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Classroom ICT integration in Tanzania: Opportunities and challenges from the perspectives of TPACK and SAMR models

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ABSTRACT

With the education systems demand of contemporary technologies, teacher trainees should be imparted with competencies and skills to integrate information and communication technology (ICT) into their future teaching and learning practices. This study assessed classroom ICTs integration opportunities and the challenges in relation to Technological Pedagogical and Content Knowledge (TPACK) and SAMR (Substitute, Augmentation, Modification, and Redefinition) models. The case study involved tutors and teacher trainees (N=206) from teacher training colleges. Results indicated that, majority of respondents have low pedagogical ICT competencies. However, tutors exhibited good knowledge level in all TPACK and SAMR constructs that we assessed, teacher trainees' revealed poor skills and inefficient support on the use of basic ICTs (hardware, software, and associated peripherals). The impacts of TPACK and SAMR models characteristics related to the technology use planning and redesign of learning tasks was evident. Most of the challenges identified were associated to the lack of infrastructures, readiness to change and lack of competencies on pedagogical ICTs applications. Among others, we recommend the government to work on a harmonized ICT in education integration framework; that consider the existing opportunities and challenges facing Tanzania teacher training systems. Further work should focus on carrying out an experimental research design to unlock the existing ICT use realities.

Keywords: *Classroom ICT; ICT Pedagogy; Tanzania; Teacher education; Teacher trainees; TPACK; SAMR*

INTRODUCTION

The knowledge and competences of teachers' ICT pedagogical application are key attributes for the future of secondary education success. The goal for use of any new technology in classrooms should always be to support enhancement of effective education as the highest priority (Brás, Miranda, & Marôco, 2014; Loveless & Ellis, 2003, p. 43). A shift in teacher roles from an ICT user to a facilitator retains the need for teachers to serve as leaders in technology enhanced classroom (lesson planning, preparation and follow-up) (Cubukcuoglu, 2013; Kreijns, Van Acker, Vermeulen, & van Buuren, 2013). Integrating ICT into the teaching and learning process should be seen as beyond the technology use only; it is what new technologies could do to promote

learners understanding (Ertmer & Ottenbreit-Leftwich, 2010; Spector, Elen, Merrill, & Bishop, 2014). Using new tools, starts from finding a best fit, followed by experimentation and then practices (Somekh, 2008). Teaching with technology demands deep knowledge of processing subject matter contents and enhance learning (Mishra & Koehler, 2007; Turunen & Tuovila, 2012). Teachers' ICT use competences is a collection of knowledge, skills, understandings and attitudes that are inseparably guaranteed with context of use and pedagogy (Doyle & Reading, 2012). The UNESCO ICT competency framework for teachers (UNESCO, 2011, p. 17) reported basic characteristics of professional teachers as: (1) ability to learn using ICT, (2) ability to solve complex real world problems using ICTs and (3) ability to create new knowledge using ICTs.

However, the TPACK and SAMR models have significant differences; they are mostly used to guide the planning, assessing, evaluating and use of technology in education (Jude, Kajura, & Birevu, 2014; Pamuk, 2012). The TPACK encompasses the connections between Technological Knowledge (TK), Pedagogical Knowledge (PK) and Content Knowledge (CK) (Harris & Hofer, 2011; Voogt, Fisser, Pareja Roblin, Tondeur, & van Braak, 2013), that contribute to teacher awareness and competences needed for effective classroom technology integration (Brantley-Dias & Ertmer, 2013). The TPACK is a tool for examining the pedagogically sound ways in which technology can support teachers' and students' knowledge while keeping pace on the technology, content and pedagogy contexts (Brantley-Dias & Ertmer, 2013; Khan, 2014). The SAMR model is a tool for assessing and evaluating technology practices and impacts in a classroom setting by looking into students, teachers and the changes (Lund, 2015; Myers, 2014; Puentedura, 2012). The impacts of SAMR could be revealed by teachers' abilities to redefine old or traditional tasks using new technological tools (Hos-McGrane, 2014). Teachers can determine their technology level as they experience small shifts in the design of technology based learning artifacts and application of technology driven learning to achieve the next level (Ahrens & Zaščerinska, 2014). In order to produce TPACK and SAMR-ready teacher trainees, teacher training institutions must integrate relevant tools within the teacher training curriculum that considers a continuing change as a process (Thomas, Herring, Redmond, & Smaldino, 2013).

Information and communication technology is a fundamental tool that is widely integrated in the teaching and learning process at all levels. The ability of teachers to practice pedagogical ICTs is highly influenced by the knowledge, competences, and skills they received during college years (Thomas et al., 2013). In Tanzania, however existing policies support the use of ICT in education(United Republic of Tanzania, 2007, 2010); there is a low intake of the pedagogical ICTs among tutors in teacher training colleges (Andersson, Nfuka, Sumra, Uimonen, & Pain, 2014, p. 9). The current syllabi focus more on teaching ICT as a subject and less on using ICT as a pedagogical tool. In addition, technology uses in secondary education suffer from lack of proper documentation proven practical. When majority of education systems around the world are shifting from teacher-student-textbook model to the blended learning model empowered by digital educational resources, it is a big challenge for a developing country to succeed without axis rigor planning. However, the TPACK and SAMR models have influenced ICT use in education; they have faced both critics and compliments. There is no framework globally accepted and applicable to all the education systems. This stand as a challenge to the future planning of the what, and how to enhance and transfer practical technology use skills among young teacher trainees. While TPACK has been the only framework referenced in the ICT use in Tanzania education, it is unclear if training received by tutors could enhance sufficient TPACK characteristics on teacher trainees (Andersson et al., 2014; Hare, 2007; Hooker, Mwiyeria, & Verma, 2011, p. 45). Examining the impacts of TPACK and SAMR models on the current technology use practices, will build a foundation for future classroom ICT Integration in Tanzania secondary education. This study stands as a road map for teachers' classroom technology use, practices, and a planning tool for technology use in secondary education.

BACKGROUND OF THE STUDY

Teachers' Use of Technology in Tanzania Education

The Tanzania Ministry of Education and Vocational Training (MoEVT) report addressed teachers' training priority areas as: (1) pedagogical skills for creativity and innovation and (2) knowledge and mastery of selected subjects, skills, and technologies (MoEVT, 2009). Technology application knowledge acquired during college could positively affect the future of technological pedagogical practices (Komba & Nkumbi, 2008; Margerum-Leys & Marx, 2002). Teachers' decision to use technology in classroom is mainly influenced by access to resources, quality of software and hardware, ease of use, incentives to change, commitment to professional learning and background in formal computer training (Mumtaz, 2000; Rastogi & Malhotra, 2013). However, recent ICT initiatives have improved access to infrastructures and digital contents and trained users; ICTs usage among tutors was reported as still low (Andersson et al., 2014, p. 15; Kessy, Kaemba, & Gachoka, 2006). The Tanzania policy for basic education addressed priority areas for ICT use improvement as such as : (1) provision of ICT training to students, teachers and administrators, (2) use of ICT resources in schools and colleges, and (3) development and use of ICT as a pedagogical tool in teacher trainees (United Republic of Tanzania, 2007).

The TPACK Framework

The TPACK framework is a generative framework that guides course design and evaluation for pre-service and in-service teachers' intention to integrate ICT into classrooms (Chai, Koh, Tsai, & Tan, 2011). The framework arose in the context of teacher education (Oliver, 2011), with the complex interplay of three primary forms of knowledge – Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK) − that goes beyond seeing these three knowledge bases in isolation (Koehler & Mishra, 2009). The reviewed studies (Chai, Koh, & Tsai, 2011; Koh, Chai, & Tsai, 2010) reported TPACK as a multiplicative framework that continue to guide course design and evaluation for teachers' preparation to integrate ICT into classrooms. A study by (Chai, Koh, & Tsai, 2011) reported that TK, PK and CK have positive influences on TPACK while TK and PK have positive influences on TPK leading to TPK positively influencing TPACK (see Figure 1).

