TPACK in teacher education: Using pre-service teachers' self-reported TPACK to improve pedagogic practice.

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Abstract

This small-scale pedagogic research utilised pre-service teachers' self-reported Technological Pedagogical And Content Knowledge (TPACK) to improve classroom practice in a Kenyan public university. Thirty-eight respondents completed the TPACK questionnaire and data was analysed descriptively into means, standard deviations and percentages using SPSS version 25 data analysis program. Results show that the pre-service teachers generally agreed about their technical knowledge to integrate with their content and pedagogical Knowledge (TPACK). The pre-service, however, were unsure about their technological knowledge (TK) and the specific technologies that are best suited for teaching and learning in their subject domains (TCK). The results further show that the pre-service teachers who pursue arts-based subjects reported low TK and technological content knowledge (TCK) compared to those pursuing science-based subjects. TK and TCK bases were thus critical areas of concern. Based on these findings, implications for practice namely: learning by doing and growth mindset strategies are proposed and discussed.

Keywords: *Technology, Pre-service education, TPACK, Pedagogy*

1. Introduction

Teacher training institutions worldwide including those in Kenya are expected to prepare pre-service teachers who are competent and confident in using technology as a pedagogical tool (Brun & Hinostroza, 2014; Tondeur, van Braak, Siddiq, & Scherer, 2016; Kaufman, 2015; Ndibalema, 2014). Such expectations emerged after it became apparent that many teachers still use traditional ways of teaching such as 'chalk and talk' and were unaware of the potential technology offers in pedagogy (Agyei & Voogt, 2011; Manduku, Kosgey, & Sang, 2012; Voogt & Mckenney, 2017).

Helping teachers to integrate technology in teaching is approached differently in different countries. In the United Kingdom, Malaysia and Singapore, for example, training in technology became part of teaching accreditation requirement (Kirimi, 2013). Alternatively, some Higher Education Teacher Training Institutions (HETTIs), for example, in England and Singapore, include technology-related modules in their teacher training programs (Polly, Mims, Shephaerd, & Inan, 2010; Tondeur et al., 2016). Questions can then be raised about the level of preparedness of pre-service teachers to integrate technology into teaching after completing such teaching training programs. This study attempts to answer this question from one Kenyan public university. The terms technology and Information Communication Technology (ICT) are used interchangeably in this study to mean analogue tools (e.g., Television and Radio) and digital tools such as computer hardware and software, internet, social media, and the electronic delivery systems like television and radios.

Technology is perceived to offer many benefits in teaching and learning processes. For instance, Leach, Ahmed, Makalima and Power (2005) argue that technology promotes learner-centred pedagogy. Moreover, whilst Tella, Toyobo, Adika, and Adeyinka (2007) found that technology-enhanced teachers' life-long learning and made teaching easier in Nigeria, Kirimi (2013) reported that technology is useful in providing explanations to learners and aroused their interest in the learning process. Generally, these findings suggest that technology can potentially revolutionise teaching and learning if skillfully integrated into teaching. Critical to these is the role of the teacher influenced by their level of preparation at pre-service levels (Hennessy, Harrison, & Wamakote, 2010; Tondeur, Roblin, Van Braak, Voogt, & Prestridge, 2017). Aware of the impact of training on teachers' ability to integrate technology in teaching, Voogt (2008) advised that teacher training does not need to focus on subject knowledge only but also on the pedagogical use of technology.

