The Development of First Year Pre-service Teachers' ICT Pedagogical Integration Knowledge and Skills.

A research report submitted in partial fulfilment of the requirements for the degree of

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List of Acronyms

CAPS: Curriculum and Assessment Policy Statement

CFT: Competency Framework for Teachers

DoE: Department of Education

F2F: Face – to – Face

IBSTPI: International Board of Standards for Training and Performance Instruction

ICT: Information and Communication Technology

ICTs: Information and Communication Technologies

IM: Instant Messaging

INTO: Irish National teachers' organisation

LMS: Learning Management System

MINEDUC: Ministry of Education

PCK: Pedagogical Content Knowledge

PDF: Portable Document File

SD: Standard Deviation

TCK: Technological Content Knowledge

TK: technological Knowledge

TPACK: Technological Pedagogical and Content Knowledge

TPCK: Technological Pedagogical Content Knowledge

TPK: Technological Pedagogical Knowledge

UNESCO: United Nations Education Scientific and Cultural Organisation

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DECLARATION

I, Monas Adjetey Allotey, hereby declare that the content of this research report is my own original work, and that I have not submitted either part or its entirety to any other academic institution for any degree.

Signature:  Date: April 12, 2022

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DEDICATIONS

To my Princesses.

ABSTRACT

This study investigated the development of first-year pre-service teachers' Information and Communications Technology (ICT) pedagogical integration knowledge and skills in an ICT literacy course at a University in Johannesburg, South Africa. It also aimed to establish the extent to which the knowledge and skills were developed in the course. The United Nations Education Scientific and Cultural Organisation (UNESCO, 2018) ICT Competency Framework for Teachers (CFT), Koehler and Mishra (2006) and Kohler et al. (2014) Technological Pedagogical Content Knowledge (TPCK) were used to design a conceptual framework to guide this mixed methods research, which employed a concurrent triangulation design. Data was collected using a questionnaire which had both close-ended and open-ended questions. The close-ended questions provided quantitative data, while the open-ended questions yielded part of the qualitative data in this study. The other part of the qualitative data was obtained through document analysis.

The document analysis was carried out using content analysis, with data from the questionnaire analysed through descriptive statistical data analysis. The findings indicated that many of the pre-service teachers prior to the course were aware of the social use of Information and Communications Technologies (ICTs), such as: entertainment, games, searching information on the internet, and offline and online information sharing. This had formed their perception on the use of digital technologies. Their perception on educational use of ICTs was mainly for administrative purposes and searching and sharing content online. There is evidence that students' development of TPCK cannot be compared to that required for practicing teachers as they do not have PCK they need to adequately integrate ICTs. The findings also showed that unequal development of any of the knowledge constructs; Technological Knowledge (TK), Technological Pedagogical Knowledge (TPK), and Technological Content Knowledge (TCK) has a significant effect on the development of TPCK (Koehler & Mishra, 2006; Koehler et al., 2014). It is of essence that the content of an ICT literacy course ensures that there are equal levels of development for all the competencies it intends to develop using established levels of indicators such as those in the UNESCO ICT CFT.

CHAPTER ONE

INTRODUCTION

1.1. Background to the Study

The rapid and significant advancement in digital technologies in recent years has swiftly and significantly affected all spheres of human society, with education equally not spared. The greater proportion of human communications and interactions are facilitated through digital technologies which include devices, application software and wireless internet connectivity (Begdouri, Chergui & Groux-Leclet, 2017). These powerful technologies have essentially brought a new dawn to the way people live, work, and learn. This is not the case with all university first-year pre-service teachers in South Africa, where this new dawn is yet to come, and ICT literacy courses become a necessity if they are to cope with their studies.

In the contemporary world of information age characterized and operated by the proliferation of digital technologies, most first-year university students, including pre-service teachers in South Africa, enter universities computer illiterate and have little or literally no concept of the computer (Brown & Czerniewicz, 2010; Chigona, 2015; Muller, 2017). To some first-year pre-service teachers, the university's computer laboratory is the first place ever in their lives where they had access and get the opportunity to operate the computer with no assistance.

In order to curb student lack of ICT competencies, first-year pre-service teachers who have no concept of a computer are identified after they have taken a test, and they are registered in the ICT literacy course. Most of these universities utilize Learning Management Systems (LMSs), where lecturers post various learning and assessment materials for the students to access and submit the completed tasks. They also require that forms of communication across the board be done electronically (Chigona, 2015; Muller, 2017; Nash, 2009). The idea of the ICT literacy courses by the universities is to capacitate students with knowledge and skills they need to survive in their studies at the university.

1.2. Problem Statement

The generation of First-Year Pre-Service Teachers at a university in Johannesburg in the Republic of South Africa, access digital information, be it photographs, audios, videos, diagrams, graphics, Text-based documents (mostly Instant Messages –IM – or Portal Document Files – PDFs), through mobile phones. For those who have had access to a computer, it could have been at a public internet café and or Community Information Centre, or a library, where they were assisted to search for information, download and or print it out (Brown & Czerniewicz, 2010; Muller, 2017; Nash, 2009). These pre-service teachers would be expected to teach children in modern classrooms powered by digital technologies after completing their training (Muller, 2017; Nash, 2009).

The teacher's capability to integrate ICT in teaching and learning depends on but is not limited to the ICT Literacy training received as part of her or his pre-service teacher training. First-year pre-service teachers need a specific kind of ICT Literacy, which incorporates the development of their ICT Pedagogical Knowledge and Skills to enable them to integrate ICTs in teaching and learning (UNESCO, 2018). However, universities provide ICT Literacy Courses for first-year students which mostly develop generic ICT operational skills to cope in the context of their university demands. It is therefore not surprising though alarming, to find that pre-service teachers are unable to integrate digital technologies in teaching and learning as expected of them after completing their teacher training (Chigona, 2015). In addition, Chigona (2015) found that the new graduates could not integrate ICTs in their teaching due to a lack of the development of their TPCK. It is inevitably significant to conduct research into the development of ICT pedagogical integration knowledge and skills of first-year pre-service teachers.

1.3. Aim of the Study

The aim of this empirical study is to determine the extent to which first-year pre-service teachers' Information and Communication Technologies (ICTs) Pedagogical integration Knowledge and Skills and the extent to which they were developed, in an ICT Literacy Course at a university in Johannesburg, South Africa.

1.4. Research Questions

This research sought to address the following question:

Main Question:

To what extent does the ICT Literacy Course for First-Year Pre-Service Teachers develop the Pedagogical Knowledge and Skills they need to integrate ICTs in their teaching?

Sub-Questions:

1. How is the Pre-Service Teachers' ICT Literacy Course designed and delivered to develop their ICTs Pedagogical Knowledge and Skills?

2. What are the Pre-Service Teachers' perceptions on the Knowledge and Skills of using ICTs in education before and after the ICT literacy course?

3. To what extent does the ICT Literacy Course for Pre-Service Teachers prepare them for use of ICTs for pedagogical integration?

1.5. Significance of the Study

This study sought to conduct appraisal of an ICT Literacy' Course for first-year pre-service teachers at a selected university. While teachers have gone through ICT training over the years, South African studies still report that there is low adoption of these technologies for teaching and learning (Chigona, 2015; Du Plessis, 2012; Padayachee, 2017; Vandeyar, 2013). This is worsened by the fact that pre-service teachers leave their teacher training institutions without their requisite knowledge and skills to integrate ICTs in teaching and learning developed.

Findings from this study, should help in the development and delivery of ICT Literacy courses for pre-service teachers, aimed at developing the students' knowledge and skills to integrate ICTs into teaching and learning. The evidence should form the basis for guidance needed in these courses which should lead to equipping pre-service teachers with the indispensable knowledge and skills in using ICTs in digital learning environments.

CHAPTER TWO

REVIEW OF RELEVANT LITERATURE

2.1. Introduction

This chapter is a literature review that covers areas that should help provide guidance on appraisal of the ICT literacy course under study. It reviews literature on ICT in Education policy, pre-service teachers, and the ICT pedagogical knowledge and skills expected to be developed in pre-service teachers to be able to successfully integrate ICTs into teaching and learning. It further engages literature on ICT pedagogical integration and Digital pedagogies which contribute to the development of pre-service teachers' ICT pedagogical knowledge and skills, and case studies of ICT literacy course evaluation.

2.2. ICT in Education policy

The focus of education (teaching, learning, and assessment) is given by the education policy, as the latter is the principles and laws which guide the former. Characteristics of the learning environment; the knowledge and skills, pedagogical processes (teaching, learning, and assessment procedures), teachers, learners, and the infrastructure (physical and or virtual), are all guided by policies (Ferguson et al., 2017, Kozma, 2008). It becomes imperative that any shift in education policy, should equally and significantly affect teaching and learning. The effect of emerging digital technologies on education has urgency necessitated a significant shift in policies guiding teaching and learning. As teaching and learning are the processes through which learners are being educated (Ferguson et al., 2017), there is a need for policy to guide the use of ICTs in the education sphere.

The ICT in education policy can contribute effectively towards achieving the national curriculum goals only if it is specific goal(s) oriented (Kozma, 2008). The goal(s) should be clear enough on whether the policy aims to "support economic growth, … promote social development, … advance educational reform, … support education management" (Kozma, 2008, p.1085), or a combination of these objectives. Kozma (2008, p. 1085) argues that ICT policies for economic growth emphasis developing the skills which will "develop [Students'] capacity to use technology to solve complex

real-world problems". In other words, these policies focus on equipping students with the ICT skills they will need to serve as the oil to propel the engines of the economy in future. On the other hand, the use of ICT in education may channel attention to provisions to address social equity and develop skills for "collaboration and knowledge sharing" (Kozma, 2008, p. 1089) among social structures to foster social cohesion.

Moreover, the goal(s) of ICT in education policy could target curriculum reform. In this regard, technology could be utilised to effect pedagogical change. The traditional chalk-talk and "tell-test" (Pich & Kim, 2004, p. 331) could be abandoned for student-centered approaches such as project-based, collaborative, discovery, and self-directed learning. Students' collaborative, creativity, communication, and critical thinking skills could be developed using technology (Irish National Teachers' Organisation [INTO], 2017; Kozma, 2008; Pich & Kim, 2004).

It is argued in the literature that clearly stating the goal(s) intended to be achieved with the ICT in education policy provides clear guidance and direction to the kind and extent of infrastructure, knowledge, skills, and training to be provided (Kozma, 2008; Pich & Kim, 2004; Rwanda Ministry of Education [MINEDUC], 2016). Additionally, it articulates whether training must be concentrated on teachers (Pre-service, In-service teachers or both), students, or both. However, the literature outline ICT in education policies with multiple goals especially for education reform and economic growth, emphasising learning with technology approach rather than learning from it (Irish National Teachers' Organisation [INTO], 2017; Kozma, 2008; Pich & Kim, 2004).

Learning from the technology according to the literature, is the approach whereby students are taught ICT as a subject on its own and teachers pedagogically integrate technology as a teaching tool for preparing and delivering their subjects content (INTO, 2017; Kozma, 2008; Pich & Kim, 2004). In the case of learning with the technology approach, the students use technology tools and devices to engage with the content to be learnt to "process information by themselves" (Pich & Kim, 2004, p. 317) and create their own understanding and digital artifacts. Pich and Kim (2004, p. 317) refer to this manner of educational use of technology as learning "with ICT, embedded ICT, or ICT-infused learning". It places technology under the student's control, with each student taking charge of their learning using ICT. Countries like Ireland, Singapore, United Kingdom, and

South Korea all have Multiple goals ICT in education policies which they have been implementing in almost a similar fashion.

The United Kingdom, Ireland, South Korea, and the Alberta Province in Canada, have been implementing their respective ICT in education policies which follow the concept of "an ICT-infused curriculum" (Pich & Kim, 2004, p. 318). According to this concept, technology is integrated in all the traditional core "subjects and grade levels" (Pich & Kim, 2004, p. 329) at the "primary [grade 1 – 6] and post-primary [grade 7 upwards] levels" (INTO, 2017, p. 10) of their schooling systems. The policies stipulate that "in every grade at the primary level", ICT knowledge and skills aimed to be developed in all subject areas should be clearly outlined together with the "more traditional types of knowledge goals" (Pich & Kim, 2004, p. 319) to be achieved in those subjects.

The "ICT-infused curriculum" (Pich & Kim, 2004, p. 318) approach permits children at the various countries' primary schools to learn ICT skills while "learning other basic subject matter" (Pich & Kim, 2004, p. 319) without having to attend separate classes for ICT. Pich and Kim (2004, p. 323) argue that children acquire ICT skills such as "word processing, presentation, data management, and communication" in primary school, which aid the development of their competencies to handle "more complex applications… in their normal course of study" in post-primary. It worth mentioning at this point that the much emphasis on developing students' ICT knowledge and skills does not suggest that the policies are silent training teachers in the much-needed competencies to implement the policies.

The countries whose ICT in education policies have been involved in this review are clear on the training to be offered to teachers (pre-service and in-service teachers) in the respective documents. Teacher training institutions are charged with the responsibility to ensure that pre-service teachers get prepared for ICT pedagogical integration. In South Korea for instance, the policy mandates "the University of Education, and teachers' colleges" to equip pre-service teachers with ICT pedagogical knowledge and skills, while in-service teachers "take ICT training every three years" (Korea Education & Research Information Service, 2002, as cited in Pich & Kim, 2004, p. 328). In all cases, the training of both pre-service and in-service teachers revolves around the acquisition of ICT skills. However, it focuses on how ICT should be perceived and used "as a tool and means

for accessing the curriculum and support, enriching, and extending teaching and learning (INTO, 2017, p. 4) in and outside classrooms to enhance students' learning experiences. This assertion is concurred by the National Department responsible for educational services in South Africa. This is reflected in the policy document (White Paper on e-Education) guiding the educational use of ICT. The next section of this review will be focused predominantly on the South African ICT in Education policy.

2.2.1. ICT in Education Policy in the South African Context

Integrating ICTs in teaching requires that teachers should have ICT capabilities (United Nations Education Scientific and Cultural Organisation [UNESCO], 2018) which according to University of Derby (2020, p. 1), are collective "skills, knowledge, and understanding which help someone to live, learn and work in a digital society". In 2011, the Department of Basic Education (DBE), published a new curriculum; the Curriculum and Assessment Policy Statement (CAPS) for the South African basic education landscape. The CAPS document states among its general objectives that the new curriculum aims "to produce learners that are able to…use…technology effectively…" (Department of Basic Education [DBE], 2011, p. 5). It is perceived that having the required capabilities to integrate ICTs in teaching in the South African schooling system should lead to the achievement of CAPS' objective. Teachers will be able to train their learners to equally utilise digital technologies effectively and efficiently for both educational and social purposes if they are equipped with the required knowledge and skills to integrate ICTs in education, (University of Derby, 2020; Ferguson et al., 2017).

The White Paper on e-Education provides guidelines and principles to be followed to facilitate a significant shift in teaching, learning, and or assessment in South Africa, using digital technology tools (Department of Education [DoE], 2004). It recognises digital technology tools as "flexible tools for teaching and learning" (DoE, 2004, p. 25). It further agrees that if teachers can effectively and efficiently utilized these tools in teaching and guide their learners on how to use them for learning, digital technology has the potential to "encourage [learners] to be fully engaged and participative in the teaching and learning process…" (DoE, 2004, p. 22). This policy instructs teacher training institutions to provide ICT knowledge and skills to pre-service teachers. However, its complementary policy on Guidelines for Teacher Training and Professional Development in

ICT, outlines the ICT knowledge and skills to be developed in pre-service teachers, "to enhance the educational experiences of learners…" (Hindle, 2007, p. ii). These policies mandate teachers to integrate ICTs in their implementation of the national curriculum of South Africa.

The fulfillment of the mandate bestowed on teachers by DoE (2004) requires that pre-service teachers' training should equip them with the requisite knowledge and skills to use ICTs and that it should be tailor-made for educational purposes. The broader aim of this research was to ascertain whether these pre-service teachers in their first year of training are being prepared to use these digital technologies for teaching and learning. As such, understanding what the national policy seeks to achieve with ICT integration into teaching and learning, what it says about the use of ICTs in education, and the training of pre-service teachers were significant to this research.

As the policy guiding the use of ICTs in South African schools, the White Paper on e-Education DoE (2004, p. 27) mandates the Department of Education to ensure that it "collaborate[s] with higher education institutions to design and deliver pre-service training programmes…" to develop Pre-Service Teachers in the required ICT competencies to integrate ICTs in teaching and learning. The policy dictates the following responsibilities to teacher training institutions - universities in this regard. They should,

- ensure "the inclusion of ICT integration competencies for teachers...in accredited pre-service teacher training programmes delivered by higher education institutions" (DoE 2004, p. 27).
- "provide [pre-service teachers] with the basic knowledge, skills and attitudes required to integrate ICTs into subjects of specialisation [so that each] graduating teacher is able to combine knowledge of the learning process and instructional [design] theory [, principles and strategies] with various forms of media and learning environments to create the most effective and efficient learning experiences [for learners]" (DoE 2004, p. 27).
- In such training, pre-service teachers "will model the use of ICTs as a mode of delivery, allowing for greater levels of collaboration, inquiry, analysis, creativity and content production" (DoE 2004, p. 27).

