

Developing digital fluency among teacher educators: Evidence from Tanzanian Schools of Education

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ABSTRACT

This study explores how teacher educators develop digital fluency as a key competence in the contemporary world. Largely, the teacher education curriculum that the educators studied did not integrate digital fluency as a key competence. The study established dimensions of digital fluency as a concept through reviewing the literature. The study was qualitative, with data collected through interviews with ninety educators, including the management of university schools of education. The findings show that both individual mechanisms, particularly individualized learning, practice, engagement in research and consultancy, and institutional mechanisms - specifically training, infrastructure and the delivery of online programmes - contribute to the development of the digital fluency of teacher educators. The study contributes to the existing body of literature regarding digital fluency as a key competence for teacher educators. As regards practice, on-going training should be aimed at professional development, supported by continuous practice.

Keywords: *Digital Fluency, digital skills, digital competencies, teacher educators, pre-service teachers, Tanzania*

INTRODUCTION

Digital fluency, also termed higher-order thinking skills, is among the critical skills needed to survive in a digitally-connected society (McQuiggan, McQuiggan, Sabourin, & Kosturko, 2015). Digital fluency embraces both knowing how to use digital technology and knowing how to construct ideas of significance with digital technology (Wang, Wiesemes, & Gibbons, 2012). In education, digital fluency refers to educators' knowledge of how to use digital tools creatively in order to achieve teaching and learning objectives (Pinho and Lima, 2013). In teacher education institutions at university level (the focus of this study), digital fluency needs to form an integral part in preparing 21st century teachers for their role. In this regard, teacher preparation programmes need to enable teachers to design the learning environment in such a way that it takes full advantage of the digital tools and resources available to maximize students' outcomes (Borthwick & Hansen, 2017).

The role of competent teacher educators in preparing pre-service teachers has also been recognized (Sickel, 2019). However, the curriculum of teacher educators largely focuses on pedagogy and content knowledge (PCK) (Shulman, 1987), which is insufficient for preparing teachers in the digital era. Although traditional skills are still important, technological pedagogical and content knowledge (TPACK), including digital fluency, needs to form part of the teacher education curriculum and continuous professional development training for teacher educators (White, 2013). According to Foulger, Graziano, Slykhuis, Schmidt-Crawford, & Trust (2016), teacher educators need to be digitally fluent and possess the related skills and competencies to enable them to be better facilitators of future teachers. A digitally fluent educator can interact with online and offline resources, tools and management systems and utilize them ethically in realizing curriculum goals (Chigona, 2018). Digitally fluent educators can also design learning using technology, and facilitate learning using appropriate digital pedagogies in all types of learning environments (McKnight, O'Malley, Ruzic, Horsley, Franey, & Bassett, 2016).

In addition to the relevance of digital fluency of teacher educators for preparing pre-service teachers, studies exploring how educators develop digital fluency and the related skills are limited (Tusiime, Johannesen & Gudmundsdotti, 2019; Heinonen, Jääskelä, Häkkinen, Isomäki, & Hämäläinen, 2019; McKnight, et al., 2016). It has not been clearly established empirically how digital fluency is developed among teacher educators in developing contexts, a gap that needs to be addressed, as recommended by Tusiime, Johannesen & Gudmundsdotti (2019). Indeed, for a while, teacher educators have been feeling that they are not sufficiently equipped to teach using technology in the classroom (Miguel-revilla, Martínez-ferreira, & Sánchez-agustí, 2020; Uerz, Volman, & Kral, 2018). Teacher education institutions are also concerned that their role of inspiring student-teachers to use technology is not being fully realized due to the insufficient number of digitally fluent teacher educators (McGarr & McDonagh, 2019). Mouza (2016) reached the conclusion that there has been little research on the effective preparation of pre-service teachers to meet the demands of the digital era, which is attributed to teacher educators' lack of digital skills and competencies.

Statement of the Problem

Technology has introduced new developments in the education sector. According to White (2013), technology has brought with it new modes of learning, ranging from e-learning to spatial, blended and fully online learning. Using technology in education is a process (Saettler, 1990), involving moving towards virtual learning, networked schools and networked learners (Gordon, 2014), which puts learning demands on teacher educators, pre-service teachers and the teacher education curriculum (Miguel-revilla et al., 2020). For teacher educators to remain competitive in the education sector and produce competent future teachers and, subsequently, competent learners, it is vital that they become digitally fluent.

