Towards mobile learning deployment in higher learning institutions: a report on the qualitative inquiries conducted in four universities in Tanzania

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Over the past two decades, mobile learning (m-learning) has been a purposeful area of research among educational technologists, educators and instructional designers whereby doubts and controversies over its relevancy and applicability have been keenly addressed. This paper explores stakeholders' perceptions of m-learning deployment in Higher Learning Institutions (HLIs). Specifically, we examine the potential of m-learning for HLIs in Tanzania and the challenges that hinder successful m-learning deployment. We adopt a comparative qualitative case study design in which four HLIs in Tanzania were purposefully selected. The study uses a combination of design science research approach and qualitative methods including grounded theory, document reviews, and observation. The respondents included university lecturers, students and ICT experts, who were selected for the interviews through theoretical sampling. The transcripts were loaded, coded and analyzed in NVIVO software. The results indicate that mobiles (smartphone, tablets, laptops, feature-phones etc.) are widely used in the HLIs. Stakeholders perceive that m-learning deployment is important and useful because it improves the quality of the learning experience. The results further indicate that there are financial, pedagogical, technological, infrastructural, individuals – and policy – related challenges that hinder successful deployment of m-learning in HLIs in Tanzania, such as limited network coverage, some students´ inability to afford mobiles, lack of qualified staff for preparation of mobile content and administration, gaps in the existing policies, and faulty course design. However, our results show that participants are optimistic about the potential of m-learning in the HLIs of Tanzania. They expect that m-learning will improve access to learning resources, teacher-student and student-student interaction without being restricted by time or place. Thus, m-learning is considered to have the potential to address issues of crowded classrooms, expertise, access to learning materials, flexibility of the learners as well as remote connectivity.

We recommend that HLIs should prioritize m-learning and commit resources to the success of the related projects. We also recommend that the governments and stakeholders provide policy interventions, subsidize mobile technologies, expand network coverage, build capacity within and outside HLIs, and improve digital literacy by integrating ICT education at all levels of education.

Key words: mobile learning, m-learning, mobile learning deployment, design science research, connectivism, critical theory of technology

1. Introduction

Mobile technologies and their applications have been a central area of research for more than two decades. Specifically, smartphones and tablets are part of our daily lives in such a way that they help to redefine the way we interact, communicate, conduct businesses as well as respond to natural disasters. As Adams (2005) asserts, "mobility is liberating and empowering". Moreover, mobile technologies free humanity from barriers of time and space, and, if applied to education, they are able to liberate learners and educators from the traditional face-to-face system, whereby learners and educators have to meet in a pre-defined location and time. Also, due to their affordability, portability and multi-functionality, mobile phones are accessible and adaptable by different social groups, including the marginalized.

The majority of studies in the area have focused on the suitability and practicality of mobiles in various social-economic sectors. Particularly, m-learning denotes the application of mobiles (smartphone, tablets, feature-phones, e-readers etc) in educational contexts that leverage the technologies to provide access and mobility to learners and educators (Chambo, Laizer, Nkansah-Gyekye, & Ndume, 2013; Mtebe, 2016; O'Hagan, 2013). Also, they explore issues concerning technological usability, design compatibility and the ability to learn through mobiles including factors that lead to adoption and use (Ally, 2009; Fritschi, Wolf, & others, 2012a; Traxler & Kukulska-Hulme, 2016). In particular, UNESCO has conducted extensive m-learning studies across the globe to understand how mobiles can be leveraged to improve access, equity and quality of education (Fritschi *et al.*, 2012; Porter *et al.*, 2016). The increased access to mobiles among youth offers the possibility to extend the reach of the education sector beyond the walls of the universities (Ally, 2009; Siemens, 2014). Also, m-learning is thought to be more relevant, personalized, interactive, collaborative and it reduces the transactional distance between learners and educators (Moore, 1993).

Unfortunately, the majority of previous studies were conducted in developed economies and Asia (Fritschi, Wolf, & others, 2012b; Hussin, Radzi Manap, Amir, & Krish, 2012; Porter *et al.*, 2016). Also, the majority of those studies were focused on m-learning deployment at pre-university levels, hence contribute little to the understanding of m-learning deployment in African universities, specifically in our case in Tanzania (Ally, 2009; Fritschi *et al.*, 2012a; Jaffer, Ng'ambi, & Czerniewicz, 2007). Significantly, supporting m-learning projects and/or initiatives beyond (a) project cycle(s) is the most significant challenge (Fritschi *et al.*, 2012a; O'Hagan, 2013). Therefore, this study focuses on the sustainable mobile learning deployment in university contexts of Tanzania, investigating

challenges that hinder m-learning deployment in this specific context. Tanzanian universities like those elsewhere in Africa generally, experience a number of challenges including infrastructure limitations, disease, poverty as well as crowded classrooms (Chambo *et al.*, 2013; Fritschi *et al.*, 2012a; Mtebe, 2016; O'Hagan, 2013; Traxler & Leach, 2006).