The DoE (2004) policy document is supplemented by the Guidelines for Teacher Training and Professional Development in ICT (DoE, 2017) which aims at guiding the development of teachers

ICT knowledge and skills they need to teach with these technologies. However, its focus is on providing descriptions of proficiency levels without articulating how they should be acquired. The two policies remain silent on what ICT pedagogical knowledge and skills pre-service teachers, should be equipped with and how they should be trained to acquire them. In the context of this research, knowledge is described as theories, concepts, principles, and strategies – pedagogies – that could be applied with ICT tools to design, develop, and share educational content, as well as to create conducive learning environments (Ndlovu, 2016). Skills on the other hand, are the abilities to apply those theories, concepts, principles, and strategies with the ICTs tools in practice. In appraising an ICT Literacy Course for developing pre-service teachers' ICT pedagogical knowledge and skills, it is important to understand how the course outcomes respond to the South African ICT in education requirements.

2. 3. Pre-Service Teachers' ICT Competencies

In 2001, the International Board of Standards for Training and Performance Instruction (IBSTPI), defined competencies as the blend of interrelated "knowledge, skill, [and capabilities] that enables one to effectively perform the activities of a given occupation or function to the standards expected in employment" (Richey, Fields & Foxon, 2001, p. 31). A similar definition was carved by UNESCO in 2018. In UNESCO (2018, p. 63), competencies are "the skills, knowledge and understanding needed to do something successfully to a professional standard". This research agrees with both authors' definition of competencies. Pre-service teachers need to be equipped with the knowledge and skills of ICTs which connects with each other, and have relevance to teaching and learning, to be capable of efficiently integrating technology tools in teaching to successfully enhance learning (Koehler & Mishra, 2005).

The ICTs competencies teachers need to use these technology tools for teaching and learning should be developed in pre-service teachers (UNESCO, 2018). The UNESCO ICT Competency Framework for Teachers (ICT CFT) prescribed six aspect of competencies which they called "aspects of teacher's professional practices" (UNESCO, 2018, p. 8), in which pre-service teachers should be trained. They are "Understanding ICT in Education Policy; Curriculum and Assessment; Pedagogy; Application of Digital Skills; Organization and Administration; Teacher Professional Learning" (UNESCO, 2018, p. 8). The authors believe that equipping pre-service teachers with

these competencies will consequently develop the ICT knowledge and skills they require to be capable of integrating ICTs in teaching and learning.

In Koehler and Mishra (2005), the authors summarised the ICT competencies for teachers, which they called knowledge domains, into Technological Knowledge (TK), Technological Pedagogical Knowledge (TPK), and Technological Content Knowledge (TCK). These competencies formed the focus of their Technological Pedagogical Content Knowledge (TPCK) framework. They argue that the competencies do not develop in seclusion but concurrently and recommend that pre-service teachers should be equipped with the requisite knowledge and skills to successfully use ICTs for teaching and learning.

This study agrees with the assertions by both UNESCO (2018), and Koehler and Mishra (2005) that pre-service teachers will be well placed with the abilities of using these technology tools in their professional practices should these ICT competencies be developed during their training. These competencies inform the pre-services teacher's knowledge of which technologies to use, and where and when they would be effective in her or his lesson. Users of the technology tools are required to be knowledgeable in what they could be used for, the benefits for using, and be skilled in how to use them to serve the intended purposes, to use subject "area-specific computer applications" (Sahin, 2011, p. 105). In the context of this research, the how to use the technologies constitutes the content knowledge of the technologies and is referred to as Technological Content Knowledge (TCK).

Newly trained and experienced teachers gain competencies and confidence to integrate technologies in teaching (Koehler et al., 2014) as required by the white paper on e-education. The Department of Education requires every teacher to have such competencies (DoE, 2004) as they will aid a teacher's use of ICTs for planning, designing, developing, executing, and evaluating her or his teaching and learning activities. They also aid in creating and managing the learning environment in her or his mandate to integrate ICTs in teaching and learning (Koehler & Mishra, 2006; Sahin, 2011; DoE, 2004).

This study adapted the TPCK framework as its lens. It consists of the teacher's knowledge of: Determining and selected the appropriate ICTs to teach content – Technological Knowledge (TK); How to use the selected technologies – Technological Content Knowledge (TCK); and theories,

principles, and strategies of instruction to design teaching and learning activities with these technologies – Technological Pedagogical Knowledge (TPK). The combination of TK, TPK and TCK to constitute the body of knowledge that amalgamates the teachers' knowledge of which digital technologies are useful in their subject of specialization, when to use, and the most appropriate ways of using such digital technologies, TPCK.

A teacher's ability to effectively integrate ICTs in teaching and learning is largely influenced by her or his competencies in modeling the knowledge set (UNESCO, 2018). According to UNESCO (2018, p. 21), "the successful integration of ICT into the learning environment will depend on teachers' ability to structure learning in new ways, merge technology appropriately with a pedagogy, develop socially active classrooms, and encourage cooperative interaction and collaborative learning and group work". To appropriate such competencies, the UNESCO's ICT CFT, proposes three Knowledge Levels; "Knowledge Acquisition, Knowledge deepening and Knowledge Creation", each of which has "six aspects of a teacher's professional practices" (UNESCO, 2018, p. 21), to augment the teacher's capabilities to successfully integrate ICT in the Learning environment. These "six aspects of a teacher's professional practices" (UNESCO, 2018, p. 21) are the group of competencies the CFT proposes to be developed in ICT literacy courses and professional development programmes for pre-services and in-service teachers respectively. It is for this reason that they shall be referred to as aspects of competencies in the context of this study. UNESCO (2018) explains the three levels of knowledge contained in the ICT CFT as follows:

Knowledge Acquisition: At this level, pre-service teachers are made aware of and to understand national policies regarding the use of ICTs in teaching and learning, and the possible affordances of integrating ICTs in teaching and learning (in South African). It also requires that pre-service teachers should be made to have basic knowledge and skills of ICTs that could be used for teaching, learning, and assessment.

Knowledge Deepening: Pre-service teachers acquire competencies which capacitate them to be able to create and adapt learner-centered "learning environments" (UNESCO 2018, p. 9), and translate National ICT Policies in Education into real world teaching and learning activities.

Knowledge Creation: The pre-service teacher obtains capabilities to motivate "them to create and "model good practices and learning environment" capable of inspiring learners "to create new knowledge" (UNESCO, 2018, p. 9) under his or her guidance.

The UNESCO ICT CFT considers each of its aspects of competencies of ICTs at each of these three knowledge levels. They recommend these competencies to be developed in ICT Literacy Course for pre-service teachers. This study sought to investigate how the design and delivery of the ICT Literacy Course under appraisal encouraged the development of these aspects of competencies in the first-year pre-service teachers.

2.4. Pre-Service Teachers' ICT Pedagogical Knowledge and Skills

The teacher's pedagogical knowledge of digital technologies, and the skills of using them has a significant effect on how she or he can integrate the technologies into the teaching and learning processes to facilitate improvement in the learners' learning (Koehler, Mishra, Akcaoglu & Rosenberg, 2013). A study by A. Chigona and W. Chigona (2010, p. 221) found inadequate technological skills and deficiency in "technological pedagogical content knowledge [TPCK]" among the factors which inhibit teachers' successful ICTs integration in teaching and learning in South African schools.

In a further study, Chigona (2015, p. 481) questioned "the quality of [ICT] training" pre-service teachers receive from their teacher training institutions (universities) in South Africa. The study found that, although newly trained teachers who were involved in the said study were teaching in schools equipped with various ICTs in the Western Cape Province of South Africa, they found it difficult to apply these technologies in their teaching as expected of them, even though, ICTs training formed part of their pre-service training.

The questions about the teacher's ICT training borders on its effectiveness and usefulness to her or his daily teaching and learning process (pedagogy), which is dependent on the content of the ICT course rendered during his or her training. The teacher does not need an ICT training that will socialize her or him into the ability to use digital technologies just like every other tertiary graduate. What she or he needs is the ICT knowledge and skills that will empower her or him to

fulfill all the "four objectives of education" (Ferguson et al., 2017, p. 6). Most important, is to be trained to well qualify to teach (work) with ICTs and earn a deserving qualification to be socialized into the community of 21st – century teachers. This calls for a special knowledge and skills of ICTs, capable of interweaving Technology, Pedagogy, and subject Content in between each other (Koehler & Mishra, 2005).

Technological Pedagogical Content Knowledge, (TPCK), according to Koehler et al. (2013, p. 2) "describes the kind of knowledge that teachers need in order to teach with technology…" which are: the teacher's knowledge of the subject matter (Content Knowledge - CK), and the Pedagogical Knowledge of teaching that subject content (PCK). The teacher needs this knowledge to teach in a conventional learning environment and this should be developed by the department responsible for the pre-service teachers' subject of specialization, as agreed in (Koehler et al., 2013). The special knowledge and Skills, TPCK, to move from the conventional teaching method to ICT integrated teaching should be the responsibility of an ICT Literacy Course designed for Pre-Service teachers (Koehler et al., 2013; Chigona, 2015). The course should prepare these Pre-Service teachers for teaching in a 21st–Century teaching environment where digital technologies are used to work, learn, and live (Ferguson et al., 2017).

2.5. ICT Pedagogical Integration

Information and Communication Technologies (ICTs) pedagogical integration should aim at achieving a particular set of teaching and learning objectives or outcomes. As agreed in Ndlovu (2016, p. 39), it involves applying digital tools and resources in creating, "sourcing, storing, and manipulating content in different forms of representations among other capabilities". This means that the pedagogical integration of ICTs involves the use of digital technology-based tools, artefacts, and networks, and aims at enhancing the experiences of education. As a result, other researchers including this study refer to ICT pedagogical integration as digital pedagogy (Post, 2019) and use them interchangeably.

The required enhancement in learning and change in approaches to teaching (pedagogy) is not made possible from the sheer use of digital technologies, but by following sound theories, principles, and strategies of instructional design, aiming at facilitating teaching and learning, through digital pedagogical approaches different from the conventional approaches (Croxall &

Koh, 2013). It follows that the effect of the teacher's integration of digital pedagogies in her or his teaching, is enhancement of her or his learners' learning.

2.5.1 Digital Pedagogies

Digital Pedagogies are the teaching approaches, which encompass "the use of electronic elements to enhance or to change the experience of education" (Croxall & Koh, 2013, para. 2). They involve teaching and learning approaches and strategies which focus on the students and train them to be capable of "figuring out…how to do something, how to find out something, or how to use something to do something new" (Scott, 2015, p.14). The authors point out that pedagogies, approaches, and strategies are student-centred, and develop in students among others, the capability for developing and designing educational contents, creativity, collaborative learning, and the ability to create their own knowledge.

Digital pedagogy is built on the concept of creative education, which is defined as "purposive imaginative activity generating outcomes that are original and valuable in relation to the learner" (Cremin et al. as cited in Barajas, Frossard & Trifonova, 2018, p. 110), and dwells on digital creative education. It is a learner-centered innovative thinking activity, that seeks to achieve an objective(s) that is authentic and explicitly set.

Creative pedagogies as defined, are the principles, practices, and strategies of teaching that "contribute to the development of" (Barajas et al., 2018, p. 111) learners' creative abilities. They are characterized variously, among which are: not restricted to any specific place nor actual time, not necessarily in a classroom, collaboration and cooperation, "and game-based learning approaches" (Davies et al. as cited in Barajas et al., 2018, p. 111). Cremin and Barnes in Barajas et at. (2018, p. 111), state that creative pedagogies are characterized among others by "multimodal methodologies, exploration and discovery…". A careful consideration of the definition and characteristics of creative pedagogies as presented thus far, summarizes into; Collaboration, Multimodal, Ubiquitous, Exploratory and Discovery, Problem-Solving, and learner-centered.

The use of digital technologies for teaching purposes (Digital Technology Integration), affects the pedagogical processes (Pedagogical Integration), thereby influencing the learning process (Loveless as cited in Barajas et al., 2018) in equal magnitude. Digital creative education is when digital technologies are being applied in creative pedagogies to foster the development of learners'

digital creativity (Barajas et al., 2018). In this regard, the characteristics of creative pedagogies are Collaboration, Multimodal, Ubiquitous, Exploratory and Discovery, Problem-Solving, and learner-centered –, mediated by digital tools to foster these approaches.

This study agrees with (Barajas et al., 2018) on their assertion of digital creative education, deems digital pedagogies as the principles and practices of teaching which contribute to the development of the learner's digital creative education, consisting of Constructivism, and Critical Pedagogy Education.

Constructivism: Ndlovu (2016) has discussed 2 aspects (Cognitive Constructivism spearheaded by Piaget, and the Social Constructivism by Vygotsky) of this theory of learning. However, they both inform digital pedagogy (Scott, 2015), and hold the principle that with their prior experiences, learners actively interact with their environment to make meaning of it and create their own knowledge. This evokes critical thinking and creativity, and with guidance from the teacher whose role becomes a mediator or facilitator, learners engage in collaboration, problem-solving, using different forms of presentations.

Critical Pedagogy: This holds the assumption that learning should be focused on and bear meaning with the learner's real–world situations, mostly concern with problem-solving, Collaboration, Multimodal, Ubiquitous, Exploratory and Discovery, and learner-centered, debunking "the banking concept of education which consists of simply depositing knowledge in a decontextualized manner" (Freire as cited in Barajas et al., 2018, p 112).

These pedagogical approaches align with the UNESCO ICT Competency high levels (Knowledge Creation) used in this course as it acknowledges context-based and high-level competency as incorporating creativity in the use of digital technology.

2.7. Case Studies of ICT Literacy course evaluations

A search for literature on ICT courses for Pre-service teachers reveals abundant research has been done in this field. However, limited literature could be found to evaluating the effectiveness of these courses. Some examples of such literature are Garba (2014), Goktas, Z. Yildirim, and S. Yildirim (2008), and Toker (2004).

The purpose of the research by Toker in 2004 was to "Reveal Pre-Service Teachers' Technology Competencies during their four-year Training Programme…" (Toker, 2004, p. iv). The researcher found that ICT courses were perceived to be effective in developing first-year and second-year pre-service teachers' ICT pedagogical integration capabilities as compared to the third-year and fourth-year students. This stems from the instructors' academic background. The research pointed out that the first and second years were taught by instructional technologists who teach from digital pedagogical approaches with the "use [of] practical, hands-on, and constructivist activities" (Toker, 2004, p. 91). The researcher noted further that during the third and fourth year however, the pre-service teachers were taught by specialists "of computer sciences or more technical field" who pay more attention to "theoretical part of the course rather than practical" (p. 91).

In 2008, Goktas, Z. Yildirim, and S. Yildirim, conducted a research to establish "the effectiveness of and the way to improve ICT related courses in pre-service teacher education programmes…" (Goktas, Yildirim & Yildirim, 2008, p. 170). Participants in Goktas et al. (2008, p. 174) are practicing teachers, "pre-service teachers", and lecturers of the "computer course" for teachers. The findings indicated that all the three participating groups affirmed the course's "effectiveness and its contribution to acquiring ICT competencies" (Goktas et al., 2008, p. 174). The practicing teachers further pointed out the course's success in capacitating them to pedagogically integrate ICTs. Moreover, "all [three participating groups] recommended that the course need to be restructured to be more effective" (Goktas et al., 2008, p. 176).

The ICT lecturers in Goktas et al. (2008, p. 176) suggested all aspects of the course should be conducted "in [the] computer laboratories and all [instances] and applications used in the course should be related to future teaching profession" to advance its efficiency. This finding corroborated the pre-service and practicing teachers' believe that the "conceptual [and or] theoretical" (p. 176) aspects of the course was too much, not useful to the course, and had no contributions to pedagogical integration. Although the theories and or concepts were not mentioned, it was recommended that the courses should be made more practical, and more ICTs facilities be provided and made accessible to pre-service teachers.

The relevance and effectiveness of an ICT course to capacitate pre-service teachers for pedagogical integration should focus greater part of its content on developing their ICTs competencies with

practical activities (Garba, 2014; Goktas et al., 2008). This as agreed in Garba (2014) and Goktas et al. (2008), will develop the knowledge and skills, and thus, competencies pre-service teachers will require for ICT integration into teaching and learning in their teaching profession. Adequate development of such competencies was not the case with the findings made in Garba (2014, p. 37) which aimed "to determine the impact of the 100 level [first year] …ICT course … on pre-service teachers' acquisition of ICT literacy skills and competence needed for the integration of ICT in teaching and learning". The author found that the second-year pre-service teachers' "knowledge of ICT skills for teaching and learning; and, the overall basic ICT literacy and competence…was low" (Garba, 2014, p. 41) after they had taken ICT course in their first year of studies. The researcher argues that the pre-service teachers' low ICTs pedagogical integration "skills… and competence…" (Garba, 2014, p. 40) emanate from a lack of practical activities in the course's content which he describes as "theory driven with much emphasis on [developing their] cognitive domain" (Garba, 2014, p. 41).

Common findings in both Garba (2014) and Goktas et al. (2008) are an insufficient or no practical in the course content and non-utilisation of ICT facilities at the various teacher training institutions where they conducted their research, which they believe contribute to the ineffectiveness of the ICT courses. The researchers found that the training institutions do have computer laboratories equipped with the required ICTs for teaching and learning in the courses. However, because the courses had insufficient or no practical content which, would have necessitated the use of these ICTs facilities, lecturers of the courses taught the pre-service teachers without using the facilities.

The current study sought to determine the ICT pedagogical integration knowledge and skills the course under study exposed the first-year pre-service teachers to, equip them with, and to what extent. The findings by Garba (2014), Goktas et al. (2008), and Toker (2004) are significant to this study, as they suggest what content an ICT Literacy Course for pre-service teachers should be focused on to achieve its aim of developing students' pedagogical integration knowledge and skills. They further share light on factors which might contribute to the relevance of the course and improving its effectiveness.