Studies linking education and technology have largely focused on integrating technology in the curriculum (Voogt & McKenney, 2017; Kirkwood & Price 2014; White, 2013). Other studies have focused on how educators embed digital pedagogies in pre-service teacher education (Kivunja, 2013) and using digital technology to improve learning (McKnight, et al., 2016; Wang et al., 2012). The study by Kivunja (2013), for example, explored how social media can be embedded in higher education to train pre-service teachers to appreciate the TPACK model. The author recommended that higher education providers should ensure that graduates are fully prepared to be effective teachers for the digital generation. Heinonen et al. (2019) found that university teachers regarded themselves as developers of technology-enhanced learning in higher education, as being active developers, adaptive developers, cautious developers and reluctant developers, which has implications for the training of university educators. Koehler and Mishra (2005) explored what teachers need to learn about educational technology and how learning takes place through the learning-by-design approach. The study summarized what teachers learnt, emphasizing learning about technology, learning about design, and learning about learning, and concluded that teachers need to develop pedagogical understanding if they are to integrate technology in their instructional practices in ways that will benefit students.

McKnight et al. (2016) established how educators use technology to improve students' learning, and showed the role of technology in transforming the role of teachers from delivering learning to facilitating learning. The study recommended that, to improve the learning process in the current era, supportive leadership and investment in technology infrastructure at the institutional level, demand-driven continuous professional development and the sharing of resources among educators are paramount. The findings are supported by Levin and Schrum (2013) and Wang et al. (2012). Jeffrey et al. (2011) recommended that more research needs to be done on how educators become digitally fluent, given limited research on this topic, especially in developing countries. Sickel (2019) reached a similar conclusion on the need for further research to inform teacher preparation as regards developing the requisite knowledge and skills for technology-

facilitated teaching and learning, and the role of educators in the process. Given the context, exploring the mechanisms in place at the individual and institutional level for developing teacher educators' digital fluency skills becomes imperative, and this the objective in this study.

Purpose of the study and the context

This study aims to explore how teacher educators develop digital skills given their relevance in the contemporary world. Specifically, the study addresses the following question: how do teacher educators in university schools of education become digitally fluent and develop the related skills? The study also conceptualizes the digital fluency of teacher educators along with reviewing the literature. According to Chigona (2018), the concept is not familiar to many and is not well conceptualized in the literature.

The study is conducted in Tanzania, which abides by the view that "Every child needs a qualified teacher and quality education needs qualified teachers", as advocated by UNESCO (2011). It also recognizes that Information and Communications Technology (ICT) is central to social and economic transformation as reflected in the ICT policy of 2016. While e-learning initiatives in Higher Education Institutions (HEIs) have existed in Europe since the 1970s (Mkonongwa 2012), these initiatives started in 1998 in Tanzania with the introduction of the Blackboard Learning Management System (LMS) at the University of Dar es Salaam, which migrated to Moodle in 2008 (Mtebe & Raphael, 2013). Although the national ICT policy recommends integrating ICT in the education system, in HEIs it has been geared towards standardizing the existing courses to align with the Moodle LMS. Few efforts have been made to prepare faculty, particularly teacher educators, to acquire digital fluency (Mtebe & Raphael, 2013) making the subject of interest to explore in the Tanzanian context.

Digital fluency is becoming a prerequisite for various core businesses, such as education (teaching and learning) and making applications (jobs, funding) as well as meaningfully participating in society, including accessing social, financial and government services (White, 2013). Indeed, being digitally fluent and competent encourages personal and professional growth, brings fulfilment, enhances employability, and facilitates social inclusion and active citizenship (Council of the European Union, 2018).

Study findings highlight that individual and institutional mechanisms are the approaches through which teacher educators develop digital fluency. Of the approaches, on-the-job training and individualized learning matter the most. Educators with a background in science and ICT seem to be more active and adaptive developers, a view also established by Heinonen et al. (2019). This study contributes to the ongoing discussion on making teacher education relevant for the 21st century, both at the institutional and policy level.