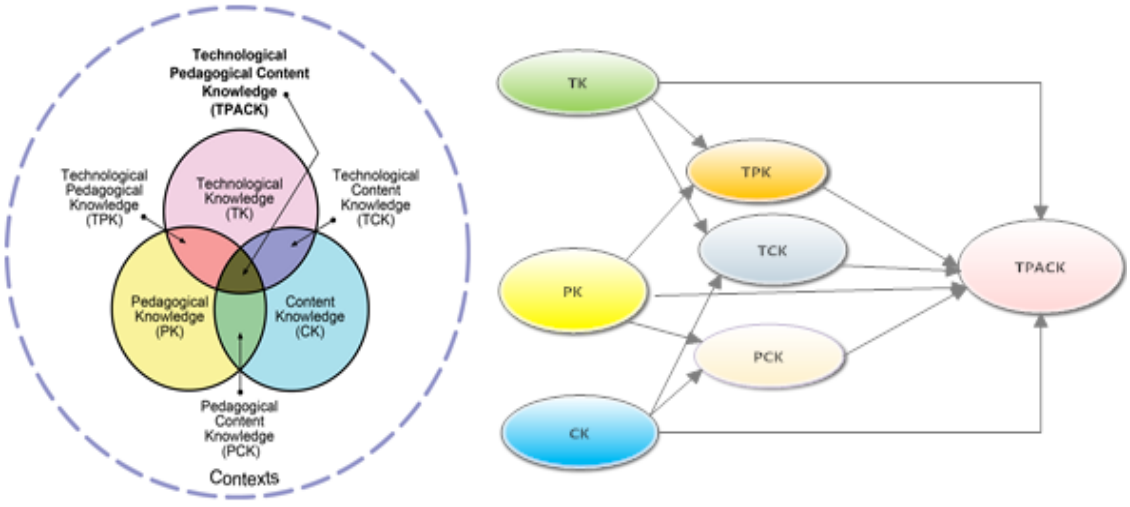

Figure 1 : *TPACK components and the extract of Structural model of interrelationships among TPACK constructs adopted from* Chai, Koh, Tsai, et al.(2011) and Koehler & Mishra (2009)

The Pedagogical Content Knowledge (PCK) defines teacher's ability to pedagogically adapt content to students of diverse abilities rather than just delivering subject content knowledge (Abbitt, 2011). Content Knowledge (CK) refers to the body of information that teachers teach to students in a given subject area such as facts, concepts, theories, and principles (Ball, Thames, & Phelps, 2008; Kleickmann et al., 2013). A Content Knowledge (CK) strategic thinking incorporates knowing when, where, and how to use domain-specific knowledge and strategies for guiding students' learning with appropriate digital, information and communication technologies (Ronau, Rakes, & Niess, 2012, p. 5). The TPACK constructs − TK, PK, CK, TPK, TCK and PCK − are the basic inputs used to explore pre- and in-service teachers' technology use and can be used to adjust training to improve areas that face limitations. Three subsets of the TPACK constructs are shown in Figure 2.

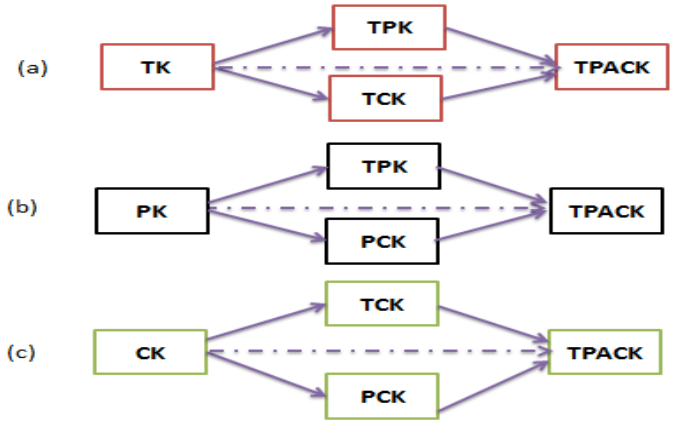

Figure 2: *The TPACK subsets mapping*

Figure 2 presented how TK, PK, and CK constructs contributed to the formation of TPACK. In each set, if one member can cause a failure to realize the TPACK, resolution can be made by adjusting changes to a relevant member from within the same set. For example, in teacher training education course content can be adjusted to meet the inadequacies in TPACK as a whole, caused by areas that are more problematic within the set members. For instance, teacher trainees may have adequate Content and Pedagogical Knowledge, but cannot prepare a Power Point presentation, although they can use flip charts. In this case, adjustment should be made in the curriculum to make them practice the use and preparation of Power Point presentations. The TPACK alone cannot advocate for the kinds of pedagogical approaches needed to maximize learning using relevant technology tools; more aspects and frameworks are required beyond what TPACK can provide (Brantley-Dias & Ertmer, 2013).

The SAMR Model

Understanding the ultimate goal of technology integration means redefining how teaching and learning should be carried out using new technologies to do things that could have never accomplished without technology. The most critical benefits the SAMR model have on the ducation system are presenting a guide when moving from substitution to redefinition of learning tasks and to switch from enhancement to transformation while exploring the massive opportunities technology have on teaching and learning (Puentedura, 2012) (Figure 3 below). The SAMR model guides learners to think differently when working in a technology enabled

environment. The model offers a method of seeing how computer technology might impact teaching and learning by outlining a progression that educators follow in their journey towards redefining teaching and learning with technology (Tucker, 2013).

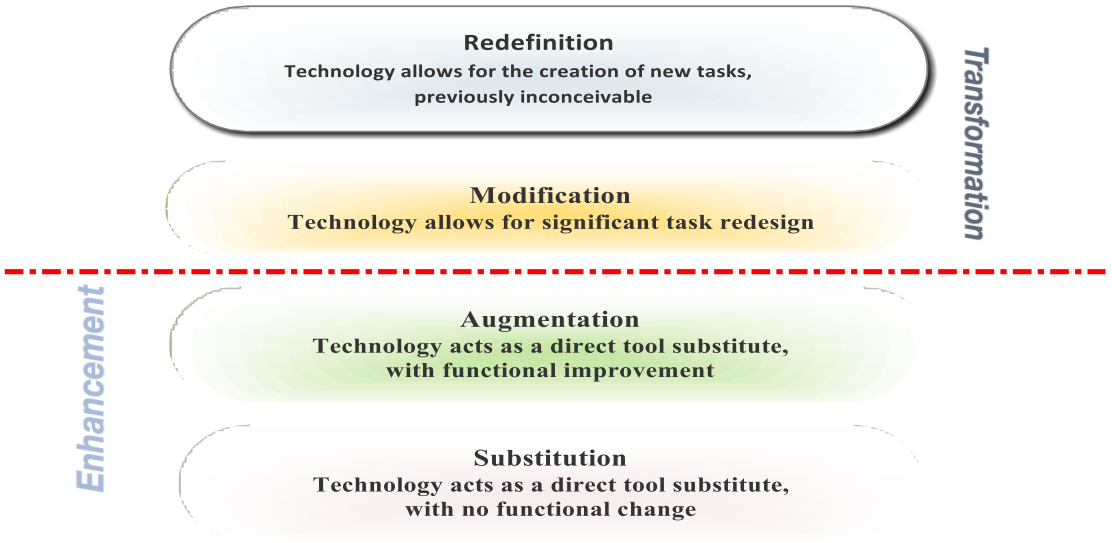

Figure 3: *The SAMR model* (Puentedura, 2010)

The classroom applications of SAMR model are as follows. (1) Substitution is used as a novel read in online version like e-book; for example, replacing traditional practices with the use of technology, like instead of coming with a poster into a classroom, could display information using PowerPoint and a projector. (2) Augmentation focuses on dictionaries, study guides, history sites linked to online text. (3) Modification focuses on textual, visual, and audio tools for construction of shared knowledge.(4) Redefinition focuses on visualization of narrative and structural aspects of text (Jude et al., 2014; Lund, 2015; Myers, 2014; Puentedura, 2010, 2012). Within the SAMR model constructs, Substitution and Augmentation, represent technology usage that enhance effectiveness on existing non-digital resources whereas the Modification and Redefinition constructs describe when a technology or application leads to transformation (Hudson, 2014).

TPACK AND SAMR Models Relationships and their Impacts

The TPACK and SAMR models both focus on technology integration in classroom. Three major characteristics differentiate ICT frameworks: (1) promoting technology use based on learning enhancement capabilities, (2) technology use technical knowhow, for instance general knowledge of how to use hardware and software and, (3) infrastructure and institutional capacity building for instance availability of computers, software and Internet access devices (Tondeur, Van Braak, & Valcke, 2007). The TPACK framework looks at the Technology, Pedagogy and Content, and argues that teachers need knowledge of all the three components (Abell, 2008; Moroder, 2013). The TPACK presents a graphical framework for teachers to comprehend the effective integration of technology in classroom practices (Koh, Chai, & Tay, 2014). The SAMR model stands on the theory that classroom technology integration is fabricated on the transformation or enhancement of traditional pedagogies to the use of new efficient technologies, either through the substitution, augmentation, modification or redefinition of educational tasks (Moroder, 2013). The SAMR model is used to describe different levels of technology integration. The lowest aspect of integrating technology, Substitution, is replacing a computer or device for another technological

tool without significant change to the tool's function (Cavanaugh et al., 2013; Jude, Kajura, & Birevu, 2014). It is the replacement of the older technology with the new technology. Augmentation occurs when the use of technology like a computer replaces another technological tool and there is a significant change in the tool's function. Modification occurs when the use of a computer results in a redesign of parts of the task. Redefinition occurs when using the computer creates new tasks that would have not been possible without computers.