Mobile proliferation in Africa including Tanzania is booming. By the end of the year 2016, there were more than half a billion unique subscribers across the continent (GSMA Intelligence, 2016; TCRA, 2016). In Africa, mobiles play a significant role in shaping all sectors including health, economics and finance, agriculture, communication, the arts and politics (Fritschi, Wolf, & others, 2012c; Traxler & Leach, 2006). Mobiles facilitate communication across ethnic groups and gender as well as connect remote and hard-to-reach communities. They offer opportunities to everyone to connect and traverse across nodes so as to learn and collaborate with the rest of the global communities (Siemens, 2014). Thus, they are ubiquitous in our lives; they possess socio-economic value and potential, but potential that can only be exploited with sufficient understanding of how well mobiles can be deployed in different contexts. This study aims to explore phenomena concerning mobile-learning deployment in the public universities in Tanzania. Specifically, we intend (i) to understand the challenges that hinder mobile learning deployment and (ii) to understand the stakeholders' perceptions pertaining to m-learning deployment potential.

Our determination to study m-learning deployment has been triggered by the desire to contribute to the understanding of m-learning implementation issues and potential roles in shaping education in Tanzania, because very little is known about m-leaning in sub-Saharan Africa and Tanzania in particular. Therefore, our study will benefit policy makers and educators in Tanzania and beyond on how to strategize and apply mobiles in the universities.

2. Literature review

As previously described, m-learning has been the subject of research for over two decades across the globe. The rise of m-learning can be attributed to developments in the area of mobile technologies, mobile applications, and wireless technologies, in such a way that more capable and sophisticated technologies are accessible to the majority of the people (Traxler & Kukulska-Hulme, 2016). As Siemens (2014) suggests, central to m-learning is the ability of the learners and educators to traverse learning nodes irrespective of location and time, in contrast to the traditional education system. In their seminal work, O'Malley & Fraser (2004) define m-learning as "any sort of learning that happens when the learner is not at a fixed, predetermined location or [as] learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies." Also, scholars associate m-learning with the ability to use a diverse range of sources from across the world (Fritschi *et al.*, 2012b). Specifically, it is thought to be a subset and natural extension of e-learning. However, it possesses distinct characteristics regarding learning content, availability and accessibility, and media capacity (Ally, 2009; Brown, 2003). Also, Traxler & Kukulska-Hulme (2016) reveal that learning through mo-

biles can become more personalised, situated, interactive and collaborative. Thus it fits both formal and informal learning setups.

Moreover, m-learning offers alternatives to the crowded classrooms that higher learning institutions face today (Lehmann & Söllner, 2014), and it strengthens student motivation and encourages a sense of responsibility as well as facilitating interaction and collaboration between students and teachers (Moore, 1993; Shao, 2014; Uden, 2006). Currently, mobiles are widely used in the educational environment by students and teachers to access learning resources (Abu-Al-Aish, 2014; Fritschi *et al.*, 2012a). Hence, a majority of instructors and students are optimistic about m-learning regardless of the existing challenges (Corbeil & Corbeil, 2011; Fritschi *et al.*, 2012b; Mtebe, 2016; Onguko, 2010).

2.1. Mobile learning in Africa and Tanzania

Brown (2003) claims that Africa is particularly suited for m-learning because of the infrastructural challenges. Africa's educational systems suffer from limited expertise, crowded classrooms, inequality and lack of adequate ICT infrastructure to support teaching and learning (Fritschi *et al.*, 2012c; Jaffer *et al.*, 2007). Also, despite the fact that e-learning services are deployed in some universities, they are highly under-utilized due to challenges such as lack of reliable electricity, limited internet access, resistance to use, and lack of pedagogical linkage with the available courses (Chitanana, Makaza, & Madzima, 2008; Mtebe, 2016). Nevertheless, the proliferation of mobiles in Africa has prompted significant research activities (Fritschi *et al.*, 2012c; Porter *et al.*, 2016). Much of the earlier research was directed towards understanding behavioral intention to use mobiles within an educational context and practicality of the mobiles being used without distracting the learners. Essentially, the majority of the works reveal positive outcomes towards mobiles. For example Mtebe and Raisamo's (2014) work reports positive student behavioral intention to use mobiles for learning activities due to their perceived ease of use and media efficacy. Also, Chambo *et al.* (2013) work on mobile access and deployment in secondary schools in Tanzania reveals the potential of learning through mobiles because the majority of students and teachers possess devices and the know-how to operate them. Similarly, other studies reveal that a majority of African students use mobiles and other ICT devices to access learning resources online (Duncan-Howell & Lee, 2007; Jaffer *et al.*, 2007; Mtebe, 2016).