LITERATURE REVIEW

Conceptualizing the digital fluency of educators and the related skill set

Fluency portrays wisdom and confidence in the application and use of digital technologies in realizing objectives (Wenmoth, 2016). In the context of education, digital fluency is the ability to strategically integrate technological and educational tools in teaching and learning with the aim of improving students' learning outcomes, and enriching the environment of a classroom by resolving instructional problems, including assessment (Miller & Bartlett, 2012). Mahiri (2011) describes digital tools as any type of software or hardware that can be used for education, ranging from a course including open courseware, to computers, tablets and interactive games. Digital tools can be employed in the classroom by an educator in various forms, from simple tools, such as a power

point presentation, to complex software programs, views supported by Haelermans (2017) and Perini (2015). Digital tools are thus connected to technology, making technology and digital literacy important for educators, if they are to use digital tools to enhance teaching and learning in any environment (UNESCO, 2011).

Several frameworks highlight the digital skill set and competencies that educators need to possess (Ferrari, Punie & Bre ko, 2013; Redecker & Punie, 2017; UNESCO, 2011, to mention a few). According to Teodorescu (2006), competence refers to a range of knowledge, skills and attitudes needed to professionally and efficiently achieve a specific goal. Accordingly, digital competence refers to a person’s ability to confidently and critically use ICT for personal development and learning as well as for active participation in society, including work (European Commission, 2011). While the terms “literacy”, “fluency” and “competency” are used interchangeably to describe one’s ability to navigate the digital environment to find, evaluate and accept or reject information (Belshaw, 2011), Bartlett and Miller (2011) see the terms literacy and fluency as interrelated, with preference given to digital fluency as a complex mixture of skills required to effectively navigate the online environment. Li and Ranieri (2010) consider ‘literacy’ and ‘competence’, to be conceptually equivalent, and emphasize ‘digital competence’ as digital literacy comprises several literacies. Niessen (2013) came to the conclusion that digital fluency as an emerging complex concept goes beyond the basic digital fundamentals (computer skills and information literacy), and that becoming digitally fluent is a lifelong process that involves inquiry, exploration and collaboration, and embraces ethical aspects. Digital fluency therefore reflects an advanced level of skills, embracing literacy, the capabilities and competences necessary for performing an online facilitation and learning task to the required standard (Ferrari, Punie & Bre ko, 2013).

Therefore, besides mastering PCK, a digitally fluent teacher educator also needs to demonstrate digital skills as part of TPACK, which includes the effective use of LMS (UNESCO, 2011; Bibi, & Khan, 2017), awareness of Open Education Resources (OER) (Redecker & Punie, 2017) and digital resources (Netsafe, 2018). Moreover, it is recommended that they should promote academic integrity in terms of copyright and privacy in the digital learning environment (White, 2013; Gordon, 2014). Since the terms literacy, fluency, capabilities and competence are related and/or used interchangeably in the literature (Beetham, 2015; Redecker & Punie, 2017; Uerz, Volman, Kral, 2019; UNESCO, 2011), this study adopts with modification from the literature and existing frameworks, the five dimensions of digital competence developed by Redecker & Punie (2017) to produce a digital skill set for teacher educators, as summarized in Table 1. The dimensions and the related skill set and competencies for teacher educators comprise: 1) Digital fundamentals – Teacher educators’ awareness of basic computer operations, Internet fundamentals and the related skills; 2) Learning design and development – Teacher educators’ ability to design and facilitate learning using appropriate pedagogies in all modes of provision, that is, face-to-face, blended and fully online using LMS; 3) Open Education Resources (OER) – Teacher educators’ awareness of OER, their usage and creation, using creative commons licensing; 4) Continuous Professional Development (CPD) – Teacher educators’ participation and engagement in continuous professional development through available institutional programmes and open courseware, including the roles and practices of educators; and 5) Academic integrity – Teacher educators’ awareness of ethical behaviour, intellectual property rights and data privacy and how to practice these along with their teaching and facilitation roles.