Owing to the above benefits of technology in education, various countries have added their efforts to enhance teachers' use of technology. Similar to countries such as the UK (Javis, 2014), Malaysia (Teo, 2008), Tanzania (Mtebe, Dachi, & Raphael, 2011; Ndibalema, 2014) Ghana (Agyei & Voogt, 2011), there have been spirited efforts in Kenya to produce teachers who can integrate technology in teaching (Kirimi, 2013; Manduku et al., 2012; MEPFET, 2012). In this regard, the Kenyan government promulgated an ICT policy in 2006 (Kirimi, 2013) which recognised ICT as a tool to raise education standards but appeared to emphasise ICT infrastructure over its use in pedagogy. The government, for example, embarked on equipping schools with ICT devices, electricity, internet and developing digital content at Kenya Institute of Curriculum Development (KICD) for use across the school curriculum. Despite these efforts, Kenyan teachers continued using traditional methods of teaching particularly, 'chalk and talk' (Manduku et al., 2012). Manduku et al. (2012) linked Kenyan teachers inability to integrate technology into teaching to their pre-service training, beliefs and attitudes. Consequently, the Kenya government policy shifted focus to teacher training institutions to help teachers integrate technology into teaching (MEPFET, 2012). According to Hennessy et al. (2010) and Tondeur et al. (2017), pre-service teacher training bears the greatest impact on teachers' later beliefs and practices. As if adopting Hennessy et al. (2010) advice, the Kenyan government directed the HETTIs to equip pre-service teachers with the needed knowledge and skills to integrate technology into teaching (MEPFET, 2012).

All Kenyan public universities which offer teacher-training programs at degree levels were expected to actualise the above government expectations. Currently, more than half of the 31 Kenyan public universities train teachers in Bachelor of Education (BEd-Hons) programs. Often, the program is offered by the universities' schools of education and takes four academic years of eight semesters. A semester lasts four months. Students in the BEd program are taught subject matter, pedagogy and technology separately by different schools. For instance, Physics modules/units are taught by the school of science whereas English modules/units are taught by the school of Arts. On the other hand, pedagogy-related modules/units are taught by the school of education. The BEd (Hons) program has BEd (Arts) and BEd (Science) options. In the former, students are prepared to teach high school arts-based subjects (e.g., languages and humanities) whereas, in the later, students are prepared to teach science-based subjects (e.g., mathematics, Physics). It is important to note that in Kenya, B.Ed (Hons) students train to teach two subjects in high schools upon completion of the programme.

Kenyan universities like many other African universities face many challenges that could hinder technology integration into teaching. The challenges include lecture-based teaching (Agyei & Voogt, 2011); limited resources (e.g., technology), large class sizes and test-driven system (Manduku et al., 2012; Voogt & Plomp, 2010); and inadequate technological knowledge and skills on the part of lecturers to undertake technology-supported pedagogy (Agyei & Voogt, 2011; Bate, 2010). Bate (2010), however, argues that nowadays most pre-service teachers possess some technical skills because they have grown up with digital technologies. These teachers may be more willing to integrate technology into teaching (Gao, Wong, Choy, & Wu, 2011).

This study was conducted in one Kenyan public university which experiences similar challenges outlined above. Nevertheless, to equip its pre-service teachers with the knowledge to integrate technology into teaching, the university in 2012 added a module: 'Computers and Information Management in Education' (TED 102) into its BEd (Hons) program. The program has been used to train secondary school teachers. To date, however, there has never been any attempt to assess by research, the students' self-reported knowledge to integrate technology into teaching upon completing the training program in which TED 102 was added.

1.1 Research Questions

The study assessed the pre-service teachers' preparedness to integrate technology into teaching after completing their teacher training program in one Kenyan university to improve practice. The study posed the question: *What is the pre-service teachers' self-reported ability to integrate technology into teaching after training?*

1.2 Significance of the study

The study intended to highlight the effectiveness of the BEd program to equip pre-service teachers with the knowledge to integrate technology into teaching and to improve practice.

2. Theoretical framework

Whilst Shulman (1986) explained that effective teaching is anchored on the knowledge of content and pedagogy, Mishra and Koehler (2006) extended this knowledge to include technology. As suggested by Koehler and Mishra (2008), viable technology integration into teaching requires three essential knowledge bases that a teacher needs: Content knowledge (CK), Pedagogical knowledge (PK) and Technological knowledge (TK). Also important are the intersections: Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), Technological Pedagogical And Content Knowledge (TPACK), and context as depicted in the TPACK framework in figure 1. Context is crucial because teachers are limited by what they are able to do within their own environment.

