TITLE

Teacher Educators' Instructional Strategies in Preparing Pre-Service Teachers to Teach with Digital Technology in the 21st Century

BY

NYARAI TUNJERA

The full thesis submitted in fulfilment of the requirement for the degree

Doctor of Education (Educational Technology)

In the faculty of Education and Social Sciences at the Cape Peninsula University of Technology

Supervisor: Professor Agnes Chigona

Mowbray Campus

October 2019

Declaration of Originality

I, Nyarai Tunjera, hereby submit this thesis for the Doctorate degree and I declare that its contents have not been previously submitted in whole or in part, for the award of any other qualification. Each significant contribution to and quotations cited in this thesis from the work, or works, of other people has been acknowledged, cited and referenced. Furthermore, it represents my own opinions and not necessarily those of Cape Peninsula University of Technology.

Signed: ____________________ Date: *10 October 2019*

Acknowledgement

Firstly, I give my utmost thanks to my El Shadai, Adonai, the Almighty God, the author and finisher of my being, for giving me grace, the health, strength, courage, wisdom and financial resources for this undertaking. Evangelist Maga, Overseers Chizeya Moshoeshoe and Mlilo, fellow brothers and sisters in the Lord, your support is greatly appreciated.

My heartfelt thanks go to my supervisor, Prof. Agnes Chigona for her unparalleled expert advice, unwavering support and guidance that made this thesis a laudable reality. Thank you for the unfailing and continual assurance that I will make it and for guiding me on this long, but exciting journey. Your persistent interrogating of my intellect and prodding of my thinking led me to a new and deeper understanding of my research. Thank you, Prof. Agnes., for generously availing me with an NRF funding thank you for believing in me.

I am also indebted to Chengetai Mutongwizo for proofreading this thesis: your skill and patience are acknowledged. Dr Neat (Nancy E Adam-Turner), Prof Isel Ramirez, thanks for always checking on me.

I am deeply indebted to my daughters, Dorothy and Jacqueline, for their unwavering

support throughout my many academic expeditions. My grandchildren Nicole and Christian, your smiles raised my hopes higher. To my brothers, Godfrey and Givemore, and sisters, Irene and Margret, thank you for the moral support, my sister-in-law, Sibongile, brother-in-law, Alex and son-in-law Munyaradzi I am exceedingly blessed to have your support and unfailing love. Thanking my mothers'; gogo Matsika, gogo Chakombera, gogo Madimutsa for your unwavering support and prayers. I am blessed and humbled to be part of such a great family, I love you dearly. You are rare jewels to me. My friend Dadirayi Chigwada, your loving nags, prayer pushed me to greater heights. Liteboho and Mthi your love, support and prayer made this journey realisable. My aunts and uncles, my cousins and nieces, I SALUTE you all for your moral support.

Dr. Zinyeka, I am intrigued by your thought-provoking arguments, incisive reasoning, and unreserved support. Dr Chantyclaire you set the pace, there is light at the end of the tunnel – you are a real inspiration. Dr. Rusenga am grateful to your support throughout this journey.

I would especially like to thank the TrEds and pre-service teachers' who availed themselves at all odds and Education Faculty who allowed me to undertake my research. The TrEds and students' willingness to participate is greatly appreciated, their contributions made a significantly to the understanding of teaching with technology in teachers' preparations programmes.

Abstract

The 21st century is characterised by an influx of information from various sources. This presents the education field with both a challenge and opportunity in the teaching practice. Technology advancements have made it increasingly easy to share and access this information almost instantly. This presents the education field with both a challenge and opportunity in the teaching practice. The challenge is that not all the available information is useful or even meaningful, therefore the 21st century requires that students acquire the 4Cs (communication, collaboration, critical thinking and creativity) on how to engage with the information and not just receive it. The mandate on educational institutions is therefore to make use of technology-enhanced practices to facilitate acquisition of these skills. The implications are applicable to teacher training institutions includes the equipping of pre-service teachers with higher level thinking skills. 21C teacher educators should be modelling instructional strategies that are relevant to the demands of the modern age, more importantly these strategies should be technology-enhanced. The technology-enhanced instructional strategies should be informed by contemporary teaching and learning theories as well as technology integration frameworks. To this effect, the researcher's original contribution to the body of knowledge was formulated – the ConTis model as elaborated on further below.

Teaching with technology in teacher preparation programmes in South Africa should respond to the 21C skill requirements. Alarmingly, research in this area has continuously reported that TrEds are falling short in their teaching with technology. There is a consensus on the importance of technology integration, however, TrEds continue to use it merely as a substitution for traditional means of teaching. Contributing to this problem is the continued use of lecture-centred teaching strategies. There is a substantial amount of literature advocating for TrEds to start to adopting student-centred approached as supported by contemporary theories that argue that the best way to learn is to actively engage with knowledge and not be passive recipients. It was on this backdrop that the researcher developed the research question of this study*: What do TrEds need to effectively prepare pre-service teachers to teach with technology in the 21C?* To better understand and explain this phenomenon the researcher developed a conceptual framework based on teaching and constructivist teaching theory as well as technology integration framework.

To investigate this phenomenon, the researcher chose to design the research study following the interpretivist paradigm for its emphasis on social contexts and in-depth understanding of phenomenon of interest. On that, the researcher made use of qualitative data collection tools to – semi-structured interviews; non-participant observations as well as a focus group interviews. The research design used was a single case study as was data collection from TrEds of one teacher education institution in the Western Cape. The data collection was conducted over a period of eight months which allowed the researcher to intensively explore TrEds' practices. The researcher made use of various sampling methods to ensure that the participants would be able to offer relevant information as they were constantly interacting with the phenomenon under study.

The findings reveal that the majority of the participating TrEds were employing lecture-centred instructional strategies, whereby technology was used to support traditional teaching approaches. The participating TrEds, contrary to their perception on their technology integration skills as reported during interviews; were observed to be using the basic functions of mostly general technology applications. This use resulted in achieving low level teaching outcomes. The institution at which the study was conducted availed technology resources to the TrEds. However, there was a deficit on the relevance, maintenance and capacity of the technology which contributed to TrEds reluctance to integrate technology.

From the findings, the researcher deduced that the failure to integrate technology effectively was due to the lack of a practical and holistic guide on how to teach with technology. The researcher, based on the data analysis and in response to this shortcomings, developed a model which the researcher coined "Constructivist Technology-enhanced Instructional strategies" (ConTIS) model which can be used as a diagnostic model for TrEds to self-assess their technology integration in their practices. The model is also useful to professional development intervention designers as they can use it to identify the gaps in technology integration. The researcher further argues that this be conducted at departments levels as the needs of TrEds may differ across teacher education institutions. The model is also useful as an evaluative model that helps educational technologist and TrEds continuously assess whether their currently adopted technology interventions are yielding the appropriate outcomes as per the teaching and learning theory employed by institution and or faculty.

The implications of this study were to both TrEds' practice as well as institutional policy development. The findings of the study highlighted the importance of institutions and the faculties within them to identify and adopt relevant contemporary teaching strategies as well as frameworks that are conducive to 21C teaching outcomes. The participating TrEds reported that their practice was not necessarily informed by any particular teaching and learning theory or technology integration framework, in fact some of them highlighted that they were not familiar with frameworks such as TPACK and PCK. Therefore, it is vital for institution's policies to enforce that TrEds practice be based on prevailing teaching with technology developments.

The limitations of the study were that the research study's design was a single case study and therefore focused on one context which limits the generalisability of the findings as the phenomenon might be experienced differently in a different setting. A longitudinal case study may also be employed in order to conduct an even more in-depth exploration of the phenomenon. It is possible that TrEd practice may have been presented as differently over time and the researcher would have discovered other factors affecting the phenomenon.

The researcher therefore suggests that for further studies, researchers should perhaps conduct a comparative study by investigating how the phenomenon manifests in different contexts. Future studies may also conduct a longitudinal case study to allow for an intensive study of teacher educator practices and perhaps analyse any changes that may occur over time with the introduction of other technology interventions. The researcher also encourages that future studies be conducted to evaluate the practicality and effectiveness of the proposed ConTis model.

Dedication

To my late mother, Martha, to whom I humbly, gratefully, and posthumously

dedicate this work, which you initiated but did not live long enough to behold its blossoming. My Great God's Family and my grandchildren Nicole Rukudzo and Christian Tadiwanashe Bongani.

To ALL who discern the power God invested in man for the fulfilment of a greater purpose to serve Him and fellow men.

List of Research Output

1. Tunjera, N. & Chigona, A. (under review). Developing a model to guide technology integration in the 21st Century teacher education. Computers & Education. An International Journal. Elsevier ISSN: 0360-1315
2. Tunjera, N. & Chigona, A. (2019). Teacher Educators' Appropriation of TPACK-SAMR Models for 21st Century Pre-Service Teacher Preparation. IJICTE: Volume 16, Issue 3, Article 10. In-print ISSN: 1550-1337 DOI: 10.4018/IJICTE
3. Tunjera, N. & Chigona, A. (2019). Teacher educators' preparing pre-service teachers to pedagogically integrate technology in the 21st century classroom. SAERA Conference 2019. Durban
4. Tunjera, N. & Chigona, A. (2017). Technology Skills Acquisition in a Pre-service Teacher Digital Storytelling Project. In J. Dron & S. Mishra (Eds.), Proceedings of E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education (pp. 672-680). Vancouver, British Columbia, Canada: Association for the Advancement of Computing in Education (AACE) ISSN: 1065-6901, ISBN 978-1-939797-13-1. https://www.learntechlib.org/p/181245/
5. Tunjera, N., Tiba, C.A., Condy, J. & Chigona, A. (2016). Pre-Service Teachers' Acquisition of Technology Skills in a Digital Storytelling Project. In G. Chamblee & L. Langub (Eds.), Proceedings of Society for Information Technology & Teacher Education International Conference (pp. 3091-3098). Savannah, GA, United States: Association for the Advancement of Computing in Education (AACE) ISBN 978-1-939797-13-1. https://www.learntechlib.org/primary/p/172130/.

List of Abbreviations and Acronyms

21C	21^{st} century
B.Ed.	Bachelors of Education
CK	Content Knowledge
CKe	Content Knowledge Expert
CSA	Content Specific Applications
ETe	Educational Theories Expert
F2F	Face-to-Face
FET	Further Education Training
FGI	Focus Group Interview
FP	Foundation Phase
GPA	General purpose Applications
HU	Hermeneutic Unit
ICTs	Information Communication Technologies
ISP	Intermediate Senior Phase
PCK	Pedagogical Content Knowledge
PK	Pedagogical knowledge
RAT	Replacement Amplification Transformation
SA	South Africa
SA DBE	South African Department of Basic Education

SAMR	Substitution Augmentation Modification Redefinition
TCK	Technological Content Knowledge
TIM	Technological integrating Model
TK	Technological Knowledge
TPACK	Technological Pedagogical and Content knowledge
PSe	Professional studies Expert
TPK	Technological Pedagogical Knowledge
TrEds	Teacher Educators
WCED	Western Cape Education Department

List of Figures

List of Table

List of Appendices

Definition of Terms

The following terms are operationally defined as used in this research study:

Teacher Educators (TrEds)

A teacher educator is someone who teaches at a teacher education institution or supports pre-service teachers' field work in schools, and contributes substantially to the development of pre-service teachers towards becoming qualified and competent teachers

Pre-Service Teachers

Pre-service teachers are students who are enrolled in an undergraduate teacher preparation degree in a tertiary education setting in order to attain teaching qualifications to teach in public or private schools' sectors domestically or internationally.

TPACKed Educator

TPACKed refers to an educator who have mastered the ability to maximise TPACK functions for effective teaching with technology. The researcher coined the term *TPACKed* educator to imply an educator who effectively integrate technology into their teaching practice entirely, i.e. efficiently using technology to wholistically transform learning.

Digital Technology

The computerised electronic devices hardware or software that support learning across the curriculum, such as computers, laptops, Smartboards, calculators, CD players, mobile phones, web tools (internet) just to name a few.

Content Specific Applications (CSA)

Software applications designed to specifically support instructional strategies within a content area e.g. Grammatica, reading tools, GIS, GPS, etc.

General purpose Applications (GPA)

In this research study these are types of software application that can be used for a variety of tasks. It is not limited to one particular function. For example, a word processor, presentation and spreadsheet application. Users can use the same application in some variety ways (Ternier, Klemke, Kalz, & Specht, 2012; Sung, Chang, & Liu, 2016; Westera, 2010) to fulfil their goals

Content Knowledge Expert (CKe)

A Content Knowledge Expert (CKE) is an educator who is an authority in a particular area or topic. Also known as a subject matter expert. An example would be a TrEd mathematics expert.

Professional Studies Expert (PSe)

PSe is an educator who systematically organised and transferable knowledge base expressing the values and norms of the professional teaching. Is a TrEd who specialises in professional aspects of the art of teaching.

Education Theories Expert (ETe)

ETe is an educator who is knowledgeable about theories of teaching in the fields of sociology, philosophy and psychology

Graphmatica

This is a graphing software application that is used for plotting graphs, solving simultaneous equations, and performing other tasks with variables.

TABLE OF CONTENTS

CHAPTER ONE

INTRODUCTION TO THE RESEARCH STUDY

1.1 Introduction

The 21st century (21C) came with a vast amount of information from numerous sources – digital sources, have overtime been preferred mostly due to ease of access and shared platforms where knowledge bearers and seekers can interact instantly. The ever increasing amount of information requires a certain level of skill set in order for it to be processed, sifted through, rejected or accepted, analysed, improved or even reinvented. Digital technologies have simultaneously been enhanced and are on a consistent upgrade to assist in this processing and sharing of information. This radical shift in knowledge acquisition presented challenges and benefits to the education sphere; demanding educators to revisit their teaching practices in order to meet the expectations of the 21C teaching and learning requirements.

Lecture rooms are no longer characterised by an educator with a blackboard and chalk, students with textbook, notepad and pen; they are now platforms where the educator is no longer the sole source of knowledge. The students get to contribute and there is the use of technological tools and applications during lesson delivery by both educator and students. There are new teaching and learning theories that facilitate student-centred teaching and learning, such as the connectivism and constructivist theories. The 21C teaching and learning environment, therefore, requires educators to possess knowledge on how to apply teaching strategies that promotes 21C learning outcomes. This shift in teaching strategy, was predicted by Laurillard and McAndrew (2003: 82) who observed that the permeation of technologies in our schools was turning teaching into a “conceptual challenge”, which implied that educators would have to re-think their approach to teaching and learning “well beyond the traditional transmission model”.

The demands of the 21C are taking educators out of their more authoritative roles where they are the main dispensers of knowledge and control how learning takes place. They are now challenged to take on a facilitative role that encourages the students to actively construct knowledge by employing technology-enhanced, student-centred instructional strategies. The 21C further demands that students be oriented towards the acquisition of higher order thinking and innovation skills referred to as the 4Cs: 1) **C**reativity, 2) **C**ritical thinking, 3) **C**ommunication and 4) **C**ollaboration (Partnership for 21st Century Learning, 2016). The objective is to equip students for the environment they will have to confront and navigate through in the workplace, this implies that teaching objectives should align with skills required in the 21C workplace where students will eventually end up (Kivunja, 2014).

With the realisation that the acquisition of the 4Cs in students relied substantially on the choice made by the educator on what technology-enhanced teaching strategy to use, it became important to investigate whether or not the educator has been equipped to do so, if they themselves possess these skills. On the backdrop of this, the researcher chose to focus on pre-service teacher training. Teacher educators (TrEds) are required to understand how technology helps to enhance teaching and learning and how they can use it to facilitate the development of the 4Cs in pre-service teachers. These new demands entail that TrEds are expected to prioritise the 21C technology-enhanced instructional strategies in their teacher preparation programmes.

The goal of 21C educators should be to provide learning environments that develop students' learning and innovative skills such that they are able to participate in and contribute to the information age. Empirical research about how students learn provides valuable insights into how educators should address 21C skill development by exploiting technology to support learning, promote team collaboration, foster students' creativity and transfer of knowledge (Keane, Keane & Blicblau, 2013; UNESCO, 2010).

The teaching and learning needs and environment have changed, henceforth, new instructional strategies need to be developed that are relevant to current students' learning requirements. Apart from adjusting instructional strategies, there has also been an increasing realisation that technology can play a role in facilitating the attainment of the 4Cs as demanded by the 21C (Keane et al., 2013). To assist with this, educational technologists *(a person trained in the field of teaching with technology)* become essential. The goal for educational technology researchers and developers is to see the potential in a given technology and how it can be used to unlock greater teaching and learning opportunities (Roehl, Reddy & Shannon, 2013). The problem, specifically in the field of professional teacher training, is that in most cases, when educational technologists train TrEds in technology integration their focus is on illustrating how the technology works. That is to say, they teach general basic knowledge of technology applications, whereby the TrEds are trained the basic hardware and software applications instead of being trained on how to use the applications to achieve their teaching and learning goals. In essence they are trained on what the tools are and not how to effectively use them for teaching and learning. Therefore, the training offered to TrEds in realising the full potential of technology and by extension, adopting it into their practices is also an area of interest.

In their study, Bhalla (2013: 176) on the use of technology for teaching and learning processes, concluded that educational technology researches have "ignored systematic … ways in which technology is used in education…" There is an acknowledgement that technology is being utilised by TrEds, however, there seems to be a concern around the implementation of it and beyond that, its relevance. Realising the importance of developing 21C skill sets in pre-service teachers and the contribution of technology to the 21C learning environment; the researcher found it interesting to explore and understand what teaching strategies TrEds were employing and how they were integrating technology to meet their objectives. This qualitative study investigated the current practices of TrEds at one of South Africa's teacher preparation institutions with the aim of understanding how technology is utilised strategically to advance the educational objectives and outcomes.

1.2 Background to the Research study

In the 21C, the advancement in teaching with technology is rapidly transforming TrEds' instructional strategies to better prepare pre-service teachers for constructivist technology-enhanced instructional strategies. In general, it is acknowledged that teaching with technology offers the means and opportunity for accelerating knowledge acquisition hence, enabling students to operate at high levels of numeracy and literacy (van der Berg, Taylor, Gustafsson, Spaull, & Armstrong, 2011). It should be noted that the quality of education in schools is dependent on the quality of teacher preparation programmes in teacher education institutions.

Of interest to the researcher was the use of contemporary teaching theories, how they inform teaching strategies, how to achieve learning outcomes and how best to use technology in achieving these outcomes. The constructivist theory was s chosen for this research study because of its reputable principles with regards to knowledge acquisition which has made it the prevalent teaching theory in the 21C (Masethe, Masethe & Odunaike, 2017). The constructivist theory promotes high order thinking 21C skills. However, constructivist theory is criticised on its multifaceted approach in that the discourse around it stem from both social and cognitive aspects (Fry, Ketteridge, & Marshall, 2009). Others have also critiqued its subjective nature (Richardson, 2003), in that it considers knowledge acquisition varies between individuals and contexts . However, the researcher, in this research study found benefit in its principles that supports 21C teaching and learning outcomes. The subjectivity of it allows, in this case, for TrEds to be able to exercise their discretion on how best to integrate technology within varying contexts. This research study, therefore, argues that TrEds' teaching with technology practice should be informed by the 21C teaching and learning needs.

In many parts of the world, the 21C has seen an increase in the use of technologies used for generating and sharing knowledge (Lindqvist, 2015). TrEds are anticipated to prepare pre-service teachers to be able to make use of these technologies to advance and optimise their teaching practices. Hence, the pre-service teacher should be able to operate in and navigate their way through the 21C learning environment (Mohapi, 2017). The 21C is characterised by a convergence of different technologies that are seamlessly impacting on the social and economic, as well as education environments (Penprase, 2018). One of the key challenges for education is preparing students for the unknown future as change and further advancements are inevitable. This therefore implies that an understanding of how the world operates and how to adapt to it are the most needed skills. Researchers argue that TrEds are failing to equip pre-service teachers with 21C critical skills needed for their future teaching practices (Butler-Adam, 2018, Chigona, 2015a). Thus, there is a critical need to implement technology integration in teacher preparation programmes.

To achieve the goal of teaching and learning with technology, various frameworks have been established, these include, the Florida centre of instructional technology's developed Technology Integration Matrix (TIM), Mishra and Koehler's (2006) Technological Pedagogical Content Knowledge (TPACK), Puentedura's (2009) Substitution Augmentation Modification Redefinition (SAMR), Hughes, Thomas and Scharber's (2006) Replacement, Amplification, Transformation (RAT). Each of these frameworks describe different interpretations of how educators can integrate technology for teaching and learning. For the purpose of this research study, the researcher makes use of the TPACK and SAMR models in understanding TrEds decision making process with regards to technology integration and how that yields certain teaching and learning outcomes. These two frameworks where chosen because they are currently the most researched frameworks (Hilton, 2016; Kriek, Ayene, & Coetzee, 2016; Kihoza et al., 2016) that researchers are recommending as being the ones with the most potential to help educators integrate technology in their practices.

With regards to the current South African teacher preparation programmes, it may be argued that pre-service teachers are not well prepared in terms of a sound understanding of education and technology issues and how that impacts their future teaching practices. Researchers, Goodwin, Smith, Souto-Manning, Cheruvu, Tan, Reed and Taveras, (2014) and Chigona & Chigona, (2013), have reported that pre-service teachers are inadequately prepared to teach with technology. Therefore, there is an urgent need for TrEds in South African teacher preparation programmes to be exposed to viable technology integration frameworks. This research study takes cognisance of present-day theories and their contribution towards TrEds teaching with technology practices as these offer a guide in terms of what knowledge TrEds need in order to achieve relevant 21C learning outcomes.