Table 1: *Digital Fluency dimensions and the related competencies*

Digital Fluency dimensions	Digital skill set and competencies
Digital Fundamentals Beetham (2015); Ferrari, Punie, & Bre ko, 2013; Gordon, (2014); Nihuka, Mbvette, &	Technological skills (basic computer concepts and operations), data literacy, digital tools, ICT productivity, proficiency and literacy, ICT and

Kihwelo, (2014); Samzug & Mwinyimbegu, (2013); Uerz, Volman and Kral (2019); Redecker & Punie, (2017); UNESCO (2011)	media literacy; virtual and mobile learning environments, Internet fundamentals and applications; digital learning resources including Multimedia elements
Continuous professional development (CPD) Uerz, Volman and Kral (2019); Redecker & Punie, (2017); Beetham (2015); Ferrari, Punie, & Bre ko, (2013); Nihuka, Mbvette, & Kihwelo, (2014); US Department of Education, (2016); UNESCO (2011)	Learning skills, cognitive ability, digital information, harnessing digital opportunities, personalized learning, professional learning, digital learning, digital scholarship, digital research, problem solving, active use of technology and practical engagement in designing, learning and using technology
Open Education Resources (OER) Redecker & Punie, (2017); McKnight et al., (2016); Beetham (2015); Ferrari, Punie & Bre ko (2013); Levin and Schrum, (2013); UNESCO (2011)	Digital innovation, creative expressions, digital content creation, creative common licensing; open courseware Massive open online courses, creation of OERs
Learning design and facilitation Uerz, Volman and Kral (2019); Redecker & Punie, (2017); Beetham (2015); Ferrari, Punie & Bre ko (2013); Kivunja, 2013; White (2013); UNESCO, (2011)	Models, frameworks and the process of designing learning; digital learning development; modes of provision and facilitation, educational settings, digital identity, institutional digital reputation, digital participation, cross-cultural awareness, digital teaching and collaboration, digital communication, technology-enabled learning
Academic integrity Uerz, Volman and Kral (2019); Füzér, (2016); Ahmed, & Ullah, (2015); Beetham (2015); Cruz et al., (2015); Ferrari, Punie & Bre ko, (2013); Nihuka, Mbvette, & Kihwelo, (2014); Langa, 2013; UNESCO, (2011)	Educators' beliefs and values, digital identity protection, data privacy and protection, personal protection, Licensing, Intellectual property rights, digital wellbeing, digital safety, plagiarism, copyright rules, ethical dimensions

Theoretical Framework

Knowledge can be acquired through formal, non-formal (more contextualized and learner centred) and informal education (personal experience, practical engagements and various kinds of exposure). Teacher-educators therefore can acquire digital skills to apply to educational practice through technology being integrated in the pre-service teacher education curriculum (Koehler & Mishra, 2008), stand-alone courses on technology (Mouza, 2016), academic programmes (Heinonen et al., 2019), self-directed learning (Gordon, 2014), individual experience and practical engagements, applying technology in teaching and facilitation roles (McKnight et al., 2016; Kivunja, 2013), professional development courses (White, 2013) and watching how others apply it (Dorgu, 2015).

According to White (2013), self-directed learning is not sufficient to master the digital educational technologies and the related complexities. There also exist a few professional development courses for existing educators on becoming digitally fluent (Mkonongwa, 2012). If these initiatives

exist, some of them might be at the inception stage in developing countries like Tanzania, as commented by Trust (2017) and Tusiime, Johannesen & Gudmundsdotti (2019) in Uganda. The skills could also be lacking and/or not developed during their pre-service teacher education training (Mueller, Wood, Willoughby, Ross, & Specht, 2008).

The study also uses the van Dijk (2017) theory of resources and appropriation to explain the development of digital fluency among teacher educators. According to the theory, inequalities emanating from job position, education, household and nation; the unequal distribution of resources; unequal access to digital technologies; and unequal participation; influence the development of digital skills among teacher educators. Regarding access to technology, van Dijk (2005) further argues that the motivation to use digital technology, the possession of facilities, particularly computers, Internet connectivity, the possession of digital skills and the frequency of usage affect the development of digital fluency among individuals. Other factors necessary for developing the digital fluency of teacher educators include their attitude to technology and willingness to learn (Johnson, Becker, Estrada & Freeman, 2015; Heinonen et al., 2019). All these factors are a useful guide to explain the variations among teacher educators in developing digital fluency.

RESEARCH METHODS

Research Design

The study has adopted a qualitative case study design, which provides for an in-depth description of a particular case or multiple cases (Creswell, 2007) to give a deep understanding of the aspect under investigation (Denzin & Lincoln, 2005). A case study also enables the researcher to collect detailed data from a small sample, which is less applicable with other research designs (Yin, 2014). The newness and limited awareness of stakeholders of the concept of digital fluency in the literature and in the Tanzanian context made the qualitative approach more relevant for the study (Raphael & Mtebe, 2016).

