Chapter # 27

THE E-READINESS OF STUDENT TEACHERS FOR 21ST CENTURY TEACHING: SOME REFLECTIONS FROM A UNIVERSITY OF TECHNOLOGY IN SOUTH AFRICA

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ABSTRACT
The COVID-19 pandemic and the hygienic measures of social distance brought impasses to education. Face-to-face activities are suspended, and this accelerated the use of Information Communications Technology (ICT) in most schools. Based on these changes, teacher education and training at universities should prepare prospective teachers that are able to function within digital and virtual classrooms. This study investigates the level to which student teachers were exposed to Technological Pedagogical Content Knowledge (TPACK) needed by them to function within such classrooms during and post-COVID-19 times. The study analyses, the Central University of Technology's (CUT) final year Bachelor of Education student teachers' e-readiness to integrate ICT and present lessons in these classrooms. A total of 60 student teachers were purposively selected for this study. Data was collected using online questionnaires. A 5-point Likert scale questionnaire was used to collect data from student teachers. Subsequently, results revealed that student teachers are aware of the importance of ICT and e-learning in schools. However, they acknowledge that they have limitations, and they are not fully ready in implementing ICT in digital & virtual classrooms. The study concludes by offering several theoretical and practical recommendations for the e-readiness of student teachers in such environments.

Keywords: e-learning, e-readiness, information communications technology (ICT), teacher education.

1. INTRODUCTION

The COVID-19 pandemic is one of the eight declared pandemics since the beginning of the 21st century. It is among the six pandemics that directly damage the respiratory system in human beings (Guillén, Cuellar, & Alfaro, 2020). In preventing the spread of this pandemic, health authorities have recommended among other contagion-prevention measures, social distancing, wearing of masks, and social confinement. As a result of these measures, COVID-19 has streamlined the obligatory use of Information Communications technology (ICT) in most fields and services including education (Guillén et al., 2020, Lake & Dusseault, 2020).

Face-to-face teaching was interrupted in schools around the world from 2019 to 2020 academic years due to this pandemic (Lake & Dusseault, 2020). Remote teaching and learning were then encouraged by most education authorities around the world. Faced with this need for change, schools are challenged by this new normal because most teachers are not properly trained for these forms of teaching (Guillén et al., 2020). This is because remote teaching and learning required teachers to be skilled in, among others, online teaching, blended teaching, e-learning, m-learning, the use of Learner Management Systems (LMS), Open Education Resources (OER), the use of the Internet, etc.

In addition to teachers’ challenges, many working parents, in general, were struggling to help with the education of their children (Department of Basic Education, 2018). This is because remote learning predominantly requires the assistance of parents at home. In essence, it requires a higher level of literacy and education from the side of parents, and this poses a challenge to illiterate parents, especially in third-world countries like South Africa.

Like many other countries, the South African government through the Department of Basic Education (DBE) encourages the introduction of remote teaching and learning during this period of the pandemic (Ndebele, 2020). Schools were encouraged to use online teaching and learning, blended learning, e-learning, m-learning, and many ICT-integrated strategies for teaching and learning (Ndebele, 2020). Noticing this global trend compelled teacher training institutions like universities to be serious about infusing the use of ICT in teacher training. The Central University of Technology (CUT) like most universities had to equip student teachers that are studying for the Bachelor of Education (B.Ed.) degree with ICT integration skills.

The purpose of this empirical research is to investigate the level to which student teachers at CUT are exposed to the integration of ICT in their teaching. This study focused only on teacher education as presented by one public university in South Africa (SA). There might be differing views about teacher education as presented by private universities in SA and/or in other countries. Again, because ICT integration is a broad concept, it can be viewed either as a goal or a process depending on the researcher’s paradigm. This study focused on the training of pre-service teachers in how to use ICT to respond to the notion of equalizing educational opportunities in SA and to capacitate student teachers in the use of ICT in the classrooms. Also, to enable student teachers to respond to the demands of the 21st-century classrooms, the 4th industrial revolution, and to respond to the requirements of providing education during and post-COVID-19 era.