The integration of technology in education has also been supported by educational organisations. UNESCO's (2011) ICT standards emphasise that educators need knowledge on how to integrate technology to support knowledge construction and problem-solving in authentic settings (Hine, 2011). It is crucial that South African education stays abreast of international trends in skill provision and be cognisant of their relevance in creating and fostering 21C skilled professionals. The South African government has set out an e-Education policy (South African Government Department of Education, 2004) that set out support systems for encouraging the use of technology as a way of empowering education institutions in knowledge generation. Furthermore, the South African Department of Basic Education (SA DBE) established a new e-Education Strategy that serves as a plan for the implementation of digital learning in the educational institutions (Department of Basic Education, n.d.). The strategy states that Information Communication Technology (ICT) for teaching should become a mandatory component of all pre-service teacher training. In response to the e-Education policy, the Western Cape Education Department (WCED) expanded the technology base and digital resources in schools to support educators and students development (WCED, 2012) – who in turn are equipped to participate in a global knowledge economy. Regrettably, regardless of the implementation of these policies, it has been observed that TrEds are not well equipped to prepare pre-service teachers to teach with technology (Tiba, 2018). This concerning pattern, therefore, motivated the objective of this research study to explore and understand how TrEds' model teaching with technology strategies to pre-service teachers in their teacher preparation programmes.

Several studies about technology in education indicate significant improvements in the technical infrastructure of schools (Groff, 2013; Buabeng-Andoh, 2012; Ng'ambi, 2006; Kihoza, Zlotnikova, Bada & Kalegele, 2016) but the concomitant instructional adjustments necessary for training teachers on how to teach with technology are not in place (Biku, Demas, Woldehawariat, Getahun, & Mekonnen, 2018). Better infrastructure at pre-service teacher preparation institutions, in particular, has to be matched by an enlightened pedagogy which facilitates constructivist learning. Unfortunately, most of the available infrastructure supports the authoritarian mode of teacher-centred instruction that was prevalent in traditional times. Regardless of the widespread agreement on the importance of teaching with technology, teacher preparation programmes that support technology-enhanced methods are almost non-existent (Johnson, Becker, Estrada, & Freeman, 2014; Chigona & Chigona, 2013). The integration of technology in teaching and learning has not yet been fully realised in teacher preparation programmes (Chigona, 2013; Buabeng-Andoh, 2012).

There is a growing body of researchers Chigona (2015a); Johnson et al., 2014; Banks, Jackson and Harper (2014); Goodwin (2014), calling for adequately prepared teachers who have a strong grounding in content, pedagogical and technological knowledge that meets the needs of 21C teaching. Educators are expected to integrate technology, pedagogy and content knowledge (TPACK) (Mishra & Koehler 2006) to create and deliver effective lessons (Mishra & Koehler, 2006; Goodwin et al., 2014). It has been argued that educators' failure to incorporate TPACK constructs into their classroom teaching could adversely affect 21C learning outcomes (Lubke, 2013; Lin, Chai & Lee, 2012)..

It is against the backdrop of this a major concern in South African teacher education that the researcher sought to explore how TrEds are preparing pre-service teachers to integrate technology in teacher preparation programmes for the achievement of quality 21C learning outcomes. This concern at a global level, for instance, has come about partly as a result of TrEds' failure to adjust to the 21C teaching and learning needs (Richardson, 2011). TrEds' successful technology integration necessitates a fundamental change in the underlying assumptions in pedagogical approaches. There should be reforms in teacher preparation programmes to better support pre-service teachers' integration of technology practice through the adoption of contemporary teaching and learning theories as well as technology integration frameworks. Contemporary theories in teaching with technology, in this study implies that learning activities should draw upon students' experiences, both in and out of the classroom (Aldoobie, 2015). The implementation of these facilitates the achievement of 21C teaching and learning outcomes. This implies that there is critical need for professional teacher technology integration knowledge. Since technology has turned out to be the primary feature in national development and social progress, lack of its uptake in education impacts negatively on the South African national development. UNESCO (2010) recommended that efficient use of technology in education is vital to meet societal demands in the most critical skills needed for national development.

1.3. Rationale for the research study

In order to understand teaching with technology in the 21C, it was important to explore the relationship between teaching and learning theories with technology integration frameworks. Teacher education and development in South Africa is designed to equip teaching professionals to meet the needs of the 21C global society (Department of Education, 2007: 9). In this regard, teacher preparation institutions are mandated to meet the demands of the 21C education. This demand provides the basis for TrEds to effectively employ teaching with technology strategies in the modern classrooms. However, studies have raised concerns on the quality of the South African teacher preparation programmes and also question their ability to achieve skills relevant for this digital era (Ndlovu & Lawrence, 2012; Chigona, 2015b). Several frameworks have been developed to help educator integrate technology into their teaching, but still, TrEds remain unenthusiastic to adopt the teaching with technology when preparing the pre-service teachers.

TrEds' technology integration in teacher preparation is not fully understood as most studies give attention to pre-service teachers' failure to incorporate technology in their practice, without investigating other factors that could possibly contribute to this pattern. There appears to be fewer studies Rana, (2012); Pramod and Madhumalathi, (2016); Baran, Chuang and Thompson (2011) focus on TrEds practices especially in how they administer teacher preparation programmes. This research study therefore, sought to explore what teaching strategies TrEds employed when teaching with technology so as to understand their practices. The current technology integration frameworks provide valuable insights into the affordances of technology in the teaching and learning. However, they do not clearly illustrate the relationship with teaching and learning theories, nor provide practical guidelines for sequencing technology enhanced learning to facilitate the achievement of specified learning outcomes. The researcher believes that the approaches used in technology integration interventions lack the grounding of underlying logic and influence of a teaching theory and technology frameworks that gives a holistic view for TrEds' teaching practices. In this research study, the researcher therefore intends to explore and understand what instructional strategies TrEds' were using and if they reflected the influences of any theory and frameworks relevant for 21C learning.

The researcher interrelated a contemporary learning theory and technology integration frameworks to develop a model that could help TrEds and institutions alike, to identify, develop and implement relevant teaching and learning with technology strategies for targeted outcomes.

1.4 Aim and objectives of the research study

The aim of this study was to explore and understand teacher educators (TrEds) technological-enhanced teaching strategies for 21C teaching and learning outcomes. Hence the following questions are set as a guideline to help fulfil the aim:

1.4.1 Research Questions

Main research question

1. What do TrEds need to effectively prepare pre-service teachers to teach with technology in the 21C?

Sub Questions

1.1 What instructional strategies do TrEds currently employ when preparing pre-service teachers to teach with digital technology in the 21C?

1.2 How are TrEds implementing the technology-enhanced instructional strategies in preparing pre-service teachers to teach with digital technology in the 21C?

1.3 What technology integration models are TrEds at the study site using for effective teaching with technology in the 21C?

2. How can TrEds appropriate existing models to effectively prepare pre-service teachers to teach with technology in the 21C?

1.4.2 The objectives of the research study include:

i. To explore what TrEds need to effectively prepare pre-service teachers to teach with technology in the 21C?

ii. To identify TrEds' instruction strategies used to prepare pre-service teachers to teaching with technology

iii. To establish how TrEds are currently integrating technology in teacher preparation programmes.

iv. To appropriate existing technology models to effectively prepare pre-service teachers to teach with technology in the 21C.

1.5 Implications of the research study

This research study has potential to impact dual settings i.e. TrEd practice and institutions' technology integration professional development. Both TrEds and teacher preparation institutions' professional development policy makers will benefit from the practical outputs of the research study.

The findings of the study highlight the need for teacher training institutions to structure programmes that facilitate the development of contemporary teaching with technology strategies in TrEds. The objective is to equip TrEds with the skills they will use to model the appropriate teaching practices to pre-service teachers. The findings of the research study suggest the need for adopting teaching models that TrEds may use to locate their current teaching with technology practice and identify what areas they might need to improve. It is vital that when TrEds design teaching and learning activities that they take into consideration the nature of outcomes they want to achieve. There is need to align the teaching and learning activities with the 21C skills. The adoption of contemporary learning theories will advise TrEds on how best to utilise technology affordances in a way that allows students to actively participate in knowledge construction as well as develop the 4Cs relevant to the 21C.

The findings also imply that the legislation makers in institutions need to structure policies that will regulate the implementation of proper teaching with technology strategies. The purpose of this will be to guide to ensure that there is a general mandate on TrEds to draw from contemporary teaching theories when designing teaching activities. These policies will also guide the administration pf professional development programmes as they will focus on the integration of technology with teaching strategies. The constant change in the external environment affects how teaching with technology should be administered. This therefore implies that there should be a constant evaluation of these policies and strategies to ensure that they stay relevant to the institution's as well as the faculty's objectives.

Due to the varying needs of TrEds as influenced by their various disciplines, it may be a wise decision to leave it up to the various faculty leaders to adopt the overall policies to match the specific technology integration concerns for their faculties. Faculty goals should advise the TrEds practices in terms of what theories and frameworks should advise their teaching and learning activities. The TrEds in teacher training institutions need to realise the value of modelling effective teaching with technology. The role of the TrEd is to develop the pre-service teacher's knowledge and skills of integrating technology, as literature reviews have indicated that educators teach the way they themselves have been taught (Oleson & Hora, 2013). There is therefore, a need to break the cycle of implementing the traditional means of using technology for low level outcomes where high level outcomes are more suitable.

It is the researchers hope that the findings and discussions of this research study will catch the attention of TrEds and institutions alike as it addresses the shortfalls and possible potentials of technology integration in teacher training institutions.

The researcher is confident that the findings of this research study outline how crucial it is for institutions to approach TrEds professional development from a theory informed approach. TrEds need to mirror the institutions and or faculty's objectives in terms of technology integration in their own practices.

1.6 The contribution to the knowledge

The primary aim of this research study was to explore and understand what TrEds need to effectively prepare pre-service teachers to teach with technology in the 21C. There are few studies that have investigated TrEds teaching with technology as they mainly explored the pre-service teachers' practise. The study approached the phenomenon of teaching with technology by focusing on the TrEds practices and how they were approaching teacher training. The researcher has not found evidence of a research study in South Africa in which a teaching theory and technology integration frameworks (constructivist theory, TPACK and SAMR), referred to in this study as constructs, were used to explore TrEds technology-enhanced instructional strategies in teacher preparation programmes. For this research study, the researcher used a conceptual framework informed by the three constructs which are all relevant for 21C teaching and learning outcomes. (Sutherland, Robertson and John (2009: 213) posit that TrEds should "… be brought into the circle of knowledge production about their own practice rather than be bystanders in a process that treats them as objects". This implies that the TrEd can be informed and guided by the principles of the constructs and use them in their daily practices. In addition, the ConTIS model formulated by the researcher in the course of this research study also build on the three constructs; is designed in a way that it is flexible and can be adaptable to any subject disciplines at any level of teaching and learning. This research study is situated at a faculty of teacher education, in South Africa. The current research study proposes a model, which is designed to help TrEds and institutions to locate their current practices and help develop knowledge and skills needed for effective 21C teaching with technology.

1.6.1 The ConTIS model

The proposed model posits three basic constructs; constructivist theory instructional strategies, TPACK and SMAR models. Their interactions maybe planned as an integrated part in a holistic model. The researcher has coined this model as ConTIS (Constructivist

Technology-enhanced Instructional Strategies) model as it is influenced by the principles of the constructivist theory and technology integration frameworks for the design of effective instructional strategies. The revised conceptual framework (see Figure 7.1) is unpacked in a comprehensive ConTIS model (see Figure 7.2) as a guide to advance their technology integrated instructional strategies.

The revised conceptual framework is presented as a hexagonal pyramid. Each point on the base of the pyramid represents a TPACK construct. It is divided into four levels representing each of the SAMR levels from substitution to redefinition, build on the foundation of the constructivist teaching and learning theory (as a base) on which TrEds can progress through as they are integrating technology.

The ConTIS model is presented in a 5 by 6 matrix (refer to Figure 6.2) that incorporates constructivist teaching and learning theory, the TPACK constructs and the SAMR constructs. The SAMR model constructs are placed as row-headings and TPACK constructs as column headings and the constructivist teaching and learning constructs are placed on the right side of the matrix. The intersection of rows and columns explains how the SAMR and TPACK constructs relate and how they are effected by teaching strategies. The description of each matrix is given from the learning activities and the instructors perspective, however, attention is given to the learner centred approaches to instructional design.

The practical outputs ConTIS model has the potential to result in the following possible uses:

i. TrEd self-evaluating instrument and self-developmental

TrEds will use the proposed ConTIS model as it has the potential to be used as an evaluative model to help TrEds locate to see the level at which they are integrating technology in their teaching practices. When TrEds locate and evaluate where they are in the matrix then they see the gaps in their practice. This way they are exposed to what they need to know, learn and do, which in turn can be used to sought professional development needs thereby informs professional designers on their specific user learning needs.

ii. Professional Development Diagnostic

The ConTIS model can be used by Professional Development (PD) designers to establish PD needs for TrEds. The PD designers can use ConTIS to analyse what kind of teaching with technology knowledge do TrEds require. Therefore, the model informs PD designers on how to develop and design PD programmes based on what the matrix suggest is necessary as stated where the gaps are. However, the researcher recommends that this be done at faculty levels as the needs might differ from one faculty to another.

While this research study concentrated on the constructivist approach for teaching with technology. The model has potential to be used with other contemporary teaching approaches. Chapter 6 presents the detailed ConTIS model.

1.7 Limitations of the Research study

This research study was limited to a single case study of one teacher preparation institution in the Western Cape Province. Therefore, it is a challenge to generalise its findings to other contexts, as the phenomenon may be experienced differently in other contexts. It is possible that the inclusion of more TrEds perhaps from other institutions might have provided a different perspective to the research study.

1.8 Structure of the Thesis

This research study is presented in nine chapters:

Chapter 1: Introduction to the research study

The chapter outlines the overall orientation of the research study and defines its background, aim of the research study and guiding questions. The rationale, a summary of the contribution of the research study and limitations of the research study are stated.

Chapter 2: Literature Review

The chapter reviews related literature on teaching with technology strategies for effective teaching with technology in the 21C as addressed other researchers and various other sources. The literature covers the review of 21C teaching theories, followed by elaborated 21C teaching strategies, the role of 21C educators and finally teacher preparation programmes in the 21C.

Chapter 3: The Conceptual framework of this research study

The chapter outlines the conceptual framework developed for this research study. The researcher explicates the 3 constructs that make up the conceptual framework: the learning theory – constructivist theory underpinnings (Vygotsky, 1978), TPACK (Koehler & Mishra, 2006) model is complemented by (SAMR) (Puentedura, 2009) model. The conceptual framework highlights the 3 constructs of the research study and how each construct relates and optimises the goal of the research study.

Chapter 4: Research study Methodology and Design

The chapter outlines the research design and methodology employed for the research study; providing an in-depth explanation of the studies philosophical underpinning, methodology and design of the study. The chapter further gives details on participant selection and instruments used for data collection. Data collection procedures are elaborated on with an analysis of the ethical, reliability and validity issues of the study.

Chapter 5: Findings and Discussions

The Chapter thematically presents and discusses the findings of the study on What instructional strategies do TrEds currently employ when preparing pre-service teachers to teach with digital technology in the 21C? – how are TrEds currently implementing the technology-enhanced instructional strategies in preparing pre-service teachers to teach with digital technology in the 21C?

Chapter 6: The ConTIS Model

The chapter articulates the importance of a holistic Constructivist Technological Instructional Strategies (ConTIS) Model. The proposed model serves as a process and evaluative model that gives insights on the conceptualisation of teaching with technology as informed by constructivist, TPACK and SAMR paradigms.

Chapter 7: Study Conclusions and Recommendations

The chapter provides this study's conclusion by offering a summary of the main findings, followed by recommendations, contributions and implications that emanate from the findings and finally highlights the gaps for further research.

CHAPTER TWO

Literature Review

2.1 Introduction

This chapter reviews published information that relates to the critical issues pertaining to the 21C instructional strategies in teacher preparation. Of great concern is what instructional strategies TrEds are using to prepare pre-service teachers to teach with technology and how they are implementing them. Relevant scholarly sources are gathered and thoroughly analysed in terms of the (i) teaching and learning theories and instructional strategies in the 21C (ii) technology integration frameworks; (iii) the role of TrEds in the 21C and (iv) the wider appropriate dialogues on 21C teacher preparation on teaching with technology.

The scope of this review is limited in that most technology integration literature focused on pre-service teachers' teaching with technology practice (Koh & Sing, 2011; Chigona & Chigona, 2013). Most of the research done indicates inadequacy of pre-service teachers' technology integration skills. This study, however, will not focus on pre-service teachers but rather on the TrEds responsible for modelling effective teaching with technology practice.

The review of current practices of TrEds in this study focuses on contemporary teaching philosophies which supports the use of approaches such as constructivist instructional strategies in preparing pre-service teachers to teach with digital technology. There is ample philosophical literature on the subject of teaching with technology, however, there are very little evaluative studies done on teacher educators' in that matter (Baran, Canbazoglu, Albayrak, & Tondeur, 2017). There are very little qualitative nor quantitative methods have been used to measure the effectiveness of existing teaching with technology programmes in teacher preparation institutions (Rana, 2012; Chigona, 2015b; Uerz, Voman & Kral, 2018). There is therefore an urgent need to assess the practicality and effectiveness of these programmes in order redress educational technology issues.

What became apparent in the process of this review was that the effectiveness of teaching with technology must be grounded on:

i. current epistemological principles
ii. frameworks that guide the teaching with technology phenomenon
iii. TrEds role in teacher preparation for 21C classrooms

iv. whether adequate evaluative measures are available to measure the effectiveness of TrEds efforts in teaching with technology

This line of inquiry guides the structure for this review of the relevant literature.

The researcher used, among others, the following keywords in electronic database and library searches; teacher preparation, teaching with technology, technology integration models, instructional strategies in 21C, educators / teacher technology integration, teacher education, 21st century teacher education, evaluating technology in education, etc. This literature review chapter is organised as follows:

2.2 Instructional strategies in the 21C

2.3 Teaching with digital technology in the 21C

2.4 Teacher preparation in the 21C

2.5 The role of TrEds in the 21C

2.6 Chapter Summary

2.2 Instructional strategies in the 21C

This section presents the literature review on teaching or instructional strategies in the 21C. Teaching and learning theories have been included as they inform educators' instructional strategies in the 21C. The purpose of this section is to explore 21C instructional strategies to understand their link with teaching and learning theories as well as technology integration frameworks. The reviewed literature sought to develop a deeper understanding in relationship to the research question *What instructional strategies do TrEds currently employ when preparing pre-service teachers to teach with digital technology in the 21C?*

Instructional strategies are teaching methods and plans that educators use to help deliver a lesson (Mustafa & Fatma, 2013). They provide educators with the how and what of content delivery, that is, educators decide on what activities to use for various content or concepts to help students' comprehension. There are instructional strategies that are traditional and consider students as passive vessels to be filled with knowledge through dissemination of knowledge by the teacher (Coffield, 2008). 21C instructional strategies on the other hand, include all teaching approaches that actively engage students in the learning process allowing them to participate in their knowledge acquisition (Mukhari, 2016). Some of the literature around instructional strategies differentiates between teaching strategies and instructional strategies, they define the latter as the modern, student-centred approaches and the former as the traditional, lecturer-directed ones (Nsamenang & Tchombe, 2011). However, for the purpose of this study the term instructional strategies were used to refer to both traditional and modern-day teaching strategies. The 21C instigates that educators need to understand the context and background of the students and build on their existing knowledge (Koehler et al., 2017). This study sought to identify the instructional strategies that TrEds are using in teacher preparation programmes and the factors that affect their choice of strategies.

The factors that affect TrEds choice of instructional strategies as indicated in literature vary from their knowledge and application of teaching theory, professional teaching practices, technology knowledge, content knowledge and targeted teaching and learning outcomes (Shulman, 1987). It is important for TrEds to identify what they wish to achieve and therefore use their knowledge of available technology and how best to use it in conjunction with instructional techniques for specific content and contexts. At the core of this, is the teaching and learning theory that the TrEd adopts, the traditional theories measure successful teaching by how much the student can regurgitate or by their exhibition of certain behaviours (Drake, 2017). The traditional theories are more aligned with lecturer-centred approaches that rely on the TrEd as the sole source of information, they direct all the knowledge acquisition activities and they do not actively engage the learner. The outcomes of this approach usually results in the learner's ability to understand the content but only to a point of memorisation and there is no critical thinking applied (Ng'ambi & Bozalek, 2013).

Contemporary theories advocate for the students to interact with knowledge and come to their own understanding of what it means to them (Katitia, 2015). The contemporary theories are well aligned with student-centred approaches that allow for the learner to actively partake in their knowledge acquisition (Sang et al., 2014). Students in this case, are allowed to independently select the best way of interacting with knowledge to accomplish tasks. They have room to make choice on how best they want to learn (Ruhl, 2015) as well as how best they wish to express their understanding of the knowledge. The outcomes of this study are that the pre-service teachers are able to understand content such that they are able to apply it in other contexts. Therefore, TrEds must employ effective instructional strategies that maximise pre-service teachers' knowledge acquisition for teaching in the 21C. New and customised instructional strategies are being developed and implemented in teaching and learning. These include activities such as, digital simulation, collaborative learning and project-based tasks. They provide teachers with the flexibility necessary to meet individual learning needs (Wagner, 1997) and also allow the students to participate in the process.

