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Feasibility of cloud computing implementation for eLearning in secondary schools in Tanzania

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ABSTRACT

This article assessed the feasibility of implementing eLearning systems in a cloud-based infrastructure for secondary schools in Tanzania. The study adopted questionnaire and document reviews as data collection tools. A total of 820 students successfully returned the questionnaire from seven secondary schools in Tanzania. The study found that 11% of government secondary schools had computer labs with 20.1% of them connected to the Internet. Moreover, more than half of surveyed students (56.6%) had access to mobile phones at home with 53.5% using the phones to access the Internet. However, the study found that the cost of the Internet had remained unaffordable to many students. This study shows that eLearning implementation in the cloud for secondary schools in Tanzania is feasible. This research will serve as a base for future studies that plan to implement eLearning systems to enhance teaching and learning in secondary schools in Tanzania.

Keywords: *Cloud computing, eLearning, Internet, Secondary schools, eLearning Tanzania*

INTRODUCTION

In the recent years, there has been an increasing interest in the development of eLearning systems to enhance the quality of teaching and learning in secondary schools in Tanzania. This was due to continued improvement of Information and Communication Technologies (ICT) infrastructure and penetration of mobile phones in Tanzania. The cost of Internet service has declined by more than 50% (MWTC, 2016) due to rolling out of two of the optical fibre network namely Eastern Africa Submarine Cable System, and the African Cable System (Mtebe, 2015). The cost of mobile devices such as smartphones and tablets has dropped to as low as US$ 30; and are affordable to the majority of Tanzanians (Mtebe & Kondoro, 2016). Additionally, Internet users have increased from 29% in 2014 to 40% in 2016 while mobile phone penetration has increased to 80% of the total population by 2017 (TCRA, 2017).

Given these developments, the Government of Tanzania and development partners have been equipping schools with ICT facilities to improve the quality of education in secondary schools in Tanzania. A recent report by the Ministry of Education, Science and Technology (MoEST), indicates that approximately 31.4% of government secondary schools (out of 3,601) have computers ranging from 1 to 68 computers (MoEST, 2017). The report further states that 20.1% these schools are connected to the Internet. Although the report did not focus on private owned secondary schools, it is estimated that the number of private schools with computers connected to the Internet is high.

Apart from ICT facilities, there exist some initiatives to develop eLearning systems in order to facilitate sharing of digital content and provide interaction between teachers and students synchronously and asynchronously via the Internet. The first effort to implement eLearning system can be traced back in 2006 when an eLearning system was developed and piloted in two secondary schools in Kibaha and Dar es Salaam (Kalinga, Bagile and Trojer, 2006). Since then, a number of similar systems such as Retooling, Shuledirect, Halostudy, and Brainshare have been developed and implemented. Shuledirect ,for instance, consist of 8 subjects benefiting more than 10,000

students countrywide (Mtebe & Kissaka, 2015). Similarly, Halostudy has multimedia-enhanced content of science and mathematics subjects from Form I to Form IV. More than 427 schools connected to the Internet by Halotel have been accessing the content benefiting more than 50,000 students in Tanzania.

The majority of implemented eLearning systems are hosted in-house in schools or in providers' computer servers surrounded by several challenges. One of these challenges is poor accessibility of these systems due to unpredictably power interruptions. The majority of computer servers hosting these systems tend to be off at some point and therefore affecting users accessing the systems. Moreover, schools are burdened with hiring technical staff who are responsible for maintaining and managing computer servers at their premises. Generally, hosting eLearning systems at schools premises is unreliable and costly.

Mtebe and Raisamo (2014) computed the cost of hosting an eLearning system at a school premise and found that the school needs to invest approximately US$ 25,441 to host eLearning system for 3 years. Similarly, the University of Education, Winneba, in Ghana spent an estimated amount of US$ 300,000 per year to implement eLearning system to service 15,000 students (Unwin et al., 2010). Therefore, hosting eLearning systems in-house requires substantial investment that many secondary schools cannot afford. However, cloud-computing technology that has been adopted and implemented worldwide to overcome these challenges has not been explored.

Cloud computing comprises virtualized servers, networks, database storage, applications and services which are delivered over the Internet. In this computing model users rent and consume computing and storage resources as needed and pay per usage similar to water and electric bills (Laisheng & Zhengxia, 2011; Carroll et al., 2011). By gaining support from largest ICT companies such as Google, Amazon, and Microsoft, cloud computing is being widely embraced by many organizations (González-Martínez et al., 2015).