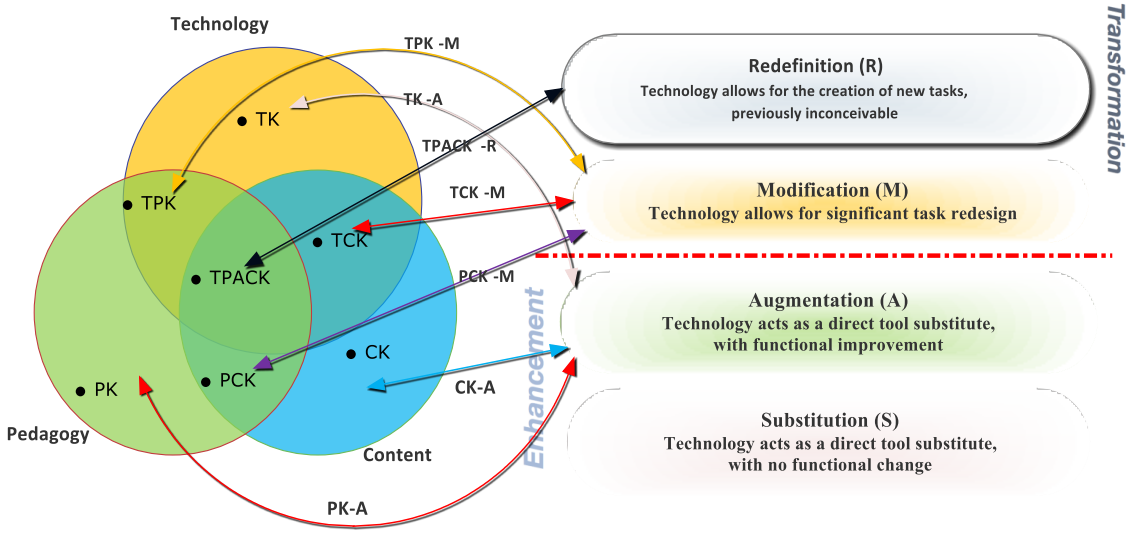

Figure 4: *TPACK and SAMR models Correlation*

The SAMR model stand on the theory that classroom technology integration are fabricated on the transformation or enhancement of traditional pedagogies to the use of new efficient technologies, either through the substitution, augmentation, modification or redefinition of educational tasks (Hockly, 2012) . The use of TPACK alone in education might be insufficient and with too small constructs that demand for additional clarification and conversation to adequately guide future educational technology use (Brantley-Dias & Ertmer, 2013). The TPACK framework address technology as part of the contextualized sets of constructs such as TK, TPK and TCK while the SAMR models does not deal with contents and pedagogy alone but deals with how technology can sustain the two.

Descriptions of TPACK and SAMR construct matches (Figure 4 above)

- *TPK-M*: The TPK and Modification supports TK, TPK and TCK. With modification, traditional classroom tasks can be accomplished using computer technology. For example, writing a report and share it with friends using emails address can be done using google doc to share and work on document collaboratively.
- *TK-A:* The TK and Augmentation are related to TK, TPK, and TCK. Augmentation acknowlegdes new technologies that extends the old ways of practices. For example, a regular power point presentation could be embedding with a sound and moving image clip just to clarify a point and enhance more knowledge.
- *TCK-M:* The TCK and modification are related to CK, TCK, and PCK. With modification, common classroom tasks are being accomplished using computer technology. The modification may assess limitations brought by lack of TCK and suggest for

transformation. For example, if teachers could mark students' essays using a pen and pencil, they can start receiving a softcopy and marking by making comments, using Microsoft word's tools.

- *PCK-M:* The PCK and modification supports CK, TCK, and PCK. If teachers cannot use content learning management systems to upload and download materials, the system could be installed and teachers allowed sharing knowledge, experiences, and materials with learners. Transformation could be made by assessing the TCK to eliminate the limitation and then include the commenting service in Google Docs, for instance, to collaborate, and share feedback on a given task.
- *CK-A:* The CK and Augmentation supports CK, TCK, and PCK. Augmentation suggests new technology may be used to increase efficiency adjacent to the old technology practices. For example if teacher and students could only create documents using Ms-word and save it manually and share it with others on a memory stick, enhancement can be made on TCK to enable teachers and student to use Google Docs to utilize extra services like auto saving, auto syncing, and auto sharing in the cloud.
- *PK-A:* The PK and Augmentation supports PK, TPK, and PCK. Augmentation suggests new technology may be used to increase efficiency adjacent to the old technology practices. For example if teacher and students could only use Ms-word to write document and save it manually and share it with others on a memory stick, enhancement can be made on TPK to enable teachers and student to use Google Docs to utilize extra services like auto saving, auto syncing, and auto sharing in the cloud.
- *TPACK-R:* The TPACK and Redefinition supports all the components of TPACK. Redefinition when related to the TPACK as a whole, suggests for the overhaul; for example migrating from traditional teaching or blended learning that mix traditional with some online technology enhanced learning and completely implement full online courses (e-learning). Old task designed by examining TPACK characteristics are redefined using the SAMR model characteristics to form new tasks and practices.

The equivalences between the constructs from the two models, TPK-M, TK-A, TCK-M, PCK-M, CK-A, PK-A and the TPACK-R proves that, the two frameworks they can be used to achieve common goals using different approaches (Hos-McGrane, 2014; Puentedura, 2010, 2014; Tucker, 2013).However, none of the two models is alone hundred percent sufficient to inspire technology use in education.

Purpose of the Study

This study examined tutors' and teacher trainees' individual characteristics that revealed the opportunities and challenges faced when implementing pedagogical ICTs. Precisely, the study assessed technological knowledge, competences, skills, attitudes, beliefs, and readiness to integrate classroom technology. In addition, two frameworks (TPACK and SAMR) were used to present the evaluation aspects they embodied. The aspects of TPACK constructs were adopted from Koehler and Mishra (2009) and the aspects of SAMR features were adopted from Puentedura (2010). Table 1 indicates the frameworks constructs linkage and the aspects of variables that were used to assess tutors' and teacher trainees' individual characteristics. However, these TPACK-related instruments are used; there is not yet a widely accepted instrument for measuring TPACK (Figg & Jaipal, 2012).

Table 1: *The TPACK and SAMR Modes Attributes and the Tasks Examined*

TPACK + SAMR constructs	***The Attributes Assessed by this study***
	Tutors' and teacher trainees' skills and preparedness to use technology
Technological Knowledge + Augmentation	-Creating multimedia presentation using scanners, digital cameras and video cameras; -Using office applications (e.g. word processors, presentations, spreadsheets etc.) -Accessing online resources communicating by use of computers (e.g. e-mail, Internet) -Making presentations using computers and LCD projectors. -Carrying out professional productivity using interactive media -Using animations/simulations that enhance the content of a lesson
	Tutors' and teacher trainee's knowledge and frequency of technology use
Technological Content Knowledge + Modification	- Video streaming (e.g. TeacherTube, YouTube etc.) - Blogs related to key subject areas - Interactive whiteboard software (e.g. Promethean, SMART Notebook etc.) - Audio/video editing (e.g. iMovie, Movie Maker etc.) - Simulation/ animation applications - Analytical tools (e.g. statistics, charting, graphing) - Internet (e.g. Chart rooms, forums, Web 2.0 tools etc.) - Presentation software - DVD Player, Video, TV, radio, audio tapes etc. - Creative IT tools (e.g. desktop publishing, digital video, digital camera, scanners) - Spreadsheets and Microsoft Mathematics - Content specific applications (e.g. Math, Science, Social Studies, music etc.) - Informative (e.g. Internet, CD-ROM, forums) - Communicative applications (e.g. email, LCD projector, computer conferencing) - Organizational software (e.g. database, spreadsheets, record keeping, lesson planning tools)
	Teacher trainees' ability to learn classroom technology integration
Technological Pedagogical Knowledge + Modification	- Using Internet for general information searching - Searching for content specific of particular subject - Using office productivity software (Word, PowerPoint, spreadsheet) - Teaching or sharing technology use in a classroom to others - Learning to use new piece of software - Locating learning opportunities that advances technology skills - Using technology to support curriculum standards - Integrating technology in into lessons - Designing activities that integrate technology
	Tutors' and teacher trainees' competences of technology use
Technological Pedagogical Content Knowledge + Redefinition	- Combining technology and non-technology resources in teaching - Using information technology that enhances students learning for a lesson - Supporting learning activities for individuals, small and large groups using technology - Using information technology resources for teaching and learning Mathematics independently - Assessing students learning using technology - Using information technology that enhances the teaching approaches for a lesson - Applying technology in research based practices (project/ inquiry-based / collaborative learning)

The study explored ICT functional skills that include skills relevant to pedagogical ICTs and the ICT skills for learning. The ICT skills for learning, in their turn include skills that combine both cognitive abilities or higher-order thinking skills with functional skills for the use of ICT applications in classroom settings (Ananiadou & Claro, 2009, p. 8). In this study, we answered the following research questions.