The majority of students learn best through active and engaging learning opportunities that are related to their context and build on existing knowledge. 21C instructional strategies embrace this and feature components that ensure learning is fun and engaging. When a teacher varies activities and uses a wide range of instructional strategies students stay motivated to learn.

The next section, the researcher engages on the theories that are related to teaching and learning in the 21C and their relevance in understanding TrEds teaching with technology strategies and how they influence TrEds teaching practices.

2.2.1 Teaching and learning theories

With the ever-increasing demands of integrating technology into teacher preparation, it is necessary to reflect upon the teaching and learning theories that form the basis of teaching practices. Behaviourist, Constructivist and Connectivist theories are the two predominant theories of teaching that form the basis of many of today's approaches to teaching with technology.

2.2.1.1 Behaviourist teaching and learning theory

Behaviourist theory mainly focuses on the idea that human behaviour can be manipulated using teacher-centred instructional strategies (Goodchild & Speed, 2018). This approach views students as 'blank slates', therefore suggesting that students are not credited with possessing prior knowledge (Nsamenang & Tchombe, 2011). In this traditional authoritarian view, knowledge is transmitted from the teacher to the students, it is one-directional. The focus is placed upon students' performance rather than on lifelong learning (von Glasersfeld, 1995). It is argued that this approach is best for preparing learners to do well in examinations and knowledge application beyond that point is limited (Ally & Tsinakos, 2014). Behaviourist theory implications to learning denotes that instructions must provide the right stimuli for learning to occur. The philosophical thinking of behaviourist that learning is a response to external stimuli ignoring internal predispositions of students oversimplifies the learning process. This suggest that learning takes place when there is a visible change of behaviour on the part of the students, therefore, provides reinforcement and stimuli on individual basis.

Research indicates that direct instructional strategies prompted the development of systematic and structured technological learning applications such as 'drill and practice' and computer-aided learning (Westera, 2010). However, this form of teaching with technology approaches has been criticised for over-dependency on technology rather than students deeper knowledge construction (Lindqvist, 2015). In other words, it is merely a mechanised version of a teacher-centred approach to teaching and learning. However, such applications do have their advantages in that unlike non-technological means to learning, the learner has room to use the technology to practice and learn concepts in their own time and at their own pace (Tucker & Morris, 2011). Nevertheless, these behaviourist oriented lecturer centred teaching approaches, are effective for instances where students do not have prior knowledge, for example basic reading and mathematics skills. In essence they can be useful as introductory approaches to concept mastery. In research done by Balanskat, Bannister, Hertz, Sigillò, and Vuorikari (2013) where such instructional strategies were used, students were reported to show an increased interest in learning, motivation and involvement. Teaching with technology in a behaviourist teaching model reflects that instructional strategies must have clearly defined learning goals and set sequence of how to achieve them. This however is limiting in that it is a restrictive approach to learning, it is not efficient for 21C skill acquisition as it is not open to multiple choices of how to learn. Learners are different, they acquire knowledge in varying ways, they express and apply this knowledge in varying ways as well, therefore, teaching and learning theories for the 21C should not take a one size fits all approach,

2.2.1.2 Constructivist teaching and learning theory

The demands of the 21C have impacted a shift in educational learning goals (Teo & Milutinovic, 2015), the emphasis has moved to education systems that equip students with competencies such as creativity, collaboration, critical thinking, and communication (Partnership for 21st Century Learning, 2016). The constructivist learning theory is derived from a student-centred principles and is of the notion that new knowledge is actively created through students' social experiences (Dewey, 1938); social support through scaffolding (Vygotsky, 1978), modelling (Bandura, 1970); discovery; (Bruner, 1973) and multiple intelligences (Gardner, 1989). Consequently, constructivist instructional strategies are designed to make learning visual, flexible and experiential. Constructivist teaching and learning affords students with opportunities to create their own meanings and in this context teachers become the facilitators, coaches, and promoters of this student-centred learning approach.

The constructivist theory advocates that educators to design teaching and learning activities around student's prior knowledge which relates to their context. Therefore, a constructivist teaching approach builds upon what students know and what is applicable to them as determined by their surroundings. Emphasis is therefore placed on student-centred instructional strategies which place the student at the centre of teaching and learning (Vygotsky, 1978; Piaget, 1936; Dewey, 1938) not the teacher. As a result, this approach allows flexibility in how students learn and demonstrate competence.

Students co-construct knowledge by gathering and synthesising information and integrating it into meaningful knowledge using inquiry, communication, critical thinking and authentic problem-solving activities (Herrington & Herrington, 2006). Student-centred approaches promote meaning-making when learning links or relates to students' prior knowledge. In this regard, educators facilitate the learning activities as students create their own meaning, instead of passively digesting material decided upon by the educator (Noor-Ul-Amin, 2013). Student-centredness emphasises the role of communication and socialisation in the learning process and in the construction of knowledge, this is an integral part of the active learning process of constructivism (Boudourides, 2003). This means that student benefit more in a social setting as they actively engage with information to generate solutions using familiar digital tools. Therefore, TrEds are required to employ instructional strategies that enables student to communicate, collaborate, solve problems and authentic tasks that compel students' creativity. In the 21C learning environment filled with technology, engagement happens digitally or in person.

Constructivist learning supports an interesting duality in knowledge acquisition. This is because it promotes self-directed learning, whereby the student gets to encounter knowledge and pursue its meaning in their own way. However, in this personal pursuit of knowledge, interaction with others is vital. This could be interaction with either mentors, facilitators or peers and it could also be physical or virtual (Ally & Tsinakos, 2014). The student acquires knowledge by actively collaborating and engaging with others within their vicinity and or globally even through the use of digital technology. This duality is fascinating in that its element of collaboration and interaction with others does not diminish the benefits of self-directed learning, Amarin and Ghishan (2013) argues that if anything, it "heightens the need for individuals to succeed together." This creates a major advantage as the learners' knowledge will be well informed and applicable across various contexts.

Effective instructional strategies embrace students' contexts into their learning by providing multiple options for representation of content, expression and assessment of student comprehension (CAST, 2011). Learning in the 21C should include hands-on and technology enhanced activities that give students access to unlimited and diverse knowledge sources. This demonstrates changes in approaches to the construction of knowledge whereby students are given a voice and choices in their learning. However, educators continue to use the same old instructional approaches; gatekeepers of the 20^{th} century teaching approaches have opposed opinions on how to respond to 21C changes (Johnson & Mcelroy, 2012).

In a classroom where technology is used to support teaching and learning, constructivist teaching activities are easy to facilitate. Instructional strategies such as collaboration and project based learning can be paired with technology resources to promote strong student engagement and relevant, authentic, meaningful learning tasks. The researcher, however, does not disapprove previous theories, but emphasises that when they are used, they should be complemented by contemporary ones to ensure that the teaching and learning outcomes are ones that are conducive for the development of 21C skills.

The next section discusses a new emerging theory put forward by Siemens Downes in 2004.

2.2.1.3 Connectivism teaching and learning Theory (CT)

Siemens (2004) in his study, instigated the connectivism learning theory that incorporates the ubiquitous nature of digital tools within a student-centred approach. He posits that when knowledge is abundant, the rapid evaluation of knowledge is important. Connectivism theory (CT) acknowledges the importance of digital tools as mediating learning Siemens (2004). The connectivist theory is linked to the 21C digital age in that it presents itself as a pedagogical approach that gives students the ability to connect to each other using technological collaboration tools. It emphasises the role of social and cultural context in how and where learning occurs. Siemens (2004) ascertains that knowledge does not just happen but it is socially constructed.

The principles of connectivism theory includes:

- Knowledge construction is informed by the diversity of opinions.
- Learning is a process of connecting specialised nodes or information sources.
- Knowledge may reside in non-human appliances.
- Capacity to know more is more critical than what is currently known
- Nurturing and maintaining connections is needed to facilitate continual learning.
- Ability to see connections between fields, ideas, and concepts is a core skill.
- Currency (accurate, up-to-date knowledge) is the intent of all connectivist learning activities.

Siemens's (2004) connectivism theory focuses on the inclusion of technology as part of knowledge construction. Critics point that connectivism theory lacks rigor in its arguments (Şahin, 2012), however, proponents find it relevant in that it is designed specificially for an ill-defined virtual environment, considering that they are many variables in virtual environments. The education field has been slow-moving to recognise both the impact of new digital learning tools and the changes in what it means to learn. Connectivism provides insight into learning skills and tasks needed for students to flourish in a digital era. This forms the foundation that connectivism theory equips TrEds moving towards that transformation level, as both educators and students can interact anywhere and anytime using the power on technology connectivity.

The discussion thus far, shows how the theories presented have contributed to the designing of teaching with technology in the 21C. The constructivist and connectivism theories resonate very well with this study because both provide an understanding of the 21C student-centred teaching and learning environment, which is key to this study. However, connectivism emphasises more on virtually connected platforms and disregards physical learning. Therefore, since the site of this study was a traditional conventional institution that offers blended learning inclusive of both virtual and face-to-face teaching and learning, the researcher focuses on constructivism as a relevant theory to this study. Constructivist theory positions learning as a social and collaborative process and is inline with what educational technology scholars are advocating for in 21C education.

Constructivist teaching methods include instructional strategies such as: collaborative learning, discovery learning, self-regulated learning, and modelling. Teaching is moving away from the traditional way of having an educator presenting or explicating content knowledge directed to passive students (Nsamenang & Tchombe, 2011). Instead, teachers create a more engaging learning environment where students are actively involved. Educators are encouraged to create a learning environment that promotes student's self-directed knowledge construction and working with other students on research projects and assignments that are both culturally and socially relevant to them (Amineh & Asl, 2015). Therefore, students develop into self-confident, self-directed, and proactive individuals. Student-centredness is characterised by the notion that students learn by taking initiative of their own learning experiences; they become knowledge and solution generators. This study focuses on student-centred instructional strategies that are now considered as common in traditional learning environments. Using technology appropriately to support a student-centred learning environment, offers a way that complements any learning process and, in most cases, it can bring inconceivable learning experiences that has not traditionally been accessible (Tondeur, Pareja, van Braak, Voogt, & Prestridge, 2017). In line with this view, the idea that knowledge exists everywhere, and learning being a process of socially creating connections mediated with digital tools. The advent of 21C teaching with technology strategies in teacher preparation is a critical issue that requires urgent attention. The technological trends and the conditions are emerging and drastically transforming the educational system (Tondeur et al., 2017). The next section explores the 21C teaching strategies that are in line with the constructivist teaching philosophy.

2.2.2. Twenty-first century constructivist teaching strategies

This section reviews technology-enhanced instructional strategies associated with the constructivist teaching philosophy. 21C educators are expected to use effective and innovative instructional strategies that fosters the 4Cs in the students. 21C technology enhanced instructional strategies are not new ideas but are a repackaging of the existing known and accepted instructional strategies mediated by technologies.

In 2010, UNESCO recommended that twenty-first century education is a means to empower students to become active participants in transforming 21C learning environment using technology that has already transformed other sectors of societies (UNESCO, 2010). Therefore, the study explores literature on teaching strategies that educators use to help empower students to be active participants in transforming 21C learning environment. Constructivist teaching strategies are based on the belief that learning occurs as students are actively involved in the process of knowledge construction as opposed to passively receiving facts from the teacher. Therefore, the key constructivist teaching strategies that promote the realisation of the 4Cs include will be explored. These include collaboration; projects-based and digital simulations.

2.2.2.1 Collaborative strategy

Collaboration is a teaching strategy sometimes referred to as cooperative or team work. It involves the educator identifying individual student’s strengths within the framework of a group or team of students (Steyn, 2017). Collaborative teaching strategy activities vary , they are mostly centred on students’ active exploration of course materials in small groups of two or more, working together to achieve a common goal (Shaikh & Khoja, 2012). This therefore implies that students’ ability to develop skills that equip them to be functional within a team setting becomes vital for both their personal and team’s success.

Today's students are not passive learners, instead, they expect to be fully engaged and directly involved in the learning process. A study done by Zhu and Du (2003), shows that students tend to enjoy class discussions and interactive classroom environments over the traditional top-down dissemination teaching method . The modern generation students tend to embrace social learning environments; they are familiar with building social networks and using technology to seek and share information. Studies are revealing that students are informally using social platforms for learning related activities (Musungwini, Zhou, & Ruvinga, 2014; Rajesh & Michael, 2015; Cao, Ajjan, & Hong, 2013). Therefore, TrEds need to tap into these collaboration patterns, habits and students' current contexts of social sharing activities. Literature shows that it is important for educators to make use of platforms that the students are already familiar with before introducing them to new ones (Rajesh & Michael, 2015; Cao et al., 2013). The use of familiar and existing knowledge serves the purpose of engaging students without bombarding them with new technology and information all at once which may have adverse effects. Thus, this inductive approach of teaching supports the general constructivist principle of teaching that states that student learner better if educators links new knowledge to existing knowledge – concrete to abstract (Lyon, 2015; Lawless & Pellegrino, 2007).

Collaboration in education is deeply-rooted in Vygotsky's social constructivist learning theory (Vygotsky, 1978). He argues that there is a natural social nature of learning and this is reflected in group-based learning. Vygotsky suggests the notion of the zone of proximal development (ZPD), which highlights the difference between a student's independent ability and what can be achieved cognitively under the guided support from more knowledgeable others. Bryan (2014) highlights that while self-directed learning may rely on factors such as personal responsibility for learning and self-confidence, the importance of getting assistance from knowledgeable others is just as crucial in achieving learning goals. Therefore, this implies that collaborative teaching strategy supports student-centred teaching and learning. This approach stimulates students' interests and gives them a voice in the learning process.

In a teaching environment, collaborative activities are designed to give students responsibility of their learning as well as develop their social interaction skills (Tunjera, Mukabeta, Ramirez, & Zinyeka, 2014). In the globalised 21C, social interaction skills are critical as they help communicate and interact with individual from various backgrounds. More importantly being able to share knowledge with others gives the student access to more knowledge sources through these social interactions. Before the advent of technology, collaborative learning mainly took place in face-to-face situations, whereby students physically sat and worked together in smaller groups or teams. Each group member brings their experience and skills to achieve the goal of their group task. The developments in society today means that it is not always possible for people to meet because of different geographical placements, busy schedules, and where students come from etc. This has potential to affect the successful running of teaching programmes learning goals. However, because of technology which has qualities to link students and reduce space and time, collaborative learning can be facilitated with the help of ubiquitous technology (Mäkitalo, Pääkkö, Raatikainen, Myllärniemi, Aaltonen, et al., 2012).

Similarly, studies reveal that many 21C students have access to digital tools, especially mobile phones connected to social media (Romrell, Kidder, & Wood, 2014; Rajesh & Michael, 2015). Therefore, students are able to seamlessly connect academic experiences to personal experiences through these digital tools. Technology offers platforms to search for information, to virtually communicate, to publish their outcomes and to create artefacts (Angeli & Valanides, 2009; Bomah, 2015). Using technology to create artefacts allows students to demonstrate creative thinking and social construction of knowledge, thereby exhibiting the desired 4Cs (Keane et al., 2013).

Researchers indicate that TrEds using structured collaborative activities with technology tools encourage students to think critically and generate ideas, share opinions and creatively construct knowledge together (Price, 2013; Liu, 2013; Chen, Jang, & Chen, 2015). This learning process is not limited and reduced to the classrooms' four walls. Students use technology to learn and master skills and share artefacts with others. The advent of Web 2.0 which in familiar terms is referred to as the world wide web, facilitated the collaboration and sharing of information via social media, blogging and web-based communities (Rajesh & Michael, 2015). In this case, students get to, not only share their opinions, but they can receive feedback from fellow students and other more knowledgeable ones.

Lombe (2010) recommends educators to adopt technology enhanced instructional strategies that enable an inclusive environment that caters for different learning styles and levels of students. Therefore, TrEds technology knowledge of applications that supports collaboration in teacher preparation, gives pre-service teachers a platform to interact with content, educators and other students. Using technology-enhanced collaborative instructional strategies facilitates deep and more authentic student-centred learning.

To sum-up, although collaboration can be done without technology, however researchers have documented that students are motivated and accomplish more when they use technology. In their study on teaching Science with blogs Jaipal-Jamani and Figg (2015) asserts that technology-enhanced collaborative instructional strategies foster the transformation of teachers' theoretical teaching ideas into their teaching practice. Selecting the appropriate technology tool for collaboration, requires that TrEds are able to synthesise their technology knowledge and intended teaching strategy. In other words, to make sure a technology is appropriate to achieve a learning goal, consider its accessibility to students (Ally & Tsinakos, 2014).

2.2.2.2 Project-based learning

Project Based Learning (PBL), is defined as an instructional approach built upon learning activities that bring challenges for students to solve authentic problems (Tlhapane & Simelane, 2010). The basic principles of PBL reflect the Vygotskian learning strategy that emphasises the role of collaboration and social learning in constructing knowledge (Yaman, 2014). In PBL strategies, students can work in small groups or as individuals over an extended period of time, from a week up to a semester. Students demonstrate their knowledge and skills by developing an artefact or present their solution to real audience (Neo, Neo & Xiao-Lian, 2007). In the process of solving the authentic problem, they develop deep content knowledge as well as critical thinking, creativity, collaboration, and communication skills in the context of solving an authentic problem (Keane et al., 2013). De La Paz & Hernández-Ramos, (2013: 4) quoting Thomas (2000) indicate that in PBL, the role of TrEd becomes more of a "designer, director, coach, facilitator, mentor and advisor" than they are a dispenser of information and instructions. Problem-solving is one of the critical and basic skills anticipated in the 21C, therefore the use of PBL is essential as it develops in the student's real-life problem solving techniques. In the context of this era of globalisation and technological revolutions problem solving can be executed more efficiently and at larger scales than would have been accomplished without technology (Tiantong & Teemuangsai, 2013).

Technology therefore assists the students to keep abreast in their learning and give them continuous access to current information which they may use towards solving problems. Technology offers students with a variety of tools to engage with content and with fellow students. PBL in its nature, when done in a group, demand a consistent exchange and sharing of vast amounts of information. The use of technology makes the access to and processing of information more manageable (Chai, Ng, Li, Hong & Koh, 2013). In this study, TrEds' technology-enhanced PBL instructional strategies benefit students by actively sharing ideas through inquiry with one another, as well as work collaboratively to research and create projects that reflects their knowledge in a more informal environment.

2.2.2.3 Simulations

The term simulation has been used in a variety of ways, but this study uses the term in ways consistent with the definitions cited below. Rieber (2005: 564) defines an educational simulation as "a computer program that models some phenomenon or activity and is designed to have participants learn about the phenomenon or activity through interactions with it". Simulations are defined as a computer program that imitates a real phenomenon in a simplified form designed to meet specific learning goals (Alessi & Trollip, 2001). Computer simulations are usually highly visual and highly kinaesthetic, for example gaming. Simulations are explicitly linked with a constructivist pedagogy as students actively engage with the program which enables discovery, experimentation, practice, and the active construction of knowledge based on concrete examples in a risk-free environment. According to Harder (2018) simulations provide students with an autonomous way of learning thereby motivating them to reach the highest level of their abilities. Garofalo and Trinter (2013) in their study observed that instructional simulations have the potential to engage students in "deep learning" that empowers deeper understanding. Researchers note that the appropriate use of technology enhanced simulation in learning activities enhances understanding that develops through application and manipulation of knowledge within context (Henrie, 2016; Romrell et al., 2014; Johnson, Becker, Cummins, Estrada, Freeman & Ludgate, 2013). Technology enhanced simulations are particularly useful for constructive learning in any discipline. As argued in this study, technology has potential to play a key role in facilitating learning. For instance, through simulations students can relate to real life phenomena in a way they can understand better i.e. simulation can show students how cyclone develops which students cannot see through naked eyes or on a static picture.

TrEds understanding of teaching and learning that informs current trends in teacher education are critical in order to provide relevant and appropriate teaching with technology in 21C. Therefore, this section indicates that using constructivist theory can help guide effective teaching with technology in the 21C, thereby informing, them what is anticipated of them. In any learning environment, the role played by the educator determine the learning experiences of the learning process. The next section consulted literature on what role do TrEds in the 21C teaching environment should fulfil.

2.3. Technology integration models

Researchers have found that educators use technology but at very basic levels that yields little to non-constructivist teaching and learning outcomes (Ertmer, 2005; Chittleborough, 2014). Others also report that the availability of technology does not necessary translate into its use (Maor, 2013). These reports point to the fact that educators know the importance of integrating technology but need guidance on how to go about it – this is where technology integration models come in. The realisation of the role technology plays in teaching and learning has seen the development of technology integration models. These are theoretical models designed to help educators think about using technology in meaningful and purposeful ways.

There are numerous integration models that were created to guide educators to integrate technology into teaching and learning, however this section will present the few that are widely used, these include Technology, Pedagogical and Content Knowledge (TPACK) Mishra & Koehler, 2006), Substitution, Augmentation, Modification, Redefinition (SAMR) (Puentedura, 2009), Technology Integration Matrix (TIM) (Florida Center for Instructional Technology, 2006) and Replacement, Augmentation, Transformation (RAT) (Hughes & Scharber, 2006) models. Table 1.1 below gives a description, characteristics and theoretical alignment of the technology integration frameworks.