In education, the adoption of cloud computing will enable schools to implement eLearning systems without procuring and hosting ICT infrastructure in their premises. By using this approach schools can save substantial capital costs for purchasing hardware and software, administration and operational costs associated with hardware maintenance, software licensing, electric power, cooling system and wages for ICT personnel (Mokhtar et al., 2013; Sultan, 2010; Carroll et al., 2011). As a result, schools will concentrate on improving students learning rather than managing ICT infrastructure and services in their premises (Chandra & Borah, 2012). Schools will also obtain substantial cost savings by paying only services they use due to pay-as-you-use pricing mechanism offered by cloud computing firms.

It should be noted that cloud computing is Internet based technology; and its success depends on readiness of schools, students, and teachers to have access to the infrastructure that enable them to access Internet services. Therefore, this article aimed at assessing the feasibility of implementing eLearning system in cloud-based infrastructure for secondary schools in Tanzania. The study adopted questionnaire and document review data collection methods. A total of 820 students successfully returned the questionnaires from seven secondary schools in Tanzania.

LITERATURE REVIEW

According to the National Institute of Standards and Technology (NIST), "cloud computing is a distributed computing paradigm that enables access to virtualized resources including computers, networks, storage, development platforms or applications via the Internet" (Mell & Grance, 2011). In terms of ICT resources proprietorship, cloud computing technology can have four types of deployment models namely public clouds, private clouds, hybrid clouds, and community clouds (Jin, et al., 2010). A private cloud model enables organization to have full control of the cloud underlying

infrastructure, data, applications, services, and resources that are provided to their users. It may be hosted on the premises of an organization or by a third party provider (Despotović-Zrakić, et al., 2013). Community cloud is managed by a limited number of organizations that have shared interests and form a community of practice in which the operations are managed by the community with the distribution of responsibilities (Selviandro, et al., 2014) . A hybrid cloud is a combination of two or more individual clouds (private, community, or public) that remain exclusive entities but are bound together by uniform or proprietary technology that enables data and application movability. Applications that access less sensitive data can be outsourced to the public cloud, while keeping business services and sensitive data in a secured private cloud (Carroll, et al., 2011).

Similarly, cloud computing has three types of service models: infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS). IaaS aims to deliver over the network computing resources and storage as a service to users. Users install and manage operating systems and software applications on virtualized machines. PaaS model provides an environment for programmers to develop, test and execute software applications via the Internet. SaaS model delivers application software such as eLearning systems to the user's client software via Internet. This model allows end users to use their browser or client software installed on their mobile phone to access application software that runs on a cloud infrastructure. The users of these services do not control or manage underlying hardware, network and application platforms (González-Martínez et al. , 2015; Bora & Ahmed, 2013; Pocatilu et al., 2010).

Several cloud computing service providers support to enhance eLearning in various contexts. The cloud can provide schools with tools to deploy computing resources on-demand for class materials and activities according to their learning needs (González-Martínez, et al., 2015). The benefits of cloud computing require the availability of ICT infrastructure within the schools and readiness of users to use various Internet services. Nonetheless, available studies in Tanzania have been assessing the availability of computers and Internet connectivity without assessing how prepared students are to use Internet services.

Malero, Ismail, and Manyilizu (2015), for example, assessed 89 schools in Dodoma region for the readiness of schools in using ICT for teaching and learning. The study found that many teachers and students indicated their willingness to use ICT to support teaching and learning. However, the majority of studied schools did not have computers or Internet. Therefore, the findings were based on their perceptions of use rather than experience of using ICT facilities and equipment for teaching and learning.

Similarly, Kafyulilo (2014) explored the access, use and perceptions of teachers and students towards mobile phones as a tool for facilitating teaching and learning using a sample 29 teachers and 40 students from Kibasila secondary school in Tanzania. The study showed that 60 % of students owned mobile phones, or had access to mobile phones; and they were in favour of the use of mobile phones for learning. A similar study was conducted in 10 secondary schools in Kilimanjaro Tanzania with a sample of 294 students (Chambo et al., 2013). The study found that 86.2% of students owned mobile phones with 65.8% of them having access to Internet connectivity.