Real m-learning success will be achieved by imparting pedagogical capacities and skills to the students and teachers (Duncan-Howell & Lee, 2007). Further, the technocratic approach to m-learning-deployment prevents projects from achieving optimal results. Hence decisions on m-learning and ICT deployment should be based on educational needs rather than technical choices (Idrus & Ismail, 2010; Jaffer *et al.*, 2007). The educational systems should develop the right curriculum and instruction design, and embed pedagogical opportunities within the techno-codes so as to justify technological relevancy. Furthermore, Siemens (2014) stresses that learning in the digital era requires switching from a teacher-centered to a student-centered approach. Teachers need to fa-

cilitate knowledge acquisition rather than being the sole generator of knowledge. Subsequently, policies on knowledge dissemination and content production should be redefined, and educators as well as students should be equipped with relevant skills, which will make them participate in the learning, exploration and application process (Idrus & Ismail, 2010; Jaffer *et al.*, 2007; Porter *et al.*, 2016).

Similarly, different initiatives have explored the potential of m-learning to improve the quality of the learning experience in Africa. They include the MoMath project in south Africa that offered access to the mathematics content and support to Grade 10 students (Fritschi *et al.*, 2012a; Porter *et al.*, 2016), the Eneza project in Kenya, that offers learning opportunities to students and teachers across Africa through SMS, web and Android applications (Brown, 2003), the ShuleDirect in Tanzania, that offers learning resources, quizzes, past-paper reviews and discussion forums to secondary school students and teachers through mobile and web-applications (shuledirect, 2017), and the mobile Moodle project at the university of Dar Es Salaam in Tanzania (Mtebe, 2016), just to name a few. Initiatives such as these contribute to a deepening footprint of success of m-learning on the African continent. It can be inferred that creative and well-thought through m-learning initiatives help to improve learners' and teachers' attitudes towards m-learning (Abu-Al-Aish, 2014; Fritschi *et al.*, 2012).

Despite positive outcomes, there are challenges regarding the design and deployment of m-learning services across the continent and in Tanzania in particular (Abu-Al-Aish, 2014). They include sustaining projects beyond completion (Fritschi *et al.*, 2012c; Traxler & Leach, 2006), contradicting educational policies and strategies, including banning mobiles in pre-university levels, while depending on the same in the universities (O'Hagan, 2013). Also, most of the initiatives failed to provide clear guidelines on how m-learning services can be deployed in the larger establishments such as universities. In addition, due to limited scope, the proposed deployment models by Chambo *et al.* (2013) and Brown (2003) are partial and outdated considering the developments in the mobiles ecosystem. For example, currently, mobiles offer more than SMS services including multimedia and location based services. Also, the situations related to m-learning differ according to contexts; hence it is viable to investigate specific challenges that hinder m-learning deployment in universities in Tanzania.

2.2. *Theoretical framework*

Because m-learning is dependent on technology, pedagogy and stakeholder involvement, we approach the study looking through three lenses: Critical Theory of Technology, Design Science Research (DSR), and Connectivism. Although a synthesis of the three would be advisable, we lack the space here to develop and test it. Our theoretical model is necessarily eclectic at this stage.

First, the critical theory of technology refutes claims that technology is neutral and autonomous (Andrew Feenberg, 2005). The prime argument in this proposition is that the designs and techno-codes are shaped to address the social-political order of the given society. In practical terms, it emphasizes the collaborative working relations between

technocrats and those affected by the designs, whereby the technocrats are responsible for translating the social requirements of the designs from the stakeholders into actionable and programmable artifacts, which can be used to accomplish the social task. In our case, the social perceptions of education and m-learning were captured by involving lecturers and students.

Secondly, DSR helps to explore social phenomena in the form of information systems (IS) problems (Hevner, 2007). We apply Hevner's (2007) three design cycles that are relevancy, design and rigor, because they are in accordance with our work. The DSR processes involve investigating the relevant social problem (s) (relevance cycle), then designing the relevant artifact to solve the problem in the form of a model, constructs, instantiation or method (design cycle), and later evaluating the output against the established theories and artifacts (rigor cycle) (Gregor & Hevner, 2013). This design science research provided us with a methodological approach to the problem.

