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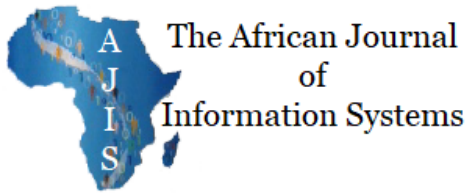
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Understanding Sub-Saharan African Learners Informal Learning Using Mobile Devices: A Case of Tanzania

Research Paper

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Abstract:

In this era of pervasive computing and the Internet, learners everywhere connect and reconnect to knowledge away from classrooms, via mobile devices and their Mobile Instant Messaging platforms (MIMs). Still, many sub-Saharan African educators continue to confine these platforms to recreational activities. There is lack therefore of knowledge about how learners from sub-Saharan Africa perform such informal and experiential learning. This paper presents a case study of Tanzanian learners learning in informal settings using their mobile devices and MIMs. It deploys the rhizomatic learning theory with the aim of understanding how such learning occurs. Findings suggest that learners use mobile devices and MIMs to organize their personal learning spaces, to access specific content and to interact with peers on academic topics. Mobile devices and their MIMs are used as support in personal learning environments understood as multidimensional networks of heterogeneous multiplicities which rhizomatic maps situate, and contain knowledge, skills, and opportunities for innovation.

Keywords: Sub-Saharan Africa, e-Learning, Informal learning, Rhizomatic Learning Theory, mobile devices, Mobile Instant Messaging platforms (MIMs)

INTRODUCTION

In this era of pervasive computing, there is fear that formal classrooms will soon disappear (Vardi, 2012). The fear is fuelled by the emergence of Massive Open Online Courses (MOOCs) (Glance, Forsey, & Riley, 2013), the rejuvenation and opening (in term of access) of distance learning, the blossoming of educational gaming (Seixas, Gomes, & Filho, 2016), the opening of institutional datasets

and users increasing reliance on other users' generated content on social media and other informational websites (Castells, 2011, 2015).

With such an abundance of information available to anyone with a stable and fast Internet connection, the potential for informal learning is significant enough to threaten the institution of formal education (Cox, 2013). It means that a determined learner would learn almost anything from his/her connected device. Such a potential thus lies with the mobile device, especially the smart device, which benefits from the explosive penetration of mobile telephony and ICT infrastructure into underdeveloped Sub-Saharan Africa (Aker & Mbiti, 2010). As a result, in countries including Gambia, Togo, Senegal, Cameroon, Uganda, Tanzania, Rwanda, Botswana, or South Africa (Just to name a few from western, eastern and southern Africa), learners happen to possess a mobile device able to access the Internet (Aker & Mbiti, 2010). They are usually immersed in them; mostly accessing social media platforms for socialisation, recreation and entertainment (Madge, Meek, Wellens, & Hooley, 2009). This seemingly only ludic behaviour alimts the assumption that learners would not learn anything using their mobile devices. However, many studies have suggested that a lot of learning deemed authentic and experiential actually occurs in personalised informal spaces (De-Marcos, Garcia-Lopez, & Garcia-Cabot, 2016; Schugurensky, 2000). This includes the spaces created by most if not all learners equipped with a mobile device in educational infrastructure deprived Sub-Saharan Africa.

On the other hand, little is known about the way in which learners all over the world and in Sub-Saharan Africa actually achieve informal learning over their mobile devices (Madge et al., 2009). This paper aims at contributing to filling that lack of knowledge by providing an understanding of the phenomenon of the use of mobile devices in informal learning by Sub-Saharan African secondary school learners. The question that arises then is: *how do Sub-Saharan African secondary school learners use their mobile devices to achieve informal learning?*

This research intends to generalize its findings to the population of learners in secondary schools in Tanzania, therefore, necessitating a discussion in Sub-Saharan African countries to replicate the approach and offer insight from their contexts. The study uses the rhizomatic theory as a lens for data collection and analysis of the case study from a single Sub-Saharan African country. Data was collected using semi-structured interviews and observation at the school setting to acquire information from learners and analysed using thematic analysis to address the identified research problem.

The paper continues with a literature review of learners' achievements of informal learning through their mobile devices, followed by a brief discussion on selected learning theories where the rhizomatic theory is argued for application in the study. Then, research methodology is discussed before the findings of the study are drawn from the case. Lastly, findings are discussed, a conclusion is drawn, and future areas of studies are highlighted.

THE CHALLENGES AND OPPORTUNITY OF INDIVIDUAL LEARNING

This study's research problem is that there is a lack of knowledge explaining Sub-Saharan African secondary school learners' use of mobile devices to achieve informal learning. To engage and understand what literature discusses on access and use of mobile devices in informal learning, this section examines the state of knowledge around the themes of informal learning, personal learning environments and the use of mobile devices in relation to informal learning and finally the educational challenges in Sub-Saharan Africa. The study uses the term learners to refer to late secondary school students.

The use of Informal learning and personal learning environment

Informal learning has been discussed at length in research where definitions, extensions and modes of application have been pondered on (Gleason, 2013; Jeng et al., 2010; Khaddage, Müller, & Flintoff, 2016; Pimmer et al., 2014; Schugurensky, 2000). The idea of informal learning stems from the fact that most of the learning does not happen in a formal educational environment like a classroom. That hidden part of the learning iceberg represents all the activities outside of a formal educational environment ensuing in the achievement of the learning of some knowledge or skill (Schugurensky, 2000).