Study Population and Sampling

The target population for the study were universities that offer education programmes. In Tanzania, there exist 26 schools of education (TCU, 2016). The researcher sampled 4 institutions - 3 public universities and 1 private university. The institutions were selected based on their national coverage and experience in providing offline and online programmes. In total, ninety participants purposively selected from the fields of science, education and the humanities were involved in this study, with each institution providing twenty two teacher educators. Of the total participants, sixty five percent were males, thirty percent were from the university management (Directors, Deans and Heads of Departments), eighty five percent were PhD holders and sixty two percent were online facilitators.

Data Collection Tools

One-on-one interviews were conducted with the study participants to address the research question. The interview guide related to the study's theoretical framework, in which both formal (institutional) and informal (individual initiatives) guided the formulation of the interview questions. To establish the validity of the data, documentary review and observing aspects demonstrating the level of digital fluency in any of the dimensions were used. To triangulate the findings, educational technologists, who also offer training to educators on digital fluency, were involved in the interviews. Data collection and analysis methods and processes were also reviewed by a specialist with expertise in integrating technology to ensure the study's credibility, which is supported by Chigona (2018).

Data Analysis and Ethical Permission

The qualitative data collected were recorded verbatim, transcribed, coded and analysed with the aid of MAXQDA 2018 software for analysing qualitative data. Thematic coding dominated the analysis, whereby participants' mechanisms for developing digital fluency were categorized as either individual or institutional, with each having sub-themes. As regards ethical permission, research clearance was provided by the researcher's university research committee. Participants' consent was also sought prior to data collection, including the permission to record the interviews. Likewise, the data were used in line with the purpose of the study (Cohen, Manion & Marrison, 2011).

FINDINGS

The study aimed to establish how teacher educators in Tanzania's schools of education develop digital fluency as a key competence in the contemporary world. The findings are organized in accordance with two mechanisms, individual mechanisms, also referred to as informal mechanisms, and institutional mechanisms, referred to as formal mechanisms. Each is discussed below.

Individual mechanisms

As regards the acquisition of digital skills, educators acquire them through personal initiative, whereby they engage in individualized learning through online programmes, on-the-job training through institutional programmes and studying specialized books on technology. Others develop digital fluency through practical engagements, particularly research and consultancy, common for educators with a specialization in ICT. As one participant commented:

"In my department, for example, we have so far conducted four pieces of research in the area of digital fluency..., which we developed in collaboration with OER Africa..., a MOOC on digital fluency. We have also been involved in developing several LMS for various government training institutions..., we have also facilitated the development of a Teachers' College LMS in collaboration with XYZ openly available for use by teacher education institutions at the diploma level..." (University Management)

Other educators have participated in conference proceedings that enhanced their digital fluency. As one educator commented:

"I participated in a Distance Education and Teachers' Training in Africa (DETA) conference where I gave a presentation..., I also developed Teacher Education in Sub-Saharan Africa (TESSA) (www.tessafrica.net/) content for teachers, which exposed me to OERs and creative common licensing..." (Educator and Online Facilitator).

Table 2 provides a summary in percentages reflecting the frequency of the mechanisms. As shown in the table, individualized learning has a higher percentage for developing digital fluency under the individual mechanisms.

Table 2: Individual mechanisms for developing digital fluency

Mechanism	Percentage
Individual learning	60
Study discipline and individual occupation	28
Research, consultancy and other practical engagements including development of OER	12

Source: Study findings

Institutional mechanisms

In addition to the individual mechanisms, it was important to establish what institutional mechanisms were in place aimed at developing the digital fluency of educators in schools of education. Table 3 below presents the summary, and illustrations that support the findings follow.