Thirdly, in order to ensure that the output reflects the pedagogical aspect of integrating technology into the educational sector, we applied the Connectivism lens to ensure that the output mirrors the availability of the distributed learning resources and communities. According to Connectivism, knowledge is distributed across networks powered by the Internet in such a way that there exist multi-level learning resources, learning communities and expertise that can be exploited by capable learners (Siemens, 2014). The abilities to access, traverse nodes, evaluate the sources as well as the content, establish and maintain connection as well as to synthesize materials from various sources are pivotal (Siemens, 2014). For learning to occur in the Connectivism world, radical changes need to happen in the way we theorize teaching and learning, set the learning environment, as well as impart necessary skills to the learners (Siemens, 2014). Therefore, we formulated our interview questions based on the requirements of Connectivism and DSR, especially those related to readiness.

3. Methodology

This is an exploratory study; we applied a combination of design science (DS) and qualitative methods especially Grounded Theory during data collection, analysis and communicating results. Qualitative enquiries are deemed to be an effective approach in exploring and inducting knowledge from individuals' perspectives (Creswell, 2009). In particular, they enable researchers to engage in conversations with respondents and seek clarity on relevant matters through probing (Creswell, 2009). On the other hand, DS allows a researcher to approach the research problem as a form of information systems (IS) problem (Hevner, 2007). In practice, DS researchers apply various data collection methods, including qualitative ones, throughout the three design cycles as described in the previous section (Dresch, Lacerda, & Antunes Jr, 2015; Gregor & Hevner, 2013; Hevner, 2007).

3.1. Data collection

Qualitative methods, such as in-depth interviews, document reviews, and observation were used during the relevancy-cycle to collect data on stakeholders' perceptions. Specifically, semi-structured interviews using open-ended questions were conducted with twenty-five lecturers, fifty-three students and six ICT experts from four universities in Tanzania: Mzumbe University (MU), the Open University of Tanzania (OUT), the University of Dodoma (UDOM), and the University of Dar Es Salaam (UDSM) as detailed in Table 1 below. The four represent the public universities in Tanzania that are at different stages of adopting learning technologies. Also, the four enclose similar and distinct characteristics that make them ideal for our study. For example, while UDSM is recognized as the oldest and 'mother' of several universities in Tanzania, and has established a high reputation in academia, the University of Dodoma is the youngest with the largest student population, and has the youngest generation of staff. Both UDSM and UDOM rely on their established schools that deal with virtual education. Also, MU's history is unique having passed through various transformations, from being a college to train local chiefs to a full university. Unlike the rest, MU relies on the ICT unit to oversee transformations. Furthermore, OUT and UDSM are the only universities offering ODL services in the country. In addition, OUT is the only university present in every regional center and some districts in Tanzania. Such diversity attracted the researcher's attention to contextualize m-learning deployment.

Institution	#Lecturers	#Student	#ICT experts	Total
MU	5	10	1	16
OUT	8	10	2	20
UDOM	7	18	2	27
UDSM	5	15	1	21
Total	25	53	6	

Table 1: Sample composition of the respondents.

3.2. Sampling method

Universities were purposely chosen based on their experiences, organization structures and their involvement in learning technologies. Respondents were selected based on the theoretical sampling. Theoretical sampling prescribes that samples should be chosen based on the emerging theories, in such a way that the next data to be collected and who to involve depend on the coded and analyzed facts (Coyne, 1997). This method of sampling is ideal for the approach of Grounded Theory, because it offers the needed flexibility to complete the study (Bricki & Green, 2007). For more information see appendix 1.

3.3. Data analysis

Data analysis was conducted in accordance with Grounded Theory's principles, whereby analysis happens almost at the same time as the data collection (Corbin & Strauss, 1990). In this work, we apply Corbin and Strauss's (1990) three coding procedures, which are open, axial and selective coding as described in appendix 1. During open coding, with the aid of Nvivo 10 software, we identified concepts from the interviews transcripts. The concepts are the abstract labels that represent the incident(s), action(s) or event(s) from the studied phenomena (Corbin & Strauss, 1990). Then the identified concepts were compared and revised so as to remain with the most relevant and acceptable concepts that clearly and concisely reflect the situation. A total of 148 concepts were open-coded during this stage. Next, similar concepts were organized into categories and sub-categories. The resulting categories and sub-categories were related to each other to identify the interplay between them as presented in the figure 1. The final results were verified by involving some of the respondents so as to ensure validity and accuracy. For more information see appendix 1.