Informal learning exists in a multitude of formats. These formats include intentional or unintentional and with the learner being aware or not (active or passive knowledge construction) of the learning whether self-directed, incidental or in a situation of socialisation (Gleason, 2013; Schugurensky, 2000). In this study, informal learning will encompass all the activities undertaken by the learner as well as unintended learning experiences whether the learner is aware or passive before the process of learning, especially away from structured and institutionalized educational environments. The learner is taken as an individual who intends to acquire knowledge when interacting with a mobile device which purports a personal learning environment.

Studies on personal learning environment (PLE) argue that the concept allows leadership, organisation and control of academic content, educational tools, socio-cultural and physical context to be on the learner loci (Attwell, 2007; Dabbagh & Kitsantas, 2012; Saadatmand & Kumpulainen, 2012). The learner thus sets up their own goals and follows a predetermined plan to attain learning (Haßler, Major, & Hennessy, 2016). PLEs are linked to informal learning in that learners organize what and how to read and set expected outcomes; all of it while outside the formal school environment (Ciampa, 2014).

In an informal setting, learners observe peers, try practices seen from peers on their own using prior knowledge and available material (e.g.: recommended textbooks, past examination papers, or contactable friends) to aid them in learning (Dangel & Wang, 2008); where mistakes are made, learners have the liberty of reaching out to peers for assistance, explanation, or direction (Dabbagh & Kitsantas, 2012). It is suggested that the use of mobile devices is an enabler of informal learning (Wu et al., 2012).

Learners use of mobile devices for learning in an informal environment

Researchers contend that mobile devices and services include cell devices, smart phones, tablets and mobile instant messaging applications (Hwangu & Shih, 2015; Khaddage et al., 2016; Wu et al., 2012) and are the most used individual technologies worldwide (Domingo & Garganté, 2016). It should also not come as a surprise that in Sub-Saharan Africa, mobile devices are widely spread (Kafyulilo, 2014) and accessible compared to electricity and water (Mtebe & Raisamo, 2014). Mobile devices are used by learners for communication, entertainment, refreshment, socialization and educational purposes (Mwapwele & Roodt, 2016; Oblinger, Oblinger, & Lippincott, 2005). Outside the classroom, some parents claim that learners are misusing these devices by watching pornographic materials and focusing on entertainment instead of studying (Kafyulilo, 2014).

Research extrapolates learners using mobile devices for academic purposes and suggests that it affords "*learners without computers at home*" access to learning material that they were unable to understand in class which supplements classroom learning (Cavus, Bicen, & Akcil, 2008; Lin & Lin, 2016; Melhuish, Falloon, & Melhuish, 2010; Wu et al., 2012). For example, relevant teaching aid, access to other concepts that were not discussed in the classroom and access to relevant books that are freely available online can be attained using mobile devices outside the classroom.

Our understanding is that learners use mobile devices outside the classroom to assist peers and siblings, search library databases, undertake online quiz, or tests, hold online meetings and discussions to supplement recommended textbooks and also to search for information they can employ for their lives (Carlson, 2005; Mwapwele & Roodt, 2016; Nguyen, Barton, & Nguyen, 2014). Despite their ability to foster learners' exposure to recreational content, mobile devices are part of learners PLEs, where they represent a lever providing control and organisation over socio-cultural and specialist networks. Learners' experiences in Sub-Saharan Africa are unique because the privilege of using mobile devices outside the classroom is usually met with challenges from parents and teachers persuaded that the technology is mostly recreational.

Sub-Saharan Africa educational system challenges

Education is purported as a means to provide humans with skills and knowledge about their environment in the quest of overcoming poverty (Katapa & Swilla, 1999; Rena, 2006; Scala, 2015). The outcome of this is an expectation of transforming one's life into better living. The skill set acquired are expected to help with practical activities while the knowledge is expected to enhance reasoning (Hew & Leong, 2011; Looi, Sun, Seow, & Chia, 2014).

Secondary schools in Sub-Saharan Africa have seen a tremendous increase in learners enrolment over the past decade (Semali & Mehta, 2012; Seniwoliba & Yakubu, 2015). This increase is caused by changes in socio-economic conditions of learners, changes in educational and related policies and the demographic explosion witnessed on the continent. While the increase in learners' enrolment is taken as a move in the right direction, the expansion of facilities to cater for the increase has not followed. Classrooms are overcrowded, curricula changes too often and the number of teachers has not increased in proportion with the learners (due to retirement and industry or geographical brain circulation) (Johnston, 2013; Semali & Mehta, 2012). Also, scarce libraries are still lacking relevant textbooks, laboratories have not been upgraded and funding for these levels of education has been shrinking alarmingly (ibid).

Coupled with this is the use of English (or other European languages) as the medium of communication and instruction in academic and official circles (Butgereit & Botha, 2009); while in informal environments learners mainly use African languages (mother tongues). It is important to note that the use of mother tongues has been argued to support better learning (Rubagumya, 1991). Rubagumya (1991) argues that learners understand the content better when presented in a language they are familiar with.

For most learners, learning happens in an informal environment that supports active or passive understanding of concepts (Strandell-Laine, Stolt, Leino-Kilpi, & Saarikoski, 2015). Learner's use of mobile devices in informal environments purports interaction for multiple purposes that do not exclude learning. Central to the discussion is learner's control of the learning environment and how it supports personal learning approach by organizing what, how and when to learn the concepts.

There exists a gap in research on empirical data that explains how learners use mobile devices in an informal environment for learning in developing countries. Specifically, in a developing country such as Tanzania where learners have access to mobile devices and use them outside the classrooms. As Sub-Saharan countries empower citizens to overcome poverty, problems in education are pertinent and mobile devices may supplement teaching and learning materials required and aid learning. To this end, there is a need to understand, through empirical evidence, how learners in Sub-Saharan Africa use mobile devices for informal learning. The lens used to provide such understanding is the rhizomatic learning theory as it represents the spread of learner's access and use of mobile devices.