The organization and content of traditional pre-service teacher education programs around the world are changing quickly due to ICTs' quick development. Pre-service teacher education faces a challenging issue in attempting to integrate modern technologies with effective teaching (Jin & Harp, 2020). Regarding its functional relationship to a pedagogical and didactical philosophy, the use of technological affordances to support learning should be considered. The use of technology in the classroom has the potential to alter how people teach and learn (Jung & Ottenbreit-Leftwich, 2019). The ability of preservice teachers to integrate ICTs into their classroom practices and teaching strategies depends on their overarching approach to education, which derives from their implicitly or explicitly adopted learning theories' perspective, as pedagogy and didactics embed the methods and practices of teaching (Jin & Harp, 2020, Jung & Ottenbreit-Leftwich, 2019). The review of the literature shows that teachers' adoption of various philosophies derived from learning theories has a direct impact on (1) how they choose and employ ICTs, (2) how they perceive their role as teachers in the context of putting their adopted learning theory into practice, (3) as well as the perceived role of their learners in the teaching-learning process.

2. ICT INTEGRATION MODEL

According to Kimmons, Graham, and West (2020) the purposes and components of a model should be characterized by what, *how, why, and who/where/when*. The first component, i.e., what, requires the model to be comprehensive enough but adequately limited to allow for parsimony and to prevent overreaching. A model should include enough variables, and ideas and have detailed explanations (Kimmons et al., 2020). Second, the model should show the interrelatedness of the components it proposes. Its structure should allow for the model to make sense of the world in different ways. Third, it must provide logic and rationale to support why components are related in the proposed form. Forth, a model must be bound by a context representing the who, where, and when of its application (Kimmons et al., 2020).

Currently, various models are used to train teachers on effective technological integration. These include among others the Levels of Technology Integration (LoTi), Technology Acceptance Model (TAM), Substitution – Augmentation – Modification – Redefinition (SAMR), Replacement – Amplification – Transformation (RAT), Technological Pedagogical Content Knowledge (TPACK), Technology Integration Planning (TIP), Technology Integration Matrix (TIM) and recently the Passive, Interactive, Creative, Replacement, Amplification, Transformation (PICRAT) (Kimmons et al., 2020, Karatza, 2019).

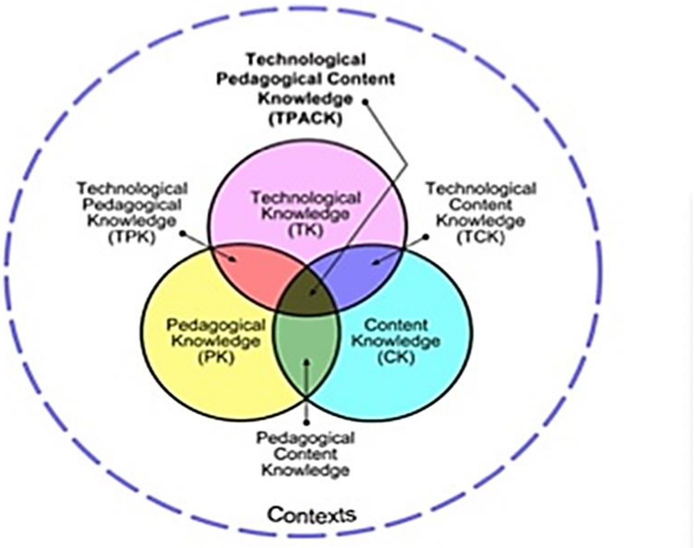
This study uses the TPACK model because according to the researcher, it is an appropriate model that is in line with the four components, what, how, why and who/where/when, as discussed above. Also, this study chooses this model because it is a model most referred to in several education policies of the South African education system, among others the Action plan to 2019: Towards the Realisation of Schooling 2030 (DBE, 2015), and the Professional Development Framework for Digital Learning: Building Educator Competencies in Facilitating Learning with Digital Tools and Resources (DBE, 2018).

Technological Pedagogical Content Knowledge (TPACK) is a teacher knowledge model aimed at enabling teachers to effectively teach with technology. It is an extension of Lee Shulman’s framework of Pedagogical Content Knowledge (PCK) to include the use of technology in schools (Shulman, 1986, 1987; Mishra & Koehler, 2006). The TPACK framework was first presented by Punya Mishra and Matthew Koehler (2006) (Koehler, Mishra, & Cain, 2013).