4. Results and discussions

4.1. M-learning potentials

Our study reveals that, though not formally integrated into education, mobiles are widely used in the universities in Tanzania due to their relative benefits. Both students and lecturers use mobiles for extending access to learning resources, and for communicating and interacting with colleagues and the learning communities as well as fulfilling school-based activities as witnessed by one of the OUT student.

> "….it [mobiles] helps to share information with group members, also to conduct discussions, to exchange materials and questions. Also, if you face some difficult issues you can send it to the lecture to help you…."

Also, we observed that social media platforms such as WhatsApp and Facebook have become the primary source of information and collaboration in the universities. Students and teachers mainly communicate and exchange information and ideas, learning resources and school activities with the aid of mobiles and specialized applications. According to some respondents, the social-pressure to join and participate in these kinds of networks forces some students to sacrifice their meals and stationary in order to buy mobiles.

Furthermore, our results reveal that the majority of lecturers and students are aware of the m-learning potentials. The respondents believe that a well-organized m-learning deployment will enhance access to quality content as well as make learning relevant. Also, they believe that learning through mobile applications such as simulations will improve the quality of learning not only within the university but also in informal setups. Both lecturers and students share the opinion that if the universities and the government

are committed to setting and supporting enabling environments for digital learning, then m-learning will be possible and desirable.

4.2. M-learning deployment challenges

The analysis of the results reveals that m-learning deployment faces a significant number of challenges that may hinder its success. These challenges can be addressed at the individual, institutional and national levels depending on the scope and granularity level. Essentially, the challenges are organized into five themes: financial, individual, infrastructural, pedagogical and policy-related. In the coming section we provide detailed description and diagrammatical representation of the challenges and how they are related.

4.2.1. Pedagogical challenges

Successful m-learning deployment relies on qualified and motivated experts as well as well-designed and organized m-learning initiatives and activities conforming to the needs of the education systems (Jaffer *et al.*, 2007). Our results reveal that Tanzanian universities lack expertise in key areas such as mobile application development and management, instruction designs, multimedia and content development. Also, there are no practical initiatives to integrate mobiles into curricula as well as class activities, and the university cultures are tailored towards traditional teacher-centered methods. Some lecturers even proudly prohibit students from using mobiles to search for materials during the sessions. The majority of students complained about the lack of an online-interaction culture with their lecturers. They also objected to the fact that they were prohibited by some lecturers from using ideas obtained from other sources. Such constraints weigh against the true Connectivist view of m-learning, which stresses learning "anywhere" and "anytime" and more importantly from all relevant sources (Siemens, 2014).

4.2.2. Infrastructural challenges

Mobility is the key to m-learning; the ability to learn without being constrained by time and space (O'Malley & Fraser, 2004). In the African context, there are two possibilities for students to connect to the Internet, via the university infrastructure or a mobile-Internet service provider. The former is the utopian belief that universities offer an appropriate learning environment to students and teachers on the university premises, whereas the latter falls under the mobile business model. In the four universities, we observed that the wireless hotspots are either disconnected or limited to a few locations in which the quality of service was close to "no-mobile". Also, the access points are equipped with contradictory access policies that limit what students can access. As a result, instead of connecting through the free university services, users often prefer using personal-Internet connection as claimed by one of the UDOM student;

"Here wireless is accessible at the administration block only. There you can access it. But all other areas have no wireless. You must buy bundle [Internet]. I think they have installed it specifically for their own use."

Also, despite Tanzania having seven major mobile-Internet service providers with over forty million subscribers (TCRA, 2016), the quality of connections is biased to favor those in town centers (Ministry of works, Transport and Communication, 2016). Rural communities are less connected, thus contributing to the digital divide. Likewise, connection silos exist even in the town-centers whereby some locations are not covered by certain mobile-Internet providers. As witnessed by students and lecturers, in some locations users are supposed to locate network signals at the top of mountains or trees. Also, in some locations, networks are overloaded.

4.2.3. Financial challenges

The ability to pay for the infrastructure, connectivity and bandwidth is crucial for m- learning. We claim that African public universities face budgetary constraints that affect their ability to pay for quality services and infrastructure. For example, none of the studied universities has bandwidth close to 1Gbps; the majority are operating on 40Mbps. These revelations limit the capability of the university to offer quality Wi-Fi services. Also, lack of financial resources makes it difficult for the universities to build capacity for their staff.

On the other hand, we observed that the learners' ability to acquire devices is diverse. While it is widely reported that the majority of African students and teachers own mobile phones (Fritschi *et al.*, 2012a; Mtebe, 2016; Porter *et al.*, 2016), we found that in fact very few students can afford modern devices without support from the government. It was revealed to us that the main source of student smartphone ownership is the government loan known as "boom" as explained by the UDOM student.