It is proven that an ICT Literacy Course for pre-service teachers does not adequately prepare them with knowledge and skills they will require for ICTs pedagogical integration if it focuses too much

on theoretical content. Rather, it should have a blend of the approaches, strategies, and skills situated in digital pedagogies to facilitate teaching and learning, and a more hands-on practical content sufficient to develop their required knowledge and skills to integrate ICTs effectively and efficiently in teaching and learning.

CHAPTER THREE

CONCEPTUAL FRAMEWORK

3.1. Introduction

This chapter outlines and describes the Conceptual Framework which was used to guide the conduct of this study. Further explanation is provided on how the various components of the Technological Pedagogical Content Knowledge (TPCK) by Koehler and Mishra (2005), the Technological Pedagogical and Content Knowledge (TPACK) by Koehler et al. (2014), the TPACK by Sahin (2011), and the (2018) ICT CFT have been adapted and amalgamated in the development of this conceptual framework.

3.2. Developing the Conceptual Framework

The rapid development in ICTs has changed the way people work including teaching (Ferguson et al. 2017). Developing the teachers' ICT pedagogical integration knowledge and skills will capacitate them to use ICTs effectively and efficiently for teaching (Koehler et al. 2014). This study aimed to establish the development of first-year pre-service teachers' ICT pedagogical integration knowledge and skills in an ICT Literacy Course. Considering the research questions advanced to be addressed in this study, TPCK was found to be the appropriate theoretical framework to guide this study. The framework helped in describing what ICT knowledge and skills were developed in the course. The TPCK according to Koehler and Mishra (2005, p. 133), consists of "three areas of knowledge: Content, Pedagogy and Technology". These "knowledge domains" (Koehler & Mishra 2005, p. 133) are inseparable, work hand-in-hand with, and complement each other.

The various definitions and explanations to TPCK and or TPACK in Koehler and Mishra (2005), and Koehler et al. (2014) respectively state that the development of TPCK and or TPACK framework(s) is as a knowledge body to aid the training of teachers to successfully integrate ICTs into teaching to enhance learning. The implication is that the framework(s) should be utilised as guidance to ICT literacy training programmes designed for both pre-service and practicing teachers.

The inclusion of Pedagogical Content Knowledge (PCK) in the TPCK framework was to align with Shulman (1986, p. 8) notion of PCK as "an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction". In Koehler et al. (2014, p. 102), Technological Content Knowledge (TCK) is the "knowledge of the reciprocal relationship between technology and content…"; and Technological Pedagogical Knowledge (TPK) "refers to an understanding of technology can constrain and afford specific pedagogical practices". This study acknowledges and agrees with Shulman (1986) and Koehler et al. (2014) on the important role PCK plays in teaching and learning. However, because they were in their first year, the pre-service teachers did not have adequate subject specific content knowledge (Harris, Mishra & Koehler, 2009; Koehler, Mishra & Yahya, 2007), and their PCK was at a lower level. It is for this reason that the ICT Literacy Course under appraisal in this study focused on technological skills hence, this study excluded PCK.

ICT literacy, according to the International ICT Literacy Panel (2002, p. 2), "is using digital technology, communications tools, and or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society". The current study agrees with this definition of ICT literacy by the International ICT Literacy Panel. Moreover, this study argues that ICT literacy courses for pre-service teachers should be focused on developing their knowledge and skills to facilitate pedagogical integration. The course under appraisal, aimed at giving the pre-service teachers a feel of how they could integrate ICTs in a teaching context. Ascertaining the development of these first-year pre-service teachers' Technological Knowledge (TK), TPK, TCK, and TPCK will assist in determining the development of their ICT pedagogical Integration knowledge and skills in the course (Harris et al., 2009) by this study.

The TK construct in the context of this study, is the Knowledge about, and understanding of the National policies guiding the use of technologies for teaching and learning. Here the focus is on two key points in the policy: (1) What the National policy guidelines say about the use of technologies for teaching, learning, and or assessment, (2) What technology-based tools are currently being used, and the contemporary technology-based tools "that can be integrated into the curriculum" (Koehler et at. 2014, p. 102) to achieve the curriculum goals in the pre-service teachers' subject of specialisation.

When the pre-service teachers are taught about the technology-based tools they could use for teaching, it does not guarantee their ability to use it for the stated purposes. They need to be taught how to use these tools for their purposes, that is, learning the technological skills to develop their TCK. In the context of this study, the TCK is the knowledge and skills of how the pre-service teachers could use technological tools to create content to facilitate teaching and learning. Additionally, their TPK needs to be developed. The TPK equips the pre-service teachers with different approaches "of instructional practices, strategies, [theories,] and methods…" (Koehler et al. 2014, p. 102) and empowers them to pedagogically employ the TCK in their respective subject of specialisations. The development of these three knowledge constructs – TK, TPK, and TCK – as ascribed to in the context of this study, leads to the development of the pre-service teachers' TPCK (Koehler & Mishra, 2005).

The set of knowledge and skills pre-service teachers require to use ICTs for teaching and learning, develop gradually and concurrently (Koehler & Mishra, 2005; Koehler et al., 2014; UNESCO, 2018). While Koehler and Mishra (2005), and Koehler et al. (2014) referred to this required knowledge and skills as Technological Pedagogical Content Knowledge, UNESCO (2018) calls it ICT Competencies for teachers. The UNESCO's (2018) ICT CFT further argue that these competencies develop at three differing levels. These three levels of Competencies within the UNESCO (2018) ICT CFT – Knowledge Acquisition, Knowledge Deepening, and Knowledge Creation – have been adapted for the development of the conceptual framework for this study.

The UNESCO (2018) ICT CFT sets its three knowledge levels which are explained in section 2.3 of this study, in an increasing order according to which pre-service teachers' ICTs competencies should be developed in an ICT training course. The ICT CFT framework has grouped the

competencies into six aspects which they call the "six aspects of teacher's professional practices" (UNESCO 2018, p. 8), and set them under and across each of the three knowledge levels. These competencies are also outlined in section 2.3 and discussed in the document analysis section of this study.

3.3. The Conceptual Framework

The aim of this study is to establish the development of pre-service teachers' ICT pedagogical integration knowledge and skills in an ICT Literacy Course. Determining the level(s) at which their knowledge and skills had developed is inherent in this aim. In developing a Conceptual Framework to achieve this aim in this research, the three knowledge levels of the UNESCO's ICT CFT were adapted. These knowledge levels were set as Knowledge levels across which each of the TPCK knowledge constructs supposed to be developed in the ICT Literacy Course were aligned, as in ***figure 1*** below. In this conceptual framework, each of the knowledge constructs: TK; TPK; TCK; and TPCK develops across the Knowledge levels, from the lower level – Knowledge Acquisition –, through – Knowledge Deepening –, to the high level – Knowledge Creation in the pre-service teachers' subjects of specialisation.

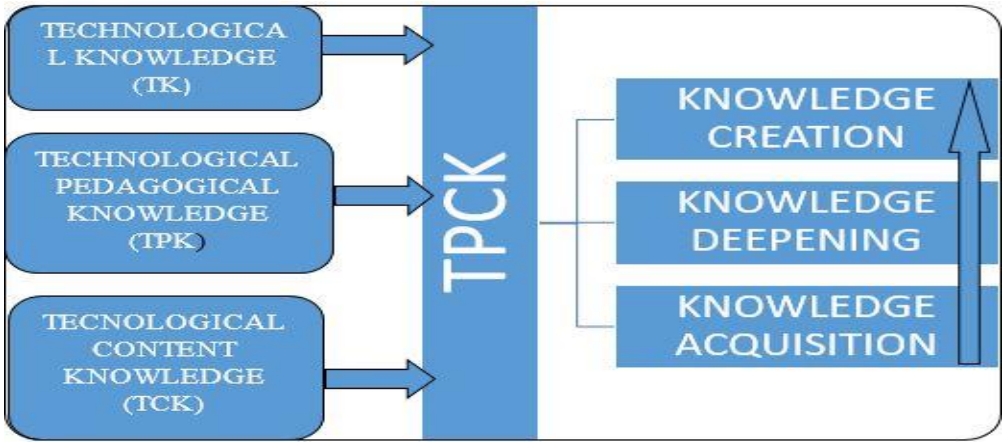

Figure 1: Conceptual Framework (amalgamation of adapted TPCK and knowledge Levels of UNESCO ICT CFT).

Some specific knowledge and skills under the TK, TPK, TCK, and TPACK constructs, expected to be developed in an ICT Literacy Course for teachers are outlined in Sahin (2011). This set of specific knowledge and skills was adapted and merged with the ICT competencies adapted from the UNESCO ICT CFT to elaborate on the conceptual framework for this study.

The adaptation decision was informed by three reasons. (1) The set of knowledge and skills adapted from Sahin (2011) TPACK aligns with the content of the ICT Literacy course under appraisal, and the UNESCO (2018, p. 8) "aspects of teacher's professional practice". (2) It also aligns with the definitions this study has ascribed to the TPCK knowledge constructs, and (3) the UNESCO (2018) ICT CFT was adapted by the ICTs Literacy Course being appraised in this study.

The merger of the specific knowledge and skills and ICT competencies from Sahin (2011) and UNESCO (2018) respectively, formed a set of areas of knowledge and skills which summarizes those expected to be developed in the ICT Literacy Course. These were spread across the TPCK constructs and the knowledge levels of the ICT CFT, in alignment with the course content, as in the ***table 1*** below.

Table 1: Eelaboration of the Conceptual Framework

KNOWLEDGE CONSTRUCT	**KNOWLEDGE LEVELS**		
	Knowledge Acquisition	**Knowledge Deepening**	**Knowledge Creation**
Technological Knowledge (TK)	1. Knowledge and understanding of South African ICT in Education Policies 2. Basic Knowledge of computer hardware and software, and their functions	Knowledge and skills of accessing and using emerging technology-based tools in achieving national curriculum goals	Knowledge and skills in creating, processing, storing, sharing, and retrieving electronic data and or documents
Technological Pedagogical Knowledge (TPK)	Knowledge and competencies to select Digital Technologies appropriate for teaching, learning, and assessment in teachers' specific subject content specialisation	Knowledge and skills of how to use technology-based tools for the purposes, and to support and enhance teaching, learning, and assessment	Knowledge and capabilities of selecting approaches, strategies, and methods of teaching and learning with digital technologies that are useful for advancing teachers' teaching career
Technological Content Knowledge (TCK)	Develop and equipped teachers with the Knowledge and Skills in using Word-Processor Software they can apply when preparing and delivering teaching and learning lessons in their subject area of specialization	Develop and equipped teachers with the Knowledge and Skills in using: 1. A Presentation Software they can apply when developing teaching, learning, and assessment activities and projects for learners 2. An electronic Spreadsheet for assessment in teachers' specific subject of specialization	Develop and equipped teachers with the Knowledge and Skills in using collaborative tools they can apply when developing teaching, learning, and assessment activities and projects for learners in their respective subjects of specialization

Technological Pedagogical Content Knowledge (TPCK)	Knowledge and skills to choose more recent teaching methods, and digital technologies for teaching content of my subject area of specialization effectively and efficiently	Knowledge and skills to: 1. Integrate more recent instructional methods and digital technologies into content of my subject area specialization 2. Combined principles and practices of teaching and learning, and assessment, Subject Content, and Digital Technology Knowledge to teach successfully	Competencies to: 1. Help colleague teachers and community of practices in integrating principles and practices of teaching, learning, assessment, Subject-Content, and Digital Technologies 2. Join and actively participate in Professional Learning Communities (PLCs)

The conceptual framework which guided the conduct of this study was the focused of this chapter. The ICT Literacy Course being appraised in this study aimed at introducing the first-year pre-service teachers to the use of ICTs in a teaching context. The course set to achieve this aim through the adaptation of the competencies spelt out in the UNESCO ICT CFT across its levels. The adaptation and merger of the TK, TPK, and TCK knowledge constructs and ICT competencies of the TPCK and the ICT CFT respectively contributed to the development of the instruments used to collect data and analysis in this study.

CHAPTER FOUR

RESEARCH METHODOLOGY AND ETHICAL CONSIDERATION

4.1. Introduction

This section outlines the research methodology that was used in this study. It presents the research design, population and sampling, data collection methods and instruments, data analysis and discussion method, and ethical issues.

4.2. Research paradigm

The process of conducting research demands that the researcher formulates a set of questions which aim at addressing the issue, problem, or phenomena being investigated. The researcher's

principles “and practices” (A. A. Shah, S. S. Shah & Khaskhelly, 2019, p. 92) influence the formulation of her or his research questions which guide the research and the research method. The research questions and research method, inform the researcher’s research philosophy or paradigm (Shah et al., 2019). In their consideration of research paradigms, Shah et al. (2019, p. 92) argued that it is “a system of beliefs and practices which impact upon deciding how the researcher will select the questions to be” studied, as well as approaches that will be followed “to investigate those questions” (Shah et al., 2019, p. 92). They elaborate that research paradigms are methodology based and categorised as the “purist methodologists and pluralistic methodologists” (Shah et al., 2019, p. 91).

The philosophical principles of the “purist methodologists” (Shah et al., 2019, p. 91) is the use of either inductive or deductive research approach which respectively inform either the quantitative or qualitative research paradigm in a single research. These paradigms are influenced by the philosophical assumptions of the positivists’ objectivity or constructivists’ subjectivity which advocate the use of either quantitative or qualitative research respectively, but not both in the same research (Shah et al., 2019). The “pluralistic methodologists” (Shah et al., 2019, p. 91), however, advocate the use of both inductive and deductive strategies in promoting the application of “both quantitative [objectivity] and qualitative [subjectivity] research approaches in a single study” (Shah, et al., 2019, p. 94). Their philosophical assumption is the pragmatism paradigm.

The pragmatism paradigm emphasizes that instead of concentrating on either objectivity or subjectivity, researchers should focus on a research method which combines the two approaches, aiming at responding to the question(s) guiding the research to address what is being studied (Creswell, Klassen, Clark & Smith, 2011; Maarouf, 2019; Shah et al., 2019). The phenomena being investigated in this study is the development of the pre-service teachers’ ICT pedagogical integration knowledge and skills in an ICT literacy course.

One main question and three sub-questions contributing to the main question to guide establishing such knowledge and skills development in the pre-service teachers were formulated to conduct this study. These questions as outlined in chapter one of this study, demanded that in the course of ascertaining the knowledge and skills development, the pre-service teachers’ perception and understanding of ICT pedagogical integration should be articulated. The pragmatism research

paradigm was found to be the most appropriate to support and guide this study. The choice of pragmatism as the research paradigm is because the phenomena being studied and the research questions take centre-stage of this study (Shah et al., 2019).

The use of the pragmatism research paradigm for this study guided the researcher's decision on the choice of research method. It further steered the design of the instrument used to collect both quantitative and qualitative data at the same time (concurrently), analysed them separately, and discussed together, the findings from these differing data categories.

4.3 Research Method

The discourse on which research method is suitable between quantitative and qualitative research has suggested the need for a form of research method that will mix the approaches of these two in single research. These two methods (quantitative and qualitative) have been argued to "represent opposing ways of researching educational phenomena" (Scot & Morrison, 2006, p. 155) due to their varying disadvantages. These disadvantages in turn sit on the opposing ends although mixing the methods could hold each other's hands to override their disadvantages (Creswell, Clark, Gutmann & Hanson, 2003).

According to Timans, Wouters and Heilbron (2019, p. 205), Mixed methods research is a form of research that "combines elements of qualitative and quantitative research approaches" in the same research and integrates the two data categories in one or more forms along the way. Creswell et al. (2003, p. 165) define mixed methods research as one which "involves the collection or analysis of both quantitative and qualitative data in a single study in which the data are collected either concurrently or sequentially and involve the integration of the data at one or more stages in the process of research". This study supports Creswell et al. (2003) definition of mixed methods research. The type of data collected, how they were collected, analysed, and the interpretation procedure took centre-stage of the decision on the appropriate research method. Mixed methods research approach was chosen for this study upon careful consideration of the research questions, data collection process and instruments, data categories, and interpretation.

The quantitative data provided numbers and charts describing the development of the pre-service teachers' ICT pedagogical integration knowledge and skills. The qualitative data on the other hand, assisted the researcher to gain more insight and better understanding of the aspects of ICTs

knowledge and skills which had been developed by the ICT Literacy Course, and gage the extent of such development. The combination assisted the researcher to establish the validity of the findings from the close-ended quantitative questions and the open-ended qualitative questions (Creswell & Clark, 2017; Creswell et al., 2003; Loeb et al., 2017; Maarouf, 2019; Mohajan, 2017; Shah et al., 2019), and triangulate the findings from the quantitative and qualitative data including findings from the document analysis.

4.4 Research Design

The flexibility in applying both quantitative and qualitative research methods in one research is associated with the pragmatism's philosophical assumption that a phenomenon of investigation could be better understood when studied from diverse viewpoints than a single standpoint (Creswell, 2014; Shah et al., 2019). An advantage of mixed methods research, triangulation, is a juxtaposition of this philosophical assumption. Shah et al. (2019) have argued triangulation as the practice of implementing an aspect or aspects of the research process from dissimilar perceptions. This technique according to Creswell et al. (2003) can be applied whether the quantitative and qualitative data were collected one after the other using different instruments (sequentially) or at the same time with one or more instruments (Concurrently).