Again, in answering the question, ‘why this framework?’, Mishra and Koehler (2006: p. 14) argue that “teaching is a complex domain. So successful teaching depends on flexible access to knowledge and the application and systematic organization of powerful knowledge in the classroom”. Again, teaching takes place in a dynamic environment. Successful teachers need to understand learners' thinking and learning pathways, how learners acquire content knowledge, and learners' technical knowledge (Mishra & Koehler, 2006; Mishra & Koehler, 2008). This can be achieved by equipping learners with the necessary knowledge they need to master their subject content.

Integrating ICT in education requires knowledge of the three main domains of a learning environment, namely, content, pedagogy, and technology. Content, pedagogy, and technology are the three knowledge dimensions that form the bases of the TPACK framework. The TPACK framework is thus the interaction between and among the above-mentioned domains of knowledge in all forms of acquisition to formulate objective knowledge needed for 21st-century classrooms (Mishra & Koehler, 2006; Koehler et al., 2013). The TPACK model is diagrammatically represented as follows:

Figure 1.
Technological Pedagogical Content Knowledge Model.



Source: Mishra & Koehler, 2006

The TPACK framework and its seven knowledge domains. The three core components of this framework are content, pedagogy, and technology (Mishra & Koehler, 2006, 2008). In addition to these, the three components are combined in pairs. These combinations form another three components, namely, Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK). The rest of the components combine to form the framework entitled Technological Pedagogical Content Knowledge (TPACK) (Mishra & Koehler, 2006).

2.1. Content Knowledge (CK)

This domain refers to the outstanding knowledge of the subject matter that teachers must have to teach. A teacher must have a thorough understanding of the subject matter or content that they are going to teach (Shulman, 1987; Mishra & Koehler, 2006; Koehler et al., 2013). The teacher must have expertise in the subject level that he/she will be teaching; for instance, the subject knowledge of mathematics at primary school, high school, and university differs. According to Shulman (1987, p. 6), the teacher's "content knowledge should embrace subject concepts, theories used in the subject, relevant philosophies, organizational frameworks, evidence, and proof, as well as reputable tactics and ways of developing such knowledge".

Teachers must possess content knowledge, which calls for insight and in-depth knowledge of the subject matter they are teaching. (Koehler et al., 2013). Teachers who lack a thorough understanding of their subject matter run the risk of losing the respect and integrity of their students in this technologically advanced age where information is so readily available (Biggs & Tang, 2011; Koehler et al., 2013). In short, the content knowledge base of teachers comprises depth and breadth of conceptualization of the subject matter (Koehler et al., 2013).

Again, content knowledge should enable a teacher to answer content-specific questions that may arise from the students and their peers. It should also be in greater depth to enable a teacher to teach beyond the textbook, at different levels, or using different methodologies or different pedagogies (MaKinster & Trautmann, 2014).

2.2. Pedagogical Knowledge (PK)

Pedagogical knowledge refers to a deepened understanding of strategies, methods, and processes that teachers should employ in the teaching and learning of their respective subject specializations (Mishra & Koehler, 2006, 2008; Koehler et al., 2013). It involves a thorough understanding of the aims and objectives of a subject, the educational purpose and values of the subject, and the ability to plan activities that will make the learning of the subject easy and make the subject relevant and enjoyable to learners (Mishra & Koehler, 2006, 2008; Koehler et al., 2013). MaKinster & Trautmann (2014: p. 340) states that "pedagogical knowledge broadly covers what teachers know related to teaching, curriculum, and assessment". Also, PK is about teachers' understanding of how learners learn, classroom management skills, lesson planning, development of classroom activities, and assessment of learners (Mishra & Koehler, 2006; Koehler et al., 2013).

2.3. Pedagogical Content Knowledge (PCK)

PCK is about the knowledge and understanding of a subject matter taught, meaning the pedagogy of a specific subject. PCK relates to Shulman's (1986, p. 4) belief that "real teaching requires an understanding of both content and pedagogy". It does not require one to be just a content expert or just a pedagogy expert, but it requires teachers to have the expertise to match content with relevant pedagogy so that effective learning can take place (Mishra & Koehler, 2006). According to Mishra and Koehler (2008: p. 9), this knowledge domain "revolves around the teacher's ability to properly teach, plan relevant activities for learning, understand the core and hidden curriculum, conduct assessment, and report results of a subject".