THEORETICAL FRAMEWORK: RHIZOMATIC LEARNING THEORY

In this era of global socio-cultural connectedness and information abundance enabled by the Internet (Castells, 2011), effective learning is better explained by the ability to create relevant and specialised connections as suggested by the learning and knowledge model of connectivism.

This study utilises the rhizomatic learning theory to deduce an understanding of Sub-Saharan African learners' informal learning using mobile devices. This section presents the rhizomatic learning theory as a theorization of a situated lifelong connectivist learning; as well as its adequacy for the study of the use of ICTs in informal learning.

Situated lifelong connectivist learning

This study is underpinned by the perspective of connectivism which suggests an understanding of Internet-enabled informal learning as an ability to connect to a network of knowledge and knowledgeable entities using Internet-enabled devices. Connectivism sees learning as an individual and chaotic process of growing a knowledgeable personal network of specialised entities, objects and information (Dunaway, 2011; Siemens, 2005). Such learning very often occurs serendipitously away from a formal learning environment; driving learners to develop personal learning spaces and initiate learning plans and outcomes (Sharples, Taylor, & Vavoula, 2005). It suggests a lifelong process of acquiring skills and knowledge (Mwapwele & Roodt, 2016).

Connectivism understands learning to be taking place in learners personal learning environments supporting the urge of learners reading in a specific context or situation which enables the achievement of the learning of a specific topic or skill. Such situated learning assumes that learners acquire knowledge using prior knowledge and the learning has to happen in a specific context (Melhuish et al., 2010). According to Dawley & Dede (Dawley & Dede, 2014), learning takes place in a specific context and the quality of the learning achieved would be the result of interactions between the people, physical environment, objects, processes and culture within and relative to that context.

In that regard, Bandura (1971) and Bappah (2013) argue that learners learn in a social environment. Events in that environment trigger a good or bad response to the learning experience. Learners use their cognitive abilities to understand what is unfolding (observed or instructed), to relate it to their learning and reflect on what is being learnt as productive or not. Their mental abilities allow them to constantly be on the learning trait; hence, when other people make mistakes, they also learn (Fabian, Topping, & Barron, 2016).

Rhizomatic learning theory

The rhizomatic theory has been used by Dabbagh & Kitsantas (2012) in education and technology, Andrews & Jones (2015) in media studies and Cronje (Cronje, 2018) in information systems. Deleuze and Guattari (1987) suggested the metaphor of the "Rhizome" to describe the creation and acquisition of knowledge. The rhizome metaphor offers a model of knowledge creation constituted by a de-centred and open network of semi-independent nodes capable of growing and spreading on their own, limited only by its immediate environment (Carrington, 2011; Cormier, 2008). Learning is understood here as a social and personal knowledge creation process. In the rhizomatic model of learning, learning is mutually constructed and negotiated in real time by the contributions of those engaged in the learning process (Cormier, 2008). We thus use rhizomatic learning theory because it allows viewing rhizomes from the point of view of learners in the quest of acquiring information and knowledge.

The rhizome aspect emerges in the process of learners producing information that is shared with peers in their networks while acquiring information that is shared by others. The rhizome recalls a knowledge map that must be produced and constructed; a map that is always detachable, connectible, reversible, modifiable and has multiple entry and exit points and its own lines of flight or escape routes (Deleuze and Guattari, 1987, p21). It depicts a dynamic and active learning environment which grows on its own and from which the learner can draw knowledge or contribute to.

The rhizomatic learning theory is based on a *connectivist* approach to learning underpinned by an assemblage theory of knowledge and asignifying semiotics. That approach to learning stems from integration of theories of “*chaos, network, complexity and self-organization*” (Siemens, 2005). The rhizomatic learning theory is a depiction of learning as a process of connecting to the learning environment. This is a process of learners acquiring knowledge and skills using their previously constituted networks of knowledge items, entities and objects (including mobile devices). The rhizomatic learning theory provides for a more realistic approach to understanding learners’ strategies for informal learning using mobile devices.

There are six principle aspects of the development of a rhizome: connection; heterogeneity; multiplicity; asignifying rupture; cartography; and decalcomania (Deleuze & Guattari, 1987; Hickey-Moody, 2015).

- *Multiplicity* refers to stacked layers of knowledge dimensions or plateau offering possible directions of development of the rhizome, not from a centre or following a line of growth. Learners have friends and peers that they engage with at different levels to acquire information and knowledge from. Learners also interact with teachers and lecturers who provide a different layer on what the learner can acquire. Each interaction allows for the creation of different knowledge that learners acquire in informal learning.
- *Heterogeneity* stems for the necessary diversity in meanings, power relations and social situation within which the connections are made. Learners define different value, application and benefits from using mobile devices in an informal environment for learning.
- *Connections* refer to established points of contact and exchange between semiotic chains, organizations of power and circumstances relative to the knowledge to be imparted. They represent contact points between members of multiplicities.
- *Asignifying rupture* refers to resisting signification and devising escape routes allowing the growth of the knowledge network in a different direction (deterritorialization and reterritorialisation processes). It represents potential alternative directions or dimensions of meaning belonging to a referent being signified; and allowing to break from one line of meaning (deterritorialization) and defining a new line of meaning (reterritorialization) from the point of rupture (Genosko, 2008).
- *Cartography* refers to the continuous development of a map of knowledge sources and the routes to reach them. Knowing for a learner would then be understood as recalling the map containing the path to a specific item of knowledge; or as a state of meaning emerging from journeying through a mental or physical plot of connections, each of them contributing a parcel of the saved item.
- *Decalcomania* refers to an action of reproduction and repetition of knowledge from any node or knowledge dimension or multiplicity onto another one. Learners share content with peers within and outside the school environment. Inside the school environment, learners share information with peers from the same class (or degree) and those outside their classrooms but within the same school, the same applies for learners within a university sharing information with colleagues from different degrees. In the process of sharing such information, learners create,

recreate and repeat sharing content to peers and friends. Learners also share information with friends in different schools (universities) which shows that the reproduction and repetition is an ongoing activity and hence the change of meaning in the process by displacing the initial concept shared.