(1) Do tutors' and teacher trainees' ICT use competences and knowledge have influence on their classroom technology use?
(2) Do tutors' and teacher trainees' ICT use beliefs, readiness, and skills have influence on their classroom technology practices?
(3) Do the teacher trainees and tutors' characteristics of technology competencies related to TPACK and SAMR constructs have influences on their classroom ICT use abilities and readiness?

METHOD

This was a case study carried out in the education domain comprised teacher trainees and tutors from Morogoro teacher training college and Mzumbe university both of Morogoro region. The design of this case study was non-experimental and involved quantitative research. In this study, the characteristics of learning environments and the contribution of TPACK and SAMR models that enhance fully use of ICT in the existing learning environments were potentially used (Smeets, 2005). The use of survey questionnaires assisted to obtain descriptive data that revealed the relationships between TPACK, SAMR, and current pedagogical ICT practices in teaching and learning. The study examined tutors' and teachers trainees' technology use competences, knowledge, skills, abilities, and readiness to use ICT. We focused on pedagogical ICTs (TPACK and SAMR models constructs) with the most likelihood of classroom application in the existing environment. In addition, participants' revealed TPACK characteristics, makes measure of TPACK confidence potentially useful as an indicator for the opportunities and impacts of technology use in education (Figg & Jaipal, 2012) . We focused on pedagogical ICTs, which have potential influence on TPACK and SAMR models' constructs. The Practices, abilities, and skills to use numerous technologies were used for assessing the impacts of these two models; conceptually TPACK is distributed across individuals (teachers, technologists, learners) and artifacts (websites, lesson plans, books, software, technology based practices etc.) (Blas, Paolini, Sawaya, & Mishra, 2014).

Participants

The study involved 206 respondents from Morogoro Teachers' Training College and Mzumbe University (Morogoro campus). They comprised 12 (5.8%) tutors and 194 (94.3%) teacher trainees comprised 158 (76.7%) Diploma in Education teacher trainees specialized in a pair combination of Mathematics, Physics, Chemistry, Biology, Information Technology, Audiology, and Geography, 36 (17.5%) teacher trainees from Mzumbe University pursuing bachelor's degree in education specialized in economics, and mathematics. Among the respondents 15 (7.3%) were female and 191 (92.7%) were male. The ratio of females in the study was very few, because the respondents were tutors and teacher trainees in basic Mathematics and Science subjects which generally comprised less females than males (UNESCO, 2012).

Instruments for Data Collection

Data were collected from tutors and teacher trainees using questionnaires, observations, and interviews. We adopted questionnaire parameters from previous studies (Holden & Rada, 2011; Milbrath & Kinzie, 2000; Wang, Ertmer, & Newby, 2004). The questionnaire had two sections.

The first section collected demographic information such as gender, education level, technology competence level, and career specialization. The second section examined current practices and classroom ICT integration parameters. The study used Likert four-point scale questionnaires to collect data about classroom technology Integration skills, preparedness, competencies (ranked as 1= Well prepared, 2= Somewhat prepared, 3= Poorly prepared and 4= Not prepared) , and the classroom technology practices frequencies (ranked as 1= Often, 2=Sometimes, 3=Rarely and 4=Never). The data collected intended to measure how excellent, good, fair, or poor respondents are when required to practice technology in classroom. Either the Likert five-point scale questionnaires were used to collect data about teacher trainees' ability to learn classroom technology integration (ranked as 1= Very strong, 2= Strong, 3= Adequate, 4= Weak and 5 = Very weak). For data analysis, we used statistical software SPSS version 21.0. We employed multiple response definition of variables to formulate collective responses that reduced the density of information for each category. The data analysis was followed by frequency tables' generation to present consolidated variables in figures and percentages.

Cronbach's alpha test of reliability and internal consistency, adopted from (Cronbach, 1951; Ferketich, 1990), was conducted on each of the items assessed. The results on Technological Knowledge and Augmentation (TK+A) attributes was (α = 0.802, n=6), Technological Content Knowledge and Modification (TCK + M) attributes was (α=0.863, n=15), Technological Pedagogical Knowledge and Modification (TPK + M) attributes was (α=0.877, n=9) and the Technological Pedagogical Content Knowledge and Redefinition (TPCK + R) attributes was (α = 0.873, n=7). The Alpha coefficient $\alpha > 0.8$ was considered good (Gliem & Gliem, 2003; Santos, 1999; Tavakol & Dennick, 2011).

RESULTS AND DISCUSSION

Participants ICT Knowledge Level

The levels of competence assessed were adopted from the UNESCO teacher professional framework (UNESCO, 2011, p. 39) ranked as (1) beginners (ability to perform basic functions in a limited number of computer applications), (2) average users (ability to use a number of computer applications), (3) and advanced user (ability to competently use a broad range of devices and tools). Results of the assessment of ICT use competence levels of tutors and teacher trainees are given in Table 2 below.

Table 2: *Tutors and Teacher Trainees ICT use Competence Levels (N= 206)*

	ICT Competence Level		
Categorical Groups	*Beginner (%)*	*Average (%)*	*Advanced (%)*
Tutors	1.0	3.4	1.5
Teacher Trainees	60.6	23.8	9.7
Total	61.7	27.2	11.2

Results in Table 2 above show that ICT competence level majority reported was beginners (61.7 %), comprised 1.0% tutors and 60.6% teacher trainees. The second score was average users (27.2 %), comprised 3.4 % tutors and 23.8 % teacher trainees. The advanced users were 11.2%, comprised 1.5 % tutors and 9.7 % teacher trainees. These results indicate majority of tutors as either beginner or average users regardless of the number of years in the teaching field. This may signal lack of ICT use innovate skills and also low levels of classroom ICT integration among tutors as the low level of Technology Knowledge leads to low usage (Andersson et al., 2014).

Teachers ICT use competences are well defined by a collection of knowledge, skills, understandings and attitudes that are inseparably assured with context and pedagogy (Doyle & Reading, 2012).The increase of teachers' ICT knowledge triggers the use of technology in their activities. Without a strong ICT Knowledge, we should not expect teachers' competence to use ICT in their professional practices to be optimum (Brás et al., 2014). This means, planning for teacher trainees training on the efficient use of pedagogical ICTs leads to the required ICT skills teachers supposed to have and then expect them to perform proficiently using ICTs.

Preparedness to Integrate ICT in Teaching

The Technological Knowledge and Augmentation attributes were used to assess tutors' and teacher trainees' readiness to integrate ICTs in classrooms. The study explored participants' knowledge and skills to use hardware, software, and associated peripherals that contains characteristics of the TPACK and SAMR models composed by Technological Knowledge (TK) and Augmentation (A) respectively. We used multiple response definition of variables followed by frequency generation that assisted to compare tutors' and teacher trainees' preparedness as shown in a bar chart with Figure 5.