Hence, the concept of PCK is the transformation, by the teacher, of the content (Shulman, 1986; Mishra & Koehler, 2006; Koehler et al., 2013). A teacher who has a deep PCK can interpret the subject matter well, can present the subject matter in a way suitable to their learners, and can develop suitable teaching and learning materials to meet the needs of individual learners in their classrooms (Shulman, 1986; Mishra & Koehler, 2006; Koehler et al., 2013).

2.4. Technological Knowledge (TK)

The technological component of this framework was added to the original PCK framework of Shulman (1986) by Mishra and Koehler in 2006. They referred to this knowledge as the teachers' standard knowledge of technology, and the skills to operate particular technologies (Mishra & Koehler, 2006, 2008). This definition did not suffice and attracted a lot of criticism due to the ever-changing nature of ICT. In trying to address the criticisms of their initial definition, Koehler et al. (2013, p. 14) implemented the definition of Fluency of Information Technology (FITness) which stated that technological knowledge is way above the traditional notion of computer literacy (Koehler et al., 2013). TK requires an individual to understand ICT in general and to apply it for productivity at work and at home (Koehler et al., 2013). FITness further specifies that TK is the ability of one to recognise when ICT can be useful or destructive towards the realisation of set goals and an individual's ability to integrate technological changes (Koehler et al., 2013). According to

MaKinster and Trautmann (2014, p. 340), “As teachers learn to use a piece of software, they need to be able to imagine how their students would use it, what opportunities it would create, and what challenges they might face.”

TK requires a deep understanding and mastery of ICT so that they can access, process, and disseminate information (Graham, 2011). It also refers to the teacher’s understanding of communication and problem-solving (Koehler et al., 2013). It requires the teachers’ knowledge of the use of both technologies that are still in analog forms, like pencil, chalkboard/whiteboard, microscope, etc., and recent technologies that are in digital forms, like computers, tablets, mobile phones, Internet, etc. The knowledge required here should not be about physical resources only but should also be about processes applied to solve problems with these devices (Graham, 2011). Most technological devices are not made for the sole purpose of education. So, TK here requires teachers to adopt and adapt these technological resources to serve and benefit the educational environment (Mishra & Koehler, 2006, 2008).

2.5. Technological Content Knowledge (TCK)

TCK refers to the teacher’s knowledge of the interchangeable relationship between technology and content (Koehler et al., 2013). It is simply the way content and technology influence and constrains one another (Mishra & Koehler, 2006, 2008). It characterizes the integration between what a teacher knows about applicable technological applications and about the topic of interest (MaKinster & Trautmann, 2014). Here the expectation is that a teacher must know a great deal about the subject matter that they teach. Teachers should have a deep understanding of the technological applications that can be used to teach the subject and to clarify and explain the subject matter. They should know that certain technologies are best suited for certain subject matter learning (Mishra & Koehler, 2008; Koehler et al., 2013). For example, software applications like Google Earth can be useful to teach geography, GeoGebra can be a useful application to teach Geometry in Mathematics and Google Translate can be used to assist students that are studying foreign languages or a second language or third language.

It involves the teachers’ understanding of the ways in which educational technologies can represent concepts, topics, and processes in ways that are challenging, engaging, and meaningful to learners. It is the teacher’s ability to find technological tools with which to present and explore a variety of subject concepts (MaKinster & Trautmann, 2014).

2.6. Technological Pedagogical Knowledge (TPK)

TPK refers to the shared relationship between technology and pedagogy. It is defined as the teacher’s knowledge and understanding of the use of technology devices that can advance the attainment of pedagogic goals (Koehler et al., 2013). It is the teacher’s ability to select the most suitable tools or applications based on their appropriateness for the specific pedagogical approach (Koehler et al., 2013). It involves knowledge of technological devices that influence the nature of learner-teacher interaction. For example, in a school that has different educational electronic resources like computers, interactive whiteboards, radios/CD players, etc., a teacher must know which electronic resource to use for which grade, for which learners, and for which subject matter. TPK is the teacher’s capability to develop creatively and be flexible in the use of available technological resources and to repurpose these resources for specific pedagogical environments (Mishra & Koehler, 2008).