Tarimo and Kavishe (2017) conducted a study to investigate Internet access and usage by secondary school students in Morogoro Tanzania using a sample of 120 students. Interestingly, 82% of students indicated that they were using Internet for searching academic information while 87.6% of them were using it for playing and downloading music. The study did not specify if the selected schools had computer labs with Internet connection. No data was provided to whether students used other devices such mobile phones to access the Internet.
Generally, there are limited studies that have investigate the accessibility and usage of Internet services in schools already connected to the Internet in Tanzania. Many studies tend to focus on perceptions of teachers and students on the use of ICT facilities regardless of whether they have

access to them or not. While these studies provide baseline for understanding the perceptions of students and teachers in ICT integration in teaching and learning, assessing usage of Internet and its services is important for future plan of cloud computing implementation in secondary schools in Tanzania. Therefore, this study investigated the feasibility of implementing eLearning systems in cloud through assessing usage of Internet and its services in seven secondary schools in Tanzania.

METHODOLOGY

Study Design

The study adopted questionnaire and document reviews as data collection tools. A total of 150 questionnaires were distributed to each school: Benjamin Mkapa, Turiani, Kibasila, Makumbusho, Kambangwa, Chang'ombe, and Kibamba making a total of 1,050 distributed questionnaires. The schools were conveniently selected focusing on government owned schools with computer labs connected to the Internet. The questionnaires were distributed to students from Form I to Form IV. This research design was chosen because it is relatively quick and easy to conduct as they do not need long periods of follow-up and data on all variables that can easily be collected at once. A total of 820 questionnaires were collected making a response rate of 96.5%. The document review was conducted to assess ICT infrastructure in secondary schools and relevant policies to support cloud computing in secondary education. The study was conducted between July and September 2017.

Demographic information

The study shows that the majority of respondents were from Benjamin Mkapa (21.8%), followed by Turiani (15.9%) and Kibamba (15.0%) secondary school. However, Kibasila secondary school had the smallest number of respondents (10.1%) who participated in the study as shown in Figure 1.

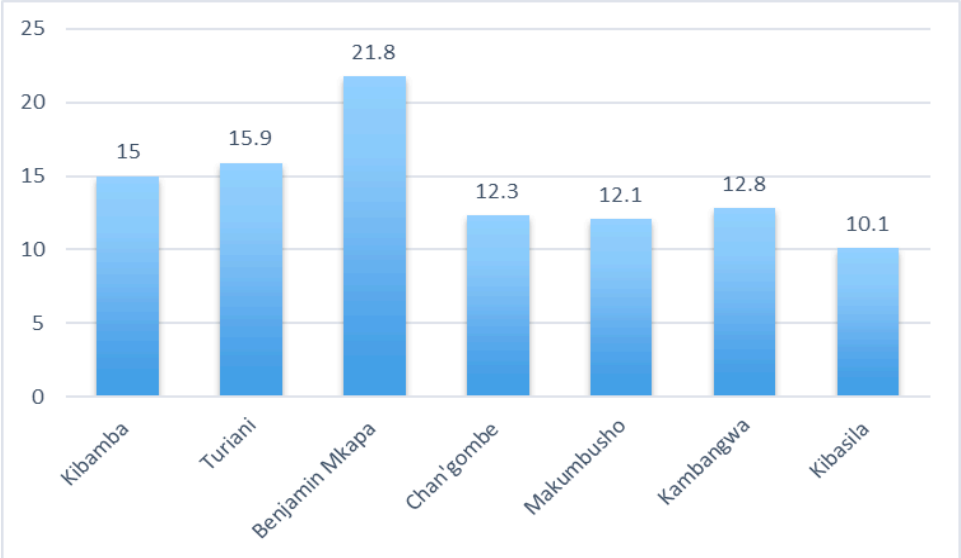

Figure 1: *Respondents by Schools in Percentage*

Moreover, the majority of respondents were Form II students followed by Form I and Form VI students. The minority of respondents (5%) were Form V students (13.2%) followed by Form III (13.2%) and Form IV students (14.3%). Figure 2 shows the distribution of respondents by the level of classes.