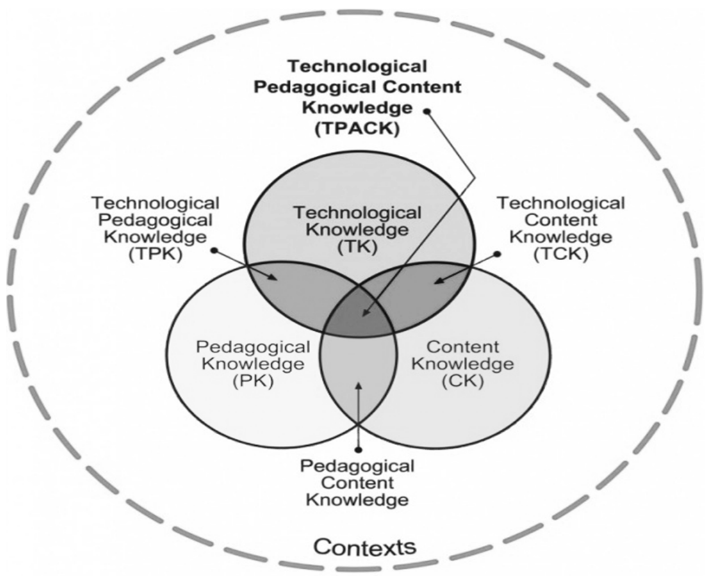

Figure 1: TPACK framework (Chai et al., 2013; Koehler & Mishra, 2008)

The study utilised the TPACK framework to measure the knowledge the pre-service teachers acquired during their four-year training. The components of the TPACK framework are explained by Koehler & Mishra (2005; 2009).

2.1 CK, PK and PCK

According to Shulman (1986), CK is teachers' knowledge of the subject matter they teach whereas PK is the knowledge of how to teach. On the other hand, PCK is the knowledge of how to teach a particular content and is considered to qualify the teaching profession (Shulman, 1986).

2.2 TK, TCK and TPK

TK is the knowledge to use technology (hardware, software and peripherals). Due to the dynamic nature of technology, TK gets outdated quickly unless individuals keep up with new technologies. Again, whereas TPK is a comprehension of how teaching and learning changes when specific technologies are utilised, TCK is a comprehension of the way in which technology and content impact and constrain each other (Koehler & Mishra, 2006). Numerous studies, however, highlight that TCK is challenging for many teachers (Bowers & Stephens, 2011; Chai et al., 2013; Tondeur et al., 2017; Voogt & Mackey, 2017).

2.3 TPACK

Finally, TPACK is the intersection of all the three knowledge areas (TK, CK, and PK). Comprehension of TPACK goes beyond any single category of TK, CK, and PK. A teacher capable of negotiating these relationships represents a form of expertise different from and greater than the knowledge of a disciplinary expert (say a mathematician), a technology expert (an ICT specialist) and a pedagogical expert (an experienced educator). A recent study by Dalal, Archambault and Shelton (2017) reported some improved TPACK abilities in teachers in some developing countries including Africa. However, it is still not common practice in many countries, Kenya being one of them.

3. Methodology

3.1 Research design and philosophy

The study employed a survey research design because ‘surveys are well suited for gathering a snapshot of how things are at a specific point in time’ (Denscombe, 2014, p.8). Therefore, a quantitative paradigm on the research problem was adopted with a positivist ontology to maintain objectivity through detachment from participants to avoid contaminating the data from researcher perspective (Dencombe, 2014; Gray, 2014). Although qualitative data could have added depth by explaining the results, that was never pursued because the study targeted breadth rather than depth. This meant measuring TPACK knowledge from as many pre-service teachers as possible (Dencombe, 2014; Oppenheim, 1992).

3.2 Participants

A total of 38 pre-service teachers consisting of 31 males and seven females who graduated from the BEd program in December 2017 voluntarily completed the TPACK survey. 38 respondents were deemed adequate since the study was a small-scale pedagogic research aimed at improving classroom level practices. Twenty respondents were from the BEd (science) cohort whereas 18 were from the BEd (arts) cohort.