2.7. Technological Pedagogical Content Knowledge (TPACK)

Technological Pedagogical Content Knowledge (TPACK – pronounced "t-pack") is at the center of the above-mentioned knowledge bases. It is the latest form of knowledge and understanding that goes beyond the basic components of content, pedagogy, and technology, of teaching and learning (Mishra & Koehler, 2008; Koehler et al., 2013). It involves the knowledge of the interaction between content, pedagogy, and technology (Mishra & Koehler, 2008; Koehler et al., 2013). TPACK is further explained as the teacher's synthesized knowledge of the knowledge areas described above with the intention to integrate technology to meet pedagogical needs within a specific context. It describes how teachers' knowledge of educational technology interacts with PCK in ways that produce effective teaching and opportunities for learners' learning (MaKinster & Trautmann, 2014).

TPACK encompasses the teacher's ability to use technology to make teaching and learning easy. It involves the use of ICT to bridge barriers to learning (Koehler et al., 2013). This knowledge domain is about the teacher's knowledge and ability to detect learners' prior knowledge (Koehler et al., 2013). It enables teachers to apply technology timeously and continuously to create, maintain and re-establish a dynamic balance among content, pedagogy, and technology (Mishra & Koehler, 2008; Koehler et al., 2013).

According to Koehler & Mishra (2009, p. 66), TPACK is "effective teaching with technology, requiring an understanding of the representation of concepts using technology; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones". In short, it is the use of appropriate technology in content as part of a pedagogical strategy within a given educational context (Koehler et al., 2013; MaKinster & Trautmann, 2014).

The revised version of the TPACK framework was not part of this study but contextual knowledge can be pursued for further research on the topics of TPACK (Mishra, 2019).

3. METHODOLOGY

To investigate the e-readiness of student teachers' ability to integrate ICT in their classrooms. This study employed a qualitative research approach. The study used an online questionnaire administered through the university's Learner Management System (LSM).

3.1. Sample

Purposive sampling was used to identify participants used in the Sixty (60) student teachers, from a total population of about 600 student teachers that are in the 4^{th} year of their B. Ed degree was used to identify participants in the study. A closed structured questionnaire was designed using a 5 Likert scale of agreements with the variables ranging from Strongly Agree (1); Agree (2); Neutral (3); Disagree (4) and Agree (5).

The structure of the questionnaire is framed around the Technological Pedagogical Content Knowledge (TPACK) model. This was done to identify the acquired and/or lacking knowledge domains regarding ICT integration in the classroom. Seven themes were identified according to the TPACK framework, these are Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technological Knowledge (TK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), Technological Pedagogical Content Knowledge (TPACK).

3.2. Ethical issues

Ethical clearance was obtained from the Central University of Technology, Faculty of Humanities, and Research Committee (FRIC) before collecting data. The participants were provided with an online consent form regarding their participation. The online consent form explained the purpose of the study and informed the participants that they participate in the study freely and without coercion and that they can withdraw at any time should they choose to do so. The researcher requested the participants to give consent before the commencement of data collection. This was done to avoid any potential risk to participants and to ensure that the researcher's methods are honest, fair, and non-manipulative (Cohen, Manion, & Morrison, 2018).

4. RESULTS & DISCUSSIONS

The aim of this study was to investigate the e-readiness of student teachers in the integration of ICT for digital education in COVID-19 times. The structure of the questionnaire was in the form of the seven (7) knowledge domains of the TPACK framework. Four statements were put in for each knowledge domain.

Table 1.
Student teachers' Content Knowledge (CK).