RESEARCH METHODOLOGY

This study is deductive, cross-sectional and qualitative. It applies the rhizomatic learning theory to a single case study design (Yin, 2013). The single case used in this study is that of secondary school Form IV (Grade 12) learners in Dar-es-Salaam – Tanzania. The case was selected because the learners hosted the fringe of the age of Sub-Saharan African population (between 16 and 25 years of age) that is starting to self-determine and would often decide on what to learn when to learn and how to learn. Data were collected at a single instance (Creswell, 2013) using participant observation of learners, semi-structured and in-depth interviews and was analysed using thematic analysis (Braun & Clarke, 2006) on Atlas-ti™ as a tool.

Purposive sampling was performed in identifying the school and respondents (Halaweh, 2012) to work with. They had to be accessible, from the Sub-Sahara African region, in the fringe of age between 16 and 25 and possessing a smart device. These criteria were then supported by headmasters, teachers and parents who would agree to the study and take us to learners. The semi-structured interview protocol was developed using themes from the rhizomatic theory where questions asked to learners aimed at providing explanations on how they use mobile devices for learning in informal learning.

The units of observation and analysis of these cases were learners' who made use of mobile devices for learning in an informal environment, as such, individuals (Halaweh, 2012). It was relevant to look at learners as individuals to enact an informed understanding of their informal learning compared to a group or community view as this will include a bias towards the generalization of findings.

As a qualitative and cross-sectional study, data was made up of narratives (observation notes and respondents opinions) collected within the year 2015 (Creswell, 2013). The semi-structured interviews were conducted for a period of one month and involved 20 learners. These interviews were undertaken on Form IV (Grade 12) secondary school learners. These learners use mobile devices for different reasons and the intention was to understand their use for learning. In principle, learners were interviewed on general and academic use of their mobile devices and interaction with their local socio-cultural system.

As a deductive study, the themes utilized in the thematic analysis were taken from the rhizomatic theory and linked to the literature review (Gregor, 2006). The six phases of thematic analysis by Braun & Clarke (2006) guided explanation of the findings of the research. Thematic analysis began by familiarising with data through transcribing the semi-structured interviews and field notes from observation. The process of familiarization included reading and re-reading of transcripts to acquire an initial understanding of that narrated by respondents.

The second phase of analysis involved generating initial codes to all transcripts depicting the phenomenon of interest. Initial coding was followed by searching for themes by linking coherent and distinct codes with the same theme. The fourth phase required the application of internal homogeneity and external heterogeneity to initial themes leading to refined and renamed themes. Themes identified in the fourth phase were related to themes from rhizomatic theory. The fifth phase required defining and naming themes based on what data 'speak of'. Development of the journal paper was the final stage of thematic analysis.

The knowledge rhizome is understood as a multidimensional map with various planes, paths and nodes with analysis following the main themes throughout knowledge maps. The breakdown of themes, sub-themes and codes from the analysis is included in the findings section (Table 1). The study generalises to the population of sub-Saharan Africa based on the similarities in the conditions to access and use of mobile devices observed within that region as identified in the introduction section of this paper.

FINDINGS

Secondary school learners Informal learning using mobile devices

Theme	Sub-theme	Explanation
Connection	Peers Parents, teachers Relatives, groups Language Topics Mobile devices as technology Roles Social-cultural norms	Learners use mobile devices to connect to peers, teachers and relatives. The connection includes those found in groups on MIM. Language and topics inform what was discussed on mobile devices based on roles that learners and peers assigned to each other. Social-cultural norms influence learning using mobile devices.
Heterogeneity	Experience Approaches Point of view Social situation (philosophy, belief) Mobile companies Network companies	Learner's use of mobile devices for learning is informed by lived experiences and approaches to learning. Further, learners are informed by the diverse point of views that teachers and peers have and the social situation. Learners' own mobile devices originated from different companies and used different cellular networks.
Multiplicity	Language Emotion and feelings Respect/frustration/gratefulness	Learners use a multitude of languages in conversations. Conversations carried using mobile devices are embedded on underlying emotions and feelings that support respect or gratefulness and even frustration on what was learned or what wasn't.
Asignifying rupture	Borderless learning Outside the classroom Different schools Relatives, peers and friends	Knowledge sharing is borderless in that learners in different schools, locations and outside the classroom share knowledge to peers that allows for the development of a new rupture independent of current peers.
Cartography	Subject/combination/form specific groups WhatsApp groups Social and knowledge layers	Learners access knowledge from peers through different means including WhatsApp groups, subjects or combination. Learners use social and knowledge layers to access information that enhances learning.
Decalcomania	Peers Internet Search engine Pictures, video and audio	Learners share information with peers in the format of pictures, video and audio that was found on the Internet and through a search engine.

Table 1: Themes and subthemes of informal learning from secondary school learners.

The main themes from the rhizomatic theory were expanded to include sub-themes that are cohesive and represent fragments of the theme as presented in Table 1. The sub-themes were further analysed based

on the semi-structured interviews. Using the interview data, the themes are explained in the last column as a summary of the content clarified in section 5.3.