"For example, when they [first year students] just arrived, before receiving their loan's money, majority had normal phones. As soon as the money were released, as many as 80% [approximately] bought smartphones."

Evidently, for a semester, the individual student receives a total of 700,000Tshs (280 USD) for meals (@8,500ths (3.4 USD) a day), accommodation and stationary. Upon receipt of the boom, the majority of students opt to sacrifice some services such as meals and stationary in favor of low quality mobile devices. Unfortunately, not all students are fortunate enough to receive the boom. Our results reveal that on average at least twenty-percent (20% of students) do not have the means to purchase smartphones and mobile-Internet subscription, especially unsupported students. Also, despite the availability of special student bundles (1GB per week @1500 (0.6 USD)), some students cannot afford even this. Subsequently, a new form of sociality has emerged: sharing the friend's hotspot. A friend with enough data shares with the "have-nots".

4.2.4. Policy-related challenges

The majority of African countries have national ICT policies (Fritschi *et al.*, 2012a; Jaffer *et al.*, 2007). Among other things, ICT policies firmly emphasize integrating ICT in education systems (Fritschi *et al.*, 2012a). However, such policies were created long before mobiles became prominent. As a result, their ICT scope is limited to the use of computers in education systems. For example, current ICT policy in Tanzania aims at bridging the digital divide through mobiles (Ministry of Works, Transport and Communication, 2016). However, there is no specific mention of mobiles for teaching and learning activities. Likewise, few of the university ICT policies in Tanzania emphasize using mobiles to enhance learning. The absence of a nationwide policy that embraces learning with mobiles has led universities and schools to institute their own policies, some of which are detrimental to the development of society. Such policies include the banning of mobiles in schools.

Furthermore, despite having national and institutional policies and implementation strategies, implementing such policies has been a challenge. Participants believe that despite budgetary constraints, managers are neither influencing nor driving change. For example, although the national ICT policies stress offering ICT knowledge in all public schools in Tanzania, the reality is that very few schools are equipped with the necessary ICTs and qualified teachers. Also, in the universities we observed that the emphasis is on traditional face-to-face systems despite having e-learning policies. Such claims can be justified by looking into course designs, activities and assessment mechanisms. For example, in all the universities, students are required to be present in the pre-defined physical geographical location and to attend classes for certain prescribed contact hours.

4.2.5. Individual-related challenges

The attitudes of individuals play a significant role in the success of any systems deployment. In our interviews it was revealed that there were mixed reactions towards adopting new technologies depending on the respondent. Students claim that most of their lecturers are reluctant to use digital systems. Also, younger lecturers claim that the problem is with the older lecturers, who have limited ICT skills. However, records suggest that the majority of lecturers (regardless of their age) and students never use the systems despite having been trained and supported. A number of respondents claimed that having policy enforcement would help to eradicate the problem.

Similarly, resistance to the use of ICT is associated with the lack of motivation. Our respondents believe that teachers and students will voluntarily use the systems if they believe that it adds value to their work or if there are rewards. Also, users need to be assured of support and encouragement whenever they try new technologies. Unfortunately, respondents believe that little is being done to motivate users, especially teachers. Universities are not doing enough to support and motivate teachers and students by creating an enabling environment or giving incentives or support, as confessed by one of the OUT lecturer;

"Support [from the university] is so limited. The university have no money. They say the OC is not coming as required. Even computers are as you can see, just one computer for all of us and it is malfunctioning. You have to use your own gadgets …"

4.3. Theoretical reflections on the findings

Based on the findings, we can theorize that the success of m-learning deployment will depend on the determination of how much the education stakeholders are able to overcome the identified challenges. Figure 1 below presents key issues for m-learning deployment, as they result from relating categories and sub-categories as described in the preceding sections.
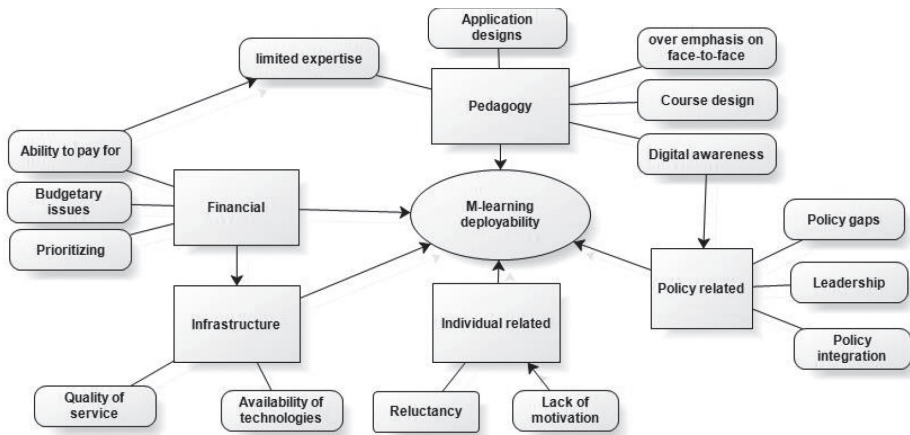

Figure 1: M-learning deployment issues in Tanzania.