Table 2.1 Technology integration Frameworks

Model	Description	Characteristics	Theoretical Alignment
TPACK	Shows the complex relationships and interactions of technology, pedagogy and content.	Developed to explain all the knowledge domains educators need in order to teach with technology. Developed mostly to assist the educator in their integration	Behaviourist
SAMR	Enables educators to design, develop and integrate technology enhanced learning activities	The model outlines four different degrees of technology integration More focused on how learners can use technology in their knowledge acquisition	Behaviourist (Enhancement level) & Constructivist (Transformation level)
RAT	Shows the effect of technology in teaching and learning	Used as a framework to understand the role of technology in teaching and learning, i.e. just as a replacement of old means, to increase efficiency of existing means or to afford new instructional strategies	Behaviourist and Constructivist
TIM	Describes and targets the use of technology to enhance	The model provides a guideline for describing and targeting appropriate use of technology to enhance learning. Effective technology-enhanced pedagogy for more active and collaborative learning practices.	Behaviourist (Entry level) and Constructivist (Transformation level)

The TPACK model was one of the earliest models provided for 21C technology integration. It emphasises that technology knowledge should not be administered in relationship to the pedagogy teaching practice as well as the content to be delivered (Koehler, Mishra & Cain, 2017). In essence the educator should have knowledge of all these elements such that they can make informed decision regarding which technology would work best with which teaching technique in teaching specific content (Koehler et al., 2017). The later models shift into student-centred approaches and do not only focus on the technology and how the educator uses it, but how the learner can also use the technology for a more advanced learning experience.

The models have similarities and differences. For example, the SAMR and the RAT models follow the same concept. They both highlight how technology can be used at replacement and or substitution level and the very least and then to transform and or redefine technology-enhanced teaching and learning activities. These two models, look at how to use technology for targeted outcomes. It goes from using technology just to replace old and outdated means to using technology to make possible teaching activities and outcomes that were previously impossible or difficult to achieve (Puentedura, 2009; Hughes & Scharber, 2006). The TIM, follows the same path of degrees in technology integration, except it has split these into five levels that go from entry level integration ending also at transformation (Welsh, n.d.). Similar to SAMR its early stages of integration are aligned with lecturer-centred approaches to teaching and learning while the later stages take more a student-centred approach. It is important to note that all these models do not follow a fixed progression from the bottom to the top, they offer a spectrum on which the educators may go back and forth depending on their technology knowledge, the content to be dispersed, the context as well as the desired outcome (Scheepers, 2015). All three of these models progress from a behaviourist approach in their early stages into more constructivist stages towards transformation of teaching and learning activities.

Technology integration models are an important element in exploring and understanding of teaching with technology. The models if not well packaged could hinder educators' attempt to embed new technology into their practices. Therefore, this study sought to develop a holistic model that educators and professional designers or developers can adopt. The next section explore literature on TrEds' teaching with digital technology practices.

2.4 Teaching with digital technology practice

In this section, the researcher presents an exploration of literature on the importance of teaching with technology as related to the study's goals. The term teaching with technology comprises of two fundamental key terms to this study – teaching and technology. The definition of teaching as defined in the Merriam-Webster online dictionaries (2019) is to guide someone to acquire knowledge. This definition of teaching suggests facilitation of knowledge acquisition as compared to imposing knowledge. Technology refers to tools and machines that may be used to solve real-world problems (Bates, 2015). Since the meaning of technology refer to tools and machines in general, for the purpose of this study, the term technology will be used to refer to digital technology resources. Digital technology is defined as all types of electronic devices and applications that make use of a computer program (Harmon, 2018). Therefore, when referring to teaching with technology, it is the way in which educators use digital technology to facilitate knowledge acquisition.

Student-centred typically refers to forms of instruction that give students opportunities to lead learning activities, participate more actively in discussion, design their own learning projects, explore topics that interest and generally contribute to the design of their own course of study.

2.4.1 TrEds teaching with technology competency

Educators are consistently encouraged to teach with technology in their classrooms in order to advance learning and engage students in the 21C (Liu, 2013). Technology is a critical component in 21C educational change and reform (Schrum & Levin, 2013); however, it is ineffective when it is viewed as an isolated component of education (Kurt, 2014). Teaching with technology is more than just "… delivering the traditional curriculum" (Richardson, 2013:11). The literature shows several technology intervention programmes designed to prepare educators to teach with technology in their practice (Koehler et al., 2014; Lynch, 2013; Saad, Barbar, & Abourjeily (2012); Hur, Cullen & Brush (2010); Puentedura, 2009). However, studies are revealing that technology is not effectively used by many educators in their daily practice to support learning, because of the lack of awareness among educators about the technology's potential to transform the learning activities (Uerz et al., 2018). There is a general agreement on the need to integrate technology in teaching, however, there is a hesitancy with regards to practical implementation. This is either because educators are not fully aware pf the affordances of technology, or they do not know how to effect it for their specific disciplines (Uerz et al., 2018).

It is believed that meaningful technology integration begins with technologically competent and confident educators (Buabeng-Andoh, 2012). In this regard, educators acquire new technological skills and competencies as well as a conceptual grasp of the power of technology in education. That process of acquiring technological knowledge is a continuous one as technology is dynamic; it keeps on improving because the needs and demands for technology keep on changing. Berrett, Murphy and Sullivan (2012) identified challenges to successful technology integration as the educator's lack of understanding of what the technology can do and also their inability to make informed decision on effective use of the technology in their own teaching practice. Studies are increasingly showing that technology is successfully being used for instruction, learning, and assessment, therefore TrEds needs to be competent in linking technology resources for the right kind of purpose and understanding the opportunities it has in their respective teaching disciplines.

Researchers claim that effective technology use in teaching enables educators to assist students in learning what they need to know (Ng'ambi, 2013). There remain some reservations on the definition of what effective use of technology means (Lim, Zhao, Tondeur, Chai & Tsai, 2013). They went on to define technology as a tool that facilitates practice and that on its own, no technology can fix an undeveloped educational philosophy or compensate for inadequate practices. Teaching with technology is not a simple matter because of diverse methods that are determined by the students and learning environments. However, researchers have indicated factors that influence the effectiveness of technology with technology, such as the extent to which teachers are trained and prepared to implement it, the level of access, and the provision of adequate technical support (Foulger, Graziano, Schmidt-Crawford & Slykhuis, 2017; Schleicher, 2014; Rana, 2012; Mukhari, 2016).

Educators face challenges on making decision with regards to what types of technology to use and how to use them (Culp, Honey & Mandinach, 2005). The lack of appropriate standards, holistic approaches and limited initiatives that are grounded on educational theories has distended the challenges. Researchers suggest that there is not one ideal type or one correct way to use technology; rather, it should be appropriate in meeting the learning and teaching objectives (Summak & Samancıoğlu, 2011). Therefore, this implies that each technology is likely to be used differently depending on the envisioned teaching and learning outcomes. For example, one educator can use PowerPoint to display text (in this case using it as a substitute or replaces text written on chalkboard with text typed on slide); another can use the same PowerPoint application with the goal of stimulating learning i.e. using colours, images, videos and shapes). Educators must consider how technology will be used to support the curriculum and how integrating technology into instruction will support the instructional goals. Dalia and Chowdhury (2017) suggested technology applications should complement classroom instructional strategies and use them to reinforce, enhance, and elaborate on existing instructional practices.

Experts in educational technology suggested that technology can enhance learning by providing the following functions in teaching:

i. Drilling and practicing of content;
ii. Accessing and gaining knowledge from many sources;
iii. Visualising difficult to understand concepts;
iv. Interacting with data, engaging in hands-on learning, and receiving feedback; and
v. Managing information, solving problems, and producing sophisticated products.

(Roblyer & Doering, 2014)

Fu (2013) in a study, has shown that appropriate use of technology can connect learning to real-life situations, and that through technology learning can occur anytime and anywhere.

Similarly, Kozma (2005) demonstrated that technology can help deepen students' content knowledge, engage them in constructing their own knowledge, and support the development of complex thinking skills. They further reported that technology alone cannot create this kind of teaching and learning environment. Educators must know how to structure lessons, select resources, guide activities, and support this learning process. However, many traditionally-trained teachers are not prepared to take on these tasks. Therefore, it is important to explore and understand their current practices so as to help equip them with skills for current teacher knowledge expectations.

Researchers stated that technology can be used as an instructional tool in teaching and learning. The appropriate use of technology in teaching and learning opens up new knowledge and provides a tool that has the great potential to challenge the existing knowledge. Many studies indicate that educators' attitudes and beliefs toward technology's role in the classroom, as well as their technological skill levels, influence the types of activities they use technology for and how often they integrate technology into the curriculum (Umugiraneza, Bansilal, & North, 2018; Gibson et al., 2014; Buabeng-Andoh, 2012). On the other hand, some studies found a significant relationship between teachers' beliefs towards technology and their instructional technology practices (Mumtaz, 2000; Palak & Walls, 2009). However, a study exploring teachers use of technology for Mathematics in KwaZulu Natal schools, reports that teachers with access to technological instructional resources and training held broader beliefs than their colleagues who had no access (Umugiraneza et al., 2018).

Agbo (2015) conducted a study on 'Factors that could possibly influence the use of Information and Communication Technology (ICT) among educator's. They reported that guidance from a head of department is very important in encouraging the development of electronic lesson materials and computer use for the specific subject in the teaching-learning environment. The study found out that the success of integrating technology into the teaching-learning interaction among school teachers depends on the support provided by the principal of the school. Other studies have supported this notion by highlighting that educators are likely to find relevance and motivation in technology integration as they see it modelled by their peers (Goodwin, Smith, Souto-Manning, Cheruvu, Tan, Reed & Taveras, 2014). This highlights the importance of having training sessions were educators share amongst each other how they are utilising technology in their fields. This is similar to the Japanese concept of lesson study (Stigler & Hiebert, 2016), whereby a small group of educators come together to discuss their achievements, progress as well as challenges they face in their practices. This will have a major impact as the educators will be able to discuss technology integration at a relatable level, and they can look at technology from a perspective of how it complements pedagogy.

Fu (2013) acknowledges that learning is an ongoing lifelong activity in which people change their expectations by seeking new knowledge, thereby departing from traditional approaches, in this case, moving from teaching approaches whereby learning was determined by the educator alone. Educators and students alike desire to explore new sources of knowledge, therefore, technology becomes an indispensable resource. Technology increases access to knowledge by exposing the students and educators to a wide range of forces of information. This suggests that educators are expected to innovate and adapt new technology-enhanced teaching styles for the 21C needs. In order for TrEds to adapt to new teaching styles, researchers report on the importance of continued professional development for educators specifically focussed on current trends in 21C education (Lindqvist, 2015; Gregory & Salmon, 2013).

2.4.2. TrEds' Professional Development

Research clearly indicates that the single most important factor in the successful use of technology is educators' ability to integrate technology into the curriculum (National Education Association, 2008). According to Yildirim (2007), educators reported that they were inadequately trained to integrate technology into their teaching practice. Researchers (Blazer, 2008) recommended that before professional development (PD) is designed, educator's current level of technological skills should be understood and therefore inform the designers what is known such that they may build on it. Researchers established that a needs-based survey, administered prior to professional development sessions, helped design training that matched educators' teaching goals (Clark & Waaili, 2010).

Research has not identified any one best model of effective professional development, approaches that have been found to be effective include:

- ✓ Providing educators with relevant training in the skills needed for successful technology integration strategies (Schrum & Levin, 2013)
- ✓ Providing educators with hands-on experiences using new skills and developing units in realistic settings with authentic learning tasks
- ✓ Educators Modelling of appropriate and relevant technology integration strategies (Alberta Education, 2017)

- ✓ Peer teammates to share strategies for technology integration as well as discussion and reflection for ongoing opportunities with other educators' based on their experiences with technology integration (Lewis, 2016)
- ✓ Linking professional development to the specific disciplines

This necessitates that institutions or faculties design custom-made PD that works in their context and with their educators' specifications and needs of the students. These customised PD interventions must be tailor-made in order to meet 21C teaching and learning outcomes.

Ertmer and Ottenbreit-Leftwich (2010) reviewed the existing literature on the necessary elements that enable educators to integrate technology as a meaningful pedagogical tool. They recommended that PD should provide educators with authentic discipline related examples that supports the positive impact of technology-based and student-centred instructions. For example, PD can provide opportunities for educators to observe a variety of examples of technology integration models, which they can then apply in their own practice. PD needs to help educators understand difficulties they anticipate when using technology in their lecture rooms, and present effective contingencies to rectify them (Scheepers, 2015).

PD designers should ensure that educators understand that the ultimate objective of technology integration is to advance the teaching and learning process and its outcomes. Fu (2013) specified that good planning and management for technology integration requires a special understanding of specific hardware and software related to the curriculum. Developing a pedagogical model requires a strong link between theory and application in order to help educators overcome the obstacles faced in technology integration (Keengwe & Onchwari, 2009). PD and pre-service teacher training are also indispensable to supporting the curriculum with technology integration.

Bauer and Kenton (2005) in their study on 'Technology integration in schools' stated that although teachers had sufficient skills, were innovative and easily overcame obstacles, they did not integrate technology consistently both as a teaching and learning tool. Reasons being outdated hardware, lack of appropriate software, technical difficulties and student skills levels. The study found that professional development has a significant influence on how well technology is embraced in the classroom. This implies that teachers training programmes often focus more on basic skills and less on the integrated use of technology in teaching. Despite the numerous plans to use technology in schools, teachers have received little training in this area in their educational programmes. The study concluded that simply teaching basic technology skills is inadequate if teachers are to constructively integrate technology constructively into their instruction. More emphasis should be placed on advanced skills in teacher education programmes in order to provide teachers with authentic opportunities to experience and develop lessons that integrate technology in a meaningful context.

Sánchez & Alemán (2011) suggested that educators keep an open mind about technology integration in teaching and learning. This therefore, implies that it is imperative that educators are exposed to contemporary teaching strategies in order to adapt new instruments into their teaching practices. Similarly, Palak and Walls (2009) established that teachers use technology mainly to support their existing teaching approaches and rarely to foster student-centred learning. However, Yildirim (2007) in their research that examined educators' use of technology in Turkish schools, found that educators use technology more frequently for the preparation of hand-outs and tests than to promote the 4Cs. One possible explanation given by the authors was a lack of models for how to use technology to facilitate learning, and limitations related to contextual factors such as class size and student ability.

Brush, Glazewski and Hew (2008) found that pre-service teacher preparation does not provide sufficient technology knowledge to support technology based instruction, nor does it successfully demonstrate appropriate methods for integrating technology within a subject discipline. Therefore, the need for subject specific training should be provided in pre-service teachers' professional teaching curricula, and technology skills must be applied in the lecture rooms in order to model effective and relevant technology enhanced teaching strategies (Oigara & Wallace, 2012; Koh & Sing, 2011). To help educators cope with these difficulties, Serdyukov (2017) suggested that rather than only providing education theories, educational technology researchers should also document examples of how educators accomplish meaningful and effective technology integration to meet their pedagogical and content goals.

Milton (2013) reported that when technology is taught in pre-service teacher preparation programmes, the emphasis is often placed on teaching about technology instead of teaching with technology. Hence, inadequate preparation to use technology is one of the reasons that educators do not systematically use technology in their teaching practice. Educators lack the necessary skills and thus need to be given opportunities to practice using technology in their pre-service teacher training programmes so that they can be exposed to ways in which technology can be used to augment constructivist student-centred activities. TrEds are more likely to adopt and integrate technology in their pre-service teacher preparation disciplines, when PD in the use of technology provides them time to practice with the technology and to learn, share and collaborate with colleagues (Byrd, 2017). The statement suggests that PD that helps TrEds to update their technology skills may aid the integration of technology. To promote technology integration in teacher preparation institutions TrEds should adopt strategies that make technology to be part of their teaching routine.

For the case of PD in technology and in administrative support, most scholars and past studies suggested that to a large extent these two variables positively affected technology implementation (Darling-Hammond, Hyler, & Garddner, 2017). Due to the lack of training on how to apply teaching with technology, few scholars like Mooij and Smeets (2001) in Holland were of the view that possessing technology skills does not warrant use of computers in teaching. On the other hand, McKnight, O'Malley, Ruzic, Horsley, Franey and Bassett, (2016) emphasise the reinforcement of specific technology skills for teaching, such as graphing software, video editing etc. This suggest that PD development should train teacher on relevant technology skill. This study aims to explore and understand TrEds teaching with technology in their pre-service teacher preparation.

2.4.3. Administrators support

Focusing on the importance of institutions' technology integration policy, Pelgrum and Law (2009) indicated that effective technology integration depends on the perceptions and vision of institutions' leaders rather than educators' technology integration skills. In their study of new technology for teaching and learning, Sife, Lwoga and Sanga (2007) reported that administrative support is critical to the successful integration of technology into teaching and learning processes. It is argued that it is the administrator's responsibility to provide the conditions that are needed, such as putting in place a technology integration policy, incentives and resources. The authors stated that for the adoption of technology to be effective and sustainable, "administrators themselves must be competent in the use of the technology, and they must have a broad understanding of the technical, pedagogical, administrative, financial, and social dimensions of technology in education" (Sife et al., 2007: 64).

Yang (2008) in a case study 'Examining university students and academic understanding of ICTs in higher education at Curtin University of technology' reported that university educators who received support from administrators had a high commitment to the adoption of technology for teaching and learning. Data in the study suggested that the adoption of technology in teaching and learning would be promoted by greater support of the change at the administrative level of the university.

2.4.4 Availability of technological resources and technical support

A critical factor contributing to the promotion of innovation is the availability of infrastructure resources: hardware, in terms of the technology available in the institution for students and educators for educational purposes, and the quality and functioning of equipment (capacity, speed and access to the internet) as well as available software applications. However, availability of technology alone is insufficient and must be accompanied by technical as well as pedagogical support. In the current study, exploring literature on availability of technological resources and technical support deals specifically issues on actual technological resources and technical support available to TrEds at the research site.

In a study, Ertmer (1999) classified barriers to technology integration in teaching and learning into two categories, first and second order. The first order, which are external barriers beyond educators control includes lack of technological resources and technical support. The second order, are internal to the educator, mainly influenced by personal philosophical beliefs. Lack of technological resources and technical support, as well as lack of professional development for teachers are other areas of first-order barriers to technology integration. Khan, Hasan and Clement (2012) stated that the reasons for Bangladesh educators' ineffective implementation of ICT in teaching and learning, were lack of appropriate infrastructure, support from administrative, inadequately trained educators, and scarce qualified ICT coordinators that could help train educators to integrate technology into their practices. Dionys (2012), in a study in Cambodia reported similar findings, as lacking both infrastructure and technological resources. Hudson and Porter (2010) made similar finding in their study of Mathematics teacher. They identified lack of professional training and support as barriers to technology integration in Mathematics instructional strategies. In their study, Amuko, Miheso-O'Connor & Ndeuthi, (2015) found that 40% of their participates mentioned that they lacked technical support and appropriate infrastructure with regards to technology integration.

In their study, Jaipal-Jamani and Figg (2015) reported that lack of technical support as one of the major barriers that resulted in computers being underutilized in the classes. Educators do not use technology in teaching when they have no immediate access for help in case something goes wrong.

Research has shown that the provision of adequate technical support is critical to the success of technology integration programmes (Poole, 2008). Technical specialists must be able to answer questions quickly, maintain or repair hardware, supply loaners, and install software. The availability of technical support means that educators and students alike have access to technology resources that are functional at all time. This implies access to immediate resolving of technical challenges users' encounter is important. The failure to provide technical support may have an adverse impact on how teaching with technology is implemented. Support teams should therefore be equipped with knowledge and resources that facilitate effective response times. Robinson and Kay (2010) recommended that a single technical specialist be responsible for supporting no more than 300 computers for effective service delivery. This reduces the length of downtimes in technology use.

This study aims to understand how TrEds integrate technology in their teacher preparation programme, therefore, it was important to explore literature on the availability of technological resources and technical support, which goes beyond educator's control.

2.5 Pre-service teacher preparation in the 21C

The transition to successful technology integration in teaching and learning indicates the need for a shift in pedagogical approaches and reforms in teacher preparation programmes. This therefore, requires specific technology integration standards, studies show that many TrEds and pre-service teachers feel unprepared to teach with technology (Stokes-Beverley & Simoy, 2016; Chigona, 2015a; Chigona & Chigona, 2013). In this section, the researcher sought to understand how TrEds prepare pre-service teachers to teach with technology in the 21C.

Teacher preparation is an important component of education and the society's development. A critical element within teacher education relates to how teachers are prepared to address the 21C needs. Robinson (1999) defines teacher preparation as programmes designed to prepare pre-service teachers to become professional teachers. Teachers are central to any education system, as they are the ones who see that curriculum programmes are successfully implemented. They are responsible for managing and creating conducive environments that produce 21C teaching and learning outcomes. This implies that teacher preparation programmes should inculcate pre-service teachers with professional teacher knowledge that meet 21C expectations. In this study, it is important to explore how technology integration is taught in pre-service teacher preparation programmes.

Most South African teacher preparation programmes are designed to provide four (4) years of coursework that includes fundamental theoretical foundations of education, content-specific courses which are organised in grade level, classroom management approaches, professional studies and teaching practice internships (Kimathi & Rusznyak, 2018). Teaching practice (TP) internship starts in their first year up until their fourth year of the teacher preparation programme. TP allows for hands-on training in real classroom dynamics and management as they are mentored and relate their theoretical knowledge into practice.

Despite the major shifts in educational policy, researchers mention that the quality of education across South Africa has not improved (Chigona, 2015). Amongst the key concerns attributed to this was the issue of teachers who are inadequately prepared. Moeini (2008), while reflecting on pre-service teacher preparation programmes, asserts that most of the existing programmes fail to address the needs of the modern classrooms. Pre-service teachers are expected to gain confidence on how to deliver content with the aid of technological resources and to professionally perform tasks as informed by their teaching professional knowledge.