The application of the pragmatism paradigm to mixed methods research permits the "researcher to select the [research design] in which it is most appropriate to locate and address the research question(s) posed…" (Scot & Morrison, 2006, p. 157). They assert that "this selection will affect every aspect of the research design and outcome (Scot & Morrison, 2006, p. 157). The researchers argue that the selection further influences "the nature and method of data collection" (Scot & Morrison, 2006, p. 157) and analysis. This mixed methods research employed the concurrent triangulation design which involved collecting quantitative and qualitative data in one set of questionnaire consisting of close-ended and open-ended questions, and document analysis. The figure below, summarises the concurrent triangulation design approach employed of this study.

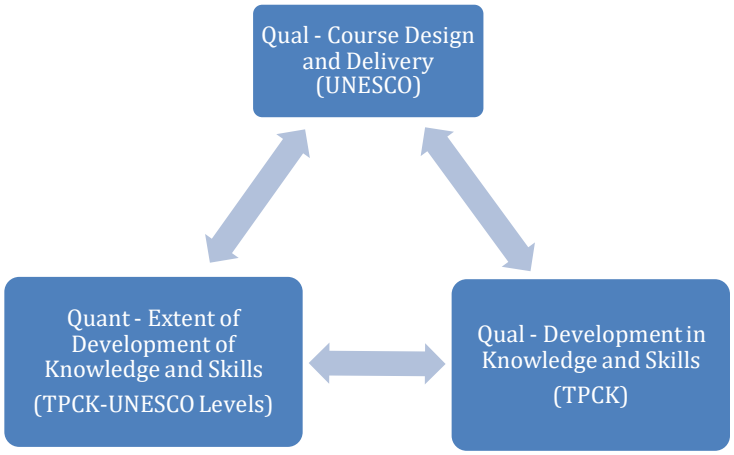

Figure 2. Concurrent Triangulation Research Design Approach

The participants being first-year pre-service teachers and the ICT Literacy Course offered for only first-years students, with the study conducted when the country was under lockdown, data could only be collected "simultaneously" (Scot & Morrison, 2006, p. 157), thus, a concurrent design. The choice of triangulation was based on a consideration of the research questions advanced in this study, which demands a comparison of the pre-service teachers' perception, knowledge, and skills on using ICT in education prior to and after taking the course, to determine whether they were developed by the course, and the extent of their development. Triangulation was employed in this study to facilitate a comparison of the quantitative data from the closed-ended questions and qualitative data from the opened-ended questions and document analysis. This was meant "to see if" data from the closed and opened-ended questions "validate each other" (Scot & Morrison, 2006, p.157), and if their findings will converge, and align with the document analysis outcome to meet the demand of the research questions.

4.5. Population

The field work of this study was conducted at the Campus of the School of Education of a University in Johannesburg, South Africa. The choice of site was influenced by proximity, as the researcher is a tutor on the course being appraised through the students. The School of Education has a diverse student population that is receiving their four-year pre-service teacher's education specializing in various subjects taught to learners in the pre-tertiary schooling system in South Africa. They consist of primary from (grade 1 – 7) to secondary (grade 8 – 12) school. A researcher's population entails every individual or object with all the distinguishing conditions

specified as a focus for the research (Alvi, 2016; Explorable.com, 2009). This study focused on establishing first-year pre-service teachers' ICT pedagogical integration knowledge and skills development in an ICT Literacy Course. Its Population was therefore the First-year Pre-Service Teachers enrolled in the course.

4.6. Sampling and Sample Size

A researcher's use of the entire members of a defined population for a particular research is inhibited by issues of lack of time, funds, and how often they could be approached (Cohen, Manion & Morrison, 2007), because it involves "a large collection of individuals or objects" (Explorable.com, 2009, p. 1) central to the research. To curb this inhibition, researchers usually follow one or more sampling processes depending on the type and purpose of the research, research methodology, and design, to select a portion of the population (sample) from which they collect the needed information for the investigation (Avil, 2016; Cohen et al., 2007; Creswell & Clark, 2006; Scot & Morrison, 2005).

Mixed methods researchers' choice of sampling technique should be informed by their choice of design (concurrent or sequential) (Creswell & Clark, 2006; Onwuegbuzie & Collins, 2007), "and relationship of the qualitative and quantitative samples" (Onwuegbuzie & Collins, 2007, p. 292) in this regard. The number of participants (sample size) according to Creswell & Clark (2006), should conform to the traditional quantitative-qualitative research status quo due to a lack of agreement among mixed methods researchers on the minimum participants for each of the quantitative-qualitative components.

In Creswell and Clark (2006, p. 119), the authors recommend the same sample for both quantitative and qualitative data categories in a concurrent design, arguing that "selecting different individuals will introduce personal characteristics that may confound the comparison" during the data analysis stage. Cohen et al. (2007, p. 100) posit that there are instances where a "researcher can access the whole population", which means the sample and population are the same and numerically equal. This concurrent triangulation designed mixed methods study agrees with Creswell and Clark (2006), Onwuegbuzie and Collins (2007), and Cohen et al., (2007), on sampling procedure, sample, and sample size. It made its questionnaire available to the entire population of 340 pre-service teachers purposefully sampled for the study. In Onwuegbuzie and Collins (2007, pp. 288 -

289), however, "a minimum sample size of 30 [and not less than] 3 participants" are recommended respectively for quantitative and qualitative components of a mixed method study. The data analysis in this study was conducted based on responses received from 139 pre-service teachers, in addition to the document analysis.

4.7. Data Collection Instruments

4.7.1. Introduction

The process of collecting data is one of the key areas which need the researcher's critical attention. It involves the decision on the data collection instrument, its design, and the best possible way to implement it to obtain the required data to address the issue being investigated which is always captured in the research questions (Creswell & Clark, 2006; Scott & Morrison, 2006). The research questions determine the category of data (quantitative, qualitative, or both) to be collected, which further determine the instrument to be used and how to design it. This section elaborates the instruments – document analysis and questionnaire – used for the data collection process in this study.

4.7.2. Document analysis

Document analysis is a process employed to collect qualitative data (Coffey, 2014). According to Bowen (2009, p. 27), this orderly process involves locating, choosing, and evaluating documents' content, aiming to provoke "meaning, gain understanding, and developing empirical knowledge" contained in these documents. The author argues that qualitative researchers prefer this technique to other methods due to its advantages. Bowen (2009) registered the existence of documents as qualitative data sources in different formats, for a wider timeframe, their availability and accessibility anywhere at any time, and comparatively low-cost involved, as some advantages of document analysis. Further, document analysis can be used as either a stand-alone data collection method, or complementary to other techniques for the purpose of triangulation in mixed methods research (Bowen 2009; Coffey 2014), and "provide background information" (Bowen 2009, p. 29) of some sort to aspects of the research.

The researcher's background knowledge of the content of the ICT Literacy Course being appraised in this study played a major role in knowing and understanding the ICT knowledge and skills the

pre-service teachers were to be equipped with, and at which levels in the course. This information was contained in the course outline, and the UNESCO ICT CFT which was adapted as a framework in creating the course. These two documents were analysed in this study through content analysis, for the specific knowledge and skills, and their levels the course should develop in the participating pre-service teachers. Since the course adapted the UNESCO's ICT CFT as its competency framework, the ICT competencies and the three knowledge levels of the UNESCO's ICT CFT were employed to organise content of the course (see ***table 2*** in chapter 5) found in the course outline during the analysis (Bowen 2009), as the course adapted the UNESCO's ICT CFT as its competency framework.

4.7.3. Questionnaire

A questionnaire as argued in Pope, Boleman and Cummings (2005, p. 4), "is a document that [poses] the same [set of] questions" to be answered by all its target audience. The authors point out that the use of such document as a tool for collecting data in research has gained prominence in recent years, because it makes it possible for all participants in the research to respond to the same question(s). Researchers prefer questionnaires to other data collection instruments. This is due to the differing ways they could be designed and administered, the various categories of data that could be used to collect, and other advantages (Brace, 2018; Jones, Murphy, Edwards & James, 2008; Meadows, 2003; Pope et al., 2005; Rowley, 2014).

Many writers have argued that questionnaires are used primarily to collect data in quantitative research (Brace, 2018; Cohen, Manion & Morrison, 2007; Creswell & Clark, 2017, 2006; Creswell et at., 2014; Creswell et at., 2003; Scott & Morrison, 2006). questionnaire can be used to obtain either quantitative or qualitative responses (Meadows, 2003; Pope et al., 2005). The literature further argued that much depends on the way questions in the questionnaire are formulated and structured, and technique(s) employed in analysing the data. The questionnaire can be designed with close-ended questions providing option-responses from which respondents select their preferred answers, which generates numeric-based data for quantitative research. Alternatively, using open-ended questions to design the questionnaire permit the respondents to answer the questions in their own words, to generating text-based data for qualitative research (Meadows, 2003; Pope et al., 2005). Assurance of respondents' anonymity, comparative low cost and multimodality in designing and delivering, and its ability to cover a large sample and or population

in a wider area coverage are other advantages of using questionnaires over other data collection techniques (Brace, 2018; Jones, Murphy, Edwards & James, 2008; Cohen, Manion & Morrison, 2007; Meadows, 2003; Pope et al., 2005; Rowley, 2014; Scot & Morrison, 2006).

The use of a questionnaire to collect empirical data for this study was based on the research method, design, number of respondents as elaborated in the preceding sections, and the respondents' geographical locations. The outbreak of the coronavirus pandemic at the time data were collected for this study had forced the ICT Literacy Course being appraised in this study to move to online mode. The best way to reach out to the respondents was through online. The questionnaire was therefore developed and designed using google forms and delivered to the pre-service teachers using the course's site. It had close-ended questions using a 3-type Likert scale, and open-ended questions, to collect quantitative and qualitative data respectively (Creswell & Clark, 2017; Creswell & Clark, 2006; Creswell et al., 2014, Creswell & Clark, 2003; Pope et al., 2005; Scott & Morrison, 2006).

Four questions based on the extended elaboration of the conceptual framework for this study (***Table 1***) were advanced under each of the knowledge constructs; TK, TPK, TCK, and TPCK (see explanations in chapter 3 of this study). The three answer-options: Agree, Disagree, and Neutral, respectively interpreted in this study as knowledge has been: developed, developed below satisfaction, and developed satisfactorily, were provided for each of these four questions. The pre-service teachers then selected the option which best describes the extent to which they believed the course has developed their knowledge and skills under the knowledge constructs.

4.8. Data Analysis

Analysis of data and discussion of the research findings begins with analysis of the various documents which were used in the design, development, and presentation of the course under appraisal. This was to establish the general knowledge and understanding of what the course is all about, what it intended to achieve (its objectives or purpose), the content outlined towards achieving such objectives, and how the course was organised. This document analysis was conducted using content analysis. The quantitative data generated through the close-ended questions were then presented and interpreted in various forms to aid ease of interpretation. Walliman (2017, p. 118) asserts that "charts and diagrams are far easier to understand quickly by

the non-expert than results presented as numbers". To make sense of the findings of this study, and more accessible and easier to understand (Loeb et al., 2017), the quantitative data from responses to each knowledge constructs in the questionnaire were summarised and presented in both statistical charts and tables.

Descriptive statistical data analysis was then deployed to analyse the data presented in these charts and tables. Loeb et al. (2017, p. 39) agree that "Measures of Central Tendency such as mean [average]... measures of variations... standard deviation…, and basic frequency analyses are useful statistical tools for description". The mean, percentages, and standard deviations of the quantitative data obtained from the questionnaire were calculated and included in the frequency distribution tables to aid the descriptive analysis and discussion of findings. This was carried out as a means of providing descriptions of how each of the three knowledge constructs – TK, TPK, and TCK –, contributed to the development of the pre-services teachers' technological Pedagogical Content Knowledge (TPCK), which informs their ICTs Pedagogical Integration Knowledge and Skills.

When analysing qualitative data in mixed methods research, Creswell et al. (2003, p. 175) posit that "transforming the qualitative data into scores [makes the findings] easily compared with the quantitative scores". The qualitative data obtained from the open-ended questions in this study were tabulated and converted into scores, and descriptive analysis utilised to achieve two aims. (1) Assist the researcher to discover and offer "descriptions to [any possible] observable patterns [and or explanations] in the data …" (Loeb et al., 2017, p. 39) which could possibly not be captured by the quantitative data, and (2) To establish validity and reliability of the findings in this study. Triangulation is the use of more than one source of the same data in a study to avert the researcher's biases and ensure validity of the research findings (G. E. Fusch, P. Fusch & Ness, 2018; Heale & Forbes, 2013; Shah et al., 2019). Findings from the two data categories obtained from the questionnaire in this study were compared with each other for their corroboration and established their alignment with the document analysis outcome.

4.9. Validity and Reliability

Validity is a feature in research that is utilized in ascertaining "the extent to which a concept is accurately measured" (Heale & Twycross, 2015, p. 66). It seeks to confirm whether the data obtained in research is exactly what the researcher intended to collect, or the data collection

instrument(s) provided something different from the intended. Reliability on the other hand, is a means to establish the "truthfulness" (Mohajan, 2017, p. 1) of the data collected with the data collection instrument(s). Validity and reliability assist to determine the exactness and consistency of the research findings, and if they could be depended on.

A researcher can ensure validity and reliability by posing the same question(s) about the same construct in a different manner to the same respondent(s) in the same or different version of the data collection instrument (Mahajan, 2017). One way of determining validity and reliability of the data and thus findings from the data in this mixed methods research, is the use of open and close ended questions in a questionnaire to collect qualitative and quantitative data. They could also be established according to Loeb et al. (2017), through the deviations from the mean using descriptive statistical analysis tools such as measures of central tendency and measures of variations.

The aim for collecting qualitative data in this research, was to establish whether the pre-service teachers' responses to the close-ended questions in the questionnaire about the same knowledge constructs (TK, TPK, TCK, TPCK) would be different if the same questions were open-ended. It was further to establish whether the findings from the open-ended questions would be entirely different from the quantitative data obtained in the close-ended questions. The validity and reliability of findings of this study could be observed in the extensive inclusion of responses from the pre-service teachers in their original texts, as well as in statistical tables, charts, and calculations all of which corroborate each other in the discussions.

4.10. Ethical Consideration

The Ethics Committee of The University granted ethical clearance with a protocol number 2020ECE032M to conducting this study, after a consideration and thorough examination of a proposal that was submitted to them, stating the intention to conduct such research. Permission was sought from the head of School of Education who allowed the school to be used as a data collection site for this study, and permitted the First-Year Pre-Service Teachers' participation in this research.

Each participating pre-service teacher's anonymity and confidentiality of the information they have given out were assured. To do this, their identities were not required anywhere in the questionnaire which was used as the data collection instrument for this research.

More so, participants were assured that participation is not compulsory, and they were free to withdraw their participation whenever they felt unable to continue with their participation. They were made aware that participation was voluntary, and that there was no reward or incentives of any kind for their participation. Finally, a consent form was attached to the questionnaire online, and each participant was made aware that by completing the questionnaire, they had consented to participate in this study.

CHAPTER FIVE

PRESENTATION AND INTERPRETATION OF DATA

5.1. Introduction

This chapter of the study covers presentation and analysis of the data collected which begins with the course's design and delivery which involves the analysis of two documents – The UNESCO (2018) ICT CFT, and the ICT Literacy Course outline (2020 Academic year) –. These documents were prominent in the design, development, and presentation of the ICT Literacy Course. The chapter continues with a presentation and analysis of data on the extent of ICTs knowledge and skills development and concludes with the presentation and analysis of data on the knowledge and skills development.

5.2. Design and Delivery of the ICT Literacy Course

The ICT Literacy Course this study sought to appraise was aimed to arm the first-year pre-service teachers with the knowledge and skills they will require to integrate digital technologies in education after graduating from the university. It is prudent that vital documents which formed the basis of, and were used for the course be identified and analysed when conducting an appraisal of such a contextualised course. Such analysis will provide useful information leading to the understanding of why and how the documents were used (Bowen 2009). In this context and in the context of this study, the two documents mentioned in this chapter's introduction were analysed as in the preceding sections.

5.2.1. Competency Framework that informed the ICT Literacy Course Design

The UNESCO ICT CFT is adaptable to suit country, area, or situational specific context (UNESCO 2018). Its three levels of competency indicators and six aspects of competencies as summarised in the chart (***figure 3***) below were adapted by the course designer and positioned as the competency framework guiding the course.