Importantly, the results contrast with the Connectivism view of the ideal environment for learning in the digital era. The success of m-learning very much depends on the limitless ability to traverse across the nodes and to learn from the multitude of content and expert knowledge across the globe anywhere and anytime. The limited infrastructure as well as the capacity to support learning does block the capacity of students and teachers to realize the full potential of the connected sphere. Hence learning becomes isolated and mundane. In practical terms, connecting education institutions in the global networks requires resources as well as political and social will-power that reside in the shared responsibility of the community and their relevant institutions. According to Feenberg (2005), it is critical for the democratic systems to shape policies so as to ensure that the technologies, instead of broadening the digital divide, provide opportunities for isolated communities to participate in the global debate. These results prompt the responsible organs to implement policies and set priorities that would facilitate learning through digital technologies.

5. Conclusions and future work

This paper contains a detailed discussion concerning the challenges facing m- learning deployment in Tanzania's public universities. We have revealed how relevant mobiles and M-learning are in the Tanzanian educational system with specific emphasis on the public universities. While we are the first to conduct the Connectivism-based m-learning deployment study in higher learning institutions in Tanzania, our results are consistent with a number of previous studies conducted in Sub-Saharan Africa (Fritschi *et al.*, 2012a; Mtebe, 2016; Muyinda, Lubega, Lynch, & van der Weide, 2010; Porter *et al.*, 2016). It is evident that m-learning deployment requires proper preparation, vision and investment in relevant policies, enabling infrastructure, strategic development and motivation of human capital as well as financial resources. In order to achieve nationwide success, the m-learning projects deserve a holistic and integrated approach so as to engage players from all relevant sectors.

Largely conforming to the Connectivism principles about learning in the digital era, which should interest policy makers and educators alike, our interviews with respondents underline the need to subsidize relevant technologies, promote a sense of creativity and innovation by means of incentives, and improve digital literacy as well as uphold ethical and responsible use of mobiles starting at pre-university levels so as to empower the new generations.

This study has contributed to our understanding of the status and situations surrounding m-learning deployment in public universities in Tanzania. More importantly, we have highlighted the damaging digital divide affecting some institutions, and students from poor families that other studies have failed to identify. More research is needed to understand m-learning deployment potentials at different levels such as in the teacher colleges, secondary schools as well as in the informal sectors. Moreover, it is important to understand the pedagogical implication of m-learning in formal and informal education so as to foresee the future of m-learning in Africa and beyond.

We acknowledge the study's limitations in that it did not involve members of the top management of the institutions to clarify key policy issues. Also, the scope is limited to public-owned universities thus lacking important aspects of the private owned universities. These limitations should be addressed in future works.

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Appendix 1: sampling and analysis process

Sampling process

Overall, we applied theoretical sampling procedures that rely on the emerging theory to decide on the next person to be involved as well as what information to investigate. However, before theoretical sampling can be applied, researchers need to have a starting sample. The initial sample is purposefully chosen based on the criteria set by the researcher regarding the questions. Because our questions relate to digital learning in universities, our first sample was composed of ICT experts at the OUT. They provided us with needed information regarding the available digital systems, their technical abilities and institutional capacity. On top of that, they provided us with the status of systems utilization. Also, they provided us with information regarding procedures and policies supporting digital learning. Such information helped to identify key lecturers, who are the prominent users as well as those who were not using the system. Because our questions were not fixed, we did not modify the existing questions. However, we opted to add as many probing questions as possible during the interviews.

Because students were on holidays, we decided to limit our interviews to lecturers and come back to students at later stages. Therefore, we interviewed lecturers using open-ended questions and additional probing question. The interviews were digitally recorded and later professionally transcribed using the original language. The interviews were held at the lecturers' office in the absence of others. On average, each interview took 40 minutes. At the end of each interview, we read the summary of what we discussed and what we recorded together with the research assistant. Respondents had the chance to correct or clarify issues. Later, in the evening while in our location, we went through the entire interview to capture key issues that needed clarity as well as identifying emerging theories. In the next day we involved other lecturers based on the emerging theories. Later, we involved lecturers who were not using the system as well as old lecturers. At first, it was revealed that aged lecturers are the problem. After working with them and using data provided by the IT experts we realised that even younger lecturers who were suggesting the old are the problem were not using the systems. We then admitted age was not an issue but attitude is.