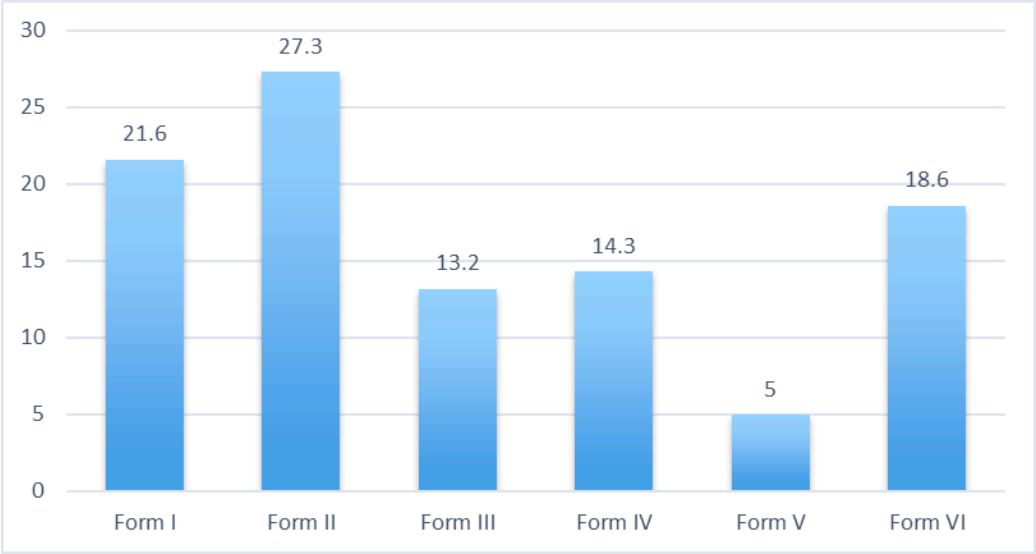

***Figure 2**: Distribution of Respondents by Their Class of Study in Percentage*

FINDINGS

Relevant Policies

The study reviewed relevant documents to assess the availability of polices supporting cloud computing in education. The study revealed that the government has developed several policies that create conducive environment for cloud computing implementation in secondary education in Tanzania. One of the important policy is the ICT Policy for Basic Education which sets the guidelines desired to transform Tanzania to information and digital driven society (MoEVT, 2007). This was planned to be achieved through the application of ICT in all levels of education. This policy was followed by the Education Training Policy in 2014 that stressed the use and application of ICT in education and training at all levels in order to improve quality education provision. Recently, the government has formulated the National ICT Policy of 2016 replacing the ICT policy of 2003 under the funding of Finnish Government (MWTC, 2016). The policy emphasizes effective integration of ICT in education while calling for increased broadband access and ICT Infrastructure development.

ICT Facilities and Basic Infrastructure

Documentary reviews and various reports (MoEST, 2017), revealed that out of 3,601 government schools in Tanzania, only 396 (11%) schools have been equipped with computer laboratories. Moreover, approximately 20.1% of government schools are connected to the Internet. The data for private schools could not be established but it is expected that many private schools will have ICT facilities compared to government schools.

Use of Internet at Schools

Since the surveyed schools were those with computers connected to the Internet, we were interested to know if students use the Internet to access learning materials. It was interesting to find out that about two thirds (65.6%) of respondents indicated that they do not use Internet to access learning materials using computers installed at their schools. On the other hand, more than half of students

(58.3%) indicated that they use Internet to access other content that are not related to learning materials as shown in Figure 3.

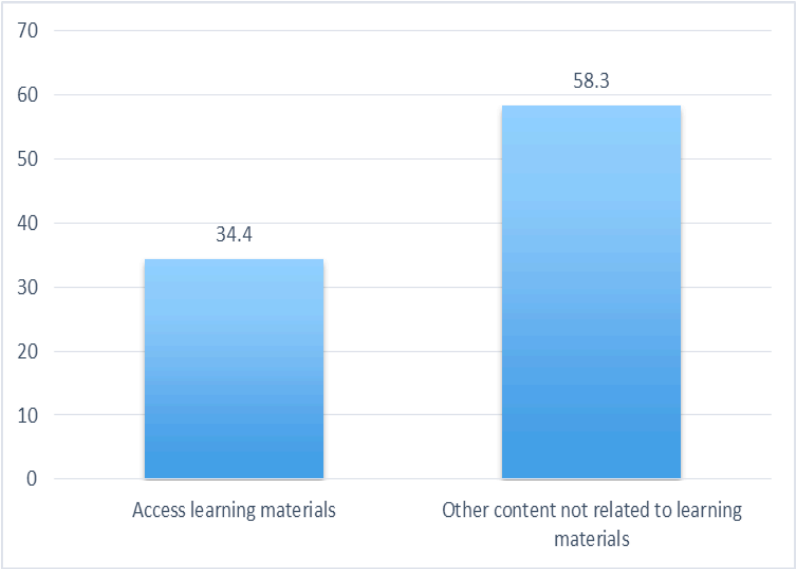

***Figure 3**: Respondents on Internet Usage at Schools in Percentage*

Access to Computer and Internet Outside of School Environment

We were also interested to find out if students had access to Internet outside school premises. As shown in Figure 4, approximately 42.3% of respondents indicated that they use computers or laptops outside school environment. Out of those students, 39.8% of them used computers or laptops connected to the Internet. The results further showed that 57.7% of the respondents did not have access to computers or laptops outside the school environment.