	Statement	Strongly Agree	Agree	Neutral	**Disagree**	**Strongly Disagree**	**Total**
1	I have adequate knowledge about my specialization in the teaching subject	32(53,3%)	28(46,7%)	0(0%)	0(0%)	0(0%)	60(100%)
2	I can use subject-specific strategies of thinking in my specialization in the teaching subject	32(19%)	28(41,6%)	0(0%)	0(0%)	0(0%)	60(100%)
3	I know the basic theories and concepts of my specialization in the teaching subject	17(28,3%)	31(51,7%)	12(20%)	0(0%)	0(0%)	60(100%)
4	I know the history and development of important theories in my specialization in the teaching subject	7(11,7%)	32(53,3%)	12(20%)	8(13,3%)	1(1,7%)	60(100%)

This domain refers to the outstanding knowledge of the subject matter that teachers must have to teach. A teacher must have a thorough understanding of the subject matter or content that they are going to teach. Content knowledge requires teachers to have an understanding and deep knowledge of the subject area they are teaching (Shulman, 1987; Mishra & Koehler, 2006; Koehler et al., 2013). From the table above most of the respondents seemed to agree that they have been provided with adequate and required content knowledge to teach the subjects of their specialization. University lecturers seem to pay more attention to content knowledge (CK) and student teachers are mostly exposed to it (Doukakis et al., 2010).

Table 2.
Student teachers' Pedagogical Knowledge (PK).

	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
1	I can alter my teaching based on what students understand or do not understand	24(40%)	29(48,3%)	7(11,7%)	0(0%)	0(0%)	60(100%)
2	I can adapt my teaching style to different learners	24(40%)	29(48,3%)	7(11,7%)	0(0%)	0(0%)	60(100%)
3	I can use a variety of teaching approaches in a classroom setting	24(40%)	29(48,3%)	7(11,7%)	0(0%)	0(0%)	60(100%)
4	I can assess student learning in multiple ways for different learners	16(4,9%)	31(8,5%)	11(3,5%)	2(53,5%)	0(0%)	60(100%)

Pedagogical knowledge refers to a deepened understanding of strategies, methods, and processes that teachers should employ in the teaching and learning of their respective subject specializations. It involves a thorough understanding of the aims and objectives of a subject, the educational purpose and values of the subject, and the ability to plan activities that will make the learning of the subject easy and make the subject relevant and enjoyable to learners (Mishra & Koehler, 2006, 2008; Koehler et al., 2013). Most respondents agree that they can handle differentiated pedagogies. However, they are slightly not in agreement when it comes to the administering of assessments in their classrooms.

Table 3.
Student teachers' Pedagogical Content Knowledge (PCK).

	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
1	I know how to select effective teaching approaches to guide student thinking and learning	32(53,3%)	28(46,7%)	0(0%)	0(0%)	0(0%)	60(100%)
2	I know how to develop appropriate tasks to promote student's complex thinking	32(19%)	28(41,6%)	0(0%)	0(0%)	0(0%)	60(100%)
3	I know how to develop exercises with which students can consolidate their knowledge	17(28,3%)	31(51,7%)	12(20%)	0(0%)	0(0%)	60(100%)
4	I know how to evaluate student's performance in my teaching subject	7(11,7%)	32(53,3%)	12(20%)	8(13,3%)	1(1,7%)	60(100%)

PCK is about the knowledge and understanding of a subject matter taught, meaning the pedagogy of a specific subject. PCK relates to Shulman's (1986, p. 4) belief that "real teaching requires an understanding of both content and pedagogy". It does not require one to be just a content expert or just a pedagogy expert, but it requires teachers to have the expertise to match content with relevant pedagogy so that effective learning can take place (Mishra & Koehler, 2006). The indication is that student teachers are appropriately capacitated with the PCK. This is because most respondents either strongly agreed or agreed with the statements that they were well-capacitated with PCK.

Table 4.
Student teachers' Technological Knowledge (TK).