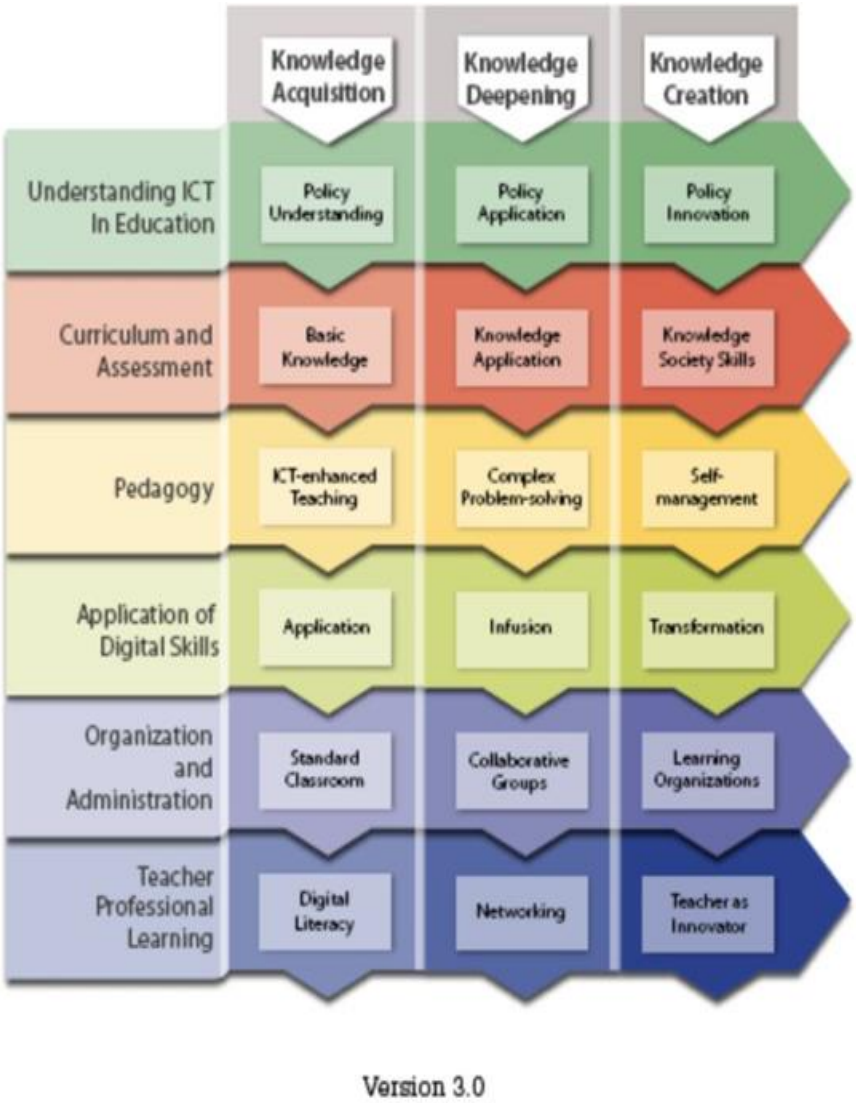

Figure 3. UNESCO (2018) ICT CFT - retrieved from: ictcftv3.png (1300×1380) (unesco.org)

The six aspects of competencies involved in this adaption were positioned as topics, with specific knowledge and skills expected to be developed in the pre-service teachers assigned to each of these topics as indicated in ***table 2*** in the ensuing section.

5.2.2. The ICTs Literacy Course Outline (2020 Academic year)

The 2020 ICT Literacy Course for first-year pre-service teachers well articulates the structure of the course in terms of its expectations for the lecturer, tutors, and students (pre-service teachers). The sections: Introduction, Objective(s), Organisation and Content were of much interest to this study, as they provided the researcher in-depth information needed about the course. The analysis of this document began with a general overview of the course and proceeded as presented in the sections below.

5.2.3. Overview of the ICTs Literacy Course

Communication between students and staff members at the School of Education used as a data collection site for this study are conducted electronically. Lecturers choose to communicate with their students either by email, telephone call, verbal announcements during classes, and consultations in their offices, or using the University's Learning Management System (LMS) at the time of communication. Teaching, Learning, and Assessments is hybrid (both Face – to – Face (F2F) and online) at the university with the use of the LMS. Lectures are conducted mostly through F2F format. Teaching and learning materials, additional resources, and assessment instructions are made available on a course site created for each course on the LMS.

Lectures for this ICT Literacy Course were conducted mostly through F2F interaction, and sometimes virtually using Microsoft Teams. All teaching, learning, and assessment materials, resources, and instructions were uploaded onto the course's site on the LMS. The pre-service teachers were required to interact with the content, respond to all assessment tasks (formal and informal), and submit all completed assessment tasks electronically using submission boxes created purposefully for such tasks on the LMS. Communications between the course lecturer and the students were conducted on the course's site with a few through emails. The course tutors and the students were communicating through the F2F, Instant Messaging (IM) specifically using the WhatsApp App, and emails sometimes.

5.2.4. Objective(s) of the ICTs Literacy Course

The Course had the general objective of developing the pre-service teachers' Knowledge and Skills in the use of Information and Communication Technologies (ICTs) in education. This objective generated two specific objectives; developing the ICTs knowledge and Skills (1) they would need

for their studies as students at the University, and (2) those they would require for work as teachers upon completing their four years Pre-service Teacher Training. These two specific objectives were clearly stated in the 'Welcome to the course', messages as it could be seen on the page in the screenshot (***figure 4***) below, captured from the course site.

'Welcome to the ICT Literacy Course for Pre-Service Teachers'

Figure 4. ICT Literacy Course - Welcome page. Retrieved from: The course's site

5.2.5. Organisation and Content of the ICT Literacy Course

The course content was chosen with intent, organised into topics, and knowledge and skills across two semesters, to achieve its specific objectives as stated in the previous sections of this study. The content begins with the introduction of the pre-service teachers to the University's Learning Management System, SAKAI. It proceeds to introduce them to Computers – Hardware and Software – in general. They are then taught how to use a processor software, specifically the Microsoft Word, as it is the most basic and common application software these pre-service teachers will be using for text documents production during their training at the University, and in their future professional practice as teachers after graduation. They are also taught the use of the

internet, how to use it, and how to stay safe online. The table below (**Table 2**), illustrates the topics and the specific knowledge and skills taught under each topic in the course as adopted from the course site on the University's LMS.

Table 2. ICT Literacy Course Content Organisation – Adopted from the course site.

SEMESTER 1	
TOPIC	**Content: Knowledge & skills**
Introduction Computer basics	SAKAI – access and how to navigate the platform About Computers o What is a computer o Hardware
Organisation and Administration – with Word	Using a computer o Software MS Word
	Using a computer o Internet MS Word o How to create a worksheet
Teacher Professional Learning Communities	Introduction to PLCs o Netiquette Subject Groups online o Creation of groups
	Connectivism o How learning happens in an online discussion
Curriculum	Critical Literacy o Power/ control/ domination online o Copyright o Plagiarism o Safety issues
	Accessing Content o Open Education Resources (OERs) Multimedia o Video and Audio o Editing video o Digital Storytelling

SEMESTER 2	
TOPIC	Content: Knowledge & skills
Pedagogy	ICTs in Education Policy
	ICT Enhanced Teaching and Learning PowerPoint: · Creating slides · Embedding multimedia
	Creating PowerPoint for Teaching
	Creating an Interactive PowerPoint
	Creating PowerPoint for Learning
Assessment	Assessment in Education · Types of assessment · Bloom's Taxonomy
	Offline and Online tools
	Recording and Evaluating Assessment · Excel · Data · Formulas
	Quiz
	Generating Reports
	Analysing data

These topics in the course content indicated in the table above, had ICT competencies adapted from the UNESCO ICT CFT to be attained by pre-service teachers in their ICT literacy course. The knowledge and skills covered in the course were decided based on the anticipated pre-service teachers' prior knowledge and the availability of digital tools with the focus on the competencies in the ICT CFT.

The two documents analysed in this section of the study have divulged information which formed the basis of the researcher's understanding of how the ICT Literacy Course was designed and

structured as well as its content. Additionally, each of the documents contributed immensely to different areas of the study. The UNESCO (2018) ICT CFT afforded the researcher an understanding of how it was adapted to design the Course and contributed to designing the conceptual framework to guide this study. The course outlined specified competencies and indicated specific knowledge and skills that were intended to be developed in the students on the course. These influenced the crafting of the research questions, conceptual framework, and the questionnaire used in collecting empirical data for this study analysed in the proceeding sections of this chapter.

5.3. Pre-service Teachers' ICTs Knowledge and Skills Development

The questionnaire from which the quantitative data reported here were obtained, was designed, and developed based on the conceptual framework for this study. The Conceptual Framework brings together the knowledge constructs – TK, TPK, and TCK –, to constitute the TPCK, which teachers need to be equipped with to integrate ICTs in teaching and learning. The extent to which such knowledge has developed or otherwise, could be determined under the three knowledge levels of the UNESCO (2018) ICT CFT. These knowledge levels were adapted, and together with the constituents of the TPCK, formed the elements of the Conceptual Framework for this study as in ***figure 1***. A 3-type Likert scale response; Agree, Disagree, and Neutral, were assigned to each of the four questions, from which the respondents were expected to select the one which best describes the type of ICT Knowledge and or Skills they had acquired in the course. The first-year pre-service teachers provided varying responses to the questionnaire. Summaries of their responses per knowledge construct are presented in statistical charts and tables in the ensuing sections.

5.3.1. Technological Knowledge (TK)

This study explored the TK of the Pre-service Teachers in the context of their Knowledge about: (1) National policies guiding the use of technologies in teaching, learning, and or assessment in South Africa; and (2) Existing technology-based tools being used, and those "that can be integrated into the curriculum" (Koehler et at., 2014, p. 102) to achieve the national curriculum goals.

The precise Knowledge areas of Digital Technologies the pre-service teachers were expected to know about in the ICT Literacy Course are summarised across the knowledge levels segment of the TK portion in the 'Extended Elaboration of Conceptual Framework' (see ***table 1***).

These pre-service teachers were expected to demonstrate that they have gained knowledge and do understand National Policies governing and guiding the use of ICTs in education in South Africa after taking the ICT Literacy Course. Moreover, they were expected to be equipped with the basic operational knowledge about recent digital technologies. These competencies fall within the Knowledge Acquisition Level in the UNESCO's 2018) ICT CFT as in ***figure 5*** below.

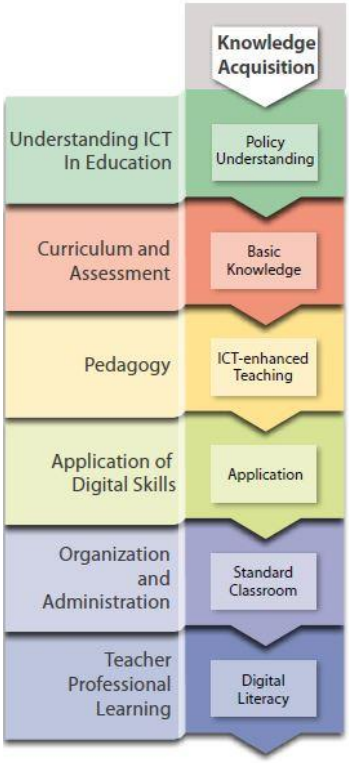

Figure 5. UNESCO (2018) ICT CFT – Knowledge Acquisition Level.

The pre-service teachers' responses to questions pertaining to the development of their TK in the course are summarised in ***figure 6*** and ***table 3*** below.

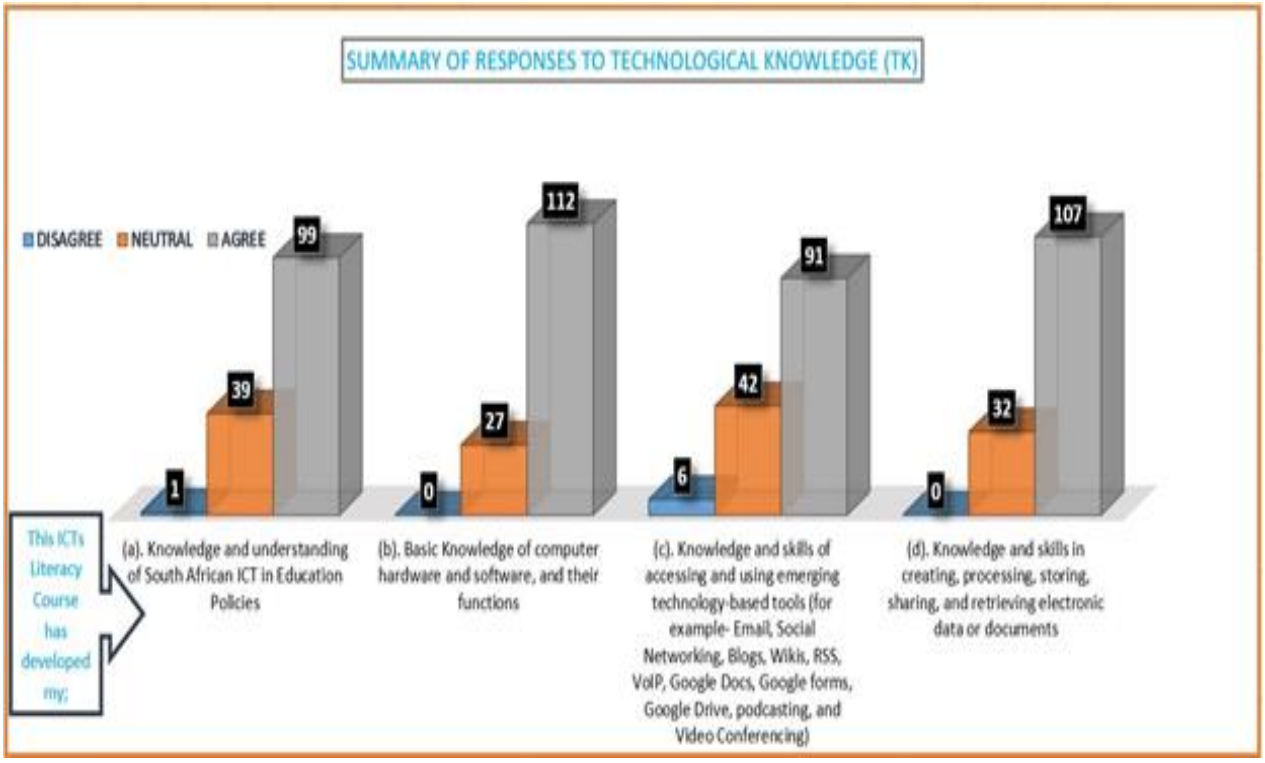

Figure 6. Responses to Technological Knowledge (TK)

The findings in ***figure 6*** are further summarised with statistical calculations to aid ease of comparison and understanding, and to establish their validity or otherwise in ***table 3*** below. The sum of responses to each of the four questions across ***Table 3*** is 139, which tallies with the totals of the numbers in each set of blocks in ***figure 6*** (above).

Table 3. A Summary of Responses to Technological Knowledge (TK)

Technological Knowledge (TK)			
QUESTION	***RESPONSE***		
This ICT Literacy Course has Developed my;	***DISAGREE***	**NEUTRAL**	***AGREE***
(a). Knowledge and understanding of South African ICT in Education Policies	***1***	**39**	***99***
(b). Basic Knowledge of computer hardware and software, and their functions	***0***	**27**	***112***
(c). Knowledge and skills of accessing and using emerging technology-based tools (for example- Email, Social Networking, Blogs, Wikis, RSS, VoIP, Google Docs, Google forms, Google Drive, podcasting, and Video Conferencing)	***6***	**42**	***91***

(d). Knowledge and skills in creating, processing, storing, sharing, and retrieving electronic data of documents	***0***	**32**	***107***
MEAN	**2**	**35**	**102**
STANDARD DEVIATION	**2.49**	**5.87**	**7.98**
PERCENTAGE	**1.3%**	**25.2%**	**73.6%**

It is evident in each set of the blocks in ***figure 6*** and the values in ***Table 3*** above that most of the pre-service teachers, 73.6%, agreed their knowledge about, and basic skills of ICTs in all the 4 areas were developed in the course. The Mean and Standard Deviation for their responses, as provided in the table support these findings. Standard Deviation (SD) for 'Agree' is 7.98, which is extremely far from its mean, 102. On the other hand, SD for the opposite response, 'Disagree', is approximately 2 (if the 2.49 is taken to the nearest whole number), which is the same as its mean value, 2. The further the standard deviation value of a set of data from its mean, the more valid it is (Loeb et al. 2017). The large difference between the mean and standard deviation for the 'agree' response validates the findings that the pre-service teachers' TK was developed by the course.

5.3.2. Technological Pedagogical Knowledge (TPK)

The TPK as elaborated earlier in this study, is the knowledge a teacher requires to identify, select, and apply most appropriate technologies and "instructional practices, strategies, and methods…" (Koehler et al., 2014, p. 102) to facilitate teaching and learning. This course aimed to introduce the pre-service teachers to different digital technologies, from which they could identify, select, and apply the one(s) appropriate for teaching and learning in their specialised subject(s). This will facilitate their self-development, sharing and improvement in best teacher professional practices, and connect and team them up with experts and other professionals in their subjects in other institutions (UNESCO 2018). These practices are listed under the Knowledge Deepening Level of the UNESCO ICT CFT as Application, Networking, Collaboration Groups, as shown below.

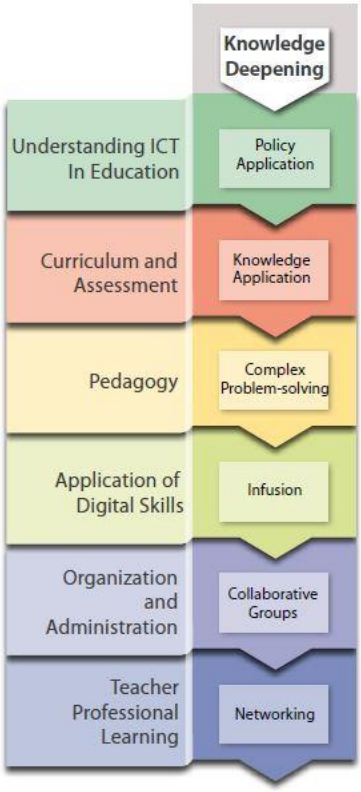

Figure 7. UNESCO (2018) ICT CFT – Knowledge Deepening Level.

The statistical chart and the corresponding table below, present a summary of the pre-service teachers' responses to this segment of the questionnaire.