Context of the school

The school in Dar-es-salaam is situated about 15km from the city centre. The school incorporates all religions, all gender and offers arts, commerce and science combinations. It has at least one teacher for each subject. The school offers computer courses (from introduction to programming) to Form IV to VI (Grade 12 to 14) learners. It has a library with all relevant textbooks. While learners at the school are well catered for, outside the school they suffer much of the problems facing secondary school learners in Dar-es-salaam.

Transport is a chaotic aspect for learners. They are not allowed to enter buses even when they are not full. As learners pay half the price for transportation on public buses, bus conductors mistreat them. This results in learners spending at least 4 hours daily to and from school.

Changes in curricula have affected this school too. Each year, learners need to scan the ministry of education and vocational training for new requirements of practical classes and changes in teaching books. It also affects results as the government has been changing national examination grading. The government has moved among a number of results grading including; division and GPA.

The rhizome of secondary school learners as they use their mobile devices for learning.

Connections: Having identified these elements, it was not shocking to hear learners depicting the use of mobile devices for learning. As the technology learners have access to, they depict use ranging from socialization, recreation, entertainment and academic. This is inclusive of girls and boys. The researchers interviewed 20 learners at this secondary school on their informal use of mobile devices for learning. Learners have complete autonomy on these devices and the purchasing of airtime (credit) and bundle (megabytes) is from their own pockets.

The nodes (connection) in this case include people, learners, peers, relative, groups and teachers, mobile devices, mobile applications, curriculum, topics, language and socio-cultural norms. A learner can easily reach all these nodes and they know they can receive academic assistance. Even if a node is disconnected, learners still have links to other nodes and know they can easily access knowledge. Respondents are identified by S (learner), number (e.g. 5th respondent) and gender (F for female and M for male).

In an informal learning environment, a learner will be connected to the curriculum by reading a certain subject within a studying environment. Learners will do this either using physical books or mobile devices. Mobile devices allow learners to use the affordances of mobile applications that link them to peers, friends, relatives, teachers and parents who willingly offer academic assistance where the learner is struggling.

Learners communicate to peers with the intention of sharing information or requesting assistance using a language known to them. This can extend to sharing information within a group that has been created on mobile applications. Using the Internet outside the classroom, learners communicate about what was learnt in class which enhances their learning. All this happens within confined socio-cultural norms.

S17M “Pictures yes. I have also recorded videos and sent to friends. On pictures, I have taken pictures and moved them to a computer using USB and I placed them on a paper (print) and shared with friends in a group. It was about a project and we focused on survey. I did something as part of it and once I had completed I placed them on paper and we could read from that. We send videos to each other about how to develop a webpage and what is needed.”

Heterogeneity: is depicted by several elements. In a classroom, gender, religion, race and locality do not play any role. Learners are given access to the same material and given the same assessments. Much in the same understanding, these learners connect to one another using mobile devices outside the classroom without segregation on any criteria. They own cell device (Itel™, Ditel™), smart device (Blackberry™, Samsung™ and Techno™) and tablets (Samsung Note and THL). These devices operate on different mobile networks i.e. Tigo™, Zantel™, Airtel™ and Vodacom™. The much differentiation could come based on the Form (Grade) they are in. Within Form, separation might be based on combination i.e. Arts, Business, or Science. Those staying far from school are assisted by peers when they get to school late by being updated on what was taught in their absence. Learners are basically teaching one another without being limited by external elements.

In a way, the type and specifications of devices learners own indirectly depict family's economic status. At the school and based on data collected, learners come from low-income families to high-income ones. During the time of data collection in 2015, iPhone 6 and Samsung S5 were the latest mobile devices in the market. Learners who own and sustain these types of mobile devices were arguably from financially stable families.

Multiplicity: As stated above, the school has diverse learners and teachers alike, which depicts multiplicity. The teachers and learners meet at the school with the same purpose and similar expectations. For the learners, acquiring knowledge and skills to foster learning is central. Learners depend on the pool of teachers to uncover a multitude of topics from a diverse curriculum that will assist them with educational development.

Per school records, as given by the Academic master, the school has 1600 learners, 76 teachers and 32 non-teaching staff. This large number of learners, most owning mobile devices, can communicate with one another at different times based on the rhizome they belong. Using their mobile devices, they can share academic information. They exist in a constantly connected society outside the school. They depict their use of mobile devices affordances in different ways.

S4F “During project time it's when I contacted my fellow learners. As learners, we could call, or text each other, or the group leader (on social networks) could send text to all members who are in that project. He would have sent a text message for everyone to go to the social media group to look at progress.”

Asignifying rupture: Learning to these learners is not confined to school only. Outside the school environment, learners learn. They use mobile devices to learn and contact peers where information consumption and generation is given a new meaning. As stated before, this learning includes peers, relatives and strangers alike. Using mobile devices, learners can explain and discuss different aspects of their learning with peers in a different school, in a different district, city, or country. Some of these peers are linked to other learners based on environment. It opens the avenue for borderless learning that would have been impossible in a traditional learning environment.

S10M “The people I am sharing these questions with are not necessarily in my class. They could be from any other school or anywhere in the world. There was a time I was using my device and I found Microsoft math, it has the Tanzanian syllabi for O-level and A-level mathematics. You can even create friendship with the people you share your solutions with.”

Cartography: Learners have multiple groups on WhatsApp. Some have groups based on Form (I, II, III, or IV), or combination (Arts, Business, or Science), yet others might be subject specific. Learners access these groups at different times without affecting other groups. If a learner decides, they may exit one group and this will not hinder access to others. In as such, learners enter and exit groups on WhatsApp that are of academic importance to them. They might be the administrator of the group or just added by the administrator. Even when the administrator quits the group, the group will still exist until the last

person exits the group. Administrator role gets moved from one user to the other. This supports their rhizomatic existence by depicting cartography as maps can be drawn of layers of communication they hold either socially, or on knowledge terms.