3.3 Instruments and data collection

Data was gathered using a validated TPACK survey questionnaire (Schmidt, Baran, Thomson, Mishra, Koehler, & Shin, 2009). The Cronbach’s alpha reliability estimates of this instrument ranges from 0.75 to 0.93 suggesting that the instrument is reliable. The questionnaire measured participants’ self-reported competency in technology and its integration with Pedagogy and Content (TPACK). The questionnaire had seven constructs: TK, CK, PK, TCK, PCK, TPK and TPACK (see appendix A). Each item response was scored from a value of 1= strongly disagree, to 5= strongly agree.

3.4 Data analysis

Data was analysed into means, standard deviations and percentages using SPSS statistical analysis version 25 program. Different aspects of participants’ knowledge (Gray, 2014) in the seven TPACK constructs were measured. For each construct, participant’s responses were averaged. For example, the six questions under the Technology Knowledge (TK), were averaged to produce one TK score. The same procedure applied to the remaining constructs. The averaged values of each construct were then used to determine the technology integration competencies of the pre-service teachers upon completing the BED (Hons) program.

3.5 Ethics

This included openess, disclosure, privacy and responsibility to the research participants and institutions. A research clearance permit from the Kenyan government via the National Commision for Science, Technology and Innovation (NACOSTI) was obtained to permit usage of the data within and beyond Kenya. Consent to collect data from university authorities and students were sort before the start of the study.

4 Findings and discussion

The study assessed pre-service teachers' self-reported ability to integrate technology into teaching upon completing training in a Kenyan university. The results in Table 1 shows two key findings relating to pre-service teachers' TPACK, TK and TCK competencies.

Table 1: Pre-service teachers' Technological Pedagogical and Content Knowledge (TPACK) after training

TPACK survey	Mean (M)	Std. Deviation (SD)
Content knowledge (CK)	4.15	0.89
Pedagogical knowledge (PK)	4.17	0.73
Technological knowledge (TK)	3.54*	1.14
Pedagogical content knowledge (PCK)	4.21	0.83
Technological content knowledge (TCK)	3.81*	0.85
Technological pedagogical knowledge (TPK)	4.19	0.76
Technological pedagogical and content knowledge (TPACK)	4.16*	0.66

N=38, 1 = *Strongly Disagree, 2=Disagree, 3=Neither agree or disagree, 4=Agree* and 5 = *Strongly Agree*

First, the mean values for CK, PK, TK, PCK, TCK, TPK and TPACK in Table 1 are all above the average (mean 2.5 in a 5 points scale, where 1= Strongly Disagree and 5= Strongly Agree). The TPACK mean score, in particular, is 4.16 suggesting that the pre-service teachers had no problem bringing technology, pedagogy and content in an integrated manner after training. This finding is confirmed by (Dalal et al., 2017) who found that secondary school teachers from developing countries including Africa had increased abilities in all TPACK domains after a semester-long technology training. Results from this study further show that the teachers scored highest in their PCK at the mean of 4.21 indicating their confidence in the knowledge underpinning their teaching expertise. This is confirmed by Shulman (1986) who recognises PCK as a core competency influencing effective teaching practices without technology.

Second, it is interesting that despite adding a technology-related module (TED 102) into the University's BEd (Hons) program, it continues to develop more of pre-service teachers' pedagogy and content knowledge competencies than the technology-related competencies. For instance, results in Table 1 reveals that the pre-service teachers are neutral in their TK and TCK responses at the mean of 3.54 and 3.81 respectively. The findings imply that the teachers were unsure about their technological skills (TK) and technologies that best suit their subject-specific domains (TCK). The findings could have implications on pre-service teachers' selection and use of technology-rich teaching and learning resources. Teachers are less likely to use technology as a teaching and learning resource when they lack knowledge about it, its features and how to use it. Based on the results, the pre-service teachers' TK and TCK competencies were analysed further as possible areas of concern.