Table 3: Institutional mechanisms for developing digital fluency among educators

Mechanisms	Percentage
Management commitment to developing digital fluency, including provision of facilities	33
Regular on-the-job training	31
Institutional policy	18
Recognizing digital fluency efforts	15
Instituting monitoring and evaluation mechanisms	4

Source: Study findings

In regard to the commitment of the management to developing digital fluency, it is reflected in the provision of on-the-job training, technical and administrative support, the provision of infrastructure such as facilities and Internet bandwidth, as well as close monitoring and evaluation of the institutional mechanisms through the existing IT and the library team, as illustrated by the following:

“It is important for institutions to put efforts into enhancing digital fluency through training..., which should be supported by the provision of facilities..., hardware, software and technicians with teaching competencies....,” (Lecturer and Online Facilitator).

However, there are challenges regarding the provision of the technology infrastructure, as one participant commented below.

“A lot needs to be done..., educators are eager to implement and practise the digital aspects..., the institution is limited given the bandwidth capacity which is at the household level., to go digital, we would need to shift resources from other sources and invest them in digital development....” (ICT Lecturer and Online Facilitator)

Accordingly:

“Developing human resources needs time and resources, it cannot be a one-time event, but a continuous process, systematically planned and executed over time. In this regard, time should be set aside for a small group of committed staff to focus on designing materials. These will be the ones to train others...” (Lecturer and Online Facilitator)

Another aspect under the institutional mechanisms include regular on-the-job training as part of continuous professional development for teacher educators. In this regard, most teacher education institutions that provide blended or fully online learning modes offer some form of training to its academic staff. Indeed, facilitators attribute their level of digital fluency to the training conducted at the institutional level, which are mostly short courses. One participant illustrated as follows:

"In my university, Moodle is used as the medium of course delivery..., this is communicated during recruitment,... we attend an Online course on Digital fluency, and online facilitation courses, and a certificate is awarded as we engage in these courses...."(Lecturer and Online Facilitator)

Another facilitator commented:

"On digital fluency and the fundamentals, I am competent..., with 40%-60% of the competencies acquired through induction courses offered by the University through the ICT unit..." (University Management).

The participants were also of the view that this training should go hand-in-hand with practical engagements, where educators put into practice what they have learnt, as one participant commented:

"I see increased competence in digital fluency through training courses..., but it should go hand-in-hand with frequent interaction with educational technologies...." (Lecturer)

Additionally:

"This training needs to be supplemented by individual initiatives..., educators lacking individual effort are lagging behind..., the ones lacking individual effort and the ones newly recruited form the majority of the population..." (Lecturer and Online Facilitator)

The schools of education should also exercise some order to ensure that educators are committed to developing digital fluency and providing a platform to facilitate the practical part, as further illustrated below:

"To develop digital fluency, a training programme is not sufficient, but the digital application to teaching is what matters the most..." (University Management and Lecturer).

Accordingly, and to deepen the learning:

"Comprehensive and proper training should be given to the academic staff..., given as application exams..., it is university requirements..., lecturers should study and do exams...." (Online Facilitator). "We also need to have live cases of educators who can lead and facilitate the digital fluency courses..., who have managed to develop their own courses... " (Online Facilitator).

Some participants perceived that the institution does not encourage them to become digitally fluent besides offering training in the LMS and the development of OER, as one participant commented:

"I happened to participate in a Re-tooling project, where we developed open education resources which are freely available for use by secondary school teachers..., I am not using the materials since the institution does not encourage me to do so... but I can now start using them.... " (University Management and online facilitator).

However, other participants put into practice what they had learnt, as another facilitator commented:

"I benefited from the Re-tooling project, we developed science materials, I learnt how to search for relevant videos to enrich my teaching.... I have been practising for about four years now..." (University Management and Online Facilitator)

Likewise, aspects like the negative attitude of educators to technology, reflected in the study participants, can be changed as one participant commented:

"I see attitude as a culture which is learned, thus it can be unlearned...." (University Management and Online Facilitator).

Indeed:

"One also needs to see the importance and value of becoming digitally fluent prior to changing one's attitude..." (Online Facilitator)

Additionally, while some members of management felt that being offered training in digital fluency was insufficient, others were of the view that other technological developments have aided the application of technology in education. On the insufficient number of training courses, one participant commented:

"We are trying to develop digital fluency..., but we are not there yet..." (University Management and Online Facilitator).