S3F “The group could be about a subject i.e. book-keepers, or the school, i.e. School X, or based on the class i.e. Form 3C.”

Decalcomania: Part of the material that learners generate and share is not new. They might have accessed it on the Internet or received it as a message from a peer and they can now share it with other peers, or group of peers. Using groups on WhatsApp, learners can share a multitude of information in the form of messages and pictures. This shows decalcomania as the learner reproduce and redistribute content received from peers on groups.

S7M “I have used screenshots. For example, when I search for something on google, then I capture the information and send to our WhatsApp group. It is a class group.”

DISCUSSION OF FINDINGS

The findings suggest that sub-Saharan Africa young adult learners finishing secondary school use their mobile devices and exploit MIMs. Learners build knowledge networks using mobile devices. These interactions are explained using the rhizomatic theory of learning.

The case suggests that Sub-Saharan Africa (SSA) learners are following an unusual path to learning: they learn mostly out of the classroom. Such behaviour depicts informal learning as suggested in studies done by Vavoula (2005) and Sharples et al., (2005) on everyday adult learning, where it was found that 51% of learning was done outside the workplaces, in informal settings. SSA learners draw from previous knowledge networks to access new ones, and in the freedom of trialability that they find with other friends or peers that connect them to new nodes. Learners perform all these activities while in their private spaces and using their personal learning environments.

To these learners, a teacher is a link to the knowledge they intend to acquire and are willing to learn from. Strandell-Laine, Stolt, Leino-Kilpi, & Saarikoski (2015) arrived at the same findings as they discussed nursing teachers use of mobile devices during the clinical practicum. They identified that nursing teachers communicated to peers and nursing learners and the interaction provided support, motivation, reduced stress, promotion of flexibility and reduced the sense of isolation. Throughout their academic years, learners traverse a multitude of subjects and topics as per the curriculum. Using their mobile devices, learners employ mobile applications (such as MIMs) to communicate with peers in a language that enhance learning. Learners open to peers and groups about their lack of knowledge through asking questions and accepting that in return, peers might laugh, or joke, but will assist in handling their query and explain to their satisfaction.

At times when explanations or discussions are not clear, audio, video and pictures are used to aid the explanation. In a study by O’bannon & Thomas (2015) on pre-service teachers in Kentucky and Tennessee, the researchers found that the use of audio, video and pictures was argued to have the same effect. Based on our study, once peers notice any challenges, they console one another and assist in any way they can. To these learners, a studying environment is not confined to borderlines, as such, they view the environment as a continuum where their mobile devices can take them too.

In all these interactions where learners’ connections operate, learners use languages that accommodate their friends, teachers, parents, peers, or other group members. As much as they understand socio-cultural norms and their limitation, they ensure they do not offend (purposely), any of the people on their nodes as each is of great value. When a rupture occurs, moving to a new school (or university), or

graduating, they know they can apply different techniques to reach multiplicity and heterogeneous peers they have for knowledge. They know they need access to one node that can open other connections and within them, they can recapture the map to the knowledge they once had (de-territorialisation and re-territorialisation). This is a confirmation of the situation and social character of learning as suggested by Dawley & Dede (2014).

This study was limited for not venturing into inquiring about other educational stakeholders and other family members, friends and relatives; types of mobile devices being used; special relationship learners have with mobile devices; the interactivity of the course content and the effects of social-cultural interactions were not adequately analysed to explore emergent plateau.

CONCLUSION AND AREAS FOR FUTURE RESEARCH

The study has used the rhizomatic learning theory to explain Tanzanian learners observed informal learning practices of using mobile devices and their MIMs to achieve knowledge and skills. That contribution has a theoretical dimension which provides empirical evidence extending the application of rhizomatic learning theory to the sub-Saharan African educational context while adding to the body of knowledge of m-Learning.

The study suggests that learners in secondary schools in Tanzania engage in their process of informal learning, prior knowledge, knowledge of various languages, local socio-cultural norms, the present formal educational environment, mobile devices and mobile applications affordances, aggregated and exploited in a way that can be explained by the rhizomatic learning theory. It suggests that mobile devices and their MIMs are used as support in the constitution of personal learning environments understood as multidimensional networks of heterogeneous multiplicities which rhizomatic maps situate and contain knowledge, skills, and opportunities for innovation.

Understanding such learners' experiences has implication for practice as education practitioners may engage with learners' access and use of mobile devices to model formal teaching that allows for engagement with the learners informal learning experiences. Teachers and lecturers may review teaching and learning activities that hinder the use of mobile devices in secondary schools and universities and deploy them as complementary tools that aid with accessing learning material. Education policy makers may review curriculum and pedagogy to open avenues for the use of mobile devices and the consideration of Internet-mediated out-of-the-classroom learning.

This research has implication to Information Systems community as a study that assesses mobile devices and their MIMs as an artefact. Mobile devices are part of the ongoing discussion in the Information Systems community and by providing empirical evidence of how secondary school learners use them for learning outside the classroom, the research engages in the discussion and extends understanding of concepts that are relevant and persistent in the field of ICT in education.

Further studies are suggested to look at other educational stakeholders and learners' family members, mentors, friends, and relatives; types of mobile devices being used; special relationship learners have with mobile devices; the interactivity of the course content and the effects of Sub-Saharan Africa sociocultural interactions.