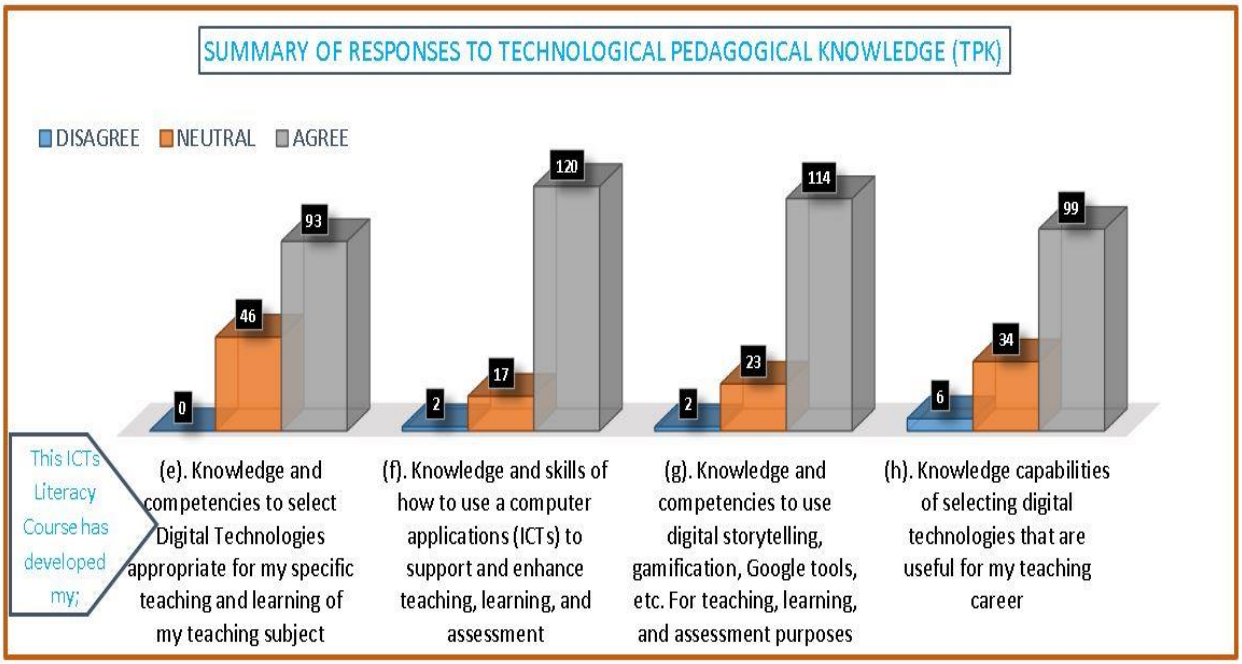

Figure 8. Responses to Technological Pedagogical Knowledge (TPK)

These findings confirm that most of the pre-service teachers agree to the development of their TPK by the ICTs Literacy Course. This study confirms the variability of these findings from the chart in a frequency distribution table below, with such statistical descriptive data analysis tools as mean and standard deviation, and percentages of the pre-service teachers' agreement or otherwise.

Table 4. A Summary of Responses to Technological Pedagogical Knowledge (TPK)

Technological Pedagogical Knowledge (TPK)			
QUESTION	RESPONSE		
This ICT Literacy Course has Developed my;	DISAGREE	NEUTRAL	AGREE
(e). Knowledge and competencies to select Digital Technologies appropriate for my specific teaching and learning of my teaching subject	***0***	46	***93***
(f). Knowledge and skills of how to use a computer's applications (ICTs) to support and enhance teaching, learning, and assessment	***2***	17	***120***
(g). Knowledge and competencies to use digital storytelling, gamification, Google tools, etc. For teaching, learning, and assessment purposes	***2***	23	***114***
(h). Knowledge capabilities of selecting digital technologies that are useful for my teaching career	***6***	34	***99***
MEAN	***3***	30	***107***
STANDARD DEVIATION	***2.18***	11.07	***10.92***
PERCENTAGE	***1.8%***	21.6%	***76.6%***

The table above indicates that only 1.8% of the 139 pre-service disagreed that the ICT Literacy Course developed their TPK, while 76.6% agreed, with 21.6% choosing neutral. These confirm the findings from ***figure 8*** above. The further the standard deviation, 10.92, of those who agreed to the development of their TPK from its mean, 107, compared to the closeness of the standard deviation, 2.18 of those who disagreed to such development to its mean, 3, validates the findings from the data in ***figure 8*** above.

5.3.3. Technological Content Knowledge (TCK)

In the scope of this study, the TCK construct was explored in the context of the knowledge and skills of using Digital Technologies tools teachers require to design, develop, and or create teaching, learning, and assessment content, and presenting such content to their students. Their responses to questions which were advanced in the questionnaire to explore such knowledge and skills development are presented in the chart (***figure 9***) below.

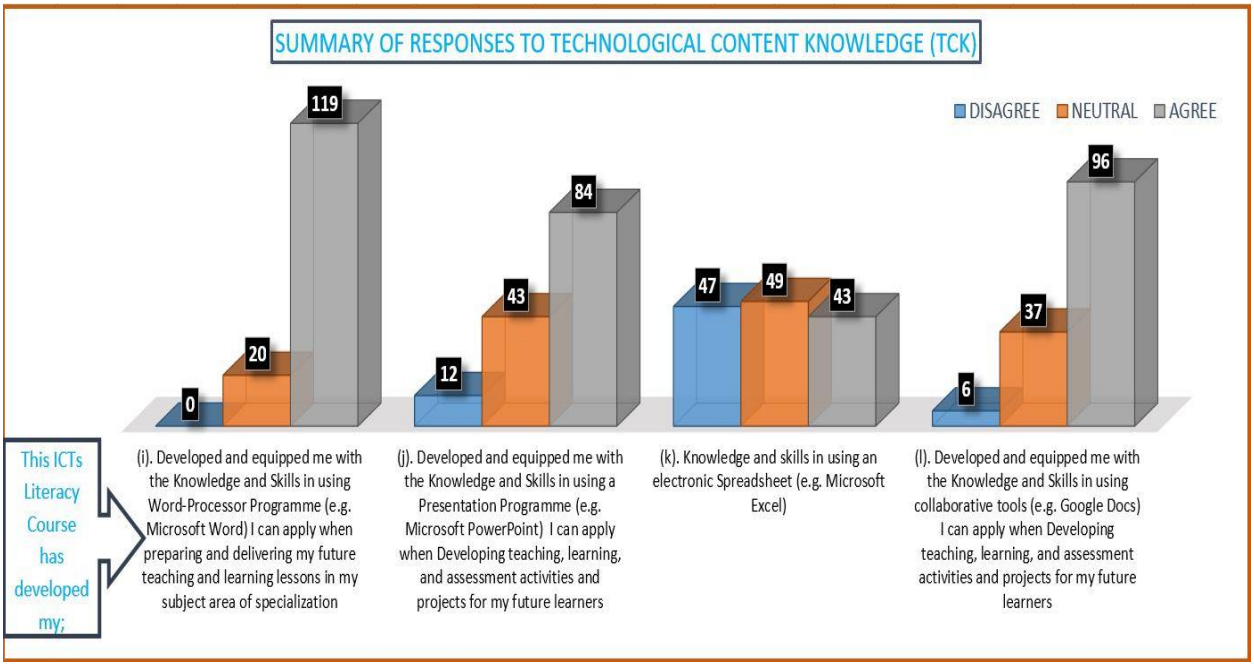

Figure 9. Responses to Technological Content Knowledge (TCK)

It is evident in the chart above that majority of the pre-service teachers agreed that their knowledge and or skills in using processing software, presentation software, and software for collaboration, especially online, have been developed by taking the course, as they show high scores amongst the 3 option-responses. However, they are not happy with their development in using a spreadsheet software – Microsoft Excel – in designing and developing content for assessment purposes as the course content dictates. These findings brought forward in ***figure 9*** were further explored with descriptive statistics data analysis calculations in a frequency distribution table (***table 5***) as presented below.

Table 5. A Summary of Responses to Technological Content Knowledge (TCK)

Technological Content Knowledge (TCK)			
QUESTION	RESPONSE		
This ICT Literacy Course has Developed my;	DISAGREE	NEUTRAL	AGREE
(i). Developed and equipped me with the Knowledge and Skills in using Word-Processor Programme (e.g. Microsoft Word) I can apply when preparing and delivering my future teaching and learning lessons in my subject area of specialization	***0***	20	***119***
(j). Developed and equipped me with the Knowledge and Skills in using a Presentation Programme (e.g. Microsoft PowerPoint) I can apply when Developing teaching, learning, and assessment activities and projects for my future learners	***12***	43	***84***
(k). Knowledge and skills in using an electronic Spreadsheet (e.g. Microsoft Excel)	***47***	49	***43***
(l). Developed and equipped me with the Knowledge and Skills in using collaborative tools (e.g. Google Docs) I can apply when Developing teaching, learning, and assessment activities and projects for my future learners	***6***	37	***96***
MEAN	***16.25***	37.25	***85.50***
STANDARD DEVIATION	***18.25***	10.83	***27.57***
PERCENTAGE	***11.7%***	26.8%	***61.5%***

The involvement of such descriptive statistics data analysis tools, Mean and Standard deviation, was to check the variability and hence, the validity of the data presented by the chart above (***figure 9***). As the table above indicates, 61.57% of the respondents agreed to all the four statements pertaining to the developed of their TCK, with a mean of 85.50 and a Standard Deviation of 27.57. These findings from the data presented in the above table validate the data presented in the corresponding chart (***figure 9***), considering how far the Standard Deviation value is away from its mean value (Loeb et at., 2017).

The table above, again reports that 11.7% of the pre-service teachers disagreed with the development of their TCK by the course. This percentage is far below the 61.5% who had agreed to all the four statements. This demonstrates that the majority of the pre-service believed the course developed their TCK.

In a particular set of blocks in ***figure 9*** above, the number of the disagreeing responses to that particular statement in the questionnaire is more than those who agreed. The raw scores indicates that 47 pre-service teachers disagreed with the statement labelled k, while 43 of them agreed with it (see ***Table 5)***. This important finding in the chart was not explained by the percentage value, 11.7% in the table because a 'percentage score' helps in breaking a whole quantity into summarised portions. The mean value and the corresponding standard deviation value of a data set indicates the dispersion of the scores [how distant the raw scores are from each other] (Loeb et at., 2017). It implies that either some of the raw scores are bigger than others, or one or a few of them are outrageously bigger than the rest of the scores in a set of raw data, as argued in Loeb et al. (2017). They point out that the raw score(s) that is outrageously bigger than all other raw scores in the same set of data is referred to as outlier(s).

The presence of an outlier(s) in a set of data is easily identified in the raw scores. Its effect(s) on data validity is that it either gets the standard deviation value much closer to the mean value as in most cases, or as in some cases, the standard deviation value exceeds the mean value (Loeb et al., 2017). The standard deviation for the pre-service teachers who in this study disagreed that their TCK has been developed by the course is 18.25, which is more than the corresponding mean value of 16.25. This is caused by the outlier, 47, which is the Disagree option-response to the statement labelled k in ***table 5*** above.

5.3.4. Technological Pedagogical Content Knowledge (TPCK)

Teachers need the knowledgebase, TPCK – to integrate ICTs into teaching, learning, and or assessment (Koehler & Mishra, 2006; Koehler et al., 2014). This indispensable knowledgebase is the consolidation of the three knowledge constructs - Technological Knowledge, Technological Pedagogical Knowledge, and Technological Content Knowledge. Pre-service teachers during their professional practice, are further required to be able to advance and lead colleagues in the quest to integrate technologies in teaching, learning, and or assessment. This calls for teachers to possess

the knowledge and skills to use contemporary technologies to innovate, transform, and be able to organise, and manage all aspects of teaching and learning professionally, as summarised in the Knowledge Creation Level of the UNESCO (2018) ICT CFT as in the chart below.

Figure 10. UNESCO (2018) ICT CFT – Knowledge Creation Level.

The attainment of such competencies follows the development of the three knowledge constructs (discussed in previous sections in this study), which in turn, facilitates the development of the pre-service teachers' ICTs pedagogical integration knowledge and skills, and thus, their TPCK as argued in Koehler and Mishra (2006). The chart (***figure 11***), and the corresponding ***table 6*** below, provide summaries of the findings on the development of the pre-service teachers' TPCK in the ICT Literacy Course.

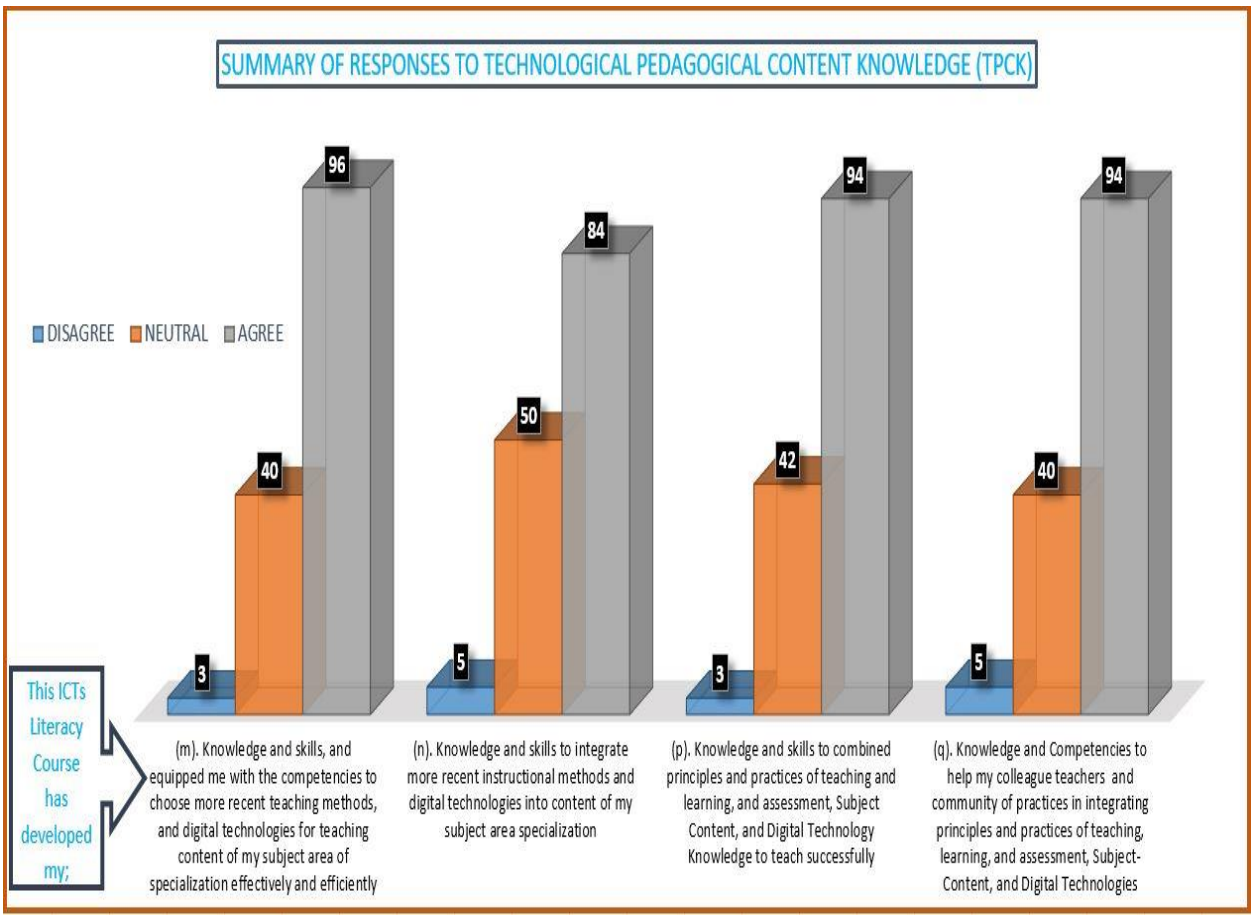

Figure 11. Responses to Technological Pedagogical Content Knowledge (TPCK)

It is observable across the cluster of sets of blocks in ***figure 11*** that the least number of the pre-service teachers who agreed to any of the four statements is 84 which is far more than the highest number of those who disagreed, 5, and the 50 of them who chose to remain neutral. Statistically, 66.2% of the 139 pre-service teachers agreed that their TPCK has been developed by taking the ICT Literacy Course, with 2.9% disagreeing, and 30.9% neutral, as evident in ***table 6*** below.

Table 6. A Summary of Responses to Technological Pedagogical Content Knowledge (TPCK)

Technological Pedagogical Content Knowledge (TPCK)			
QUESTION	RESPONSE		
This ICT Literacy Course has Developed my;	DISAGREE	NEUTRAL	AGREE

(m). Knowledge and skills, and equipped me with the competencies to choose more recent teaching methods, and digital technologies for teaching content of my subject area of specialization effectively and efficiently	***3***	40	***96***
(n). Knowledge and skills to integrate more recent instructional methods and digital technologies into content of my subject area specialization	***5***	50	***84***
(p). Knowledge and skills to combined principles and practices of teaching and learning, and assessment, Subject Content, and Digital Technology Knowledge to teach successfully	***3***	42	***94***
(q). Knowledge and Competencies to help my colleague teachers and community of practices in integrating principles and practices of teaching, learning, and assessment, Subject-Content, and Digital Technologies	***5***	40	***94***
MEAN	***4***	43	***92***
STANDARD DEVIATION	***1***	4.12	***4.69***
PERCENTAGE	***2.9%***	30.9%	***66.2%***

The variability and hence, validity of these findings were established with the mean and standard deviation of each of the three option-response. As indicated in the table above, the mean value of the pre-service teachers who agreed to all the four statements is 92, with a standard deviation of 4.69. Those who disagreed on the other hand, are with the mean value of 4, and standard deviation of 1, and the mean value for those who remain neutral is 43, with a standard deviation of 4.12. The standard deviation values for each of the three option-response is far lower than their respective mean values, which in descriptive statistics data analysis terms validates the findings of the data (Loeb et al., 2017).