However, there are concerns that traditional models of teacher education are not fully capable of producing teachers for the changing times (Tsui, Edward & Lopez-Real, 2009). Gomes (2017), for example, asserts that traditional teacher education programmes fall short in preparing teachers, and states that contemporary teacher preparation practices need to go beyond training pre-service teachers in isolation, but needs to give them more practical and sustainable teaching techniques that meet 21C requirements. Similarly, Lieberman and Miller (1990) draw attention to the fact that many contemporary approaches to teachers' training have focused on traditional models with no links to the realities of current needs, which makes it difficult for teachers to teach effectively in a developing context. Teaching in a digital age requires educators to explore new teaching strategies (McKnight, O'Malley, Ruzic, Horsley, Franey, & Bassett, 2016)Therefore, this suggests that TrEds are expected to migrate from traditional to modern approaches in their pre-service teacher preparation programmes.

Choy, Wong and Gao (2009) conducted a mixed study to examine pre-service teachers' technology integration before and after a technology integration course. They compared the findings before and after the integration course. The researchers concluded that teacher education programmes need to increase awareness of the benefits of integrating technology with student-centred learning approaches. They further argued for the exploration of technology integration models that align with student-centred teaching strategies. This finding supports the objective of this study, with regards to the adoption of technology enhanced student-centred teaching approaches.

The interminably changing technology driven environments, necessitate that education has to be structured in ways that meet current needs while anticipating emerging trends and challenges for students (Akyeampong, Pryor, Westbrook & Lussier, 2011). For a successful and quality education, it is critical to position teacher preparation programmes in ways that benefit schools and learners. Henceforth, teacher preparation institutions have an ongoing challenge of ensuring their teacher preparation programmes produce well prepared pre-service teachers. However, Chigona and Chigona (2013) reports that pre-service teachers are inadequately prepared for 21C classrooms. Teacher preparation programmes must guide "… pre-service teachers toward the abilities, strategies, and ways of thinking for teaching today and tomorrow…" (Niess, 2008: 224). The urge for adequately prepared pre-service teachers must start by cultivating appropriate teaching knowledge anticipated in a professional teacher, bearing in mind the current need to foster critical thinking, analysis and knowledge application in learners

Changes in the demand for skills have profound implications for the competencies which TrEds themselves need to acquire to effectively model 21C teaching skills to pre-service teachers (Ananiadou & Rizza, 2010). The quality of pre-service teacher preparation programmes is considered as most significant in realising transformation in education (Deacon, 2014). TrEds are challenged to design learning that meaningfully integrates content, pedagogy and technology in ways that foster the development of 21C skills. To adequately prepare pre-service teachers, TrEds needs to have a broad background and understanding of current development in the classrooms (Katitia, 2015). In their study, (Deacon, 2014) suggested improvements in initial teacher preparation where TrEds need to practice and develop their own pedagogy in teacher preparation programmes as informed by contemporary teaching and learning theories. Modelling good practice is recommended as a key developmental tool in teacher preparation (Abadzi, 2012). Several studies give emphasis to the need for training and equipping TrEds first (Tondeur, Van Braak, Sang, Voogt Fisser & Ottenbreit-Leftwich, 2012; Ching, Ng, Li, Homh, & Koh, 2013; Tiba, 2018). In reading for this study, the researcher did not find many studies looking specifically at how TrEds develop their professional teaching practice or in-service training in order to acquire new developments in teaching and learning. This therefore highlights discernible gaps in the existing literature which provides lucid directions for future research into technology use.

A review of the existing literature makes it apparent that technology integration is mediational and entails an evolving process, not a final product. The achievement of successful integration of technology requires an effort from three main stakeholders: TrEds, pre-service teachers, and institution administrators.

The understanding of the pre-service teacher preparation in the 21C, informs the researcher what TrEds' need to stay current and up to date with currently prevailing knowledge in 21C education. The next section explores TrEds roles in the 21C teaching and learning.

2.6 The role of the TrEd in 21C teaching and learning

In the 21C teaching and learning, the educator's role is to engage and facilitate student's individual meaning making process (knowledge construction). The educator's focus should be guiding students by creating an appropriate learning environment that leads them to develop their own understandings of the content. Therefore, TrEds need to successfully design lectures that align technologies with content and pedagogy to successfully meet learning outcomes, act as models, mentors, coaches of 21C knowledge and skills to pre-service teachers (Partnership for 21st Century Learning, 2015). The following subsections explore these roles in detail.

2.6.1 TrEds as designers of 21C teaching experiences

The goal of 21C teaching is to provide learning environments for student's which incorporates authentic learning, assessing and personal development. 21C is characterised by the mastery of information, embedded knowledge and understanding and the advanced use of technology in society as they develop higher-order skills such as the 4Cs (creativity, critical thinking, communication, collaboration). Therefore, TrEds' role as a designer entail that they creatively design relevant and meaningful learning activities that engage students' minds thereby taping into the development of the 4Cs. Inventively, TrEds knowledge on teacher preparation should be grounded in contemporary teaching knowledge technological integration frameworks such as SAMR and TPACK. TrEds ability to unpack every knowledge construct embedded in these frameworks assists in setting a learning environment that support students creativity (Henriksen, Mishra & Fisser, 2016). Technology seamlessly supports a 21C learning environment by giving access to and incorporating online wealth of resources and outside knowledgeable others. TrEds ability to design teaching and learning activities that expand the spatial spaces of the four walls is a critical skill for 21C learning outcomes. OECD's Innovative Learning Environments (ILE) argues that a contemporary learning environment should innovate the elements and dynamics of its "pedagogical core" (OECD, 2017).

21C is dominated by language that describes comparative thinking, design thinking, project-based learning, game-based learning, strength-based learning, personalized learning, collaborative learning, blended learning, and kinaesthetic learning (Pearlman, 2008;

Donovan & Green, 2014; Leggat, 2015). This language all highlights the demand on both educators and learners to be able to navigate through a highly technical world with so much information sources. As pedagogical practices are evolving, educators encounter a redefinition of their values, priorities, and conceptualisations of the teaching and learning processes and environment. The 21C requires an in-depth understanding of the current learning environment's needs as well as what students are expected to achieve to fit into and be able to operate in such an environment. TrEds are also expected to put into demonstrate skills they expect pre-service teachers to acquire. In the next section the researcher discusses the role of the TrEds in modelling expected teaching practice.

2.6.2 Modelling 21C teaching practices

Jonassen (1999) posits that the role of an educator is to model knowledge construction through 'reflection-in-action'. TrEds exert a significant influence upon pre-service teachers' readiness, understanding and views of teaching with technology. Several studies have argued that modelling of technology use, especially by TrEds, is possibly a successful strategy for pre-service teachers' effective technology integration (Neal & Eckersley, 2014; Westbrook et al., 2013; Divaharan, 2011). Teachers' preparation programmes remain central for modelling, training and subsequent implementation of the effective use of technology-enhanced learning. For pre-service teachers to learn to effectively implement digital pedagogy into their teaching, they must first see it modelled effectively by TrEds. This is crucial in that it given the pre-service teachers a demonstration of how to practically use technology in context. Oigara and Wallace (2012) mention that for pre-service teachers to learn to incorporate digital pedagogy, they must be modelled using current instructional technologies. They recommend that TrEds model a variety of digital pedagogical tools in their teacher preparation programmes to help develop an understanding of how to implement digital pedagogy that facilitates learning. Modelling provides pre-service teachers with examples of teaching with technology that help achieve desired learning outcomes. This may assist in elaborating on or providing alternative technological representations of how to meet the objectives of those activities. The pre-service teachers are in an ideal position to see how TrEds use technology from an educator's perspective and they as the learner in this case can practically assess its effectiveness. This gives them the opportunity to formulate more creative ways of implementing technology enhanced teaching activities.

2.6.3 Coaching and mentoring 21C teaching experiences

Coaching and mentoring given by TrEds can have a significant effect on the development of pre-service teachers during this 21C transition and change. Coaching is defined as a way of having a thought-provoking conversation that helps individuals maximise their personal and professional potential (London Leadership Academy, 2014). Mentoring is whereby a senior member share their knowledge and experiences, thereby creating new networks between the mentee and mentor (London Leadership Academy, 2014). In this study, coaching and mentoring is one teaching strategy that TrEds can use to help develop their own professional development on teaching with technology, as well as implement into their own teaching practice.

Coaching and mentoring fits within a constructivist paradigm. Constructivists emphasise that people develop meaning through their own interactions with the environment. In line with this, coaching and mentoring encourages a student-centred approach. Thus, coaching and mentoring as a learning strategy differs from behaviourist lecturer-centred approach as the coach often facilitates non-directive methods, thereby encouraging the students to find their own presumed solutions to a given scenario. TrEds facilitate the development of effective teaching practices that transform learning and therefore, are themselves expected to be competent in the new skills that deal with these new changes such that they can be effective mentors.

Since the main role of educators in the development of 21C skills is facilitating effective technology enhanced teaching practices, it is inevitable that TrEds need to excel in innovative competencies that deal with these current changes (Westbrook, Durrani, Brown, Orr, Pryor, Boddy & salvi, 2013; Oigara & Wallace, 2012). Studies recommending teacher preparation improvements, argue that TrEds need relevant school experience; and should develop pedagogy in teacher preparation programmes that is being promoted in and aligns with school curricula (Neal & Eckersley, 2014; Oigara & Wallace, 2012; Kadzera, 2006). A knowledgeable coach inspires students by showing them good practice in action. TrEds are expected to be competent in effective teaching with technology skills that they want to inculcate among their pre-service teachers: they need to continuously seek innovative and better ways of knowledge acquisition through improved skills. Against this backdrop, technology, because of opportunities it offers in facilitating learning, can play a big role in helping students attain 21C skills.

2.6.4 Scaffolding

Scaffolding is an instructional strategy used to move students progressively towards an incremental and deeper understanding of content that leads to independence and critical thinking in solving problems (Tiantong & Teemuangsai, 2013). In other words, the educator enhances learning by building on students' experiences and current knowledge as they learn new skills. Similarly, (Tondeur. Scherer, Baran, Sidding, Valtonen & Sointu, 2019) assume that students are given the support they need while learning new skills, they stand a better chance of using that knowledge independently. Scaffolding instructional strategy was found to resonate with this study as it supports and helps develop the 21C skills.

An educator using instructional scaffolding employs a student-centred approach that affords students ownership of their learning; while gradually decreasing the teacher's role in the process (Jonassen, 1999). The concept of scaffolding is directly related to Vygotsky's Zone of Proximal Development (ZPD): in that a student constructs knowledge with the guidance of a more knowledgeable other (Shabani, Khatib & Ebadi, 2010). ZPD is defined as the distance between what children can do by themselves and the learning outcomes that they can be helped to achieve with competent assistance (Masters, 2013). TrEds act as the more knowledgeable others in this study: scaffolding facilitates a student's ability to build on prior knowledge and internalize new knowledge. An important aspect of scaffolding is that the scaffolding provided by the more knowledgeable other (MKO) is gradually withdrawn as the student's abilities and self-reliance increase. The goal of the TrEd when using the scaffolding teaching strategy is for the pre-service teacher to become an independent and self-regulating student and problem solver (Hardman & Amory, 2015). (Lange et al., 2016) classify two major steps involved in scaffolding; (i) development of instructional plans to lead the students from what they already know to a deep understanding of new material, and (ii) execution of the plans; the educator provides support to the student-centred learning process. According to Hartman & Lange (2012) scaffolding includes models, cues, prompts, hints, partial solutions and think-aloud modelling. Instructional scaffolds are designed to assist educators who are engaged in student-centred learning activities.

According to McKenzie (1999) there are six main scaffolding characteristics:

1. Providing clear direction; reducing students' misconceptions of what is expected. TrEds need to know of, and about, any learning difficulties and misconceptions students have concerning technology integration; so as to develop step-by-step guidelines that illustrate what a student must do to achieve their learning goals.

2. Clarifies purpose of learning activity as educator sets out what needs to be achieved at the end of the activity: students understand the objective of doing the work and its importance as they relate to the broader content areas.
3. Keeps students engaged with their task as they follow the guidelines proposed by the knowledgeable other. The students can make decisions about which pathways to choose but they cannot wander too far off the pathway.
4. Clarifies expectations and incorporates assessment and feedback: expected outcomes are clearly stated from the beginning of the activity. Illustration of the exemplary work, rubrics and standards of excellence are shown to the students. In the context of this study, TrEds set up exemplary teaching practice integrated with technology and high standards.
5. Points students to worthy sources since educators provide possible sources for students to reduce confusion, frustration and time. The students may decide which of these sources to use. TrEds identify effective teaching with technology strategies and recommend pre-service teachers to explore how best they can use them in the practices.
6. Reduces uncertainty, surprise and disappointment; for example, educators test their lessons to determine possible problem areas and then refine the lesson to eliminate difficulties so as to maximise learning.

Despite the envisaged importance of scaffolding in constructivist learning, Milton (2013) indicates the complexity of its representation and the difficulties of understanding it by educators. Despite its difficulties, scaffolding plays an important role; in that TrEds can set guidelines to help pre-service teachers comprehend teaching with technology strategies. TrEds scaffold pre-service teachers learning on designing and implementation of student-centred approaches and technology-enhanced lessons.

To sum-up, lack of TrEds facilitative, cooperative, collaborative and student-centred teaching approaches deprives pre-service teachers of opportunities for more robust and universal solutions to problems. In the 21C classroom environment, effective teaching occurs when teachers bring together knowledge of content and instructional strategies that will make students understand concepts; by incorporating digital technology. According to CAST (2011) technology supports different pathways and provides students with multiple means of knowledge representation, expression and engagement by means of audio, digital text, video and images. The question is how to use technology in a manner that enhances student-centred learning by employing specific technological tools and using specific technology-related instructional strategies in teachers' preparation programmes.

2.7 Chapter Summary

Teaching with technology in the 21C is a key factor towards the development of skills that are crucial to navigating these modern times. While teaching strategies alone have the potential to accommodate the development of these skills, the contribution made by technology is so vast it cannot be overlooked. Technology gives access to a wider range of information. Technology allows for the acquis ion, process and application of knowledge in constructive and less costly and or time consuming ways depending on the context. Above all, technology and its affordances take the burden off the educators of being the sole source of information. Well used, teaching with technology is the medium through which student-centred learning activities may be achieved.

The review of researches conducted prior to this one show that TrEds are not fully equipped with the required knowledge to prepare pre-service teachers to teach with technology. Factors that contribute to this include the lack of uptake of contemporary technology integration models and contemporary learning theories. While most studies focused on pre-service teacher practices, this study will focus on the TrEd practice. The literature reviewed in this chapter highlights the important role of the TrEd in 21C teaching and learning with technology. However, for successful implementation TrEds must adopt models and theories to guide them towards specific outcomes. The evaluation of technology outcomes is an important consideration for technology integration and for design of effective technology integration professional development. The comprehensive coherence of contemporary integration models and teaching theory will provide learning opportunities for TrEds that sustain technology integration that is student-centred.

The reviewed literature discussion demonstrates that there is a dearth of information about how pedagogy and technology are linked: although there is considerable material on both aspects separately not in a holistic manner. Therefore, there is need for a viable integrated model that assist TrEds in improving their practices in teaching with technology, so that pre-service teachers are adequately prepared. No model currently exists for simulating such a correlation of constructivist teaching with technology integration frameworks. This research undertakes to provide such a process model for integration. Digital pedagogy may be the concept that can encompass many so far disparate areas of speciality. Chapter 3 presents the conceptual framework developed as informed by literature.

CHAPTER THREE

THE CONCEPTUAL FRAMEWORK OF THE STUDY

3.1 Introduction

The aim of this study is to explore and understand teacher educators (TrEds) technological-enhanced teaching strategies. This chapter addresses some fundamental understandings of development within key theoretical paradigm in order to contextualise the study findings on teaching with technology phenomenon. This study is informed and structured by three key focus areas; (constructivist theory, TPACK and SAMR) that assist in an attempt to answer the research questions. The reasons to focus on a teaching and learning theory and technology integration frameworks was explained in Chapter 2. Therefore, this chapter sets out the conceptual framework of this study.

Designing an effective teaching with technology environment is built upon the combination of teaching and learning approaches that are informed by what needs to be achieved, and the technology's affordances thereof. The researcher combined three concepts that guide this study by linking the constructivist theory (Vygotsky, 1978) with Mishra & Koehler's (2006) TPACK and Puentedura's (2009) SAMR frameworks. By combining a constructivist teaching and learning theory with technology integration (TPACK and SAMR) frameworks, made it possible to create a viable conceptual framework to be used to conduct this study. The combined technology integration frameworks enable the researcher to draw upon the analytical and social aspects of the teaching with technology phenomenon under study. Therefore, a combination of the viable and recognised theory and frameworks helped create a dependable conceptual framework to underpin this study on.

Constructivist teaching and learning in the 21C is aligned with student-centred teaching strategies, in which students are encouraged to discover, discuss and interpret knowledge. Therefore, in this study, the researcher considered the constructivist theory to be the critical fundamental knowledge in teaching and learning (see section 2.2). Further, the researcher used the TPACK framework to highlight TrEds professional knowledge on effective teaching with technology. For effective teaching with technology, TrEds need to be able to integrate technology, pedagogy and content knowledge (Mishra & Koehler, 2006). Discussion of the meaning of TPACK knowledge domains inevitably becomes necessary to define the parameters of the discussion sustained in this study (see section 2.3). However, TPACK does not provide the progressive levels that TrEds work through as they endeavour to effectively integrate technology. Therefore, there was a need to incorporate the SAMR model. The SAMR illustrates the technology integration successive levels through which educators progress. This demonstrates a progression from a simple tool substitution to a sophisticated transformation that is well aligned with constructivist task design. Teaching with technology skill in this regard is viewed as a gradual process (Puentedura, 2009).

This chapter is organised as follows:

Section 3.2 Choice of the conceptual framework

Section 3.3 Explanation of the conceptual framework

Section 3.4 How the conceptual is guiding the study

Section 3.5 Chapter Summary

The following sub-sections elucidates the relationship of the three constructs that will assist educators in linking learning theory with technology integration frameworks of teaching with technology

3.2 Choice of the conceptual framework

This section explains the study's chosen learning theory and the technology integration frameworks that were used to develop the conceptual framework that guided the study. As argued earlier, no single strategy applies across all subjects and students: the teacher needs to appropriate the particular type of instructional strategy to meet the desired goals of the specific learning activity. Educators should therefore be aware of teaching and learning theories, their principles and instructional strategies they support. TrEds should be aware that some instructional strategies work better in some places; not in other places.

There are several frameworks, but this study is interested in frameworks that informs teaching knowledge with technology and that which helps the progress with the technology to effective levels. This section of the literature review further expands the TPACK, and SAMR, frameworks and provides a comparison of the frameworks for usefulness in teaching with technology in the 21C. The TPACK and SAMR were selected because they are the most studied in literature therefore referenced (Hamilton, Rosenberg, & Akcaoglu, 2016; Hilton, 2016; Kihoza, Zlotnikova, Bada, & Kalegele, 2016; Kriek, Ayene, & Coetzee, 2016; Ledford, 2016; Tunjera & Chigona, 2017).

While there are a number of teaching theories, the constructivist theory was selected for the purpose of this study due to its focus on the student and how they acquire knowledge in the

21C. This concept of the theory complements the SAMR model focuses on student activities (Puentedura, 2009) and how technology can be used to their benefit and not just the TrEds. The TPACK framework is equally important as it brings the component by which to understand the knowledge domains that the TrEds need to integrate with technology (Mishra & Koehler, 2006) in order to successfully implement these learning activities.

3.2.1 Constructivist teaching and learning theory

21st century witnessed the philosophical shift from traditional behaviourists teaching approaches to constructivist (see section 2.2.2). Constructivist teaching and learning theory is based on the principles that occurs when new knowledge is linked to prior knowledge. In this regard, constructivist posit that learning is achieved when students actively engaged in the learning process, instead of receiving knowledge passively. Constructivist principles argue that educators give students tools to constructs their own knowledge as they construct, acquire and interpret knowledge differently. The researcher sought to understand how TrEds hold to the principles of constructivist teaching and learning theory in their endeavour as they integrate technology keeping up with the demands of 21C teaching and learning environments.

3.2.2 Technological Pedagogical Content Knowledge (TPACK) framework for educator teaching knowledge in the 21C

The TPACK framework focus on the interplay amongst three primary form of specialised teacher knowledge: Technology, Pedagogy and Content.