On the aspect of technological development, one participant commented:

"We used to organize college-to-college training in Moodle..., we now offer one-to-one facilitation..., Moodle as a learning management system is no longer difficult..., the population is exposed to several digital devices that enable the transferability of skills for using education digital tools and systems..., other tools like mobile devices, mobile apps, online systems for purchasing materials, making bookings, submitting applications..., mobile banking and software of various kinds have assisted individuals in using learning management systems such as Moodle..., since the same skills can be used...." (University Management and ICT lecturer)

With regard to the policies advocating the need to develop the digital fluency of educators, all the study institutions possess an ICT policy. One of the college staff interviewed encouraged the acquisition of sustainable technologies, such as open source, and intends to create organizational (trainer capacity, training management) and technical support and resources to cater for the broad interests of all users through appropriate funding, upgrading and management. The license for open source software (OSS) gives users the freedom to run a program for any purpose, to study and modify the program, and to redistribute copies of either the original or modified program (without having to pay royalties to previous developers).

Another institution has an OER policy now that all of its programmes are offered online. The policy gives guidelines on the provision of online courses, with the management forming part of monitoring the delivery process. As one participant commented:

"We have more than 1000 courses facilitated through the Moodle learning management system..., the courses need to be engaging..., interactive..., we have set a guiding format....,

with introduction, objectives, body, summary and references..., almost 70% of the course meets the set structure..., there are some sanctions if educators fail to abide” (Educational Technologist and a Trainer).

On the recognition aspect one participant noted:

“As an institution, we are forcing educators to develop digital fluency..., when we started, we recognized the efforts made by educators to develop online courses through monetary incentives... however this does not happen now...” (University Management and Online Facilitator).

Regarding monitoring and evaluation:

“The top management demands a list of the courses, the status of uploading the content and the staff responsible for monitoring progress..., the IT team have set criteria and evaluate the courses continuously to check whether educators are uploading the content according to the criteria..., in addition, the top management have access to the courses...” (Lecturer and Online Facilitator)... they can sign in and observe the facilitation trend....” (Assistant Lecturer and Online Facilitator)

Overall, there exist various mechanisms for developing the digital fluency of educators, ranging from on-the-job training, with the training content largely focusing on the Moodle LMS, to institutional support for implementing the existing ICT policies. There also exist various individual initiatives, including various kinds of exposure, which enable the development of various dimensions of digital fluency.

Likewise, while institutional efforts matter in developing digital fluency, the participants were of the view that individual mechanisms matter the most, as illustrated below:

“I find that the institutional mechanisms comprise 10% with the remaining 90% left to the individual to develop digital fluency...” (University Management and Non-Online Educator).

DISCUSSION

The study findings show that both individual and institutional mechanisms matter in enhancing digital fluency, with the study participants using informal mechanisms more to develop their digital fluency. This finding is supported by van Dijk (2005), who associated individual learning with practice and observing and interacting with more digitally fluent faculty or experts, who give feedback, a view shared by Koehler Mishra, & Yahya (2007). Regarding the formal institutional mechanisms, management commitment in terms of resources and provision of on-the-job training were found to be the mechanisms most used to develop the digital fluency of teacher educators. With regard to institutional commitment, the study findings relate to those by Shapley, Sheehan, Maloney, & Caranikas-Walker (2010) and Levin & Schrum (2013) that state that institutional commitment is key to the development of technology. Indeed, researchers show that for technology to make a difference in learning, specific factors, such as leadership support, frequency of using technology and instructional models, must be in place (Shapley et al., 2010; Greaves et al., 2010; Levin & Schrum, 2013). Likewise, as commented by McKnight et al. (2016), teachers' professional development matters for educators as it enables them to learn about specific technology, and appreciate its role in education, including integrating it in learning. Sickel (2019) adds that any professional development programmes in the area of technology that target pre-service or in-service educators should be designed in such a way that they are deliberately aligned with specific

learning outcomes, including getting the participants to identify any constraints in the technology. Indeed, “teacher preparation and professional development should focus on helping educators unpack the characteristics of technology and align it with learning theory and pedagogy along with the content” (Sickel, *ibid*, p. 11). Levin and Schrum (2013) add that engaging institutions’ experienced educators in providing other staff with professional development has a profound impact on the acquisition of technological skills and acquiring digital fluency, a view that was also established in this study.