5.4. Pre-service Teachers' ICTs Knowledge and Skills Developed

The use of mixed method in a research presents the researcher with the opportunity to blend quantitative and qualitative data in the same research (Timans, Wouters & Heilbron, 2019). The use of a mixed method for this study was intended to examine and compare the qualitative and

quantitative data to gain more insight and understanding of the two data categories. It was to explore whether they would yield similar if not the same findings, or findings from the quantitative and qualitative data would disagree with each other, if the same questions were posed in different ways to elicit responses from the same pre-service teachers (Creswell & Clark, 2017). Findings from the qualitative data would have to be compared with that from the quantitative data in this regard. This section presents and analyses findings from the qualitative data obtained from the open-ended questions section of the questionnaire used for collecting empirical data for this study.

The analysis of qualitative data in this study makes references and comparisons to the findings obtained from the quantitative data presented in the preceding section of this study. The qualitative data was transformed into quantities to make such referencing and comparison easier (Creswell et al., 2003). This was intended to determine if the document analysis outcomes aligned with findings from these two data categories, and to establish corroboration and convergence as argued in Creswell et al. (2003).

5.4.1. Perceptions of Technological Knowledge

This section explored the knowledge and skills of digital technologies the pre-service teachers had and their understanding of the use of such technologies for educational purposes prior to enrolling for the ICT Literacy Course. It further explored how the course had altered such knowledge, skills and understanding. This information was elicited from them through the open-ended question in the questionnaire for the data collection. Responses from the 139 pre-service teachers to these questions were "transformed …into scores" (Creswell et al., 2003, p. 175), and are presented as part of the tables below, with a descriptive analysis of the findings as follows:

Table 7. Scores of Knowledge of Digital Technologies Prior to the Course

Question 1. What knowledge of digital technologies did you have before taking this ICT Literacy Course and how has this course helped to further develop your knowledge and use of digital technologies?		
	Freq.	%
No Knowledge of Digital Technologies	96	69%
Means of communication and access the internet for information using cellular phone	15	11%
Awareness of apps for processing, storing, and sharing of information	28	20%
TOTAL	139	100%

The table above indicates that majority of the pre-service teachers, did not have any knowledge of digital technologies, with a few, indicating they had little knowledge before enrolling in the course. Their knowledge was mostly limited to among others, the functionalities of their cellular phones which resulted in them perceiving digital technologies as a means of communication and for surfing the internet for information. The rest were aware of application software such as Microsoft Word, PowerPoints, and Excel for processing, storing, and sharing of information. However, they all indicated that the course improved their knowledge of digital technologies. Here is what two of them had to say.

Student 1:

> I had no knowledge of digital technologies since I come from a less privileged community with almost 0% of internet access and I had no access to computers at high school. This ICT Literacy course has helped me to develop knowledge and use of digital technologies. It has developed my basic knowledge of software and hardware. It has developed my knowledge and skills in using and accessing emerging technology-based tools.

Student 2:

> Before enrolling for the ICT Literacy Course my knowledge was limited to the smartphone world as I was only able to make something meaningful only through using smartphones. I had the knowledge and understanding that computers can be used to store, share and process data, and are a means of communication. After I taken [took] the course my knowledge base expanded. I am able to operate other digital technologies such as computers and software applications. The information I have received from this course has made me more aware of digital technologies and that they are not only limited to laptops, computers or cellphones.

The pre-service teachers' proficiency was based on their socio-economic status, exposure, and experience with the digital technologies. The course managed to close these gaps that resulted in their exclusion from accessing the knowledge and skills needed to use ICTs for teaching and learning.

5.4.2. Perceptions of Technological Pedagogical Knowledge

The pre-service teachers had different understanding and perceptions of the use of digital technologies for educational purposes. Their responses to a question relating to their understanding on the use of digital technologies in education indicated that slightly more than half of them had perceived technology to serve administrative purposes at the school and for internet surfing as its educational use. The rest had perceived digital technologies to be used for only entertainment as indicated in the table below.

Table 8. Scores of Understanding and perception of Computers in Education Prior to the Course

Question 2. What was your understanding about technologies in education before you took this ICT Literacy course, and how has the course changed this perception?		
	Freq.	%
Used for administrative purposes at school	73	53%
Surfing for information on the internet for educational purposes	25	18%
Used for entertainment purposes	41	29%
TOTAL	139	100%

The perceptions pre-service teachers had before taking the test got changed by the course offering, as it was pointed out in their responses such as the one below.

Student 3:

> I only perceived computers as equipment for entertainment: playing games & movies. My understanding about the computers in education was that a computer is used to [for] conducting research and a better way to access the internet, record marks, type and print assignments, lesson plans, letters, and learners' reports. I now see computers as a tool to not only store but analyze and arrange information, and also develop, create and deliver teaching, learning, and assessment activities.

The table below (***table 9***), presents a summary of responses the pre-service teachers provided to a question about the computer skills they had acquire prior to enrolling on the ICT Literacy Course.

Table 9. Scores of Skills in using Computers Prior to the Course

QUESTION 3. What skills did you have in using computers before taking this ICT Literacy Course and how has this course helped to further improve your skills of using digital technologies?		
	Freq.	%

No skills of using a computer	114	82%
Surfing the internet for information using the computer	18	13%
Basic skills in using a computer	7	5%
TOTAL	139	100%

The majority, 82%, of the pre-service teachers had no skills in using the computer prior to joining the course, while a few, 5%, of them had computer basic skills such as typing a document with either Microsoft Word, Excel, or PowerPoint prior to the course, as ***table 9*** indicates. Although a further 13% had indicated they had accessed the internet using the computer, they used public facilities such as internet cafes and with the assistance of someone at the cafe. The course equipped and improved their skills in using digital technologies, as evident in their responses like what the following two students said.

Student 4:

> Before taking this course, to be honest I did not know how to use a computers. Even when I had assignments that needed to be typed or use the internet, I paid the people at Internet café to help me out. This course helped me gain and improve skills of using laptops and finding my way around digital technologies.

Student 5:

> Before taking this course, I knew most of the skills in Microsoft Word, Excel, PowerPoint and even database, but were never as refined as they are now. I have been able to improve my skills with the help of this course.

It is evident that for those who did not have skills on how to access the internet had to pay those with the skills in public facilities and this course gave them those skills. Those who came with computer basic skills had them deepened.

5.4.3. Knowledge and Skills of Technological Pedagogical Content Knowledge

A policy document on education is fashioned by a national department with the responsibility to guide the teaching, learning, and assessment of learners at various levels of education in the country. This study sought to elicit from the pre-service teachers, their knowledge and skills of

using ICTs in teaching, learning, and or assessment. The table below (***table 10***) presents their responses to the question 4 stated earlier in this section.

Table 10. Scores of ICTs Knowledge and Skills for Educational Purposes Prior to the Course

Question 4. What Knowledge and Skills of using digital technologies for teaching and learning purposes did you have before taking this ICT Literacy Course?		
	Freq.	%
No knowledge and skills of digital technologies for teaching and learning purposes	12	9%
Knowledge and skills for accessing content shared by teachers through social media and or surfing the internet and communicating with classmates for information using cellular phones	92	66%
Observing teachers' use of technologies to deliver content to learners in class	32	23%
Knowledge and skills for creating, delivering, and administering teaching, learning, and assessment content	3	2%
TOTAL	139	100%

The data presented in the table above indicate that before enrolling in the course, the pre-service teachers were at varying levels of knowledge and skills of educational uses of digital technologies. One of the students (student 6) elaborated that,

Student 6:

> I was not equipped with any skill or knowledge of using digital technologies for teaching, although in my previous school we had the privilege of using smart boards as one of our resources for learning. The teacher usually does everything and we note his or her steps, but never do it practically.

On the other hand, another student (student 7) responded that:

Student 7:

> Before the ICT literacy course, I knew how to create learners question papers where they will be printed out to learners and they will write manually, creating slides, downloading videos and/ or pictures that will be used for the lesson being taught.

At school level some pre-service teachers were exposed to digital resources but did not interact with them. Those who did, the technologies were used for administrative purposes.

This study further explored whether these pre-service teachers' digital technologies integration knowledge and skills were further developed or otherwise by the Course. Findings of this exploration are presented in the next section.

5.4.3. ICT Pedagogical Knowledge and Skills Development

The preceding sections of this study have reported that the pre-service teachers' knowledge and skills of ICTs in education ranged from having no knowledge and skills, to being passive observers of their pre-tertiary teachers' usage, and how they had used some aspects of it themselves. The data in ***table 11*** below, provides a summary of the specific ICT integration knowledge and skills the pre-service teachers got equipped with by the course.

Table 11. Scores of Development of ICTs Knowledge and Skills for Educational Purposes

QUESTION 5. How has this ICT Literacy Course helped to further develop your Knowledge and Skills of using digital technologies for Teaching, Learning, and Assessment purposes?		
	Freq.	%
Technologies help learners to understand certain concepts they struggle to grasp when taught using the 'talk to chalk' approach (TK)	18	13%
Knowledge and skills to use appropriate technologies and instructional approaches in creating content to enhance learning (TPK)	52	37%
Knowledge and skills to Create and administer assessment content (TCK)	5	4%
Knowledge and skills to design, develop, create, and deliver content to facilitate hybrid teaching and learning (TCK)	28	20%
Knowledge and skills to identify and select appropriate technologies to be used for content in subject of specialisation (TK)	28	20%
Knowledge and skills to use collaborative tools to communicate, create, and or share content with others (TCK)	8	6%
TOTAL	139	100%

Knowledge and skills to use appropriate technologies and instructional approaches in content creation to enhance learning, dominates the knowledge and skills developed by the course, as confirmed with 37% of the pre-service teachers in the table above. This knowledge and skills speaks to TPK, based on its assigned definition in the early sections of this study. Findings from the quantitative data in ***table 4*** indicate that 76.6% of these pre-service teachers agreed that the course developed their TPK.

It is evident in ***table 11*** that knowledge and skills classified TK together constitute the second

highest developed amongst the three. A total of 33% of the pre-service teachers admitted that the course has developed their TK related knowledge and skills. This comparatively high percentage again confirms the quantitative category with 73.6% as reported in ***table 3***. The remaining 30%, comparatively the least percentage of the pre-service teachers responded that their TCK related knowledge and skills were developed by taking the course. Findings from the quantitative data as recorded in ***table 5*** indicated that 61.5%, which compared to those of TK and TPK, is the least percentage of these pre-service teachers agreed that the course developed their TCK.

Student 8 said:

> This ICT literacy course has helped me to develop Knowledge and skills to combined principles and practices of teaching and learning, and assessment, Subject Content, and Digital Technology Knowledge to teach successfully. It has helped me discover different platforms to create learning for myself and others especially when it comes to sharing knowledge with others.

Student 9 confirmed:

> It taught me that students can easily understand some concepts if taught with videos and pictures. And I have learnt how to make lesson videos, narrated slides, digital storytelling, and I can design and develop both interactive and non-interactive educational resources in multiple media. It introduced me to policies that I wasn't aware of and I now know how to avoid plagiarism.

The findings from ***table 11*** above, generally corroborate those obtained from the quantitative data in the previous sections of this study. Findings from the quantitative data in ***table 6*** indicated that 66.2% of the 139 pre-service teachers agreed that the course had developed their TPCK. The same data reported that 30.9% of them believed their TPCK had developed satisfactorily, with only 2.9% of them indicating such development occurred below satisfactory. These findings from the qualitative data and quantitative data, confirm and validate each other. This study explored the effectiveness of the course in developing the pre-service teachers' TPCK in the proceeding section.

5.4.4. Effectiveness of the ICT Literacy Course

Lastly, this study sought to find out from the pre-service teachers on how effective the course has been in developing their ICT pedagogical integration knowledge and skills. They were asked to state whether the course was Effective, Ineffective, or neither of the two. Their responses are summarised in ***figure 12*** and the corresponding ***table 12*** below. The sum of the values indicated on the three blocks in the chart below is 139, which equates the number of the pre-service teachers who participated in this study.

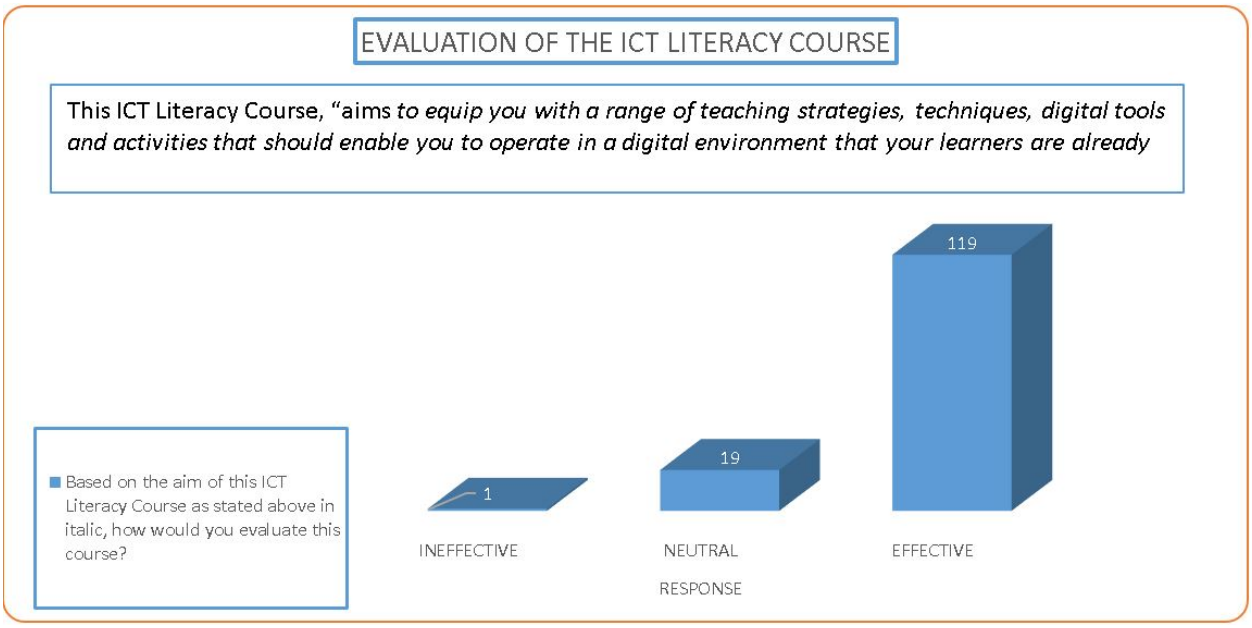

Figure 12. Responses to the Effectiveness of the ICTs Literacy Course

Statistical percentages of these responses are presented in the table below to make the data presentable in different forms to be easily understood.

Table 12. Summary of Responses to Effectiveness of the ICT Literacy Course

This ICT Literacy Course, "aims *to equip you with a range of teaching strategies, techniques, digital tools and activities that should enable you to operate in a digital environment that your learners are already exposed to."*			
QUESTION	RESPONSE		
Based on the aim of this ICT Literacy Course as stated above in italic, how would you evaluate this course?	INEFFECTIVE	NEUTRAL	EFFECTIVE
	1	19	119
PERCENTAGE	0.7%	13.7%	85.6%

The majority, 119, of the pre-service teachers, which represents 85.6% in the chart and the table respectively, affirmed the course's effectiveness, 13.7% indicated satisfactorily effective, with only 1(0.7%) of them indicating the course's effectiveness was below satisfactory as shown in ***figure 12*** and ***table 12*** above.

Conclusion

The findings in this study, across statistical charts, calculations and tables converged that the course developed the pre-service teachers' ICT pedagogical integration knowledge and skills. This evidenced that the course achieved its objective to develop the pre-service teachers' knowledge and skills to use digital technologies for both studies as students at the university, and future practice as teachers.

The UNESCO ICTCFT was adapted to design the course in a way that caters for students with no computer basic schools and have a sense of writing or typing and therefore began with knowledge and skills needed for administrative purposes. The course seems to be designed around ensuring students: (1) are familiar with the technologies (2). have support through the module on PLCs (3). can access and create content and (4). can use content to teach and learn.

The positive responses the students provided to the knowledge and skills they learnt demonstrate the effectiveness of the course design approach. While they admit to coming with low knowledge and skills and they acknowledge that the course prepared them to use for teaching and learning. They provide justifications for their low knowledge and skills and make explicit how the course developed their TPCK.

CHAPTER SIX

6.0. DISCUSSION OF FINDINGS

6.1. Introduction

This study explored the development of the pre-service teachers' knowledge and skills in the six aspects of competencies expected to be developed in the course: ***(1) Introduction to Computer Basics; (2) Organisation and Administration; (3) Teacher Professional Learning Communities; (4) Curriculum; (5) Pedagogy; and (6) Assessment***. The competencies were divided into digital

technologies (TK), how to use the technologies tools with specific-subject content knowledge (TCK), and how to use the technologies with appropriately instructional design principles to improve teaching and enhance learning (TPK) that pre-service teachers acquired in the duration of the course. This chapter discusses findings from the quantitative data, and the qualitative data, presented in the previous chapter.