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REFERENCES

- Aker, J. C., & Mbiti, I. M. (2010). Mobile phones and economic development in Africa. *The Journal of Economic Perspective*, 24(3), 207–232.
- Andrews, J., & Jones, M. (2015). What’s happening in “their space”? Exploring the borders of formal and informal learning with undergraduate students of education in the age of mobile technologies. *Journal of Interactive Media in Education*, 1(16), 1–10.
- Attwell, G. (2007). The personal learning environments - The future of eLearning? *ELearning Papers*, 2(1).
- Bandura, A. (1971). *Social learning theory*. New York: General Learning Press.
- Bappah, A. S. (2013). Appraisal of social learning potentials in some trending mobile computing applications. *International Journal of Computer Trends and Technology*, 4(7), 2017–2021.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101.
- Butgereit, L., & Botha, A. (2009). Hadedda: The noisy way to practice spelling vocabulary using a cell phone. In *IST-Africa 2009 Conference Proceedings* (pp. 1–7).
- Carlson, S. (2005). Tech-savvy “millennials” have lots of gadgets, like to multitask, and expect to control what, when, and how they learn. Should colleges cater to them? *The Chronicle of Higher Education*, 52(7), 34–37.
- Carrington, S. (2011). Service-Learning Within Higher Education: Rhizomatic interconnections between University And The Real World. *Australian Journal of Teacher Education*, 36(6).
- Castells, M. (2011). *The rise of the network society* (2nd ed.). Cambridge: Wiley-Blackwell.
- Castells, M. (2015). *Networks of outrage and hope: Social movements in the internet age* (2nd ed.). Cambridge: John Wiley & Sons.
- Cavus, N., Bicen, H., & Akcil, U. (2008). The opinions of information technology students on using mobile learning. In *Proceedings of 08 International Conferences on Educational Sciences* (pp. 1–7). Magosa.
- Ciampa, K. (2014). Learning in a mobile age: An investigation of student motivation. *Journal of Computer Assisted Learning*, 30(1), 82–96.
- Cormier, D. (2008). Rhizomatic Education: Community as curriculum. *Innovate: Journal of Online Education*, 4(5), n5.
- Cox, M. J. (2013). Formal to informal learning with IT: Research challenges and issues for e-learning. *Journal of Computer Assisted Learning*, 29(1), 85–105.
- Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Los Angeles: Sage publications.
- Cronje, J. (2018). Learning 3.0: Rhizomatic Implications for Blended Learning. In *Educational Technology to Improve Quality and Access on a Global Scale. Educational Communications and Technology: Issues and Innovations* (pp. 9–20). Springer, Cham.
- Dabbagh, N., & Kitsantas, A. (2012). Personal learning environments, social media and self-regulated learning: A natural formula for connecting formal and informal learning. *The Internet and Higher Education*, 15(1), 3–8.
- Dangel, H. L., & Wang, C. X. (2008). Student response systems in higher education: Moving beyond linear teaching and surface learning. *Journal of Educational Technology Development and Exchange*, 1(1), 93–104.
- Dawley, L., & Dede, C. (2014). Situated learning in virtual worlds and immersive simulations. In *Handbook of research on educational communications and technology* (4th ed., pp. 723–734). New York: Springer New York.

- De-Marcos, L., Garcia-Lopez, E., & Garcia-Cabot, A. (2016). On the effectiveness of game like and social approaches in learning: Comparing educational gaming, gamification & social networking. *Computers & Education, 95*, 99–113.
- Deleuze, G., & Guattari, F. (1987). *A thousand plateaus: Capitalism and schizophrenia*. London, UK: University of Minnesota Press.
- Domingo, M. G., & Garganté, A. B. (2016). Exploring the use of educational technology in primary education: Teachers' perception of mobile technology learning impacts and applications' use in the classroom. *Computers in Human Behavior, 56*, 21–28.
- Dunaway, M. K. (2011). Connectivism: Learning theory and pedagogical practice for networked information landscapes. *Reference Services Review, 39*(4), 675–685.
- Fabian, K., Topping, K. J., & Barron, I. G. (2016). Mobile technology and mathematics: Effects on students' attitudes, engagement, and achievement. *Journal of Computers in Education, 3*(1), 77–104.
- Genosko, G. (2008). A-signifying Semiotics. *The Public Journal of Semiotics, 2*(1), 11–21.
- Glance, D. G., Forsey, M., & Riley, M. (2013). The pedagogical foundations of massive open online courses. *First Monday, 18*(5).
- Gleason, B. (2013). #Occupy wall street: Exploring informal learning about a social movement on twitter. *American Behavioral Scientist, 57*(7), 966–982.
- Halaweh, M. (2012). Integration of grounded theory and case study: an exemplary application from e-commerce security perception research. *Journal of Information Technology Theory and Application, 13*(1), 31–51.
- Haßler, B., Major, L., & Hennessy, S. (2016). Tablet use in schools: A critical review of the evidence for learning outcomes. *Journal of Computer Assisted Learning, 32*(2), 139–156.
- Hew, T. S., & Leong, L. Y. (2011). An empirical analysis of Malaysian pre-university students' ICT competency gender differences. *International Journal of Network and Mobile Technologies, 2*(1), 15–29.
- Hickey-Moody, A. (2015). The Rhizomatics of Practice as Research. In *Arts, Pedagogy and Cultural Resistance* (p. 169).
- Hwangu, G. J., & Shih, J. L. (2015). Experiences of using a blended mobile learning approach to connect classroom and in-field learning activities in a local culture course. In *Seamless Learning in the Age of Mobile Connectivity* (pp. 319–333). Singapore: Springer.
- Jeng, Y.-L., Wu, T.-T., Huang, Y.-M., Tan, Q., H, S. J., & H Yang, S. J. (2010). The add-on impact of mobile applications in learning strategies: A review study. *Journal of Educational Technology & Society, 13*(3), 3–11.
- Johnston, K. (2013). A guide to educating different generations in South Africa. *Issues in Informing Science and Information Technology, 10*(1), 261–273.
- Kafyulilo, A. (2014). Access, use and perceptions of teachers and students towards mobile phones as a tool for teaching and learning in Tanzania. *Education and Information Technologies, 19*(1), 115–127.
- Katapa, R. S., & Swilla, I. N. (1999). Gender differences in school performance evidence from the national form IV examination results and implications for poverty. *Eastern Africa Social Science Research Review, 15*(1), 33–54.
- Khaddage, F., Müller, W., & Flintoff, K. (2016). Advancing mobile learning in formal and informal settings via mobile app technology: Where to from here, and how? *International Forum of Educational Technology & Society, 19*(3), 16–26.
- Lin, Y.-T., & Lin, Y.-C. (2016). Effects of mental process integrated nursing training using mobile