	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
1	I am aware of new technologies in education	13(21,7%)	14(23,3%)	22(36,7%)	9(15%)	2(3,3%)	60(100%)
2	I frequently latest technologies used in my subject specialization	13(21,7%)	14(23,3%)	22(36,7%)	9(15%)	2(3,3%)	60(100%)
3	I know about a lot of different technologies applied in education	9(15%)	13(21,7%)	21(35%)	12(20%)	5(8,3%)	60(100%)
4	I have the technical skills I need to use educational technology	9(15%)	13(21,7%)	22(36,7%)	12(20%)	4(6,6%)	60(100%)

The technological component of this framework was added to the original PCK framework of Shulman (1986) by Mishra and Koehler in 2006. They referred to this knowledge as the teachers' standard knowledge of technology, and the skills to operate technologies (Mishra & Koehler, 2006, 2008). TK requires a deep understanding and mastery of ICT so that they can access, process, and disseminate information (Graham, 2011). The technological knowledge is still a challenge to the respondents. Most of them are neutral about their knowledge of educational technologies while some indicated that they lack this kind of knowledge.

Table 5.
Student teachers' Technological Pedagogical Knowledge (TPK).

	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
1	I can choose appropriate technologies to enhance the teaching approaches for lessons	7(11,7%)	11(18,3%)	21(35%)	15(25%)	6(10%)	60(100%)
2	I can choose appropriate technologies that enhance students' learning	7(11,7%)	11(18,3%)	21(35%)	15(25%)	6(10%)	60(100%)
3	I can adapt the use of the technologies that I am learning about to different teaching activities	7(11,7%)	11(18,3%)	21(35%)	15(25%)	6(10%)	60(100%)
4	I can think critically about how to use educational technology in my classroom	7(11,7%)	11(18,3%)	21(35%)	15(25%)	6(10%)	60(100%)

TPK refers to the shared relationship between technology and pedagogy. It is defined as the teacher's knowledge and understanding of the use of technology devices that can advance the attainment of pedagogic goals (Koehler et al., 2013). It is the teacher's ability to select the most suitable tools or applications based on their appropriateness for the specific pedagogical approach (Koehler et al., 2013). TPK seems to be a challenge to the respondents because the majority of them are neutral about the statements and a number of them are in disagreement with the statements.

Table 6.
Student teachers' Technological Content Knowledge (TCK).

	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
1	I know how technological developments have changed the field of my subject	3(11,7%)	10(18,3%)	17(35%)	19(25%)	11(10%)	60(100%)
2	I can explain which technologies have been used in research in my field	3(11,7%)	10(18,3%)	17(35%)	19(25%)	11(10%)	60(100%)
3	I know which new technologies are currently being developed in the field of my subject	2(11,7%)	8(18,3%)	18(35%)	20(25%)	12(10%)	60(100%)
4	I know how to use technologies to participate in scientific discourse in my field	2(11,7%)	8(18,3%)	18(35%)	20(25%)	12(10%)	60(100%)

TCK refers to the teacher's knowledge of the interchangeable relationship between technology and content (Koehler et al., 2013). It is simply the way content and technology influence and constrains one another (Mishra & Koehler, 2006, 2008). It characterizes the integration between what a teacher knows about applicable technological applications and about the topic of interest (MaKinster & Trautmann, 2014). The respondents have indicated that they lack knowledge of the technological developments in their subjects.

Table 7.
Student teachers' Technological Pedagogical Content Knowledge (TPACK).

	Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
1	I can use strategies that combine content, technologies, and teaching approaches that I learned about in my coursework in my classroom	3(11,7%)	10(18,3%)	17(35%)	19(25%)	11(10%)	60(100%)
2	I can choose technologies that enhance the content for a lesson	3(11,7%)	10(18,3%)	17(35%)	19(25%)	11(10%)	60(100%)
3	I can select technologies to use in my classroom that enhance what I teach, how I teach, and what students learn	3(11,7%)	10(18,3%)	17(35%)	19(25%)	11(10%)	60(100%)
4	I can teach lessons that appropriately combine my teaching subject, technologies, and teaching approaches	3(11,7%)	10(18,3%)	17(35%)	19(25%)	11(10%)	60(100%)

Technological Pedagogical Content Knowledge (TPACK – pronounced "t-pack") is at the center of the above-mentioned knowledge bases. It is the latest form of knowledge and understanding that goes beyond the basic components of content, pedagogy, and technology, of teaching and learning (Mishra & Koehler, 2008; Koehler et al., 2013). It involves the knowledge of the interaction between content, pedagogy, and technology (Mishra & Koehler, 2008; Koehler et al., 2013).