The study findings further show that, beside the individual and institutional mechanisms, it is important to continuously blend training and practice to enable the development of higher levels of digital fluency among educators, which is also highlighted in the literature (Tusiime, Johannesen & Gudmundsdotti, 2019; Benali, Kaddouri & Azzimani, 2018). In regard to the training content, most training in the schools of education focus on the application of the Moodle LMS and digital fundamentals, with less emphasis placed on other digital fluency dimensions. One institution, however, designed an online course with five modules on digital fluency, reflecting some of the study dimensions, namely, Digital Fundamentals (Module 1), Working with OER (Module 2), Learning Design and Development for Online/Blended Provision (Module 3), Academic Integrity in a Digital Age (Module 4) and Storage of and Access to Digital Resources (Module 5). The digital fluency course modules with the content for each module are therefore accessible to all educators, a view also discussed by Nihuka, Mbwette, & Kihwelo, (2014).

The study further established that there is reluctance among educators to embrace new technologies, attributed to the difficulty of changing their attitude and them not being committed to dedicating quality time to harness the available opportunities, such as the training courses available and use of OER. This is supported by Nihuka, Mbwette, & Kihwelo, (2014) and Heinonen, Jaaskela & Isomaki, (2019). Johnson et al. (2015) argued that student teachers might not see the importance of being digitally fluent and the relevance to their work unless teacher educators change their attitude and become more committed. Indeed, educators’ beliefs, practices and willingness to learn are relevant if teacher educators are to become digitally fluent. Support for this view can be seen in the study findings of Prestridge (2012), Mama & Hennessy (2013) and Heinonen et al., (2019).

CONCLUSION AND RECOMMENDATIONS

The study aimed to explore the individual and institutional mechanisms in place to develop the digital fluency of teacher educators in university schools of education. Based on the study findings, the following recommendations are made and practical implications are noted as follows:

-) Dedicated time is needed to develop the capacity of digitally fluent educators in line with technological changes. University teams at the library and ICT departments should be at the forefront in harnessing new developments and offering training in line with the new developments.
-) The management needs to make educators aware of the importance of digital fluency, recognize the initiatives taken at the personal level and encourage others to do the same. Orientation programmes for newly recruited staff on digital fluency could also be used to improve the digital fluency of teacher educators.
-) Investment is needed by the government in infrastructure, facilities and human resources, especially instructional designers, content developers and educational technologists, who would blend the subject matter of the educator with technology, thus enabling the provision of quality digital resources in line with the curriculum goals. Institutions also need to support tutorial assistants in studying educational technology to enable them to groom and practise these skills from the first year at the university and throughout their career. Time

- should also be set aside to review the existing course materials, including the curriculum, especially the ICT and/or computer literacy courses meant for pre-service teachers, to incorporate aspects of digital fluency.
-) Given the role of educational technologists, instructional designers and content developers of working closely with educators in line with developing digital fluency, these personnel would need to be reflected in the government scheme of service, as at the moment they do not exist.

The findings of this study also has social implications, particularly concerning digital exclusion brought about by social differences and the existence of marginalized groups. These aspects negatively affect development of the digital fluency of teacher educators, as has been established in this study. As supported by the literature, while the provision of technology and infrastructure can develop the digital fluency of socially excluded groups, including educators (Popova & Fabre, 2017), their technophobia hinders them from acquiring digital skills (Krish et al., 2017). Therefore, educators should be given practical training to change their mindset that will enable them to see the relevance of linking technology with their academic roles of teaching, researching and consultancy. On digital inclusion, (Krish et al., 2017) argued for an inclusive digital economy that addresses the reasons for the digital divide, such as the low level of digital fluency, barriers to information and lack of access to infrastructure. This would require obtaining infrastructure that is affordable (Sossa, Rivilla, & González, 2015), identifying the skills needed and building the capacity of users, considering the aspect of gender, to enable them to see the relevance of technology to their core activities (Krish et al., 2017). Education stakeholders at the national and international level need to be involved in promoting digital inclusion, reforming policy and addressing the social and cultural norms of the wider community, especially the marginalized.

LIMITATIONS AND FURTHER RESEARCH

This study established mechanisms for developing the digital fluency of teacher educators in university schools of education in Tanzania. With the diverse mechanisms, further research could assess the level of digital fluency of teacher educators and the related skills gap, taking into consideration the specialization studied. The study findings provide relevant details on developing the digital fluency of educators in the Tanzanian context and in other areas with a similar context.

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