learning, by promoting this tradition among different education levels. Training seminars regarding mobile learning issues have to be organized that are aimed at increasing IT literacy among educational professionals. On the other hand, inadequate support and budget limitations are the most common challenges facing the system and thus, it is recommended that attention be given to these challenges.

REFERENCES

Ageng'o, C. 2012. "Interview with Toni Maraviglia, CEO of MPrep". from https://techweez.com/2012/08/09/interview-with-toni-maraviglia-ceo-of-mprep/

Aker, J, C., Ksol, C. & Lybbert, T. J. 2011. "ABC, 123: Can Mobile Phones Improve Learning? Evidence from a Field Experiment in Niger". *Center for Global Development*

Alhajri, R. 2016. "Prospects and Challenges of Mobile Learning Implementation: A Case Study". *Information Technology & Software Engineering,* vol. 6, no. 5.

Baran, E. 2014. "A Review of Research on Mobile Learning in Teacher Education". *Educational Technology & Society,* vol. 17*,* no. 4. pp. 17–32.

Bidin, S. & Ziden, A. A. 2013. "Adoption and application of mobile learning in the education Industry". *Procedia - Social and Behavioral Sciences*, vol. 90, pp. 720 – 729.

Brown, T. H. & Mbati, L. S. 2015. "Mobile Learning: Moving Past the Myths and Embracing the Opportunities". *International Review of Research in Open and Distributed Learning* vol. 16, no. 2. pp. 115-135.

Cabanban, C. L. G. 2013. "Development of Mobile Learning Using Android Platform". *International Journal of Information Technology & Computer Science (IJITCS),* vol. 9*,* no. 1.

Chambo, F. F., Laizer, L. S., Nkansah-Gyekye, Y., & Ndume, V. 2013. "Mobile Learning model for Tanzania secondary schools: case study of Kilimanjaro region". *Journal of Emerging Trends in Computing and Information Sciences,* vol. 4 no. 9. pp. 698-701.

da Costa, R. D. A. & Lopes, P. T. C. 2016. "M-learning: Development and evaluation of an application for the teaching and learning of human anatomy". *Interciencia,* vol. 41, no. 7. pp.482-487.

Dias E. A. J. 2013. "Encontro Prod. Discente PUCSP/Cruzeiro".

Elias, T. 2011. "Universal Instructional Design for Mobile Learning". *International Review of Research in Open and Distance Learning,* vol. 12, no. 2, pp. 143-156

Ellis, C. 2013. " Broadening the scope and increasing the usefulness of learning analytics: The case for assessment analytics". *British Journal of Educational Technology,* vol. 44, no. 4, pp. 662-664.

Ferry, B. 2008. "Using mobile phones to augment teacher learning in environmental education". *The Australasian Society for Computers in Learning in Tertiary Education.* pp. 295-298.

HAKIELIMU 2012. "School Children and National Examinations: Who Fails Who?". A Research Report on the Relationship between Examination Practice and Curriculum Objectives in Tanzania.

INFODEV, FINANCE, and PRIVATE SECTOR DEVELOPMENT 2013. "*Crowdfunding's Potential for the Developing World".* Washington DC: World Bank.

Isaacs, S. V. 2012. "Mobile Learning For Teachers In Africa And The Middle East: Exploring the Potential of MobileTechnologies to Support Teachers and Improve Practice". *UNESCO working paper series on mobile learning*

Johnson, L., Smith, R., Willis, H., Levine, A., & Haywood, K. 2012. "*NMC Horizon Report:". 2011 Edition*: The New Media Consortium.

Kafyulilo, A. C. 2013. "Professional development through teacher collaboration: An approach to enhance teaching and learning in science and mathematics in Tanzania". *Africa Education Review,* vol. 10, no. 4, pp. 671-688.

Kafyulilo, A. C., Moses, I., & Rugambuka, I. B. 2012. "The implementation of competency based teaching approaches in Tanzania. The case of pre-service teachers at Morogoro teacher training college".

Kalloo, V., & Mohan, P. 2012. "MobileMath: An innovative solution to the problem of poor Mathematics performance in the Caribbean". *The Caribbean Teaching Scholar,* vol. 2, no. 1.

Kemp Simon (2018) Digital in 2018 : "World internet user Pass the 4 Billion mark" Available at https://wearesocial.com/blog/2018/01/global-digital-report-2018

Kisanga, D. H., & Ireson, G. 2015. "Barriers and strategies on adoption of e-learning in Tanzanian higher learning institutions: Lessons for adopters". *International Journal of Education and Development using Information and Communication Technology (IJEDICT),* vol. 11, no. 2, pp. 126-137.

Mikre, F. 2011. "The roles of information communication technologies in education: Review article with emphasis to the computer and internet". *Ethiopian Journal of Education and Sciences,* vol. 6, no. 2, pp. 109-126.