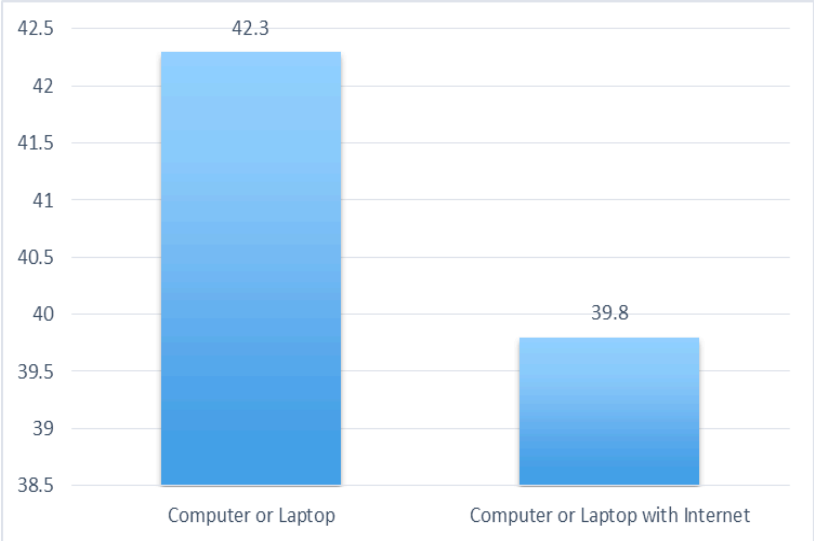

***Figure 4**: Students' Access of Internet Outside of the School Environment in Percentage*

Access and Use of Smartphones for Studies

Regarding access and use of smartphones, the analysis showed that more than half of the respondents (56.6%) indicated that they use smartphones at home while 53.5% used smartphones to access the Internet. The study also revealed that 58.8% of respondents use smartphones to search for learning materials at home as shown in Figure 5.