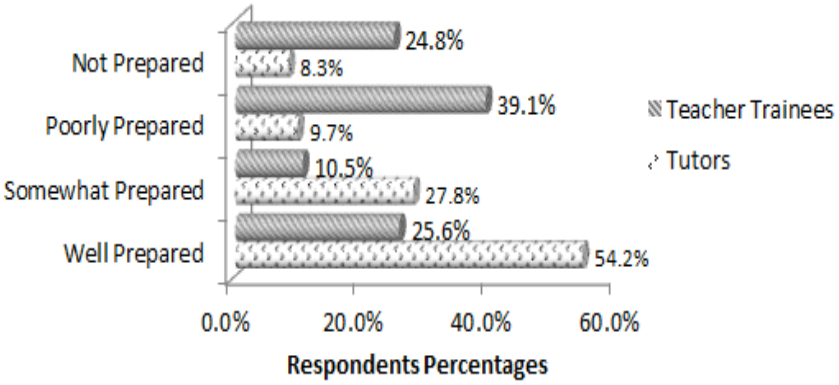

Figure 5: *Respondents' percentages of the preparedness levels to integrate ICTs in classroom (N=206)*

Figure 5 above shows variations in the level of preparedness to integrate technology in a classroom among tutors and teacher trainees. The majority of tutors 54.2 % reported well prepared followed by 27. 8% reported somewhat prepared. Only 25.6 % of teacher trainees reported well prepared while 39.1% reported as poorly prepared followed by 24.8% who reported as not prepared. Although tutors were supposed to transfer the skills of classroom technology use to their peer teacher trainees, some of them (8.3%) reported as not prepared. However, TTC and a University have computer laboratories; many factors have contributed to tutors and teacher trainees lack of preparedness to use ICT tools in classrooms. Examples are lack of sustainable power supply, insufficient resources (hardware and software), lack of digital educational resources supporting curriculums, and unreliable internet connections etc. (Andersson et al., 2014, p. 88) . As a fact, tutors mostly use traditional practices that do not always involve innovative classroom ICT tools in the process of training teacher students. This means poorly prepared teachers could not have adequate skills to mix technology based and non-technology based blended learning as classroom practices. By enhancing teachers with knowledge that entail the TPACK and SAMR models characteristics, technology tools that are more user friendly to both tutors and teacher trainees becomes more transparent and easy to find and model .

Hence, the two frameworks can complement each other and eliminate any drawbacks rising from using only one framework. The effects of TK visualizes digital tools, how they can accommodate traditional contents and merge with pedagogical strategy used by teachers (Brantley-Dias & Ertmer, 2013). The Augmentation construct (SAMR) is used to evaluate old practices, reinvent technology based practices and add value to the teaching process(Hudson, 2014). As in the ICT policy for basic education, today the use of ICT in education is inevitable (United Republic of Tanzania, 2007); the availability of the documented local contextual application of the TPACK and SAMR models characteristics uncovers future direction as the roadmaps for the planning of the ICT in education and the teacher training needs in Tanzania.

Classroom Technology Use

The TCK and Modification (M) attributes were used to assess tutors' and teacher trainees' classroom rate of technology integration. Results for the percentages of use frequencies are presented in Figure 6.

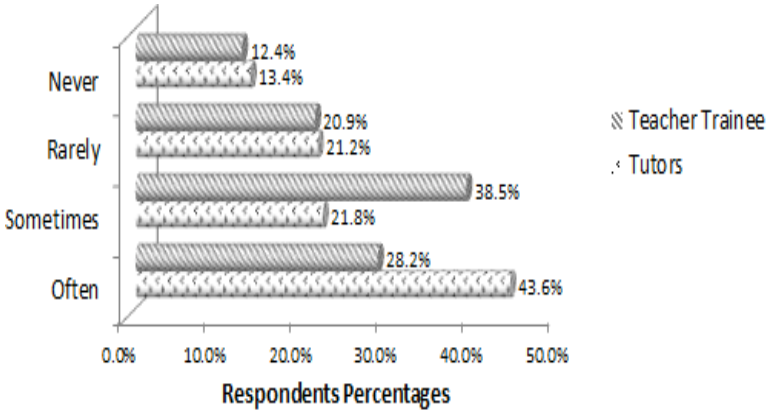

Fig. 6: Respondents'' percentages of classroom technology use

Figure 6 above shows that there is a correlation on the frequencies of technology use among tutors and teacher trainees. The study revealed, majority of tutors 43.6% reported often, 21.8% reported sometimes, 21.2% − rarely, and 13.4 % − never have used technology in classroom. In addition, majority of teacher trainees 38.5% reported sometimes, 28.2% often, 20.9 % rarely, and 12.4% never. Most of the ICT tools used were pedagogical ICT tools, either Internet based or offline ICT tools. Previous study already reported less than 50% of tutors use ICT for teaching and learning (Andersson et al., 2014, p. 9). Based on these results, we present the impact of the TPACK and SAMR model in three aspects:

1) The TPACK can help to uncover the affordances of pairing appropriate technology to the content teachers teach and eliminate resistance to change tutors face. We found that most of tutors have insufficient skills of numerous ICT tools that emulate classroom pedagogical practical application. That has led to low frequencies of pedagogical ICT classrooms application where the challenge for many if not most teachers, particularly in developing countries, is changing their practice of teaching in ways that accommodate the use of technology (Olson et al., 2011, p. 2,13).

2) The TPACK could help tutors to understand which specific technologies are best suited for addressing subject-matter. Both tutors and teacher trainees with this knowledge, they will be motivated within their professional domains to use technology (Pamuk, 2012).
3) The SAMR model (Modification) provides the best visualization of substantial numbers of ICT tools useful for redesigning tasks that are more traditionally presentable into technology based tactics. Good teaching facilitates learners by leveraging relevant ICT resources as meaningful pedagogical tools for building quality and effective knowledge (Ertmer & Ottenbreit-Leftwich, 2010).

Humans learn to use new tools by, first, attempting to find a 'fit' with existing social practices and over time, through experimentation, developing new social practices that take advantage of their affordances (Somekh, 2008).

Perceptions of Teacher Trainees on their Abilities to Learn New Technologies

Sometimes technology is not efficiently employed because users are slow to learn and adopt the technology. The Technological Pedagogical Knowledge (TPK) and Modification aspects were used to measure teacher trainees' perception on the ability to learn new ICT tools. The percentages of teacher trainees' perception on how easy they could learn technology are shown in Figure 7 below.

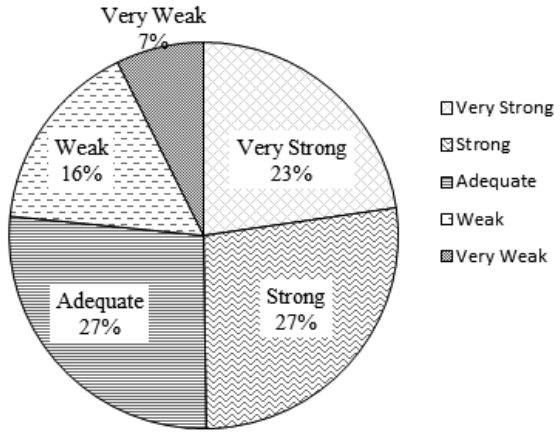

Figure 7: *Percentages of teacher trainees' perception on personal abilities to learn new technologies*

Figure 7 above shows that 27.0% of teacher trainees reported their personal abilities as strong, 27.0% adequate, 23.0% very strong, and 7.0% week. This means that the majority of teacher trainees could easily learn new skills if they had such an opportunity. A study by Tsai & Chai (2012), however, reported first-order barriers (external) such as lack of adequate access, time, training and institutional support could affect abilities to learn new technological tools. The second-order barriers (internal) were teachers' pedagogical beliefs, technology beliefs, and willingness to change as major cause of many teacher failures to use technology. The opportunity TPK provide might be impacted negatively by the lack of pedagogical experience and could limit development of appropriate technology integration approaches among new generation of teachers (Pamuk, 2012). Even though use of ICT in education is increasing, there is still a significant learnability-based digital divide. The low number of weak teachers' perception means that if the infrastructure (hardware and software) are in place and the organizational culture is

supportive, teacher trainees could learn technology easily and would be able to perform traditional tasks using technology in different ways.

Tutors' and Teacher Trainee's Preparedness for Classroom Technology Integration

The TPACK and SAMR constructs assessment focused on tutors' and teacher trainees' competencies based on how they were prepared to integrate technology in classroom. The TPCK and Redefinition (R) constructs were used (see Table 1 above) to assess various practices that involved technology to perform a task. Percentages of respondents' preparedness for classroom technology integration are shown in in Figure 8 below.