Data presented indicate that most of the respondents are still experiencing challenges with TPACK. The challenges are as a result that the knowledge base needed for pre-service teachers is multidisciplinary in its broadest sense and combines information from various fields, including educational technology, pedagogy and didactics, academic subject-matter discipline, educational psychology, and educational sociology (Irwanto, 2021). For pre-service teachers to be able to analyse, evaluate, and synthesize data from various disciplines to make meaningful connections and integrate the various disciplines to render them into reasoned decisions while utilizing ICTs in their teaching, the interdisciplinarity of their professional knowledge base is crucial. Therefore, the results above the respondents still lack a number of knowledge domains regarding TPACK.

5. FUTURE RESEARCH DIRECTIONS

The finding of the research study suggests further research into student teachers' technological pedagogical teaching practices during their preparation program. To determine the extent to which the intention to use ICTs in teaching does differ, comparative research between practicing novice and in-service instructors could be done later. Future research should look for efficient ways to integrate technical knowledge with pre-service teachers' understanding of pedagogy and didactics, knowledge of the subject matter being taught, knowledge of their students, and knowledge of the educational environment. Therefore, it is important to discover ways to include technology knowledge and its consequences (rather than just its practices) into the course profiles of pedagogy, educational psychology, educational sociology, and different subject methodologies. Based on these types of research findings, the researcher expects that educators, academics, and administrators would be able to construct course profiles that strengthen pre-service teachers' ICT teaching expertise from various fields of education.

6. CONCLUSION

Looking at the above discussions and analysis of the findings based on the research questions, the research draws the following conclusions. It seems CUT not equipping student teachers with adequate ICT integration skills, as a result, student teachers might have to cope with the demands of the digital education environment in COVID -19 times. Several suggestions can be made based on the findings of this study. Firstly, there are strong indications that student teachers can use ICTs in teaching with a moderate level of knowledge and skills. However, to meet the demands of the *Professional Development Framework for Digital Learning: Building Educator Competencies in Facilitating Learning with Digital Tools and Resources* (DBE, 2018) as set by the Department of Basic Education, the university education faculties should make more of an effort to prepare qualified future teachers. The suggested national strategy calls for incorporating the most recent ICT breakthroughs in education and anticipates that newly minted prospective teachers would be skilled at utilizing the pedagogical affordances of the emerging technologies to support their teaching of academic topics. The relevant goals stated by the *Action plan to 2019: Towards the*

Realisation of Schooling 2030 (DBE, 2015) require thorough proactive strategic planning to develop the ICT pedagogy-based expertise of pre-service teachers. The ultimate emerging case for all stakeholders in the faculty of education is to ensure that aspiring teachers are prepared to pursue the aims of the national education plan.

Second, and more specifically at the practice level, the results point to the need for the faculty of education to pay closer attention to student teachers' ICT pedagogical practices, practical experimentation, and promotion of reflection on these experiences to filter and archive what would be considered ICT pedagogy-based "good practices." Therefore, it is strongly advised that more proactive support be provided for the meaningful pedagogical use of technology in student teachers' practice. The most effective teaching tactics must be taken into consideration; hence it is crucial that teacher preparation programs give lecturers plenty of opportunities to practice using a range of ICTs. Thirdly, university administrators need to support technology use in higher education and teacher preparation programs that will help teachers across the country integrate technology into their classrooms in the future.

Finally, the study recommends that rather than being taught in separate "stand-alone" courses, pedagogical ICT knowledge building needs to be integrated into all facets of teacher education. Education software used and those anticipated for use in the near future should be made acquainted to students. By doing so, student teachers are not only ready for the classrooms of today, but they are also equipped with the skills and knowledge necessary to integrate technology into the teaching and learning of the future. Additionally, the results of this study emphasize that developing student teachers' awareness of the connections between ICT knowledge and other sciences of education is crucial if pre-service teachers are to be able to use their knowledge of ICTs and their pedagogical affordances, pedagogy, content, learners, and context to successfully teach a variety of subjects using technology. Also, this chapter proposes that student teachers be afforded in-service training immediately after completing their teacher qualifications. In-service training should be largely based on TPK, TCK, and TPACK**.**

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