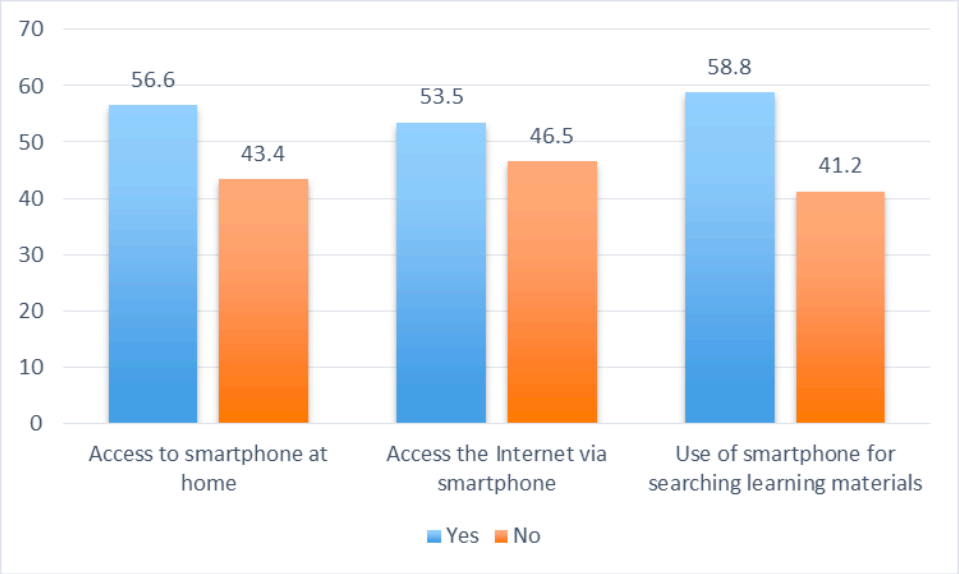

***Figure 5**: Respondents on Access and Use of Smartphone in Their Studies in Percentage*

Expenditure on Internet Bundles

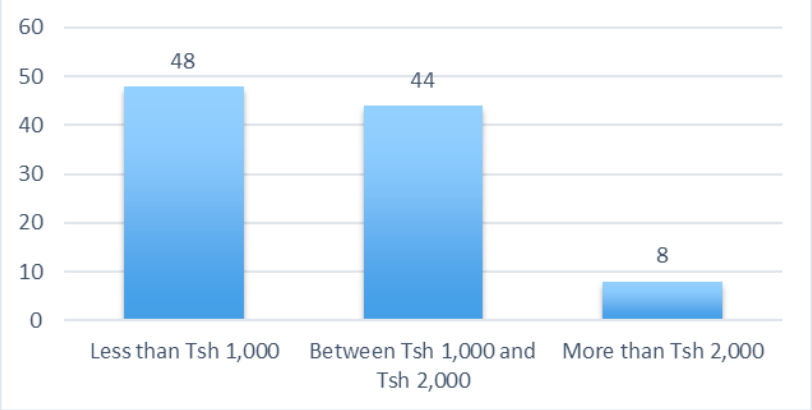

***Figure 6**: Students' Expenditure on the Internet per Week in Percentage*

Students were asked to indicate how much they spend for buying Internet bundles via smartphones per week. The study found that the majority of students (48%) spend less than Tsh. 1,000 (equivalent to US$ 0.5) to pay for the Internet bundles, while 44% of students spend between Tsh 1,000 and Tsh 2,000 per week. A small number of students spent more than Tsh 2,000 for Internet bundles per week (See Figure 6).

Students were further asked to indicate if they use students' special bundles provided by the majority of mobile phones operators in Tanzania, and 36% of students said YES while more than half of students (63.2%) indicated that they do not use them.

Awareness of the Existing eLearning Initiatives

There are many eLearning initiatives in Tanzania which have developed content for secondary schools and shared them via various platforms accessible via the Internet (e.g. Shuledirect, Halostudy, etc). Therefore, we were interested to know if students are aware of these platforms and if they have been using them. The study found that more than half of the students (53.8%) are aware of these initiatives, and 46.2% accessed to them at least once (See Figure 7).

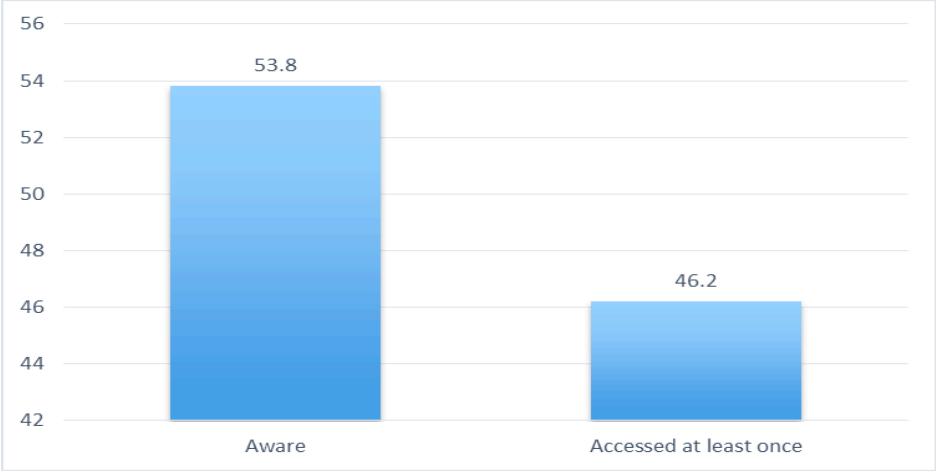

***Figure 7**: Awareness of the Existing eLearning Initiatives*

When they were asked to mention at least one eLearning platform they have been frequently accessing in the last 2 months, the majority of students mentioned Halostudy (61%) followed by Shuledirect (30%), and Elimuyangu (9%).

DISCUSSION

The effective use of eLearning systems can potentially improve the quality of teaching and learning in secondary schools in Tanzania. Teachers can share and exchange information and knowledge with their students easily using these systems. With this in mind, the government and development partners have been creating conducive environment to enable smooth adoption and implementation of eLearning systems in Tanzania. However, very few schools have managed to implement eLearning systems due to costs as well as lack of reliable ICT infrastructure in school premises. The majority of existing eLearning initiatives such as Halostudy, Shuledirect have been implemented by NGOs or mobile firms.