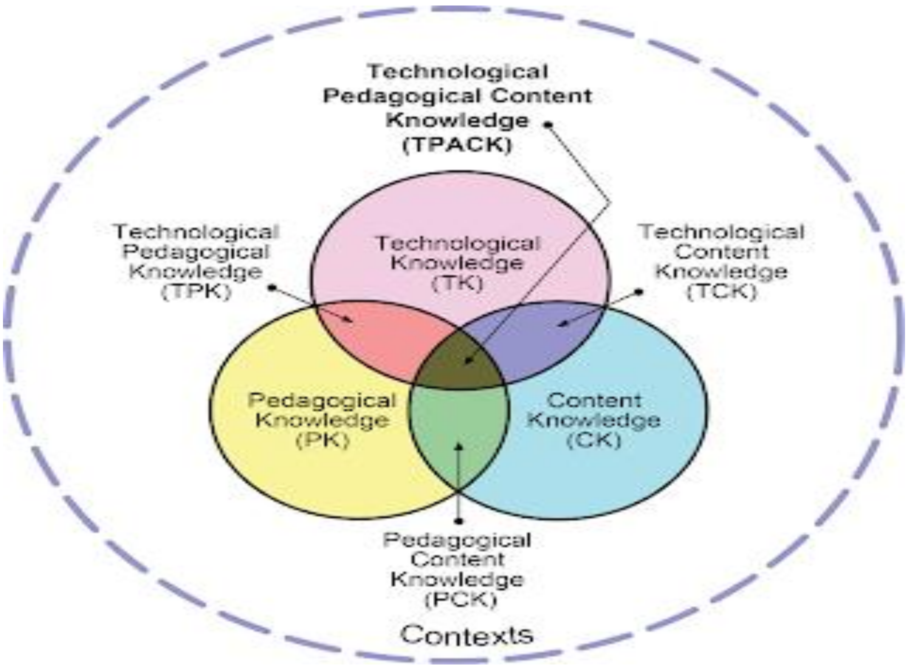

Figure 3.1: TPACK Framework source (http://tpack.org/)

TPACK emphasise the important of educators placing and combining the three thematic constructs as the most appropriate manner to determine effective knowledge for technology integration (Mishra & Koehler, 2006). However, TPACK is more aligned to teacher-centred instructional strategies as it was conceived from the behaviourist traditional practices which gave prominence to teacher as the source of knowledge. The benefits of TPACK is that it provides guidance to the development of skills that are needed for effective integration of technology in teacher practices thereby forms the basis for teaching strategies for integrating technology in teaching and learning. However, TPACK offers teachers on what needs to be considered, but do not indicate how and what to do to plan technology integrated teaching. Furthermore, TPACK do not outline developmental levels that teachers go through when integrating technology.

3.2.3 Substitution Augmentation Modification Redefinition (SAMR) model for TrEds levels of technology integration

The Substitution Augmentation Modification Redefinition (SAMR) model was developed by Dr. Ruben Puentedura in 2006 for the planning of teaching with technology learning activities. The SAMR is a technology integration model that focus mainly on teaching and learning activities that can be applied at different levels in integration technology (Keane et al., 2013; Romrell et al., 2014). SAMR is aligned with student-centred activities as informed by the as informed by the constructivist theory, which encourage hands-on activities. The SAMR model can help educators locate their practice progression along the continuum. As the educator progresses along the continuum, technology integration increasingly gets embedded into the learning activities, further becoming more effective on simultaneous authentic learning engagement.

SAMR provides insights on learning activities that can be used with a technology, also, SAMR helps educator to classify and evaluate technology enhanced learning activities. However, SAMR is dependent on the technology knowledge and its availability to the learning environment. It provides educators on what can be done but not clearly elaborate on what to do to transform learning activities. The SAMR continuum is not reflective of real classroom environment scenarios. While critics of SAMR model argue that it implies lecturer incompetence when transformation is not achieved Love (2015), however provides a counter argument by integrating SAMR and TPACK models that implies that TPACKed educator is able to manipulate their knowledge to purposefully achieve enhancement level if that is the approach that is fitting for their objective in that context.

Below is the SAMR diagram model that show augmentation as the lowest level of using technology, whereby the educator simply substitutes a traditional technology with a digital technology. At this level the digital technology is used in it basic or simplest form. The augmentation is the next level in which the digital technology is integrated with the incorporation its advanced functions. Although used at an enhancement, however the digital technology

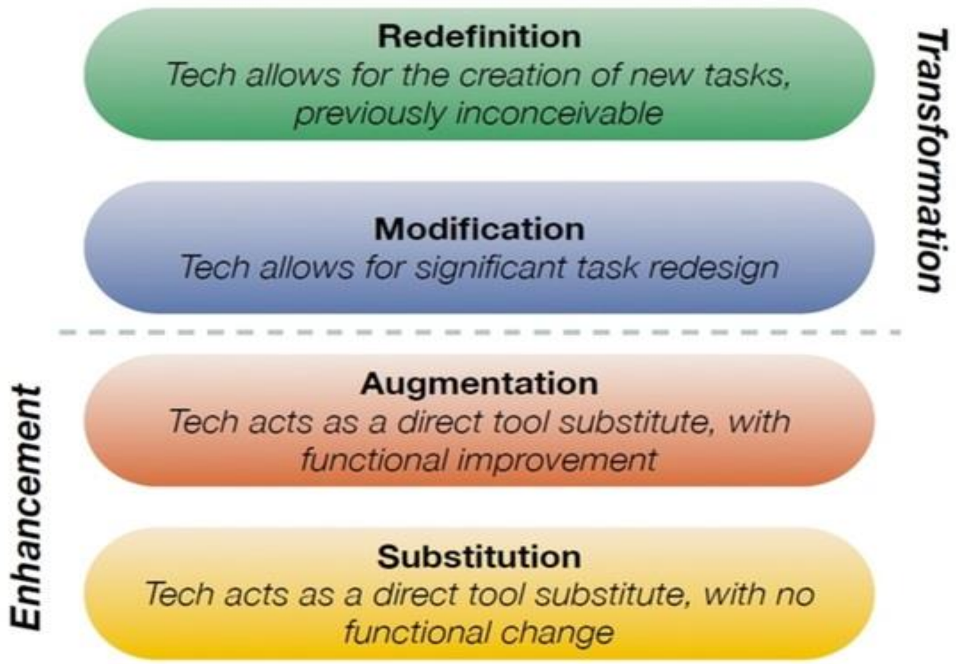

Figure 3.2 SMAR skill acquisition process (Puentedura, 2009)

While, both TPACK and SAMR frameworks sound ideally useful, however, each has its own limitations. Both do not offer specific guidance on helping educators think about what needs to be changed to make their teaching with technology effective. Therefore, TPACK and SAMR will serve as technology integrating frameworks in this study that will inform this study on what TrEds need to improve their teaching with technology practices in the 21C.

Table 3.1 presents the comparison of TPACK and SAMR models illuminating their interdependence.

Table 3.1: TPACK and SAMR relationship

	TPACK Explore the teacher teaching knowledge with technology	SAMR Differentiates levels of technology integration	TPACK & SAMR affordances Technology integration systems
Focus	interrelation of Technology; Pedagogy; and Content	heuristics for teacher designed technology activity tasks	Technology integration in education
Underlying assumption	Pedagogy is content specific PCK precedes TPACK Teacher controls learning	SAMR existence dependent on TPACK Technology is readily available technologically deterministic	incomplete without the other
Theoretical links	Behaviourist	Constructivist in nature	Split along 20th and 21st theories
Target	Teachers	Learning activities	Split along teacher-centred or student-centred
Tool	Plans technology integration	For planning learning activities	Both aids value to technology integration
Contributes with	Teacher competences for effective teaching	Locate one's level of technology integration Evaluate technology-enhanced learning activities	Both contribute to technology integration
Benefits	Reveal 21st century teacher knowledge needed for integrating technology Provides guidelines for planning for technology integration	Provides structure in ways of technology integration	Provide focused specific guidelines
Drawbacks	Suggest teacher knowledge with little direction on how Teacher-centred Focus mainly on content knowledge	Distinctively favours technology rich activities Systematically hierarchal	Both offer no clear guidelines on How teaching can be accomplished effectively

3.2.4 Combining constructivist theory with TPACK and SAMR models

This section of the chapter explores the three constructs of the conceptual framework as suggested in Chapter 2. Educational technology researcher and designers should understand the complexity of teaching with technology through a holistic understanding of teaching and learning theory underpinnings relating to technology (Lim & Chai, 2011)

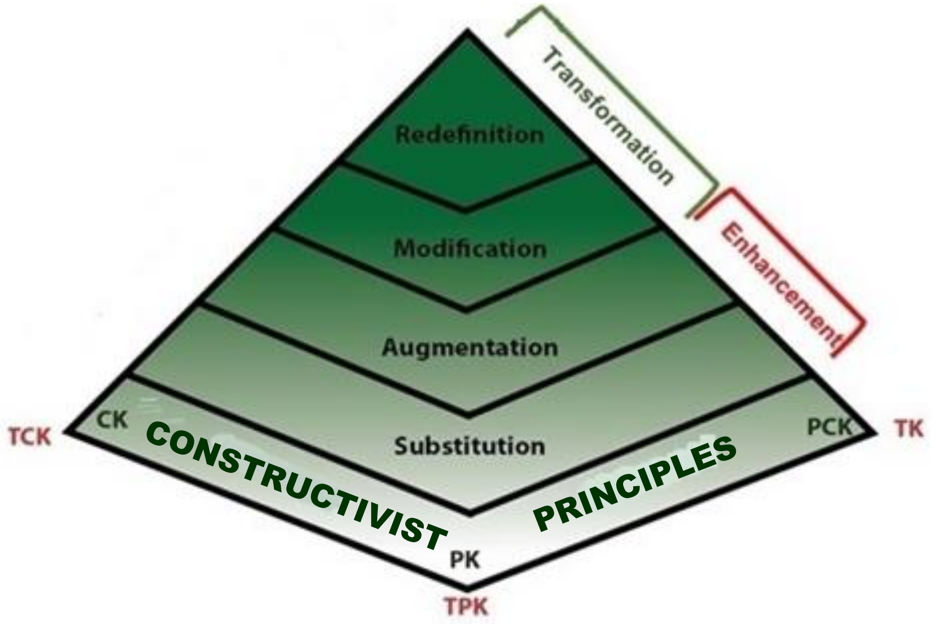

Figure 3.3: Conceptual Framework guiding the study

Figure 3.3 above is the researcher's visual illustration of the study's conceptual framework as informed from the reviewed literature in Chapter 2. The framework is presented in a pyramid that has the constructivist philosophy as the foundation on which the technology integration frameworks stand. The TPACK teaching knowledge constructs are represented on each side of the hexagonal pyramid which is split into the four levels of SAMR. This study focuses specifically on the TK, TPK, TCK and TPACK, the teacher educator teaching with technology knowledge move up with a constructivist underpinning up starting at substitution through to redefinition level reaching to the fused TPACK at the apex of the pyramid.

In this study, the teaching with technology phenomenon begins by conscientising and empowering TrEds to be digital enablers who will use constructivist theory and technology integration frameworks in this case the TPACK and SAMR models. This correlation exceeds teacher professional preparation knowledge and involves technology-oriented critical thinking that assists TrEds to gain deep knowledge on how to apply teaching with technology in the 21C supported by authentic problem-solving techniques. This study delineates the study's conceptual framework which highlights the stages through which TrEds progress in their teaching with technology practice, however, the progress is not linear as TrEds may constantly move between the levels.

Integrating constructivist-teaching strategies with technology integration frameworks is one way of providing educators with 21C digital instructional strategies for effective teaching in the 21C. This conceptual framework provides essential insight that can change how educators view and integrate technology. For example, mobile phones are good enough for doing a research project where students can take photographs of site on a field trip, but they are not appropriate for doing a class PowerPoint presentation.

TrEds’ technology knowledge and their ability to integrate it into their teaching and learning has become the centre of current research focus. Ertmer (2005) in her study reports that technology has become an integral part of providing a quality education in the 21C. In this case, teaching with technology goes beyond the use of technology per se, but it is the creation of relationship between teaching learning theories and technologies. Teaching with technology changes the traditional role of the TrEd (refer to Chapter 2). Chapter 2 outlined 21C TrEd four roles, design 21C environment, modelling 21C teaching experience, coaching & mentoring and scaffolding 21C learning experiences. However, these roles require TrEd specific teacher knowledge based on constructivist pedagogical content knowledge integrated with technological knowledge.

TrEds effective teaching with technology is defined as those who employ technology in student-centred constructivist compared to those who use lecture-centred teaching approach. Constructivist teaching engages students in active, authentic activities in collaborative approaches (see Chapter 2), in which students use technology to engage with content and peers, prompting them to apply higher level 4C skills. This is attributed to technology’s affordances that provide students with resources to actively construct new knowledge and eventually own it (Ashe & Bibi, 2011).

Kong and Song (2013) indicate that teachers have difficulty with integrating technology with constructivist practices because of the complexity and differences from more traditional instructional practices. In a technology-rich constructivist classroom the teacher provides authentic learning challenges, a variety of learning resources, fosters creativity and critical thinking, and encourages collaboration (Keengwe, Onchwari & Agamba, 2014).

3.3 Explanation of the conceptual framework

The study's conceptual framework illustrates the need for TrEds to understand the complexities of teaching with technology instructional strategies in the 21C. By offering a combined view of a knowledge base needed for effective technology-enhanced teaching strategies and the various levels for technology integration.

As highlighted in Chapter 2, the TPACK framework helps TrEds to understand relationship of technology, pedagogy and content for the integration of technology into teaching. However, it does not offer TrEds with an outline of the developmental levels that they need to go through to effectively teach with technology. Furthermore, because the TPACK framework was developed from the PCK, this implies that it was conceived from the traditional lecturer-centred teaching strategies. Therefore, TPACK is used to provide opportunities for TrEds to integrate context, content and teaching strategies as part of teaching with technology in the 21C.

On the other hand, SAMR provides some guidelines on what can be done with technology, on which TrEds can structure teaching with technology activities. Although the SAMR is limited in terms of guidance on what should be done to transform the teaching and learning tasks. The SAMR model could be used to identify and evaluate technology integration that was planned and determine the level of technology use as informed by the framework. TrEds could modify their teaching strategies to move towards transforming student-centred levels of the SAMR continuum, thereby demonstrating more of a facilitative role of the educator as opposed to that of lower levels enhancement that is viewed as lecturer-centred.

Therefore, the conceptual framework, with its theoretical foundations and technology integration framework influence, brings awareness to how teaching with technology should be approached in teacher preparation programmes. It emphasises the need to implement student centred teaching strategies and pairing them with well thought out technology integrated learning activities.

TPACK is the base because it is the fundamental that must be present for integration to start – it is also that which attends to teaching with technology – then that SAMR progress from this base from basic to complex levels of integration – hence…that why the framework is depicted as a pyramid and the two constructs are placed.

3.4 How the conceptual framework is guiding the study

The conceptual framework provides the scope from which to explore and understand TrEds' teaching with technology practice. It helped to structure the interview questions as well as the observation guide used for data collection. The framework gave the context in which to make sense of the data collected as well by considering the technology enhanced teaching strategies used by TrEds. These strategies were studied to see if they were aligned to any teaching theories as well as technology integration models suited for the 21C. The researcher, guided by the framework, sought to identify how the TrEds were combining their technology knowledge with their pedagogy and content knowledge to design student-centred learning activities.

3.5 Chapter summary

This chapter discussed in detail the three central axial constructs guiding this study.

1. The constructivist student-centred approach was a first consideration to help understand the contemporary learning approaches that empower students develop the 21C skills. Student-centred learning emphasises skills and practices that enable life-long learning and individual or team problem-solving approaches.
2. Second, the focus of TPACK on 21C teacher knowledge domains was emphasised for effective classroom practices. According to Koehler and Mishra (2006), effective digital technology enhanced teaching for an effective teaching is achieved through interrelating technology, pedagogy and content knowledge; bearing in mind the contexts of the students.
3. The SAMR model was discussed as it posits TrEds' progressive levels of technology adoption and how they apply it to create tasks

The combination of the constructs; constructivism, TPACK and SAMR facilitated a conceptual framework for understanding and exploring TrEds teaching with technology. the conceptual framework assisted the researcher searching for literature, and analysing the findings. Digital pedagogy may be the concept that can encompass many so far disparate areas of speciality.

In conclusion this conceptual framework will be used for analysing of the data.

Chapter 4 will discuss the methodology used in the study.

CHAPTER FOUR

STUDY METHODOLOGY AND DESIGN

4.1 Introduction

The research study explored TrEds' teaching with technology in the 21C. This chapter outlines the process used in the study to design, collect and analyse data for answering the study questions. It explains and justifies the method used in this study. The researcher presents the various steps and design decisions made in conducting the study, such as the description of the site, sample and participants; data collection procedures and data analysis process. The critical issues of researcher's positionality, trustworthiness and ethical considerations will be addressed.

The researcher designed a qualitative research study which used an exploratory case study to investigate TrEd teaching with technology practises. The research study's philosophical orientation was located in the interpretivist paradigm for a more subjective understanding of TrEd practises. Multiple sampling methods were employed in participant selection and data collection was completed using multiple instruments. Data analysis was conducted from both inductive and deductive perspectives.

This chapter is divided into the following main sections:

Section 4.2 Philosophical orientation

Section 4.3 Research Methodology for the study

Section 4.4 The research design

Section 4.5 Site and participants

Section 4.6 Data Collection

Section 4.7 Data analysis

Section 4.8 Trustworthiness

Section 4.9 Ethical consideration

Section 4.10 Limitation of the study

Section 4.11 Chapter Summary

4.2 Philosophical orientation

A lucid and appropriate philosophical orientation helps researchers to comprehend the way in which data about a certain phenomenon should best be gathered, analysed and used. In order to understand TrEds' teaching with technology, the selection of an appropriate research approach was required. This section therefore explores several philosophical paradigms and substantiates the one selected for the purposes of this research study. There are a number of paradigms available to select from including the following: positivism, post-positivism, critical theory and interpretivism.

The positivist paradigm is of the notion that there exists a single objective reality which can be observed, understood and explained mathematically to point to and ascertain a cause and effect relationship (Lincoln & Guba, 1985b). The positivist approach seeks to make use of scientific approaches to understand human behaviours, it is more experimental in nature (Ryan, 2018). This approach results in a more quantified approach of analysing and explaining human behaviours. The principle here is that knowledge is only that which can be observed and or measured (Kivunja & Kuyini, 2017). The goal of this paradigm is to systemise findings into tentative patterns and theory (Ryan, 2018). The paradigm has been criticised for its objective approach as it completely disregards the human element and its contribution to phenomena, it views them as being passive and having no effect on the external environment.

The post-positivist paradigm unlike its predecessor - positivist paradigm makes a slight turn from the purely objective stance towards a partially subjective approach to knowledge understanding (Ryan, 2006). However, post positivism is also of the stance that there is a reality that exists outside of our thinking that science can be used to study. This approach is therefore more of a mash of both objective as well as subjective elements. For the purposes of this study, the positivist and post-positivist approaches were considered lacking due to their complete or partial disregard of subjectivity in understanding of lived experiences. The researcher sought a more subjective approach which would consider individual perceptions as well as the social constructs that influence these.

The critical paradigm, based on a historical realism approach, carries the view that reality is shaped by social, political, cultural, economic, ethnic, and gender values (Guba & Lincon, 1994, p. 110). This paradigm takes an extremist approach towards social influences on human behaviour. It takes more of a rebellious stance by arguing the acceptance of realities that were previously deemed unorthodox by basing it on social, political cultural, ethnic and gender constructs (Danermark, Ekström, Jakobsen & Karlsson, 2001). For the purpose of this study, the critical paradigm has too broad a spectrum that may misdirect the focus of the study. While the research study looks into social influences, it considers this from a more professional ethos governed by regulations, i.e. the educational field, whereas the critical paradigm looks at the broader social construct that is all inclusive.

The researcher chose to design the research study on an interpretivist paradigm as being germane due to its subjective nature which allows for understanding of the lived experiences that take place out of the confines of scientific and calculated human behaviour analysis (Cohen, Manion & Morrison, 2011). Interpretivism is often linked to the opinions of Wilhelm Dilthey (1833–1911), Heinrich Rickert (1863–1936) and Max Weber (1864-1920) who suggested that human sciences are concerned with understanding contextual behaviour patterns, therefore, requires distinctive methodology. Interpretivists reject the claim that objective knowledge exists independent of the human element; stating instead that knowledge is subjectively constructed (Nguyen, 2015). The Interpretivists principle emphasises that all human actions are meaningful and have to be interpreted and understood within their social contexts. An interpretive paradigm presents reality as consisting of people's socially constructed experiences (Nguyen, 2015), its proponents, in turn, posit that to make sense of how knowledge is gained in a social world, researchers must understand the meaning shared within the social setting (Cohen et al., 2011). This suggests that interpretivists highlight the importance and impact of the social context upon participants' view of reality.

The proponents of this paradigm insist that a researcher should become familiar with participants' contexts in order to form a subjective understanding of social conduct. To answer the *'how'* and *'what'* questions in this study, the interpretive approach was deemed to grant a broader scope. It helps make sense of the decision process of TrEds in the application (*how*) of their various teaching with technology (*what*) practises The interpretivist paradigm employed in this study was guided by the way in which the research questions were framed; it is particularly important in understanding *how* TrEds experienced the phenomenon of teaching with technology in the 21C.

Interpretive paradigm assumes that reality is constructed inter-subjectively; through meanings and understandings developed socially and experientially (Tuli, 2010). The researcher made use of interpretive underpinnings to analyse and understand the TrEds practises based on their experiences. Tuli (2010) asserts that the purpose of an interpretive approach in educational research is to produce an understanding of the context and the process surrounding a certain phenomenon or question. In this case, the paradigm principles suggest that TrEd practices are influenced by their context, negotiated within organisational cultures, social settings and relations with other people in their context. In interpretive design, truth is negotiated and there can be multiple, valid claims to knowledge depending on how an individual has encountered a phenomena (Nguyen, 2015). This approach allows for the study of a phenomena from multiple perspectives. TrEds, based on varying factors, e.g. existing teaching knowledge, subject discipline etc., would experience teaching with technology differently.

In the context of this study, an interpretivist paradigm reflects a particular epistemological stance which allowed access to participants' context and exploring how it shaped their realities. This approach helped in contextualising the experiences of TrEds teaching with technology in 21C. The researcher examined these uniquely shaped realities in line with existing literature on teaching with technology in higher education; specifically, at teacher preparation institutions. Throughout this study, the researcher interprets participants' viewpoints about reality and relate them to literature as discussed in Chapter 2 and the conceptual framework elaborated in Chapter 3 on the phenomenon under study.