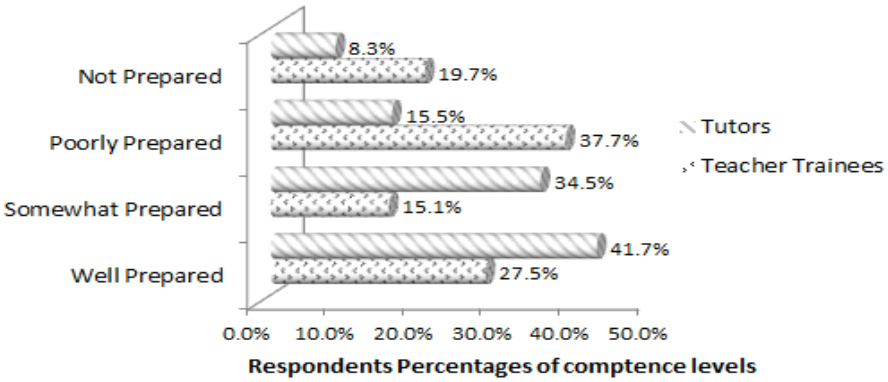

***Figure 8**: Percentages of Respondents' Preparedness for Classroom Technology Integration*

Figure 8 above shows that the majority of teacher trainees (37.7%) reported poorly prepared and 19.7% as not prepared, thus more than 50% of teacher trainees were unprepared. The majority of tutors (41.7%) reported themselves as well-prepared, 15.1% as somewhat prepared. The percentage of those who reported themselves as poorly and not prepared taken together is 23.8%. This may lead to the situation where new teachers leave colleges without sufficient technological practice background. Developing Pedagogical Content Knowledge (PCK) is considered as an important factor over all technology integration (Pamuk, 2012); however, lack of Technological Knowledge for the 21st century teacher would make knowledge transferred to learners obsolete. True classroom technology integration can be attained when understanding and negotiating the relationships between the three components of knowledge-TK, CK, and PK (Thomas et al., 2013). The benefits and impacts that TPACK and SAMR can offer are beyond competences enhancements. Redefinition stage of the SAMR model calls on all three knowledge areas- the PK, CK, and TK that enhance redefinition of tasks (Hos-McGrane, 2014). Teacher trainees and tutors should encompasses competencies related to technical skills of operations and concept, and productivity of several ICT tools including personal computers, mobile devices, communication devices, digital educational resources and application available on-line or off-line.

LIMITATIONS OF THE STUDY

Due to the choice of non-experimental research design, we must consider the possibility that only participants with a positive attitude on the pedagogical ICT use in education have chosen to respond. For this case, we may have contributed to the exclusion of ICT users' reality, which could be determined by carrying out an experimental study for measuring the practical use of

ICTs as they integrate technologies in their practices. The survey was a self-perception on the ICT knowledge and self-perception have been shown in the past to generally predict higher level than reality (Doyle & Reading, 2012). However, the knowledge that research team have on the process of training teacher trainees, recruitment of tutors, the ICT use challenges teacher training colleges face and the relationship of the curriculum and technology integration persuaded us to use personal perception data and make general conclusion believing that participants' answers were true and they reflect real situation. However, the geographical dispersion and the large number of teacher trainees' population dissuaded us to collect data from many institutions - we visited only one teacher training college and one University, which may give out different results if the study sample could have picked from wide range of institutions.

CONCLUSION AND FUTURE RESEARCH

The education systems in Tanzania, suffer from lack of relevant ready to use curriculum based e-contents. However, previous ICT initiatives carried out by the government and donor agencies put a foundation for ICT use in education, they could not manage to come up with a sustainable ICT use solution. Existing teacher training colleges and Universities that offer teacher professional training do not have a harmonized teacher professional ICT training programs, hence suffer from unrealistic and fragmented ICT knowledge transfer on teacher trainees. The findings of this study indicated a low level of ICT usage by the respondents irrespective to their education level. Tutors have to be equipped with sufficient ICT use skills and competencies in order to be on par with teacher trainees' prerequisites prior to their entry into the job market. The lack of an ICT use harmonized framework that could work as a roadmap towards technology integration in secondary education hindered the opportunities propelled by the TPACK and SAMR models to the education system. However, challenges like lack of access to computers, unsustainable power supply, lack of readiness to use ICTs among key users and lack of Internet connectivity have continued to demoralize the use of ICT in education. The mission statement in the ICT policy for basic education, which carries the philosophical benefits of the ICT use in basic education stated "Integration of ICT to enhance access, equity, quality, and relevance of basic education, while stimulating and improving teaching and life-long learning"(United Republic of Tanzania, 2007). However the TPACK constructs (TK, PK, CK, TPK, TCK, and PCK) examined by this study, have provided critical measure and potential inputs for exploring a contextualized knowledge mix of technology, contents, and pedagogy, they have not being efficiently used to adjust teacher training programme in areas that face limitations. The critics and compliments brought by the TPACK and SAMR models into the education system should be considered as the best inputs for redesigning and planning for the major changes that consider ICT use in education as an inevitable attribute.

Today, educational information technology and pedagogical practices are inseparable fields. As a digital generation citizen, teachers should not give excuses as technology is evolving rapidly. Embracing positive attitude will motivate use of ICT effectively and further upgrade the needed skills. The ICT perception recorded in relation to the competencies and ICT knowledge characteristics of tutors and teacher trainees, unless it have shifted from beginner and average users to the advanced users, there should never be innovative teachers who take technology not only as a pedagogical tool but also a learning and teaching resource that old and new classroom tasks demand. One not only needs the ICT infrastructures, but also the personal skills, knowledge and competencies in order to use ICT. It is evident from the literature that unless the issues of ICT competencies are addressed in the mirror of TPACK and SAMR models' characteristics, it can itself be a barrier to classroom ICT integration. The impacts of the TPACK and SAMR models implementation in education are noticeable through clear and practical use of technology, teachers' abilities, skills, competencies, and apparent change in behavior and

attitude in classroom and outside classroom technology use. Teachers can determine their technology level when experiencing small shifts in the design of new technology oriented tasks and innovatively have applied technology driven learning with the higher level beyond of quality and old practices (Ahrens & Zaščerinska, 2014).

The usefulness of TPACK and SAMR frameworks depends much on the destiny of teacher professional and their understanding of several ICT tools and what they can do to improve and increase the effectiveness of teaching practices. Nevertheless, technology by itself cannot replace teachers. It is the attitude of teachers and their mentors that need to accept the fact that teaching with contemporary technologies is more effective and teaching the old style will make them obsolete. While some of tutors and teacher trainees may learn to use ICTs by themselves through their personal efforts, the contributions of the ICT related training institutional courses and programmes are important, however were limited. The moment teachers training colleges see the light that the TPACK and SAMR models characteristics make the use of technology interesting, organized, exciting, and easier; they would perceive it as mandatory and future professional teacher relevance. Beyond the enhancement of ICT use competencies, the benefits and impacts that TPACK and SAMR constructs can offer are not credited to the framework as a single entity that could hundred percent inspire technology use in secondary education.

Based on the research results we draw up such recommendations that: First, necessary conditions should be provided for the tutors and teacher trainees to own personal computers, demonstrate some level of pedagogical ICT use before being issued a teaching certificate and early adapters' should be encouraged to help others in the field. Second, however this study did not examine the use of mobile application as a tool for examining the impacts of TPACK and SAMR frameworks; mobile app could be used as a diagnostic tool for measuring teachers and tutors ICT use competencies, incorporating features of decision-making and expert systems. This tool should provide information on which ICTs to use in the lesson context depending on the teacher's level of competencies. It should be able to trace the dynamics of teachers' level of ICT competencies (if they are progressing or not over the time). Third, the government should design a harmonized ICT integration framework; that consider critical limitations facing Tanzania technology use. The ICT competencies, skills and knowledge levels teachers' professional needs to have as proposed by the UNESCO framework for professional teachers (UNESCO, 2011, p. 17) should be benchmarked and practiced together with existing national standards. In order to alleviate critical challenges encountered, ICT related courses in teacher training programmes and institutions should be redesigned to help prospective teachers gain ICT use competencies. Fourth, further work should focus on carrying out an experimental research design that cover more geographical locations to unlock the realities of existing ICT use practices in teacher training colleges.