- device on students' cognitive load, learning attitudes, acceptance, and achievements. *Computers in Human Behavior*, 55, 1213–1221.
- Looi, C., Sun, D., Seow, P., & Chia, G. (2014). Enacting a technology-based science curriculum across a grade level: The journey of teachers' appropriation. *Computers & Education*, 71, 222–236.
- Madge, C., Meek, J., Wellens, J., & Hooley, T. (2009). Facebook, social integration and informal learning at university: 'It is more for socialising and talking to friends about work than for actually doing work. *Learning, Media and Technology*, 34(2), 141–155.
- Melhuish, M., Falloon, G., & Melhuish, K. (2010). Looking to the future: M-learning with the iPad. *Computers in New Zealand Schools Learning Leading Technology*, 22(3), 1–16.
- Mtebe, J. S., & Raisamo, 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*, 10(3), 4–20.
- Mwapwele, S. D., & Roodt, S. (2016). The extent of usage of mobile devices for learning outside the classroom in a secondary school in Tanzania. In *International Conference on Information Resources Management 2016* (Vol. Paper 15, pp. 1–11).
- Nguyen, L., Barton, S. M., & Nguyen, L. T. (2014). iPads in higher education-Hype and hope. *British Journal of Educational Technology*, 46(1), 190–203.
- O'Bannon, B. W., & Thomas, K. M. (2015). Mobile phones in the classroom: Preservice teachers answer the call. *Computers & Education*, 85, 110–122.
- Oblinger, D., Oblinger, J., & Lippincott, J. K. (2005). *Educating the net generation*. Brockport Bookshelf. Brockport.
- Pimmer, C., Brysiewicz, P., Linxen, S., Walters, F., Chipps, J., & Gröhbiel, U. (2014). Informal mobile learning in nurse education and practice in remote areas—A case study from rural South Africa. *Nurse Education Today*, 34, 1398–1404.
- Rena, R. (2006). Higher education in Africa - A case of Eritrea. *Journal of Educational Planning and Administration*, 21(2), 125–140.
- Rubagumya, C. M. (1991). Language promotion for educational purposes: The example of Tanzania. *International Review of Education*, 37(1), 67–85.
- Saadatmand, M., & Kumpulainen, K. (2012). Emerging technologies and new learning ecologies: Learners' perceptions of learning in open and networked environments. In *8th International Conference on Networked Learning 2012* (pp. 266–275). 8th International Conference on Networked Learning 2012.
- Scala, E. (2015). Tailoring tertiary education and ICTs for sustainable development in LDCs: Challenges and opportunities. *TIGOR*, 7(1), 15–34.
- Schugurensky, D. (2000). The forms of informal learning: Towards a conceptualization of the field. In *Wall Working paper* (Vol. 19). Toronto, CA: Centre for the Study of Education and Work.
- Seixas, L. R., Gomes, A. S., & Filho, I. J. M. (2016). Effectiveness of gamification in the engagement of students. *Computers in Human Behavior*, 58, 48–63.
- Semali, L. M., & Mehta, K. (2012). Science education in Tanzania: Challenges and policy responses. *International Journal of Educational Research*, 53, 225–239.
- Seniwoliba, J. A., & Yakubu, R. N. (2015). An analysis of the quality assurance policies in a Ghanaian university. *Educational Research and Reviews*, 10(16), 2331–2339.
- Sharples, M., Taylor, J., & Vavoula, G. (2005). Towards a theory of Mobile learning. In *In Proceedings of mLearn* (pp. 1–9). Cape Town.
- Siemens, G. (2005). Connectivism: A learning theory for the digital age. *International Journal of Instructional Technology & Distance Learning*, 2(1).

- Strandell-Laine, C., Stolt, M., Leino-Kilpi, H., & Saarikoski, M. (2015). Use of mobile devices in nursing student-nurse teacher cooperation during the clinical practicum: An integrative review. *Nurse Education Today*, 35(3), 493–499.
- Vardi, M. Y. (2012). Will MOOCs destroy academia? *Communications of the ACM*, 55(11), 5.
- Vavoula, G. N. (2005). *A study of mobile learning practices: Internal report of MoBIlearn project*.
- Wu, W. H., Jim Wu, Y. C., Chen, C. Y., Kao, H. Y., Lin, C. H., & Huang, S. H. (2012). Review of trends from mobile learning studies: A meta-analysis. *Computers and Education*, 59(2), 817–827.
- Yin, R. (2013). *Case Study Research: Design and Methods* (5th ed.). Thousand Oaks, CA: SAGE Publications Inc.