Mtebe, J. R. R. 2014. "Investigating students' behavioural intention to adopt and use mobile learning in higher education in East Africa". *International Journal of Education and Development using Information and Communication Technology,* vol.10 no.3, pp. 4-20.

Mtega W, Bernad R, Msungu A, Sanare R(2012) "Using mobile phones for teaching and learning purposes in higher learning institutions: The case of Sokoine University of Agriculture in Tanzania" *Proceedings and report of the 5th UbuntuNet Alliance annual conference"* pp. 118-129

Ndume, V., Tilya, F., & Twaakyondo, H. 2008. "Challenges of adaptive elearning at higher learning institutions: a case study in Tanzania". *International Journal of Computing and ICT Research,* vol. 2, no. 1, pp. 47-59.

Norman, D. A. 1999. "Affordance, conventions, and design". *Interactions,* vol. 6, no. 3 , pp.38-43.

Parry, D. 2011. "Mobile perspectives: On teaching mobile literacy". *Educause Review,* vol. 46, no. 2, pp.14-16.

PCT. 2016 . "No Limit for Mobile usage" *Reuter* Retrieved 27 August 2018.

Sanga, C., Magesa, M. M., Chingonikaya, E. & Kayunze, K. A., 2013. "Can e-learning promote participation of female students in STEM disciplines in higher learning institutions of Tanzania?" *International Journal of Education and Development using Information and Communication Technology (IJEDICT),* vol. 9 no. 3, pp. 86-102.

Schaal, S. & Lude, A. 2015. "Using Mobile Devices in Environmental Education and Education for Sustainable Development—Comparing Theory and Practice in a Nation Wide Survey". *Open access:Sustainability, vol. 7*, pp10153-10170

Shao, D. A. 2014. "Mobile learning a new wave of learning: A survey among University of Dodoma students". *International Journal of Computer Applications.* vol. 98, no. 16 .

Sibanyoni,N. A & Alexander, P.M 2017. "Assessing the Potential of Levelup as a Persuasive Technology for South African Learners". *Proceedings of the 13th International Conference Mobile Learning 2017, pp 10-12 April, Budapest, Hungary.* pp. 18-24

Skiba, D. J. 2011. "On the HorizonMobile Devices: Are They a Distraction or Another Learning Tool?" *Nursing Education Perspectives,* vol. 32 no. 3, pp. 195-197.

Swarts, P. & Wachira, E. M. 2010. "Tanzania: ICT in Education Situational Analysis". *Global e-Schools and Communities Initiatives (GESCI)* from http://www.gov.go.tz/egov_uploads/documents/Situational_Analysis_Tanzania_sw.pdf

Tan, N., Chen, W., Looi, C.-K., Zhang, B., Seow, P., Chan, A., et al. 2007. "Handheld computers as cognitive tools: An environmental learning project in Singapore". *Frontiers In Artificial Intelligence And Applications,* pp.162-377.

TCRA 2017. "Quarterly Communications Statistics Report: October- December 2017 Operator Returns". from https://www.tcra.go.tz/publication-and-statistics/statistics

Teale, W. H. 2009. "Students Learning English and Their Literacy Instruction in Urban school". *The Reading Teacher* ,vol. 6, pp. 699-703.

THL. 2018. "Notes, Practicals na Review Questions for Form I – VI". from http://thlappstore.co.tz/

TWAWEZA 2013. "Form Four Examination Results: Citizens Report on the Learning Crisis in Tanzania" . Dar es Salaam: Uwazi at Twaweza

UNESCO 2012. "*Mobile learning for teachers in Africa and the Middle East:bExploring the Potential of Mobile Technologies to Support Teachers and Improve Practice".* Paris: United Nations Educational, Scientific and Cultural Organization.

URT (United Republic of Tanzania), 2011. "*Basic Educational Statistics in Tanzania (BEST): 2006-2010 National Data"*. Tanzania: Ministry of Education and Vocational Training.

URT, 2016. "*National Information and Communications Technologies Policy"*. Tanzania: Ministry of Works, Transport and Communications.

URT, 2018. "The Environmental Management (Fees and Charges) (Ammended) Regulations". Tanzania: Ministry of State, Vice President's Office Union Affairs and Environment.

Wong, C. A., Afandi, S. H. M., Ramachandran, S., Kunasekaran, P. & Chan, J. K. 2018. "Conceptualizing Environmental Literacy and Factors Affecting Pro-Environmental Behaviour". *Iinternational Journal of Business and Society,* vol. 19, no.1, pp.128-139.

Zhang, B., Looi, C. K., Chen, W., Tan, N., Seow, S. K., Oh, T. T., & Chung, T. M. 2006. "Using Mobile Learning Technologies for Primary Environmental Education in Singapore Schools*". Paper presented at the International Science Education Conference*, November, Singapore.