REFERENCES

Abbitt, J. T. (2011). Measuring Technological Pedagogical Content Knowledge in Preservice Teacher Education. *Journal of Research on Technology in Education*, *43*(4), 281–300. http://doi.org/10.1080/15391523.2011.10782573

Abell, S. K. (2008). Twenty Years Later: Does pedagogical content knowledge remain a useful idea? *International Journal of Science Education*, *30*(10), 1405–1416. http://doi.org/10.1080/09500690802187041

Ahrens, A., & Zaščerinska, J. (2014). Analysis of Teachers' Use of Web Technologies: Focus on Teachers' Enterprise 3.0 Application. *Journal of Information Technology and Application in Education*, *3*(1), 25. http://doi.org/10.14355/jitae.2014.0301.04

Ananiadou, K., & Claro, M. (2009). *21st Century Skills and Competences for New Millennium Learners in OECD Countries* (OECD Education Working Papers No. 41). Retrieved from http://www.oecd-ilibrary.org/education/21st-century-skills-and-competences-for-new-millennium-learners-in-oecd-countries_218525261154

Andersson, B., Nfuka, E. N., Sumra, S., Uimonen, P., & Pain, A. (2014). *Evaluation of Implementation of ICT in Teachers' Colleges Project in Tanzania* (Final Evaluation Report No. Sida61745en urn:nbn:se:sida-61745en). Stockholm, Sweden: Swedish International Development Cooperation Agency (Sida). Retrieved from http:// sidapublications.citat.se/ interface/ stream/ stream.asp

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content Knowledge for Teaching What Makes It Special? *Journal of Teacher Education*, *59*(5), 389–407. http://doi.org/10.1177/0022487108324554

Blas, N. D., Paolini, P., Sawaya, S., & Mishra, P. (2014). Distributed TPACK: Going Beyond Knowledge in the Head. In M. Searson & M. N. Ochoa (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2014* (pp. 2464–2472). Jacksonville, Florida, United States: Association for the Advancement of Computing in Education (AACE). Retrieved from http://www.editlib.org/p/131154

Brantley-Dias, L., & Ertmer, P. A. (2013). Goldilocks and TPACK. *Journal of Research on Technology in Education*, *46*(2), 103–128. http://doi.org/10.1080/15391523.2013.10782615

Brás, P., Miranda, G. L., & Marôco, J. (2014). Teachers and Technology: A Complicated Relationship. *GSTF International Journal on Education (JEd)*, *2*(1), 56–65. http://doi.org/DOI: 10.5176/2345-7163_2.1.44

Cavanaugh, C., Hargis, J., Kamali, T., & Soto, M. (2013). Substitution to augmentation: faculty adoption of iPad mobile learning in higher education. *Interactive Technology and Smart Education*, *10*(4), 270–284. http://doi.org/10.1108/ITSE-01-2013-0001

Chai, C. S., Koh, J. H. L., & Tsai, C.-C. (2011). Exploring the factor structure of the constructs of technological, pedagogical, content knowledge (TPACK). *The Asia-Pacific Education Researche*, *20*(3), 595–603.

Chai, C. S., Koh, J. H. L., Tsai, C.-C., & Tan, L. L. W. (2011). Modeling primary school pre-service teachers' Technological Pedagogical Content Knowledge (TPACK) for meaningful learning with information and communication technology (ICT). *Computers & Education*, *57*(1), 1184–1193. http://doi.org/10.1016/j.compedu.2011.01.007

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*(3), 297–334. http://doi.org/10.1007/BF02310555

Cubukcuoglu, B. (2013). Factors enabling the use of technology in subject teaching. *International Journal of Education and Development Using Information and Communication Technology*, *9*(3), 50–60.

Doyle, H., & Reading, C. (2012). Building teacher educator TPACK: Developing leaders as a catalyst for change in ICT Education. In *Future Challenges /Sustainable Futures 25-28 November 2012* (pp. 272–282). Wellington, New Zealand: ASCILITE.

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher Technology Change: How Knowledge, Confidence, Beliefs, and Culture Intersect. *Journal of Research on Technology in Education*, *42*(3), 255–284. http://doi.org/10.1080/15391523.2010.10782551

Ferketich, S. (1990). Internal consistency estimates of reliability. *Research in Nursing & Health*, *13*(6), 437–440. http://doi.org/10.1002/nur.4770130612

Figg, C., & Jaipal, K. (2012). TPACK-in-Practice: Developing 21st Century Teacher Knowledge. In *Society for Information Technology & Teacher Education International Conference, Mar 05, 2012* (Vol. 2012, pp. 4683–4689). Austin, Texas, USA: Association for the Advancement of Computing in Education (AACE).

Gliem, J. A., & Gliem, R. R. (2003). Calculating, Interpreting, and Reporting Cronbach's Alpha Reliability Coefficient For Likert-Type Scales. In *Midwest Research-to-Practice Conference in Adult, Continuing, and Community Education*. Columbus, Ohio : Ohio State University,USA: Ohio State University,USA. Retrieved from https://scholarworks.iupui.edu/handle/1805/344

Hare, H. (2007). *Survey of ICT and Education in Africa: A Summary Report Based on 53 Country Surveys* (Report). World Bank. Retrieved from http://oasis.col.org/handle/11599/247

Harris, J. B., & Hofer, M. J. (2011). Technological Pedagogical Content Knowledge (TPACK) in Action. *Journal of Research on Technology in Education*, *43*(3), 211–229. http://doi.org/10.1080/15391523.2011.10782570

Hockly, N. (2012). Substitute or redefine. *Modern English Teacher*, *21*(3), 40–42.

Holden, H., & Rada, R. (2011). Understanding the Influence of Perceived Usability and Technology Self-Efficacy on Teachers' Technology Acceptance. *Journal of Research on Technology in Education*, *43*(4), 343–367. http://doi.org/10.1080/15391523.2011.10782576

Hooker, M., Mwiyeria, E., & Verma, A. (2011). *ICT Competency Framework for Teachers (ICT-CFT) :Contextualization and Piloting in Nigeria and Tanzania* (World Bank and GESCI Initiative Synthesis report . Draft). Dar-es-Salaam, Tanzania: Ministry of Education and Vocational Training (MoEVT), Tanzania. Retrieved from http://www.gesci.org/assets/files/Tanzania_Needs_Assessme nt_Report_Draft_Final_230911%20_3_.pdf

Hos-McGrane, M. (2014, June 30). SAMR and TPACK: Using technology with a focus on learning [Blogpost]. Retrieved June 9, 2015 from http://www.maggiehosmcgrane.com/2014/06/samr-and-tpack-using-technology-with.html

Hudson, T. (2014). Best Practices for Evaluating Digital Curricula. DreamBox Learning, Inc. Retrieved August 12, 2015 from https://fs24.formsite.com/edweek/images/WP-DreamBox-Best-Practices-for-Evaluating-Digital-Curricula.pdf

Jude, L. T., Kajura, M. A., & Birevu, M. P. (2014). Adoption of the SAMR Model to Asses ICT Pedagogical Adoption: A Case of Makerere University. *International Journal of E-Education, E-Business, E-Management and E-Learning*, *4*(2), 106–115.

Kessy, D., Kaemba, M., & Gachoka, M. (2006). The reasons for under use of ICT in education: in the context of Kenya, Tanzania, and Zambia. In *Fourth IEEE International Workshop on Technology for Education in Developing Countries, 2006* (pp. 83–87). http://doi.org/10.1109/TEDC.2006.31

Khan, S. H. (2014). A model for integrating ICT into teacher training programs in Bangladesh based on TPCK. *International Journal of Education and Development Using Information and Communication Technology*, *10*(3), 21–31.

Kleickmann, T., Richter, D., Kunter, M., Elsner, J., Besser, M., Krauss, S., & Baumert, J. (2013). Teachers' Content Knowledge and Pedagogical Content Knowledge : The Role of Structural Differences in Teacher Education. *Journal of Teacher Education*, *64*(1), 90–106. http://doi.org/10.1177/0022487112460398

Koehler, M., & Mishra, P. (2009). What is Technological Pedagogical Content Knowledge (TPACK)? *Contemporary Issues in Technology and Teacher Education*, *9*(1), 60–70.

Koh, J. H. L., Chai, C. S., & Tay, L. Y. (2014). TPACK-in-Action: Unpacking the contextual influences of teachers' construction of technological pedagogical content knowledge (TPACK). *Computers & Education*, *78*, 20–29. http://doi.org/10.1016/j.compedu.2014.04.022

Koh, J. H. L., Chai, C. S., & Tsai, C.-C. (2010). Examining the technological pedagogical content knowledge of Singapore pre-service teachers with a large-scale survey. *Journal of Computer Assisted Learning*, *26*(6), 563–573. http://doi.org/10.1111/j.1365-2729.2010.00372.x

Komba, W. L., & Nkumbi, E. (2008). Teacher professional development in Tanzania: Perceptions and practices. *Journal of International Cooperation in Education*, *11*(3), 67–83.

Kreijns, K., Van Acker, F., Vermeulen, M., & van Buuren, H. (2013). What stimulates teachers to integrate ICT in their pedagogical practices? The use of digital learning materials in education. *Computers in Human Behavior*, *29*(1), 217–225. http://doi.org/10.1016/j.chb.2012.08.008

Loveless, A., & Ellis, V. (2003). *ICT, Pedagogy and the Curriculum* (2nd ed.). RoutledgeFalmer, USA: Taylor & Francis Group.