To enable many schools to be able to implement eLearning the need to find a reliable and cost-effective solution is important. Cloud computing, which has been used to implement eLearning systems worldwide, has not been considered. Nonetheless, successfully implementation of cloud computing requires availability of ICT infrastructure and users' readiness in using Internet services. This study investigated the feasibility of implementing eLearning systems in cloud through assessing ICT infrastructure and usage of Internet services in seven secondary schools in Tanzania.

The study found that use of eLearning in the cloud for secondary schools in Tanzania is feasible. The study also found that the majority of existing formulated policies: ICT Policy for Basic Education (2007), Education Training Policy (2014), and the National ICT Policy (2016), support the ICT integration in education and the use of Internet services in education. In addition to these policies, the Government has been capacitating schools with computers and Internet connectivity to increase accessibility of eLearning systems and other Internet based services.

The study also found that many students had access to the Internet both at school and at home. The finding are similar to other studies conducted in secondary schools in Dodoma (Malero, et al., 2015), Morogoro (Tarimo & Kavishe, 2017b), and Kilimaro (Chambo, et al., 2013). Despite having access to the Internet, many students use Internet to access content that is not related to learning materials (66%). It seems that many students in secondary schools tend to use Internet for accessing content that is not related to studies. This evident is similar to the finding in Morogoro where Tarimo and Kavishe (2017) found 87.6% of students used Internet for playing and downloading music. A possible explanation for this might be due to the fact that students are not aware of existing eLearning systems with content that can be accessed to enhance their learning activities. For instance, this study found that only 53% of students were aware of these systems.

There is a need to promote awareness of the existing eLearning systems such as Halostudy and Shuledirect so that students can use Internet to access these systems rather than downloading music and other content that is not related to learning. The fact that students have access to the Internet and can use various Internet services provide a strong base for implementing eLearning in the cloud for secondary schools in Tanzania. This is to say; even those schools without computer labs students will still use eLearning systems using Internet access at home or elsewhere.

Another important finding was that more than half of surveyed students (56.6%) had access to mobile phones at home with (53.5%) of students using mobile phones to access the Internet. This finding corroborate with that of Chambo, et al., (2013) conducted in ten schools in Kilimanjaro which found that 86.2% of students had access to mobile phones; and 65.8% of them students used them to access the Internet.. Similarly, Tarimo and Kavishe's (2017) study of schools in Morogoro found that 97.8% of students had access to the Internet via mobile phones. These findings provide an evidence that many students have access to mobile phones connected to the Internet which provides a strong base for implementing eLearning in the cloud. It seems, therefore, that schools do not need even to have computer labs to be able to implement eLearning systems. The system can be implemented in the cloud and enable students to access learning materials via mobile phones.

The study also found that the cost of the Internet was unaffordable to many students. This is evident from the fact that many students (48%) were paying less than Tsh 1000/= (US $ 0.5) for Internet per week. There is a need for the government to subsidise Internet costs, especially those dedicated for learning and teaching in secondary schools. Currently, many mobile firms have special bundles for students to enable them access Internet at a special rate. The findings from this study have shown that 63.2% of students did not use those special bundles provided by mobile firms. The possible reason for this could be that even special bundles are still expensive for secondary school students.

CONCLUSION

Cloud computing can shape the way eLearning is implemented in secondary schools in developing countries. Once this technology is adopted, it can reduce the burden of purchasing ICT infrastructure for implementing eLearning systems in schools' premises. Cloud computing resources and storage could be provided by service providers as a service to the schools for hosting their eLearning systems which will be accessible through the Internet anytime anywhere. Therefore, schools need to have supportive infrastructure and Internet to access and use these systems once they are hosted in the cloud infrastructure.

This study looked at the feasibility of implementing eLearning in the cloud for secondary schools in Tanzania. The findings from this study have revealed that it is feasible to implement eLearning systems in the cloud for secondary schools, and students can continue accessing learning materials via the Internet. Many students have access to mobile phones and have been using these devices to access the Internet. With more than 31% of schools having computer labs connected to the Internet, this provides a strong base for implementing eLearning in the cloud. The study also found that the Government has formulated relevant policies that support the implementation of cloud computing in secondary schools. Many of the reviewed policies in this study have shown that the Government has been setting up conducive environment for ICT integration in teaching and learning in secondary education. Generally, the implementation of cloud computing is secondary schools in Tanzania is feasible.

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