Interpretive perspectives facilitated and enhanced the researcher's understanding and description of the lived experiences and opinions of TrEds in terms of the phenomenon under study; on the basis of rich, contextual and detailed data (Creswell, 2003). The researcher gained rich data from a variety of perspectives, which emphasised the meaning and interpretive understanding of how TrEds are effectively teaching with technology in the 21C.

With the paradigm decided on, the researchers next step was to decide on the research methodology to employ that would complement the paradigm. The next section discusses available research methodologies and motivate the one selected for this research study.

4.3 Research Methodology

There are three predominant research methodologies: the qualitative, quantitative and mixed methods. Qualitative studies are defined as "an enquiry process of understanding … that explore social or human activity" (Creswell, 2007:5). Qualitative research is formed using words, reporting detailed views of informants, and are usually conducted in the participants' natural settings (Maxwell, 2008). Qualitative researchers prefer to study the world as it naturally occurs. Qualitative research methodologies align with the interpretivist paradigm due to their inquisitive and in-depth nature.

On the other hand, quantitative research is associated with positivist paradigms which tend to generate quantitative data and are concerned with hypothesis testing (Tuli, 2010). Quantitative methodologies seek to present data in a numerical fashion. It generalises findings by quantifying human behaviour it does not provide details into the influences of such behaviour (Ryan, 2018). Quantitative data collection leads to a statistical analysis of findings, which will mainly be presented in tables and graphs. The main shortfall of a quantitative approach is its disregard to detail, there is no in-depth analysis of studied behaviours. This creates cracks in the research design, where certain human behaviours that can't be observed and therefore quantified are not addressed. For example, a quantitative report may highlight high frequencies in the occurrence of a particular behaviour but fail to explain the underlying reasons to that occurrence.

In an effort to counter this discrepancy, others opt to combine quantitative with qualitative research methodologies. The use of a combined approach allows for a more in-depth look at statistical patterns and seeks to not only present them but explain them, giving a holistic approach to phenomena. Researchers call for a combination of research methods in order to improve the quality of research (Scotland, 2012; Babbie, 2013; Miles, Huberman, & Saldaña, 2014; Creswell, 2008). While other researchers like Benbasat, Goldstein and Mead (1987) state that no single research methodology is intrinsically better than any other methodology. The selection of a research methodology is mostly influenced by the aim of the research study and its key questions. The question is, does the researcher seek to freely explore a phenomenon as it naturally occurs, or do they want to measure it by manipulating its occurrence.

Since the aim of this research study is to explore TrEds teaching with technology strategies, it demands an in-depth investigation that looks into the phenomenon not only collectively but also from individual perspectives. For this reason, this study follows a qualitative methodology. Qualitative research studies the phenomenon in a context, therefore the researcher can have a better understanding of its occurrence (Denzin & Lincoln, 2011). Additionally, qualitative takes interest in processes, social context, and participants' perspectives of their world (Creswell, 1998:15).

Maxwell (2008) argues that a qualitative approach uses an inductive approach; making it effective to determine the deeper meaning of TrEds' experiences about the phenomena under study, in their real and natural contexts. Hammersley, (2007) however, refutes this statement by asserting that qualitative results are not easy to generalise due to lack of statistical analysis. However, qualitative researchers emphasise the occurrence of the in a specific context, therefore their main concerns are not on generalising the findings, but may use them to make assumptions and draw comparisons. The philosophical assumptions' underlying this study are derived mainly from an interpretive paradigm which helps to garner in-depth and rich data collection and analysis (Scotland, 2012).

Qualitative investigation allows careful and deep understanding of a complex situation by unravelling hidden experiences in a particular studied social context (Merriam, 1998). As indicated earlier, the purpose of this qualitative study focuses upon understanding socially constructed teaching with technology in the 21C phenomenon from the perceptions of TrEds. Qualitative research methodology was suitable for investigating the phenomenon in this study because the study focussed upon the world of TrEds and issues surrounding their role of teacher preparation on teaching with modern technologies.

The next section discusses the various qualitative research designs in detail and motivates for the one selected for this research study.

4.4 Qualitative Research design

Qualitative research categorises five different types of research designs: case study, ethnography, narrative, phenomenological and grounded theory. Commonalities among these qualitative methodologies exist: the central purpose of all of them is to enrich our understanding of the phenomena in question. The differentiating factor amongst them is research purpose, choice of data collection methods. It's important to note that although data collection tools are the same for all the designs, they are however employed differently for example, a researcher may choose to carry out observation by immersing themselves in a social context over an extended period of time, while another might conduct non-participatory observation over a shorter period (Creswell, 2007).

An ethnographer observes and interacts with a study's participants in their real-life environments. This research design mainly utilises observations and interviews. The researcher in ethnographic research becomes immersed in the research context as an active participant and uses extensive field notes as data source. In this case, observations take place over an extended length of time with the researcher being a part of activities. The interviews take place in an unstructured manner in that the researcher may interact and ask questions to the participants as events occur (Parker, 2005).

Phenomenology is concerned with exploring reality or truth as the participant experiences and perceives it (Pietkiewicz & Smith, 2012). This type of research design is centred around interviews conducted with individuals who intensively interact with the phenomena under study. The objective of this design is to get detailed understanding of a phenomenon by asking relevant questions to a conveniently selected group of participants who are identified as being knowledgeable of that construct.

Narrative and conversational analysis is concerned with describing the diction participants use during conversations, the patterns these conversations reveal and the social interactions performed during them (Blaxter, Hughes, Tight, 2010). This kind of research design can be carried out with as little as 1 or 2 participants and may also be carried out over a length of time, compiling in-depth information by studying and analysing individual stories or documents kept.

A qualitative case study is a descriptive or exploratory analysis of people, organisations, entities and or events in their natural setting. Other research designs focus mainly on individuals that interact with phenomenon of interest and the context in which this occurs. Case studies on the other hand, give the researcher the opportunity to also study an entire entity or organisations and how those effect and or affect the phenomenon. Case studies also allow the researcher to make use of a variety of data collection tools including interviews, observations, documents and reports.

Due to the interpretive nature of the research and the aim of this study, the case study design was found to be an appropriate approach as it offers a systematic way of exploring issues, collecting data, analysis of information and presentation of the results (Yin, 2013). A case study focuses on the experiential knowledge of the participants and the impact of social and context influences. Case studies offer a broader approach that allows an insight not only on human influences to phenomena but looks at other influences such as critical events and institutional influences as well. Therefore, this helps the researcher to holistically and meaningfully understand the experiential knowledge and brings the readers as close as possible to the experience being explored (Yin, 2013). The case study design is a useful approach in exploring teaching and learning in higher education environment (Ibid). He further indicated that the strength of case study is its flexibility in terms of the research question that the researcher can use. Case study addresses questions such as *how* and *why* with the researcher having no control of the events but focusing on the phenomenon within an authentic context.

In a case study, the researcher has the option to study multiple cases, however, for this research study the researcher opted to study a single case i.e. TrEds in a selected faculty of a specific Institution. The rationale of studying a single case was to focus time and resources on the one specific context, in order to gain an in-depth understanding of TrEds' teaching with technology strategies in teacher preparation programmes. According to Bryman (2016), one criterion of choosing a case is that it should provide a suitable context that provides answers to the study's questions.

There have been suggestions on different types of case studies using different classifications. Stake (2005) classifies case study based on case selection, i.e. intrinsic, instrumental or collective case studies. Intrinsic case study is when the case is used to learn a particular phenomenon, an instrumental case study is used to develop a general understanding of a phenomenon and a collective involves the collection of several cases and is viewed as an extension of instrumental case study. This study employs the instrumental case study design with the aim to come down to a general yet in-depth understanding of teaching with technology strategies in teacher preparation programmes.

Yin (2013) suggests three types of case studies that relates to the purpose of the study i.e. exploratory, descriptive and explanatory. The exploratory case study, according to Yin (2013:141), aims at building "…a hypothesis-generating process to develop ideas for further study…", whereas the explanatory presents data casual relationships and descriptive case study provides a complete contextual description of a phenomenon. This current study therefore employs an exploratory and descriptive case study as the researcher is investigating a distinct phenomenon that lacks detailed researches and offers a viable teaching with technology framework. The exploratory case study allows the researcher to gather in-depth information from the case, which complements the instrumental case study adapted in this study.

The critics of case study question its context-dependent nature; they claim that this brings in bias and preconceived ideas as well as its inability to generalise the findings. However, Flyvberg (2006) offered some strong arguments in response to the critics. Responding to the question on generalisation of a phenomenon, he argued that this is the nature of case studies – humans tend to self-reflect and respond to social issues differently therefore the issue of generalising should not be a deterrent to make use of case studies. Bryman (2016) alludes to issue of contextual perspectives in which one may attribute meaning to an event and its environment, which is not so for natural scientists who opt for scientific and statistical application of data. Furthermore, Stake (2005) and Shenton (2004) also responding to the argument state that while each individual case study is considered unique, each is an example (not a reflection) of a greater population, therefore, can form an element of the population.

In response to the question on context-dependant, Flyvbjerg (2006: 221) asserts that the case study produces the type of context-dependent knowledge which allow researchers to develop from 'rule-based beginners to virtuoso experts'. He further argues that the outcomes of context-dependent knowledge research on learning proves to be necessary in allowing people to develop in-depth understanding of the participants in their natural setting and produces more concrete authenticity of the phenomenon under study.

Flyvbjerg (2006) in response to case study tendency toward bias and verification of researchers preconceived ideas, argues that case studies follow rigorous process just like quantitative studies do. For example, researcher uses multiple methods to collect data, and further follows rigorous validation techniques such as member checking, confirmation of reports made. He further argues the view of being in the context and directly test views as they occur is the major advantage of case studies. The trustworthiness and authenticity of this study is discussed in section 4.8.

To sum up, this study uses a case study research design. Which is classified as an exploratory case study in an instrumental approach. This case study therefore seeks to provide a holistic in-depth analysis of TrEds teaching with technology in the 21C, therefore helping to answer the study's research questions. The next section describes the study site setting and the selection of the participants.

4.5 The research site and participants selections

This section, gives an overview of the research site where the study was conducted. The participant selection process will also be presented.

4.5.1 The selection of research site

The site for the study was a teacher preparation faculty at a University of Technology in the Western Cape Province. The faculty in which this research study took place was deemed ideal in that it produces the highest number of pre-service teachers in the Western Cape province. It was the researcher's assumption that the site being a university of technology would provide the necessary technological infrastructure to effectively study the integration of technology in teaching and learning. The researcher is a fulltime candidate at the site of the study which was an added advantage in terms of convenience with regards to saving time and cutting travelling costs. The participating TrEds were therefore at close proximity to the researcher. This meant that the researcher had enough time with participants and was flexible with any schedule arrangements. The fact that the researcher was a familiar face, made it easier for the participants to open up with regards to their experiences. This familiarity ensured trust and honest insights from the participants (see 4.5.2.1). Furthermore, the researcher was familiar with the research site, this made it easier to approach participants in their natural setting and allowed the researcher a detailed contextual background.

4.5.2 Sampling

This section elaborates on the sampling methods used in participant selection as well as a breakdown of the studies participants and their characteristics. The unit of analysis of the study was TrEds, however, pre-service teachers were interviewed for validation of data collected. The sampling methods used were influenced by the need of the study, which was to collect in-depth data with regards to the phenomenon.

4.5.2.1 Sampling methods

Sampling refers to the selection process in extracting a representative portion of a population to participate in a research study (Cohen et al., 2011). Qualitative research studies typically employ purposive sampling methods.

Initially the researcher made use of convenient sampling technique which is a method that relies on data collection from population members who are conveniently available to participate in study (Elfil & Negida, 2017). In order to find willing participants, an email survey was sent out to sixty-three possible participants in the targeted faculty of which twenty-two responded. To counter the issue of low credibility which is associated with convenience sampling the researcher further used purposive sampling also known as subjective sampling. It is a non-probability sampling method that selects participants from a population based on specific characteristics that meets the objective of the study (Kumar, 2011). The researcher made use of this sampling technique to identifying twelve TrEds who indicated in their response that they frequently made use of technology in their practice. The power of purposive sampling is that it provided the researcher with information-rich participants that affords an in-depth data collection and analysis. Merriam (2002) emphasises that “purposeful sampling is based on the assumption that the researcher wants to understand and gain insight, therefore must select a sample from which the most can be learned.” In this case, all participating TrEds were at some level, making use of technology in their practice.

From the twelve TrEds, five participate pulled out of the study before data collection commenced. One of the participating TrEds, during the initial interview phase, referred a colleague to participate in this study, which the researcher welcomed. The referred TrEd fitted the criteria as indicated that they indicated using technology in their teaching and that they were trained on technology integration. This particular participant came through what is usually termed snowballing. Snowballing is considered is a nonprobability sampling technique where existing study subjects recruit future subjects from among their acquaintances (Cohen et al., 2011).

The eight participants were sufficient for this study as they all met the criteria. Yin (2009) noted that due to the nature of the case study approach, "the typical criteria regarding sample size are irrelevant." Yin (2009) suggests that the researcher should rather focus on getting information on the various aspects of the case. Additionally, Creswell (2013) notes that in reality, getting diverse perspectives on the phenomenon under study is possible even with a small group of participants and called this sampling process, 'purposeful maximal variation'.

4.5.2.2 Participating Teacher educators

Eight TrEds comprised the participants of this study. These TrEds were involved in teacher preparation programmes at the research site. The participating TrEds comprised of:

i. Three content knowledge educators,

ii. Two teaching professional studies educators and

iii. Three educational theories educators

Content Knowledge Educator

Content Knowledge Educator (CKe) is a subject matter expert with in-depth content knowledge in a particular discipline area. These TrEds specialise in a specific content area, for example, Natural Science educators, Mathematics educators, Computer Science educators etc. The CKe is proficient and has strong knowledge in their content area therefore can prepare pre-service teachers with accurate content knowledge required for teaching (Kolb, Kold, Passarelli & Sharma, 2014). In other words, they facilitate mastery of content knowledge. Their duty is to demonstrate and impart the content knowledge of their discipline to the pre-service teachers. Since this research study focused on the TPACK construct, it benefited from having a CKe as a participant as they gave insight on how they appropriate content specific digital pedagogy in their content areas. Further, the study of how they applied their knowledge contributed in understanding how they design technology enhanced learning activities.

Professional Studies Educator

Professional Studies Educator (PSe) prepares pre-service teachers on the know-how of teaching as a profession. Teaching profession knowledge includes the following: (i) Educational Management and Leadership (ii) Curriculum Studies (iii) Education Law and (iv) Comparative Education. In a professional studies programmes, the pre-service teachers are exposed to the teaching profession knowledge from various educational systems. It also develops their knowledge of relevant legislation and how to design and implement teaching plans for targeted teaching and learning outcomes (Shulman, 1987; Koehler & Mishra, 2009). To the relevance of this study, PSe contributed first-hand information on they integrated technology to prepare pre-service teachers in various aspects that pertain to the teaching profession. The researcher studied whether the use of technology was informed by the various aspects of teaching profession knowledge.

Educational Theory educators

Educational Theory educators (ETe) are experts in the foundational knowledge of the educational History, Philosophy, Psychology and Sociology. They are education experts in the theories of learning that illustrates how information is absorbed, processed, and retained during the learning processes. The role of ETe includes interpreting the goals and meaning of education, what is the nature of knowledge; how learning takes place; in the endeavour to unify purpose of education, curriculum, and pedagogy (Scott, Gentry & Virginia, 2014). ETe informed this study on how they were implementing digital pedagogies as informed by past events their beliefs systems and understanding of cognitive and social influences on teaching and learning.

To sum up, the use of purposive sampling enriched the research study by helping select TrEds with knowledge and expertise that were relevant to the aspects of this study and its constructs. The participating TrEds offered first-hand information based on their day-to-day interaction with the phenomena of interest thereby contributing to the trustworthiness of the data collection and analysis. The following section refers to pre-service teachers participating in the study.

4.5.2.3 Pre-service teachers' selection

In order to ascertain if TrEds and the institution were effectively preparing pre-service teachers to teach with technology, a focus group discussion of fifteen (15) final year preservice teacher students who consented to participate were included in the study. It is important to note that the pre-service teachers were not the unit of analysis in this study and were therefore interviewed only to validate collected data. They were randomly selected to validate what the TrEds' said about teaching with technology practice in teacher preparation programmes. The selection process was done from a professional studies class because it has students from across disciplines. All the pre-service teachers picked a number from a hat and the ones who picked a selected were allocated to take part in the focus group interviews. These pre-service teachers' role in this study was not major as they were not the unit of analysis – TrEds. The use of pre-service teachers was only to validate TrEds practices thereby providing a holistic view and in-depth understanding of teaching with technology in teacher preparation.

Table 4.1 A summary of participating TrEds profiles

Code	Qualifications	Years of teaching experience	Phase	Subject
TrEd001	Doctorate	30	ISP	CKe
TrEd002	Doctorate	15	FET	CKe
TrEd003	Professor	39	ISP	PSe
TrEd004	Doctorate	25	ISP	PSe
TrEd005	Doctorate	32	FET	ETe
TrEd006	Masters	13	FP	PSe
TrEd007	Masters	21	FET	CKe
TrEd008	Masters	10	FP	ETe

Table 4.1 highlights participating TrEds profiles data generated from interviews. The table shows the qualifications, years of teaching experience – these included both Higher Education (HE) and basic education teaching experience. The table further shows the teaching phases that each TrEd is working from. FP and ISP are Grade – 9 and FET phase is designed for grade 10 – 12. Lastly, the table highlights the subject specialisation of each participating TrEd. This demographic data provided the researcher with insight into the composition of participating TrEds', however the data was not used for any analysis.

The next section presents the study's research methods, instruments and data collection processes.

4.6 Data Collection

As indicated earlier, the study sought to explore and understand TrEds' experiences and perceptions of teaching with technology in the 21C. The current study used multiple methods of data collection for triangulation purposes i.e. online survey, interviews, lecture observations and FGI in order to explore and understand how TrEds integrate technology in their teacher preparation programmes. This section discusses in detail the methods used for gathering information for the study and why they were used. Each of these research methods are separately explored in the following sections.

4.6.1 Data collection and instruments

This section discusses the data collection methods and instruments used to help solicit data from the participants. The researcher gives rationale for each method and instrument employed in this study.

4.6.1.1 The online survey

An online survey is a computer questionnaire that the targeted audience can complete over the Internet. The online survey was deemed useful as it provided the opportunity to reach a wide variety population pool with ease (Alahmari & Kyei-blankson, 2016). The online survey questions were adapted from the questionnaire originally developed by a team of researchers (Schmidt, Baran, Thompson, Mishra, Koehler & Shin, 2009) to measure preservice teachers' self-assessment of their TPACK and related knowledge domains included in the framework. The researcher selected this instrument as an initial sampling tool to conveniently identifying TrEds that would be potential participants for the study as well as to foresee the applicability of the study in the current context. The instrument was ideal as the questions related to TrEds teaching with technology practices. Creswell (2007) emphasises the importance of selecting appropriate candidates for interviews (see Appendix D). Therefore, the data collected in this survey was not analysed to draw any finding for this research, as it was merely a sampling tool.

A draft of the survey link was shared with two TrEds to ensure the clarity of the questions on the instrument. It is important to note that this was not a pilot study as no data was collected and analysed from this exercise, the TrEds were used to test the tool in terms of comprehension and clarity of instruction (Ryan, Gandha, Culbertson & Carlson, 2014). The survey used a 5 point Likert scale. A Likert scale is often used to measure respondents' attitude by asking the extent to which they agree or disagree with a particular statement (Heimann, 2015; Alahmari & Kyei-blankson, 2016). The researcher adapted one from other studies that were measuring aptitude of using digital technology in teaching (Schmidt, Baran, Thompson, Koehler, Mishra, & Shin, 2010). The survey was generated using survey monkey, which is a web form with a database that stores participants' responses and provides an analysis of the responses. The survey questionnaire was intended to explore and understand TrEds' level of TPACK. Sixty-three TrEds from the GET and FET bands received the survey link via email and only twenty-two responded. TrEds' responses were automatically stored in the provider's database, therefore easily accessible to the researcher. The survey results were used to identify TrEds who were using digital technology in their teacher preparation programmes.

The first page of the survey consisted of the information sheet with relevant explanation of the study and the researcher's contact details as well as TrEds' privacy declaration. The TrEds were given an assurance that the information sought was going to be used for this specific research studies only. Pressing next button was an indication of their agreement and consent. They were informed that they could exit the survey at any point and were further advised that they could not retract submissions already made. The option was made available to the TrEds to backtrack to erase or change erasing their responses before closing and or submitting the questionnaire. Although their identities were kept anonymous, the TrEds were asked to indicate whether they were willing to participate in the main study, this was made mandatory question.

The survey questionnaire (Appendix D) consisted of four main sections;

TrEds' awareness on availability of digital technology resources at the institution

TrEds' general technology skills and usage

TrEds' use of digital technology in their lecture delivery

TrEds' TPACK understanding

The questions on the survey were formulated with the conceptual framework of the research study in mind. Survey monkey has an analysis tool that graphically represents each question on participants' responses which enabled the researcher to conveniently identify appropriate participants. The online survey was beneficial in its ease of administration as it was easily accessible to targeted TrEds as well as providing an analysis of responses to the researcher for convenient decision making.