4.1 Pre-service teachers' TK

Further analysis of TK shows that almost half of the pre-service teachers feel they know little about different technologies at 37% with another 16% being neutral. The pre-service teachers' TK also registers the highest standard deviation of 1.14 in table 1 indicating respondents' variability in this construct. The finding is confirmed by (Ndibalema, 2012). Since technology is dynamic (Mishra & Koehler, 2009), the finding may be attributed to a range of institutional and individual-related challenges. For instance, the pre-service teachers' lack of confidence in their technical skills could be caused by their awareness of the world's advancement in technology. As a consequence, they compare themselves in that scale and can see how far behind they are in technology because of inadequate computer hardware, software and the internet facilities at the University as supported by previous studies (Manduku et al., 2012; Voogt & Plomp, 2010). This view is further supported by the results showing that the pre-service teachers almost disagree that they know about different technologies and play around with technology at means of 3.21 and 3.32 respectively. Perhaps the pre-service teachers expect more training on technologies than what the university currently provides. Moreover, previous research observes that learning institutions including universities are always slow to adopt new technologies contrary to their students' expectations (Tondeur et al., 2017; Voogt & McKenny, 2017).

Despite the lack of confidence in their knowledge about different technologies, the teachers have some positive attitude towards technology since they almost agree that they can learn technology easily and had some knowledge to use technology both at (M= 3.76, SD= 1.08). This implies that majority of the teachers are willing to learn about technologies and possess basic technological skills. The findings concur with the research findings by Bate (2010) and Gao et al. (2010) who found that the current pre-service teachers enter the profession with a set of basic technological skills and were more willing to learn and use technology. The large standard deviation of 1.08 in the teachers' responses about their ability to learn and use technology points to the variations in individual students' attitudes and efforts to acquire technical skills. It could be that some of the pre-service teachers either struggle on their own or through peer support to gain familiarity and fluency in the use of different technologies than others.

The result shows that the BEd (arts) students had less technological skills compared to the BEd (science) students. For instance, whereas 65% of BEd (science) respondents agree that they know about a lot of different technologies, only 28% of the BEd (arts) testified to this. Furthermore, the BEd (science) respondents reported keeping up with important new technologies at 80% than the BEd (arts) at 56%. The finding linking the science-based pre-service teachers to more technical skills than the arts-based teachers may be unique to the university. Alternatively, the finding may apply to other teacher training institutions subject to confirmation by future research. A possible explanation for this finding is that science and technology are related. Whilst science is the study of the natural world via collection and logical analysis of data, technology is the application of science to make devices that can perform tasks and solve problems. This means technology originates from science. Therefore, it could be that the BEd (science) students could be finding it easy to learn and keep up with technology because it is related to science. For instance, the BEd science group might possess a logic-oriented mind which supports technology learning than their BEd (arts) students who could be artistic and inductive in thinking.

Although the female sample of seven in the study was low and needs to be treated with caution, the result suggests that only 29% of the female teachers feel they know about different technologies compared to male student teachers at 52%. Two factors could explain this finding. First, a gender-based stereotype which perceives Science, Technology Engineering and Mathematics (STEM) as male-related subjects. Such stereotype could limit many Kenyan girls from passing sciences at high school thus denying them the chance to pursue science-based courses at the university. Hence, the male students are highly likely to outnumber females in the BEd (science) stream. Second, since technology is dynamic, its learning and use are mostly linked to interest and experimentation with technologies. Therefore, it is probable that the African male child could be advantaged in keeping up with and learning about new technologies due to their adventurous trait and willingness to experiment with new things than their female counterparts.