Data analysis process

As required by the grounded theory, data analysis was conducted in parallel to the data collection so as to identify emerging theory thus conforming to the theoretical sampling. After, finishing with OUT lecturers, we moved to UDOM's College of informatics and virtual education (CIVE). We were led to CIVE by the top management after they processed our approval letter as well as sign ethic clearance forms. Unfortunately, only UDOM required the signing of the clearance forms. Other universities approved our study without signing the forms; however we knew we were liable to the ethics proceedings as researchers. in the same way, we started at CIVE with lecturers using the same questions prepared for them with more probing questions. After, interviewing a few lecturers we discovered that everything seemed perfect to them regarding digital mediated learning

and mobile learning, which is not surprising because that is what CIVE was all about. The infrastructure at CIVE is supported by Microsoft, so it was much of a high standard. We then decided to turn to the ICT experts for their insight on the capacity and ability to manage m-learning activities. There we first identified that staffing and skills on mobiles application and multimedia were limited. Also, we discovered that possibly the situation at UDOM is not the same in all the colleges. So we decided to ask for the permission to visit other colleges especially the college of education.

Before going to the college of education, we decided to interview students at CIVE. Like the lecturers, they were positive in all aspects. To them, everything looked perfect including the digital capacity. The only negative was the lack of wireless connectivity at the college. Because it was important, we interviewed lecturers and IT experts on the reasons for missing wireless. Once we were satisfied with what we achieved at CIVE, we went back to the administration block to ask for the permission to visit the college of education. Because of administrative processes we were to wait for three weeks before gaining permission to visit the college of education. During the break, we worked on the interviews, transcribed them and started coding the same way we did with OUT. The patterns of responses from lecturers were identical to those at OUT. A majority of lecturers were positive about mobiles in education with some degree of scepticism regarding support and motivation. Also, issue of wireless connectivity and ability to pay for the technologies became a central focus.

At the college of education, we started with interviewing students. We purposefully wanted to learn from students first so that their insight and questions would lead to questions that we could ask the lecturers. Specifically, we started with students from classes that had used digital media such as Moodle. After few interviews, we discovered that we had to follow leads in two directions: those coming from sponsored students and those not having sponsors. We discovered that those who did not have sponsors faced serious financial problems to own mobiles. But also, even those with sponsors, such as loans, required sacrificing because the money was not enough. We then discovered that the Internet and wireless was the worst problem. The university Internet was unreliable compared to CIVE and OUT. So we started to probe the reason for such gap from the ICT experts and lecturers. We concluded the interview of the lecturers and returned to Mzumbe University for mode analysis and coding in the Nvivo 10 software. These processes were repeated at the UDSM College of ICT and college of education and later at MU. The saturation point was reached when we could not receive any new leads.

Coding process

Coding is pivotal in the grounded theory. Coding started as soon as we finished interviewing lecturers at the OUT. All the interviews and transcripts were loaded in Nvivo 10 software and a special naming scheme was developed to simplify the identification process. We read the transcripts and assigned initial codes during the open coding process. In Nvivo codes are recorded within nodes. Each time we came across a recurring concept we attached it within the existing nodes. Until all the interviews were coded, we printed

the resulting codes 148 so that we can synthesize and relate them. Conscious of the research questions, we grouped the codes based on the research objectives. We started to analyze all entries of the same objectives to understand the descriptions and missing information. In the process we revisited the transcript and whenever necessary called the respondents to clarify if the insight was not recorded in our memos. By the time we visited the college of education at UDOM, we already had the coding structure in place, what we thought represented our line of enquiries. Therefore, the axial codes group the initial codes into sub-categories and their respective categories. For example the policy gaps, leadership and policy integration were the categories of policy-related challenges. Likewise, we grouped all the codes related to Internet access and wireless into the infrastructure, where we have two groups: quality of service and availability of technologies such as access points and bandwidth. Nvivo gives a feature to associate child-node to the parent-node easily.

Upon finishing with categories, we established their relationships. We combined the insights from the respondents with our own conceptualization of the data. For example respondents frequently pointed out that the lack of policy leadership were due to limited digital awareness. Also, they suggested that the lack of money contributed to the inability to pay for the experts as well as the right infrastructure. Thus, we related all of them with the central focus of the study, m-learning deployment (figure 1).

The final codes in the figure 2 were evaluated by the respondents in the workshop. In addition, we individually presented them to some of the respondents and their inputs were used to update the details.