6.2. DISCUSSIONS

6.2.1. Developing Technological Knowledge

The study found that 66% of the pre-service teachers had knowledge and skills of accessing the internet and content shared with them by their friends, teachers, and families, using cellular phones (cellphones) prior to taking the course. While a cellphone may be considered as a computer, knowing how to operate it does not translate into knowing how to operate a laptop or desktop (Muller, 2017; Nash, 2009). The majority (82%) of pre-service teachers lacked knowledge and or skills of using a computer prior to taking the course. Koehler et al. (2014) argue that the lack of knowledge and skills leads to deficiencies in competencies and confidence. The course therefore had the obligation of ensuring students taking this course develop a clear understanding of digital technologies and can use the devices, software, and networks that are available in schools comfortably as they teach their subjects. This study found that TK of 73.6% of the pre-service teachers had developed in the course. It could be that the course used their operational knowledge and skills of using cellphones and internet in its introduction as they learned how to create administrative documents.

The focus in the ICT Literacy course was on exposing pre-service teachers to various technologies (Hardware, Software, and Networks), progressively develop their competencies in preparation for the use for teaching and learning.

6.2.2. Developing Technological Content Knowledge

The TCK as argued in Kohler et al. (2014) is the knowledge and skills to blend digital tools and content of the teacher's subject of specialisation to create teaching and learning activities including assessment. This study submitted that the pre-service teachers enrolled in the ICT Literacy Course with varying abilities and access to use digital technologies tools, but mainly mobile technologies

for social use. Initially, 2% of them had the capabilities to create, and deliver digital content for educational purposes, prior to enrolling on the course. The remaining majority lacked the knowledge and skills to use mostly the Microsoft Office Suite (Word, PowerPoint, and excel), and other digital tools to create materials and resources that induce learning (UNESCO, 2018) for both Online and Offline learning in the course. Their lack of knowledge and skills could result from lack of experience and exposure to these technology tools in schools (Muller, 2017; Nash, 2009).

This study further found that the TCK of 61.5% of the pre-service teachers developed after they had been exposed to and gained experiences of using the technology tools in the course. It could also be that the digital tools selected (Microsoft Word, PowerPoint, Google Docs, Forms, Mobile Games), were practically aligned to designing and developing content for teaching and learning purposes. However, about a quarter (33.8%) of them could not integrate technologies in assessment. This may perhaps be that either the technology tool (Microsoft Excel), which was selected for the purposes of creating assessment did not align to creating assessment activities or was not practical enough (Garba, 2014). According to Garba (2014, p. 41) "theory driven" content ICT course, hampers adequate preparation of pre-service teachers for a successful ICT pedagogical integration. This then suggests that, creating a practicing environment within the design and development of the courses could augment its practicality to sufficiently capacitate pre-service teachers for ICT pedagogical integration (Goktas et al., 2008).

The teacher's competencies to combine technological tools and subject content to create teaching and learning content is indispensable competencies to be developed in an ICT literacy course (UNESCO, 2018). Such capabilities aid the development of pre-service teachers' competencies to align appropriate digital tools to specified subject content to design, develop, and deliver teaching, learning, and or assessment instruction. Moreover, explicit indication of the levels at which the competencies are intended to be developed in the course provides consistency in training, and pre-service teachers' progress of development could be easily determined (UNESCO, 2018).

6.2.3 Developing Technological pedagogical Knowledge

Teachers' perceptions towards educational technology play a significant role in the way they use them for teaching (Ndlovu, 2016). In this study, about half of the pre-service teachers (53%) perceived digital technologies as administrative educational tools. Unless students are exposed to

appropriate digital pedagogies (Scott, 2015), they are bound to leave these training institutions without knowledge and skills on how to use ICTs meaningfully.

This study found that the course developed the majority (76.6%) of the pre-service teachers' TPK. The first-year pre-service teachers might not have had pedagogical knowledge at the early stage of their training as Koehler et al. (2014) agree. However, the course provided them with knowledge on instructional design principles and strategies they could use in the teaching of their subjects. This was perhaps a good enough reason for the ICT course to have delayed exposing the pre-service teachers to content on curriculum, and pedagogical principles towards the end of the course as indicated in the course content.

Developing ICT pedagogical knowledge and skills should concentrate on pedagogical approaches which develop the pre-service teachers' creativity and critical thinking abilities to "manipulating content in different forms of representation" (Ndlovu, 2016, p. 39). This further extends the focus onto instructional principles and strategies, which will develop the much-required competencies to transform the teaching and learning environment, and content to foster learner-centeredness, collaborative, critical thinking, discovery learning, exploratory learning, project-based learning, problem solving, among others (Barajas et al., 2018; Croxall & Koh, 2013; Freire as cited in Barajas et al., 2018; UNESCO, 2018). While the course engaged them in group activities, provided them with opportunities where they could make decisions with regards to the appropriate design of learning environments for their subjects and participated in projects, this course sought to introduce them to these digital pedagogies that they could develop later.

6.2.4 Development of TPCK

Developing the pre-service teachers' digital knowledge and skills purposefully for pedagogical integration involves paying attention to the development of their TK, TPK, and TCK, all of which come together to complete the development of their TPCK (Koehler & Mishra, 2006). It is at this point that they can create and deliver digital content for the purposes of teaching and learning (Koehler et al., 2014). As this study found that over 90% of the students did not have TPCK and could not identify and select the appropriate technologies and instructional principles and combine them with their subject content to improve teaching and enhance learning, this aligned with Koehler et al. (2014) and UNESCO (2018) assertions.

Pre-service teachers' ICT pedagogical integration competencies can develop by introducing them to methods of designing teaching and learning instructions, and the appropriate digital tools they can apply (UNESCO, 2018). In this study, the TPCK of 66.2% of the pre-service teachers was found to have developed after taking the course. Such development may be the result of : (1) the development of their TK, which capacitates them to identify and select appropriate ICTs to develop content; (2) the development of their TPK, to combine appropriate instructional principles and the selected ICTs; (3) the development of their TCK to apply the selected technologies to the content they desire to teach; and their ability to fuse all these abilities effectively in a teaching, learning, and or assessment process (Koehler et at., 2014; UNESCO, 2018).

The development of pre-service teachers' TK, TPK, TCK, and TPCK as this study has established, could be summarised as 73.6%, 76.6%, 61.57%, 66.2% respectively. The lower development of TPCK compared with TK and TPK could be a result of a comparative lower development of their TCK, which was also affected by the lower development of the assessment component in the course content. This pattern in the findings is of significance to educational technology in the sense that unequal development of any of the knowledge constructs (TK, TPK, and TCK) has a significant effect on the development of TPCK (Koehler & Mishra, 2006; Koehler et al., 2014). It is of essence that the content of an ICT literacy course ensures that there are equal levels of development for all the competencies it intends to develop using established levels of indicators such as those in the UNESCO ICT CFT.

6.2.5 The extent to which TPCK was developed

This study further sought to establish the extent to which the Pre-service teachers' ICT pedagogical integration knowledge and skills were developed by the course. The six aspects of competencies and the three knowledge levels of the UNESCO ICT CFT were used to guide such exploration. The competencies and knowledge levels were chosen for this exercise because the ICT CFT had been involved in the design and delivery of the course. Expounded in the next paragraphs, are the contributions each aspect of competency is set to make towards the development of the knowledge and skills the pre-service teacher would require for ICT pedagogical integration.

Understanding ICT in Education: This served as the introductory platform where the national ICT in education policy gets introduced to the pre-service teachers and equips them with the

competencies to interpret and understand it at Knowledge Acquisition Level. They also acquire the competencies on how ICT could be aligned to the policy towards achieving the curriculum goals (Knowledge Deepening Level). Lastly, they acquire capabilities to evaluate the existing policy with the aim of offering a possible amendment to facilitate educational reform (Knowledge creation). Where policy is concerned, all pre-service teachers were not aware of the policy and exposing them prepared them well for the focus on how to integrate ICT into pedagogy as they created content for teaching and learning through ICTs. This last competency gave them an opportunity to demonstrate that they had TPCK. Considering that the students at this stage (first years) did not have adequate PCK required, this course seems to have given them a feel of what they needed to know prior to teaching in modern classrooms.

Curriculum and Assessment: Participating pre-service teachers attained competencies to explore the possible affordances of using digital technology for teaching and assessing. In the module, they learned about assessment principles and how to apply them in their subjects through a task they did. Concerning the competencies they needed for curriculum integration, relevant modules prepared them on how to access different forms of content online. In their digital literacy for teachers, they also learned how to use online content in a legitimate way, for instance, without plagiarising or contravening copyright laws. This level of engagement is at Knowledge Acquisition Level. They were then made to create Google Forms. assessment based on a concept they had presented in a worksheet on MS Word, on Google Forms. Students were introduced to how they could select content that can be used to achieve curriculum objectives. This could be considered as operating at a Knowledge Deepening level. With regards developing the competencies to evaluate, redevelop existing "curriculum to function effectively within a Knowledge Society" (UNESCO, 2018, p. 25) that is at Knowledge Creation Level, students were given opportunities to evaluate responses for students using MS Excel. In addition, they created assessment they used to determine what content to cover for the materials they created for their final exam. They also created interactive content with multimedia (including digital storytelling activity) that could be used by learners to learn on their own with assessment and feedback using MS PowerPoint. While the students were given the feel of how they could use ICTs for teaching and learning, their TPCK cannot be compared to in-service teachers whose experiences in the practice should give them a rich knowledge base for using ICTs (Mishra & Koehler, 2005).

Pedagogy: The study established that the pre-service teachers with no knowledge and skills to pedagogically integrate ICTs were in the majority. For this reason, the pre-service teachers began the course on the same level. Pre-service teachers were equipped with the knowledge they needed to prior to teaching with ICTs. For instance, when they were exposed to the ICT in Education Policy, they acquired knowledge on how ICTs should be used if they will enhance learning. In addition, students' understanding of ICT pedagogical integration was enriched through Laurillard (2002) Conversational framework and ICT affordances from Conole and Dyke (2004). At this level, students operated at Knowledge Acquisition Level. They then proceed to acquire competencies to integrate digital technology-tools and unconventional pedagogies such as "project and problem-based" (UNESCO, 2018, p. 25) learning, collaborative learning, and learning (Barajas et al., 2018; Croxall & Koh, 2013; UNESCO, 2018). They were made to apply these as they worked on collaborative tasks that were subject based as they gave each other feedback for individually assessed activities. This engagement is at Knowledge Deepening Level. Findings from the quantitative and qualitative data prove that the pre-service teachers' competencies were set to develop around applying digital technology-tools with the conventional methods of teaching and that this was achieved. The ability they were supposed to display in the creation of content However, the level of engagement cannot be pitched at the level that the UNESCO ICT CFT places Knowledge Creation as this would take at least 3 more years and beyond to achieve it.

Application of Digital Skills: The delivery always began with the basics to give everyone equal opportunity to accomplish required tasks although the findings from this study provide that some of the pre-service teachers came to the course with some aspects of knowledge and skills. Pre-service teachers were equipped with knowledge and skills to incorporate digital tools such as word processor software, presentation software, and spreadsheet software and online tools that could be used for teaching, learning, assessment, and collaboration. They were therefore equipped with TK across the three levels (Knowledge Acquisition, Deepening and Creation). The weakness of this course is that it does not include developing competencies in pre-service teachers' subject-specialisation software. Given that this is a generic and a year's course, not all could be covered. It is hoped that as students advance in their methodology courses, they would be exposed to these.

Organization and Administration: Pre-service teachers were empowered with some of the competencies required to organize the ICT facilities of the school "to support effective use of ICT

for learning" (UNESCO, 2018, p. 25). For instance, they learned how to create attractive, effective and interactive worksheets and do calculations of student marks. They were then equipped with competencies at Knowledge Acquisition Level. When they applied these in tasks, students operated at Knowledge Deepening Level. Furthermore, the pre-service teachers were empowered with the capabilities that would help them with designing, developing, and implementation "of ICT plans to actualize the school's technology" (UNESCO, 2018, p. 25) approaches (Knowledge Creation Level). The data demonstrates that participating students had TPCK that relates to this competency, but the fact that they were not exposed to the use of ICTs for the rest of teacher organisation and administration still puts their competencies at a lower level of the competencies.

Teacher Professional Learning: The course design made provision for the pre-service teachers to acquire competencies to communicate with colleagues and subject experts and participate in PLC for professional development. These competencies incorporate digital technologies into other forms of learning such as collaborative learning and facilitate learning beyond the classroom walls using digital technology-tools during their professional practice. The pre-service teachers were therefore capacitated with knowledge on the use ICT to advance their professional development (Knowledge Acquisition Level). They were also equipped with the competencies to meaningfully communicate with colleagues and participate in "educator networks and access resources" (UNESCO, 2018, p. 25) for their professional learning as they applied these in their group work tasks that demanded they support each other and share ideas on how to advance their activities (Knowledge Deepening Level). Furthermore, the pre-service teachers acquire the competencies to create resources, "innovate and model best practice" (UNESCO, 2018, p. 25), and share with their colleagues at school, and their professional learning networks (Knowledge Creation Level). The teaching approach used enabled pre-service teachers' competencies to be developed as they engaged through social media. While this experience gave them an opportunity to work in a Professional Learning Community (PLC), the level of engagement cannot be compared to that of in-service teacher PLC because their PCK is at a low level.

Conclusion

The findings as discussed in this study, point to the pre-service teachers' acknowledgement that the ICT Literacy Course equipped them with ICT knowledge and skills, that they need to gain

TPCK. Based on the competencies and knowledge levels as explained in this section, competencies developed by the course ranges between the knowledge acquisition and knowledge deepening levels of the UNESCO's ICT CFT. It could then be concluded that the first-year pre-service teachers' ICT pedagogical integration knowledge and skills in the ICT Literacy Course, were developed at all levels of the CFT. However, the fact that pre-service teachers lack PCK, the course could not have developed them at the level required for a practicing teacher. Their TPCK is therefore at a lower level and thus creating a low level in the UNESCO ICT CFT framework.

CHAPTER SEVEN

7.0. CONCLUSION AND RECOMMENDATION

7.1. Conclusion

The course under appraisal in this study aimed "to equip [the first-year pre-service teachers] with a range of teaching strategies, techniques, digital tools, and activities that [would] enable [them] to operate in a digital environment that [their future] learners are already exposed to" (The Course

site 2020). This aim implicitly converges into equipping the pre-service teachers with TK, TPK, and TCK.

The development of the TK, TPK, and TCK, according to Koehler and Mishra (2006), and Koehler et al. (2014), should subsequently complete the development of TPCK. They argue that Digital Technologies could be used for educational purposes if pre-service teachers' TPCK is developed, to ensure the development of their Pedagogical Integration Knowledge and Skills. This study sought to determine if the Pedagogical Integration Knowledge and Skills of the first-year pre-service teachers were developed, and the extent of this development by the ICT Literacy Course they were enrolled on. It is conclusive based on the findings and discussions in the preceding sections of this study that:

Most of the pre-service teachers before the course, were aware of the social use of ICTs, such as: entertainment, games, searching information on the internet, and offline and online information sharing. This had formed their perception on the use of digital technologies. Their perception on educational use of ICTs was mainly for administrative purposes and searching and sharing content online. The course extended their perception of ICTs in education to include, but not limited to sourcing, creating, sharing, and delivering digital content for the purposes of teaching, learning, and or assessment.

The structure, sequencing of the topics, and the specified knowledge and skills intended to develop in the course as indicated in ***table 2*** in section 5.2.5 of this study, was based on the pre-service teachers' prior knowledge and skills of digital technologies. This could be used to determine the knowledge and skills, and the level at which to begin a teacher training programme, the appropriate content to cover, and the levels of competencies to develop (UNESCO, 2018). However, the ICT Literacy Course's content revealed that its design and delivery did not specify the levels of knowledge and skills the pre-service teachers would be developed to by the course. Again, the aspects of competencies it intended to achieve were not explicit. Moreover, certain deficiencies were spotted in the course content which would require attention in the future design and delivery of the course since it is using a framework with levels.

The development of pre-service teachers' ICT pedagogical integration knowledge and skills up to the appropriate knowledge creation level of the UNESCO's ICT CFT would imply that they have acquired the competencies to critique the existing ICT policies and recommend how they could be amended (UNESCO, 2018) for instance. Moreover, they need to have competencies to design and develop such policies and determine the most appropriate way and level ICTs should be integrate in "student-centred and collaborative learning" (UNESCO, 2018, p. 41) to meet the curriculum and the knowledge society's requirements. These competencies were missing in the ICT Literacy Course for the first-year pre-service teachers.

7.2. Recommendations

Based on the discussions of findings in the previous chapter, and conclusions in the preceding section of this chapter, the following recommendations are advanced.

- The course's designer(s) could consider redesigning and redeveloping the content on the assessment aspect of the course content to enhance the development of the TCK of the pre-service teachers who will be studying the course in subsequent academic years.
- Pre-service teachers could create an e-portfolio of artefacts of integrating digital technologies in all aspects of teaching and learning, with assistance and guidance from tutors and lecturers. This could be done as part of their academic assessment and during Teaching Experience (TE). This could provide a practical environment where they can showcase, share, and develop their competences as they advance in their studies and later, their experience and qualified teachers.
- The University could consider extending the duration of the ICT Literacy to cover half, if not the entire duration of the pre-service teacher training. This will allow students who might have deficiencies in the development of their TPCK in their first-year pre-service, the chance to be developed in the subsequent years. It will further allow all pre-service teachers to be trained in how to use subject-specific Software in their respective subjects of specialisation to enhance the development of their TCK.

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