4.2 The pre-service teachers' TCK

Another result from table 1 which required further analyses is the pre-service teachers' TCK competency at a mean of 3.81. The analyses showed that although the teachers felt they can think critically about how to use subject-specific technologies, they also felt unfamiliar with such technologies at a mean of 4.00 and 3.61 respectively. The challenges posed by the TCK knowledge has been widely discussed in the literature with Bowers and Stephens (2011) attributing it to the fact that some subject domains may require more specialist technologies which many teachers may not be conversant with. Voogt and McKenny (2017) also found that many pre-service teachers in Dutch training institutions struggled in preparing technology-rich lessons in their subject-specific domains. Furthermore, Chai, Koh, and Tsai (2013) and Tondeur et al. (2017) highlight that subject-specific technologies (TCK), is the least researched and the most challenging component of the TPACK framework because it means teaching technology-rich lessons across different subject-specific areas. Using graphing calculators in Mathematics or using google maps in geography, for example, can be challenging for many teachers because certain content can limit the choice and type of technologies that can be used. However, the reason why the pre-service teachers in this study scored higher in TCK than in their TK, presents the ground for in-depth future investigation at the institution.

Further analysis by degree cohort also revealed that more BEd (arts) students lack TCK competencies than the BEd (science) students. For instance, 30% of the BEd (arts) disagree that they possess TCK knowledge compared to BEd (science) students at 10%. Again, this finding implies that the BEd (arts) students would require more support to improve their TCK component than the BEd (science) students.

5. Implications for practice

The study found that the pre-service teachers' technological knowledge (TK) and the knowledge about subject-specific technologies (TCK) are moderate and need support. The findings have institutional implications which might include re-designing the curriculum materials and improving the ICT infrastructure, which again, require a huge amount of time and resources to implement. In this paper, however, we argue that it is better to start improving the pre-service teachers' TK and TCK competencies by utilising whatever technologies available at the institution. For instance, students' mobile devices with multimedia functions and the use of appropriate teaching strategies can be exploited as a starting point. This small-scale pedagogic research will only focus on using the study results to improve practice at the classroom and individual levels. The paper utilises theory to underpin good practice. In particular, the paper proposes two instructional strategies to improve pre-service teachers' TK and TCK: learning by doing (Aldrich, 2005; Bot, Gossiaux, Rauch, & Tabiou, 2005) and growth mindset (Dweck, 2006).

First, moving towards student-centred experiences is critical. Teachers' TK and TCK competencies could be enhanced via an instructional shift from the passive chalk-and-talk, to active learning of technologies by 'doing' (Aldrich, 2005; Bot et al., 2005). We all learn by doing, yet with regards to finding out about technologies, this is fundamental. It can be difficult for pre-service teachers to learn about technologies by essentially reading books and listening to lecturers as is currently the case in most African universities including Kenya (Agyei & Voogt, 2011). The methods develop more of the cognitive awareness rather skill competency needed in the learning about and using technology. Lectures and books only provide ideas of what is conceivable about technologies, yet until students utilise it themselves, or solve problems with it, they may just have a surface level instead of a deeper understanding about technologies. Learning by doing could provide answers to teaching about technology.

Essentially, developing pre-service teachers' TK and TCK needs not only theoretical knowledge about different technologies such as blogs (cognitive domains) but also opportunities to practice using such technologies (psychomotor domains) through collaborative activities (affective domain). By working collaboratively, students not only benefit from peer and tutor support but also feedback, for example, on how to use subject-specific technologies (TCK) in their subject areas of specialisation. Currently, the delivery of the technology-related module (TED 102) could be too theoretical to permit adequate TK and TCK development. Shifting towards active learning by doing with a focus on student-centred experiences is critical.

Learning by doing is an active learning method (Bot et al., 2005) which according to Porkony and Warren (2016), enables deeper learning using student-centred experiences. Student-centred experiences include collaborative sessions, projects and group work that enable students to actively learn in a socio-constructivist way (Vygotsky, 1978) about what they are reading about technologies. Through learning by doing, pre-service teachers are likely to be more engaged in practical tasks which support their understanding, reflection and application of new knowledge (Biggs & Tang, 2011), for example, about technologies such as Wikis and Blogs. But how can learning by doing be implemented to improve pre-service teachers' TK and TCK competencies?