Lund, J. (2015, January 9). Transforming your Teaching: The SAMR Model [Educational Technology and Online Course Design Help]. Retrieved from http://www.iddblog.org/?p=2092

Margerum-Leys, J., & Marx, R. W. (2002). Teacher Knowledge of Educational Technology: A Case Study of Student/Mentor Teacher Pairs. *Journal of Educational Computing Research*, *26*(4), 427–462. http://doi.org/10.2190/JXBR-2G0G-1E4T-7T4M

Milbrath, Y. L., & Kinzie, M. B. (2000). Computer Technology Training for Prospective Teachers: Computer Attitudes and Perceived Self-Efficacy. *Journal of Technology and Teacher Education*, *8*(4), 373–396.

Mishra, P., & Koehler, M. J. (2007). Technological Pedagogical Content Knowledge (TPCK): Confronting the Wicked Problems of Teaching with Technology (Vol. 2007, pp. 2214–2226). Presented at the Society for Information Technology & Teacher Education International Conference. Retrieved from http://www.editlib.org/p/24919/

MoEVT. (2009). *Curriculum for Diploma in Teacher Education Programmes in Tanzania*. (Tanzania Institute of Education, Ed.) (Edition of 2013). Dar-es-Salaam, Tanzania: Tanzania Institute of Education. Retrieved September 14, 2013 from http://www.moe.go.tz/index.php?option=com_ docman&task=doc_download&gid=226&Itemid=619

Moroder, K. (2013, November 4). Push My Thinking: TPACK or SAMR or ? [Blogpost]. Retrieved April 10, 2015 from http://www.edtechcoaching.org/2013/11/ed-tech-frameworks-why-i-dont-use-tpack.html

Mumtaz, S. (2000). Factors affecting teachers; use of information and communications technology: a review of the literature. *Journal of Information Techology for Teacher Education*, *9*(3), 319–342. http://doi.org/10.1080/14759390000200096

Myers, J. (2014, December 19). Digging into the SAMR Model [Safe, Online Teaching and Learning Platform]. Retrieved April 10, 2015 from /speaks/digging-into-the-samr-model/

Oliver, M. (2011). Handbook of technological pedagogical content knowledge (TPCK) for educators. *Learning, Media and Technology*, *36*(1), 91–93. http://doi.org/10.1080/17439884.2011.549829

Olson, J., Codde, J., deMaagd, K., Tarkelson, E., Sinclair, J., Yook, S., & Egidio, R. (2011). *An Analysis of e-Learning Impacts & Best Practices in Developing Countries: With Reference to Secondary School Education in Tanzania* (Information & Communication Technology for Development). Michigan, USA: Michigan State University. Retrieved from http://cas.msu.edu/wp-content/uploads/2013/09/E-Learning-White-Paper_oct-2011.pdf

Pamuk, S. (2012). Understanding preservice teachers' technology use through TPACK framework. *Journal of Computer Assisted Learning*, *28*(5), 425–439. http://doi.org/10.1111/j.1365-2729.2011.00447.x

Puentedura, R. R. (2010). SAMR and TPCK: Intro to advanced practice. Ruben R. Puentedura's Weblog. Retrieved 11 April, 2015 from http://hippasus.com/resources/sweden2010/SAMR_ TPCK_IntroToAdvancedPractice.pdf

Puentedura, R. R. (2012). *The SAMR model: Background and exemplars*. Presentation slides. Retrieved 28 March, 2015 from http://wiki.milaca.k12.mn.us/groups/samr/wiki/welcome/attachments/9dbda/ SAMR%20Geography%20Examples.pdf

Puentedura, R. R. (2014, December). *SAMR and TPCK: A Hands-On Approach to Classroom Practice*. Presentation slides presented at the 1C Learning Conference, Hong Kong. Retrieved 28 March, 2015 from

http://www.hippasus.com/rrpweblog/archives/2014/12/11/SAMRandTPCK_HandsOnApproachClassroomPractice.pdf

Rastogi, A., & Malhotra, S. (2013). ICT skills and attitude as determinants of ICT pedagogy integration. *European Academic Research*, *1*(3). Retrieved October 16, 2014 from http://www.euacademic.org/ UploadArticle/22.pdf

Ronau, R. N., Rakes, C. R., & Niess, M. L. (2012). *Educational Technology, Teacher Knowledge, and Classroom Impact: A Research Handbook on Frameworks and Approaches*. Hershey, PA. USA: Information Science Reference (an imprint of IGI Global).

Santos, J. R. A. (1999). Cronbach's alpha: A tool for assessing the reliability of scales. *Journal of Extension*, *37*(2), 1–5.

Smeets, E. (2005). Does ICT contribute to powerful learning environments in primary education? *Computers & Education*, *44*(3), 343–355. http://doi.org/10.1016/j.compedu.2004.04.003

Somekh, B. (2008). Factors affecting teachers' pedagogical adoption of ICT. In *International handbook of information technology in primary and secondary education* (pp. 449–460). Springer. Retrieved from http://link.springer.com/chapter/10.1007/978-0-387-73315-9_27

Spector, J. M., Elen, J., Merrill, M. D., & Bishop, M. J. (2014). *Handbook of Research on Educational Communications and Technology* (Fourth Edition). New York,USA: Springer Science+Business Media. Retrieved from DOI 10.1007/978-1-4614-3185-5

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, *2*, 53–55. http://doi.org/10.5116/ijme.4dfb.8dfd

Thomas, T., Herring, M., Redmond, P., & Smaldino, S. (2013). Leading Change and Innovation in Teacher Preparation: A Blueprint for Developing TPACK Ready Teacher Candidates. *TechTrends*, *57*(5), 55–63. http://doi.org/10.1007/s11528-013-0692-7

Tondeur, J., Van Braak, J., & Valcke, M. (2007). Curricula and the use of ICT in education: Two worlds apart? *British Journal of Educational Technology*, *38*(6), 962–976. http://doi.org/10.1111/j.1467-8535.2006.00680.x

Tsai, C.-C., & Chai, C. S. (2012). The "third"-order barrier for technology-integration instruction: Implications for teacher education. *Australasian Journal of Educational Technology*, *28*(6). http://doi.org/10.14742/ajet.v28i6.810

Tucker, C. (2013, October 21). Beyond SAMR: The Teacher's Journey To Technology Integration [Blogpost]. Retrieved March 28, 2015 from http://catlintucker.com/2013/10/beyond-samr-the-teachers-journey-to-technology-integration/

Turunen, T. A., & Tuovila, S. (2012). Mind the gap. Combining theory and practice in a field experience. *Teaching Education*, *23*(2), 115–130. http://doi.org/10.1080/10476210.2012.669751

UNESCO. (2011). *UNESCO ICT Competency Framework for Teachers* (Framework Document) (p. 95). de Fontenoy, PARIS,Frence: UNESCO. Retrieved October 16, 2014 from http://unesdoc.unesco.org/ images/0015/001562/156209E.pdf

UNESCO. (2012). *Tanzania Education Sector Analysis* (Analytical document No. SN/2012/ED/PI/1). Dar-es-Salaam, Tanzania: Ministry of Education and Vocational Training (MoEVT),The United Republic of Tanzania. Retrieved May 14, 2013 from http://unesdoc.unesco.org/images/0021/ 002152/215247e.pdf

United Republic of Tanzania. (2007). *Information & Communication Technology (ICT) Policy for Basic education* (Policy Document) (pp. 1–30). Dar es Salaam, Tanzania: Ministry of Education and Vocational Training (MoEVT). Retrieved June 30, 2013 from http://www.moe.go.tz/index.php?option=com_docman&task=doc_download&gid=226&Itemid=619

United Republic of Tanzania. (2010, June). Education Sector Development Programme-ESDP (2010-2015). Ministry of Education and Vocational Training (MoEVT). Retrieved January 11, 2012 from http://www.moe.go.tz/index.php?option=com_docman&task=doc_download&gid=226&Itemid=619

Voogt, J., Fisser, P., Pareja Roblin, N., Tondeur, J., & van Braak, J. (2013). Technological pedagogical content knowledge – a review of the literature. *Journal of Computer Assisted Learning*, *29*(2), 109–121. http://doi.org/10.1111/j.1365-2729.2012.00487.x

Wang, L., Ertmer, P. A., & Newby, T. J. (2004). Increasing Preservice Teachers' Self-Efficacy Beliefs for Technology Integration. *Journal of Research on Technology in Education*, *36*(3), 231–250. http://doi.org/10.1080/15391523.2004.10782414