This paper proposes three simple steps to implementing learning by doing towards the improvement of pre-service teachers TK and TCK competencies: 1. create a goal 2. get started, and 3. practice. To start with, creating a goal is crucial to help teachers identify the immediate application of technology. This may include a quick overview of what students can do with the technology. Next, the precursor to doing this is the getting started stage. Here we propose that teachers be helped to focus on aspects of the technology that will be immediately valuable to them.

Resources to practice the skill are also provided at this stage, including steady internet access, so that teachers can delve deeper into the topic if and whenever they feel necessary. For instance, pre-service teachers may be asked to download and install free applications and play around with it. Struggling students at this stage can do a further reading from books or watch tutorial guides on how to get started. This way, pre-service teachers can also observe, discuss and reflect on uses of a particular technology for TK development. This may help them see the utility, value and feasibility of using a particular technology in a particular subject area. Finally, students need opportunities to practice. For example, through relevant practical assignments about the technology teachers transform themselves into active designers of technology-rich-lessons in their specific subject areas by working in collaborative teams in order to improve their TCK competencies. Through collaborative working, pre-service teachers can design, critique and re-plan a variety of micro-lessons which identify and make use of the immediately available technologies in their subject-specific domains. The aim of such lessons is to connect technology with content for TCK development. In small groups, for instance, pre-service Mathematics teachers can design and teach a statistics miro-lesson using Microsoft Excel. Similarly, history teachers may decide to use podcasts to teach World War 2. This way, not only the pre-service teachers' TCK is enhanced but also their technological knowledge (TK) in a more critical and practical manner.

Because our capacity to learn new things is impacted upon by our attitudes and perceptions, supporting a growth mindset (Dweck, 2006) in pre-service teachers can be another useful strategy. According to Dweck (2006), there are two types of mindsets. One that embraces challenges as opportunities to learn and one that avoids them out of fear to fail. People who avoid challenges can be described as having a fixed mindset. Those who see challenges as opportunities to improve have a growth mindset. Growth mindset thus refers to the idea that intelligence and abilities are not fixed but can be developed through persistence and support. Growth mindset according to Dweck (2006), creates love for learning new things. Growth mindset strategy can be targeted at the BEd (arts) and female students which according to the findings, perform dismally in their TK and TCK. A growth mindset could help pre-service teachers to persistently learn about technologies and subject-specific technologies. Also, since pre-service teachers can be frustrated when their lecturers struggle with digital skills (Voogt & McKenny, 2017), growth mindset strategy would also be helpful towards improving lecturers' technological skills.

Developing growth mindset requires constant learning, perseverance, and accepting challenges, failure and feedback. Constant learning by growth mindset standards does not seek approval but rather, others' support to improve and come up with new and better ideas about technologies. As teachers and teachers' educators are likely to encounter challenges such as inadequate ICT infrastructure within universities, they are encouraged to embrace the challenges as opportunities to confront through personal responsibility. Although failures are inevitable in such undertakings, growth-mindset teachers and instructors are expected to learn from them. As Race (2001) argues, feedback is about the work and not about the individual who did the work. Embracing feedback and using it to improve TK and TCK competencies can be crucial for pre-service teachers and their instructors. Instead of feeling intimated by feedback, growth mindset teachers would see it as opportunities for future improvements.

In conclusion, the study found that the pre-service teachers already have prior knowledge in all the TPACK areas. However, their self-reported technological Knowledge (TK) and subject-specific technologies (TCK) were neutral. The finding makes the pre-service teachers' TK and TCK as possible areas of concern at the university. Also, a new finding emerging from this study is that the pre-service teachers who study science-based subjects perform better in their technical skill than those pursuing arts-based subjects. Additionally, the male pre-service teachers seem to perform better in their technical skills score than the female teachers. The study recommends a follow-up study to gain deeper insights into pre-service teachers' TK and TCK inadequacy before any major curriculum review and equipping of the university with additional ICT infrastructure can be undertaken.

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