4.6.1.2 One-on-one semi-structured Interviews

An interview is a qualitative technique that is a valuable method of gaining insight into people's perceptions, understandings and experiences of a given phenomenon and can contribute to in-depth data collection (Jackson, 2013). Conversation is a basic mode of human interactions, therefore using interviews is a move away from obtaining knowledge through external means towards an understanding by means of engaging with the participants to be understood (Blaxter et al., 2010). In qualitative research, interview involves an interviewer, who coordinates the process of the conversation and asks questions, and an interviewee, responds to the questions. Yin (2013) mentions that interviews are essential sources of information in case studies. Interviews are classified into three main structures: structured, semi-structured and unstructured.

Structured interviews use predetermined questions that the researcher will ask, with few or no variation and no follow-up questions that seek elaboration from participants. Therefore, structured interviews are relatively quick, though they lack in-depth that is afforded by follow-up or probing questions (Turner, 2010). This study does not employ structured interviews due to their rigid nature. They would have no room to ask for clarity on certain responses that may not make sense or are unclear. The researcher in an unstructured interview is more of a facilitator and adds no advantage to the data collection process.

On the other hand, unstructured interviews do not have pre-conceived notions, hence the interviews are conducted with very little to no structure (Cropley, 2015). Consequently, due to of its lack of planning and structure they are time-consuming and difficult to manage (Cohen, Manion, & Morrison, 2007; Knapik, 2006). The researcher, when making use of unstructured interviews has no control on how the conversation may unfold since there are no questions that are designed to direct the participants. The researcher may end up with a range of information that may not be useful to them. However, this setback is frequently overlooked for the advantage unstructured interviews afford which is that they allow for an in-depth introspection of the phenomena of interest.

Whilst semi-structured interviews consist of key questions they allow the interviewer room to probe and make follow-up questions to seek clarification on an issue (Cropley, 2015). Semi-structured interviews are flexible and are open in that both the interviewer and interviewee can engage in conversation to elaborate issues of interest (Cohen, Manion & Morrison, 2011). This flexibility enables an ‘in-depth’ data collection as the interviewer can explore the views and experiences that are important to the study.

In this study, semi-structured interviews were used for collecting qualitative data to allow for a 'deeper' understanding of phenomena under study (see appendix E for the instrument). Semi-structured interviews were used because the researcher sought to retain some control on the direction of their interviews without limiting responses. The main purpose of the one-on-one interviews was to obtain an in-depth exploration and understanding of how TrEds prepared pre-service teachers to teach with digital technology. A face-to-face (F2F) semi-structured, in-depth interview was conducted with each of the eight TrEds from the teacher education faculty. A semi-structured Interview was chosen because it allows the interviewer to probe in order to pursue a response in detail (Thomas, 2010; Babbie, 2013). Bates, Droste, Cuba and Swingle (2008) state that semi-structured interviews captures interviewee's personal perspectives and first-hand experiences. The advantage presented by conducting a F2F interview is that the researcher can simultaneously work on the interview as well as observe body languages which may be recorded and used for data analysis and interpretation. In a semi-structured interview, the researcher may ask questions or make certain adjustments in response to the observed demeanours.

The aim of conducting one-on-one interviews was to seek information on teaching strategies TrEds use in preparing pre-service teachers to teach with digital technology in the 21C. The researcher used the conceptual framework as provided in Chapter 3 to design the interview guide (refer to Appendix E).

The semi-structured interview guide consisted of open-ended questions to help structure; guide interview conversations and seek further explanations. Turner (2010:756) states that "open-ended questions facilitate a free flow of conversation and establish a comfortable rapport between the interviewer and interviewee in a research." In a semi-structured interview, the interviewee responds by giving the facts of a matter, as well explaining further by giving their opinions on the facts under discussion. Cropley (2015) suggests that an interviewer may invite or probe the interviewee to elaborate their opinion on a phenomenon which the interviewer may use for further inquiry. For this study the use of semi-structured interviews in this manner created a situation whereby the interviewee became more of an informant, therefore, at times they did not directly respond to the questions but rather opened up to share their personal opinions on the matter.

This open conversation allowed the researcher to make an informed assessment of the participant's opinions and approaches to the phenomena under study. McMillan and Schumacher (2001) clarify that an in-depth interview is considered as a purpose-directed conversation. Questions are formulated around topics and issues to be covered, these are selected in advance and set out in a semi-structured interview guide, participants were encouraged the freedom to narrate what they felt was important and relevant to the study (Bates et al., 2008). In other words, the researcher used a set of questions prepared in advance to conduct the interview, but was not limited to that set of questions or the same wording for all interviews. The semi-structured guidelines consisted of a number of loose and open-ended questions to illicit a deeper discussion on a topic.

Interviews with TrEds were conducted in English and were carried out in the participants' places of work, at a time convenient to the interviewee for an average length of forty minutes (see Table 4.2.) TrEds were provided with a detailed information sheet, a consent form and the interview guide. Permission to audio-record was sought before the interviews started. The audio-recorded interviews were transcribed verbatim for analysis. During the interview, the researcher made systematic observations of body language and other non-verbal gestures, which are used during the interpretation of data.

Considering the research study was designed on an interpretivist paradigm, the interviews allowed for the researcher to get detailed information on TrEds integration of technology in their practises. The interview process gave the researcher an insight on TrEds thought processes, as well as the social influences and experiences on which the thought processes were built. The interviews allowed the researcher to probe and get more information to help understand the phenomena in question.

In this study, the in-depth one-on-one formal interview was the primary data collection strategy. In order to minimize the effects of any biased responses, whereby the TrEds may have reported what they did not necessarily practise, the researcher triangulated the interview discussions by conducting naturalistic participant observation. In the next section participant lecture observations are discussed.

4.6.1.3 Lecture observations

Observation is a research method that is used when a researcher wants to visually witness participants behaviour, reactions and practices as they occur in their natural context (Creswell, 2014; Cohen et all., 2011). The researcher in detail writes down comprehensive field notes during the observations. To triangulate the participants' subjective interview reporting, the researcher employed a naturalistic observation of the "phenomena understudy in the environment where it naturally occurs using unobtrusive means" (Chitiyo, Tauken & Chitiko, 2015: 282). This is because participants may behave differently from what they say in interviews or surveys.

Observations are classified into participant and non-participant observations. Participant observations entail a situation in which the researcher is immersed in the social setting in order to observe the targeted participants and elicit meaning from their behaviours. For the purpose of this study, participant observations were not used due to the risk of researcher losing control of the focus of the study. There is also no structure which may result in extended time frames. On the other hand, in non-participant observation, the researcher does not participate in what is happening within the social setting, but quietly sits, observes and takes down notes.

Non-participant observation data collection method was used extensively in this study with the purpose of enhancing the credibility of data collected. The researcher intended to gain a direct understanding of the phenomenon in its natural context (Pietkiewicz & Smith, 2012). The researcher's ability to develop a strong relationship with TrEds, not only increased level of access that the researcher obtained, but it also deepened the insights gained from their world views (Creswell, 2007; Callary, Rathwell & Young, 2015). As a non-participant observer, the researcher overtly observed how TrEds were preparing pre-service teachers to teach with technology; noting the strategies and the available resources used to uncover factors important for a thorough understanding of the instructional strategies (Lock & Redmond, 2010).

Cohen et al. (2011) distinguish two types of observations, structured and semi-structured. In a structured observation, the researcher knows in advance what behaviour that will be observed and uses a pre-determined check list. On the other hand, in a semi-structured observation, the researcher is aware of issues to observe, however, the observation is conducted in a more loose and open manner, allowing for the observation of unforeseen issues that either effect or affect the phenomenon of interest. In the current study, the researcher used semi-structured, non-participant observation. The objective of the observations was to confirm what TrEds reported during the interviews by observing how they employed teaching with technology. Of interest to the researcher were factures such as available technological resources, physical classroom setups and teaching strategies (see Appendix E and F).

The researcher primarily took a tour of the research site in an effort to gain perspective of the context in which observations would be conducted. During the tour the researcher used a guide to record the various venues and technology resources available to TrEds (see Appendix D). This exercise aligns with the interpretive paradigm that emphasises the importance of context in which a phenomenon occurs. With an understanding of the layout of the context, the researcher commenced lecture observations.

To record activities observed during lectures the researcher made use of the observation guide (see Appendix E), which was developed using the study's conceptual framework (see Chapter 2 and 3). The observation guide included the teaching strategies that TrEds indicated during the interviews, which were observed in relation to TPACK and SAMR constructs. The observation guide had a note section for each teaching strategy to record any activities related to that strategy but not necessarily relating to TPACK and SAMR constructs. A general note section was included to record activities or incidences of interest that did not directly relate to the teaching strategies under observation as facilitated by semi-structured observation.

The objective of conducting observations was as a follow-up to the one-on-one interviews to ascertain if the practice in the natural environment mirrored the interview reports. The researcher set-up schedules as per the TrEd's teaching schedule and made appointments prior to the visit. The TrEds were made aware of the purpose of the study and that they were being observed. A possible drawback to this approach is TrEds implementing technology-enhanced instructional strategies for the purpose of the observation lecture which may not necessarily be their usual practice. However, to reduce the effects of this drawback, the researcher observed each TrEd multiple times (an average of 5 times) with each lecture ranging from 45 to 90 minutes, over a substantial period of time (eight months).

Table 4.2: A summary of data collection

Code	Phase	Subject	Interviews duration	Number of Observation sessions
TrEd001	GET	CKe	50 minutes	4 sessions
TrEd002	FET	CKe	45 minutes	None
TrEd003	GET	PSe	45 minutes	6 sessions
TrEd004	GET	PSe	40 minutes	None
TrEd005	FET	ETe	45 minutes	6 sessions
TrEd006	FP	PSe	60 minutes	None
TrEd007	FET	CKe	38 minutes	5 sessions
TrEd008	FP	ETe	55 minutes	None

Table 4.2 summarises the data collection sessions and their durations. TrEd002, TrEd006 and TrEd008 where not actively teaching during the observation scheduled times. TrEd004 did not consent to be observed citing personal reasons. An average of 5 observations were conducted.

To further confirm TrEds interviews report and researcher's observations, a Focus Group interview (FGI) with 15 pre-service teachers in their final year pre-service teachers was conducted. The next section presents an exploration of this endeavour.

4.6.1.4 Focus group interviews (FGI)

FGI is a data collection tool typically used for qualitative research. This kind of interview is conducted with a group of selected individuals in order to investigate their opinions or perceptions about a particular topic (Thomas, 2010). Similar to one-on-one interviews, FGI may also be structured, semi-structured and unstructured. This study employed a semi-structured approach as it allowed for an interview environment that was interactive whereby participants freely aired their shared or differing opinions on the given topic.

The FGI were used to validate the data collected from both interviews and observations. This was accomplished by investigating the views and feeling of the pre-service teachers on their digital pedagogy preparedness (Ryan et al., 2014). This dynamics social interaction provided a deeper and richer understanding of TrEd practice as perceived by pre-service teachers (Eatough & Smith, 2007). The FGI questions were formulated based on the conceptual framework of the study. It used semi-structured open-ended questions which allowed interviewees to express themselves and stayed focused on the issues at hand. Eatough and Smith (2007) further note that this type of interview uses time efficiently.

The final data collection was the use of observations as a means to ascertain TrEd technology integration added to the researcher's in-depth understanding of TrEd teaching with technology practice. This method gave insight on how TrEds implemented technology enhanced teacher preparation in the 21C. The researcher was able to collect evidence that would triangulate TrEd accounts as reported in the one-on-one interviews. The FGI complemented data collected as it would either confirm or debunk, not only the TrEd accounts but also the researcher's observations.

The next section presents how the researcher organised, interpreted and identified patterns in the collected data in line with the research questions.

Table 4.3 The data collection methods used to answer the research questions

Research Question	Research method
1.1 What instructional strategies do TrEds currently employ when preparing pre-service teachers to teach with digital technology in the 21C?	Interview Observations
1.2 How are TrEds currently implementing the technology-enhanced instructional strategies in preparing pre-service teachers to teach with digital technology in the 21C?	Interview Observations FGI
1.3 What technology integration models are TrEds at the study site using for effective teaching with technology in the 21C?	Interview Observations

4.7 Data Analysis

Data analysis is defined as a process of bringing order, structure and meaning to the collected data (Biggerstaff & Thompson, 2008). It is a messy, ambiguous and time-consuming, yet, essential and fascinating process (Culén, 2010). Analysing qualitative data is a challenging task, because qualitative methods generate large volumes of rich data, which can be overwhelming and difficult to navigate through. In order to circumvent from such challenges, data analysis for this research study process was started early – as the data collection process was ongoing (Thomas, 2010). The researcher listened to the audios and made transcriptions to read after each interview. The researcher focused more on the most pertinent information that answered the research questions (Bryman, 2016).

Identifying the study's units of research and analysis are critical to determining the scope of data analysis, it defines the boundaries in which data collected is to be organised and interpreted. Defining both allows the researcher to indicate what is being studied as well as what aspects are being studied (Clarke, 2013). In a case study design the unit of analysis can be an individual, a programme, an institution, or community whereby the researcher is interested in a contextual analysis of an event, conditions and their relationships (Patton, 2005). In this study, the unit of observation was teacher education and the unit of analysis was TrEds' teaching with technology practice. The analysis of data as explained in the sections that follow was advised by the units of research and analysis.

For a complete understanding of the data collected, both inductive and deductive approaches were employed. Deductive data analysis is the breaking down of raw data based on a predetermined structure formulated by the researcher. This structure is typically based on the research questions of the research study (Bryman, 2016). In this case, the researcher pre-determined the study's conceptual elements constructivist principles, TPACK and SAMR models, Inductive analysis on the other hand, is the organisation of data that does not follow a predetermined structure (ibid). This is how the researcher arranges collected data that was not anticipated into meaningful categories. The conceptual framework guided the researcher to identify codes that were to be used to arrange data as it was collected. The researcher, however, remained open-minded to any unanticipated themes that emerged from the research process. Throughout the research, the researcher took cognisance of advice from John-Steiner & Holbrook, (1996) who advised that themes that do not fit in the conceptual framework and reviewed literature should be viewed as possible sources of new knowledge. The following sections give details how each data set as collected using each of the techniques employed was analysed.

Qualitative data analysis software, Atlas.ti 7 was used to capture and store all the collected data materials in a single repository. The software supported the researcher in navigating around different documents by creating a hierarchy of codes assigned to the text. The codes are used to query the data using query tools and visualising concepts that emerges from the data to give it meaning. Additionally, the Atlas.ti 7 provided a means of recording interpretations and activities in the data analysis process using the memo feature. There were different options for qualitative data analysis software, but Atlas.ti was selected because the researcher had undergone a training programme on using this software.

The researcher formulated categories (codes) in which the data was to be organised based on the research questions as well as the conceptual framework constructs. These are categories that the researcher anticipated to get data on from both the interviews and observations. The researcher went on to input these codes into Atlas.ti 7 so that data captured would be arranged under the relevant codes. The software, however, added codes that it generated based on keywords it picked up from the transcripts and field notes that the researcher had not identified.

For this research study the researcher organised data collected from one-on-one and focus group interviews using the guides (Appendix E, F and G), which themselves were designed based on the research questions and the conceptual framework.

The interview data analytical process involved: (1) transcription verbatim; (2) reading and re-reading; (3) initial noting; (4) developing emergent themes; (5) searching for connections across emergent themes; and (6) interpreting the data. The transcribed recordings were anonymised by removing names of people or places. Below are the stages that the researcher went through in analysing the one-on-one interviews and the FGIs.

The audio-recorded interviews were transcribed using verbatim transcription technique using Express Scribe Transcribing software which allows for paced and controlled listening of recordings. This process of transcription was a good opportunity for the researcher to be immersed in the data, as the researcher listened and re-listened to the audio recordings. Although the accent of the respondents was sometimes not clear enough, the transcription software feature of pause and repeat every five seconds made it a bit easier to comprehend. The researcher adapted transcription notations developed by Gail Jefferson in 2004 to give meaning to certain behaviours and or activities observed mid conversation for example, pauses, elevated pitch, speech overlaps etc. To anonymise participant's identity, the terms interviewer and interviewee were used on the transcripts. The original transcripts that were securely kept in password-protected files.

During the process of simultaneously re-reading of transcripts and listening to audios, the researcher made notes and summaries from the transcripts before coding (Callary et al., 2015; Jori, 2014). The researcher then made use of the Atlas.ti 7 computer software, which facilitated text analysis; in particular selecting, coding, annotating and comparison of noteworthy text segments. In Atlas.ti 7, all the transcribed primary data files are stored in one "Hermeneutic Unit (HU)" which the researcher named TrEds-Interviews and each interview was added as a primary document (P-Docs). In the Atlas.ti 7 the researcher generated codes, quotes and memos. This allowed the researcher to keep reflective notes that record details of the nature and origin of any emergent interpretations (Stanford University, 2012). Furthermore, the Atlas.ti 7 offers a code and retrieval function that facilitates interconnections between codes thereby establishing superordinate classifications and categories (Eatough & Smith, 2007). The categories helped in formulating propositions that imply a conceptual structure that the data fits. The embryonic relationships between emerging themes were grouped according to the study's conceptual correspondences, and providing each cluster with a descriptive theme. Although the automated logic of coding and searching for coded texts differed slightly from the manual techniques, the speed and comprehensiveness of the Atlas.ti 7 searches was of a greater benefit. Notably the Atlas.ti 7 managed the multiple overlapping codes without losing context.

The researcher worked closely and intensively with the text, annotating insights into the participants' experience and perspective on digital instructional practices making descriptive comments/memos on the interview transcripts using Microsoft Word and or Atlas.ti 7. Each participant's response was analysed word by word; sentence by sentence (Eatough & Smith, 2007) in an effort to afford deep understand of what the participants were directly and indirectly communicating.

The organisation of collected data using both deductive and inductive approaches broadened the scope through which data was reviewed. The combination of both approaches helps in not limiting possible outcomes of the research study investigation. It allows the researcher to capture context influenced emerging themes, which may not be directly addressed by the research questions and the conceptual framework constructs, but have a noticeable influence on the phenomenon of interest. (Hajhosseini, Zandi, Shabanan and Madani (2016) asserts that deductive and inductive data analysis approaches can be used to complement each other. In this study, deductive reasoning was complemented with inductive that afforded an in-depth and detailed presentation of collected data, thereby adding weight and value to the data collected. The next section details how the researcher ensured that data collection process guaranteed the usefulness of the data.

4.8 Trustworthiness

Trustworthiness in qualitative studies is a way of establishing the research's findings credibility, transferability, confirmability, and dependability (Creswell & Miller, 2000; Drost, 2011). In contrast, quantitative research, uses validity and reliability measures to evaluate the quality of the research (Lincoln & Guba, 1985b). Trustworthiness in this qualitative research was demonstrated by researcher's reflexivity, the use of appropriate methodology and data collection instruments (Leung, 2015; Flyvberg, 2006). As mentioned earlier, qualitative researchers should address the issues of credibility, transferability, confirmability, and dependability.

4.8.1 Credibility

Credibility is defined as the researcher's success in describing the phenomenon of the study by accurately representing the data (Korstjens & Moser, 2018). To achieve this, it is essential that the researcher's understanding of the phenomena as in that context is unquestionable.

For this study, the researcher ensured data credibility by intensively exposing themselves to the units of observation and analysis. The prolonged duration of the study allowed the researcher to spend a sufficient amount of time engaging with the participants and the phenomenon itself. The use of semi-structured interviews also supported detailed data collection by giving the researcher room to probe further and the participants were not restricted in expressing their opinions on the issue under study. All the measures taken worked collectively towards achieving an in-depth understanding of the unit of analysis which in turn assisted the researcher in how they made sense of and presented the data.

4.8.2 Positionality and Bias

Social science researchers are considered to have their own beliefs, understandings, philosophies and personal views that may affect how they interpret or present collected data (Jackson, 2013). However, these aspects were acknowledged and strategies that counter them were put in place, by the researcher's flexibility and self-reflective measures (ibid). The interpretive perspective adopted in this study emphasises the importance of researchers being mindful of their positionality, in this case, they proposed that one should question their pre-existing views and values (Cousin, 2010). This therefore, suggests that with the researcher having worked in the educational technology field for more than 10 years, they have to ensure against any biased or corrupted understanding of the participants and their context. In response to that, the researcher used other researchers and the participants to do verification and credibility checks.

4.8.3 Confirmability

Confirmability is the researcher's ability to ensure that the interpretations of the findings match the data. In presenting the findings of the research study, the researcher was able to substantiate their claims by grounding them on evidence from the data collected (see chapter 5 and 6). To further substantiate claims, a clear link was made to frameworks and existing literature in interpreting and explaining data or findings.

4.8.4 Dependability

Dependability is when the researcher presentation of their research methodology, data collection process, and instruments enables others to attempt to collect data in similar conditions or contexts. In this study, the researcher elaborates the methods, process and instruments of choice. The researcher presented rationale for the selection of each by highlighting how it contributed to the study.

4.8.5 Transferability

Transferability reflects the need to be aware of and to describe the scope of one's qualitative study so that its applicability to different contexts (broad or narrow) can be readily discerned (Given & Saumure, 2008). The study ensured transferability by clearly identifying the study's unit of research and analysis. This directs other researchers on the scope in which data was collected and interpreted.

4.8.6 Data Triangulations

The processes of triangulations, such as data triangulation, conceptual triangulation and methods triangulation played a significant role in ensuring all the above aspects of trustworthiness (Lincoln & Guba, 1985a). In this study, data triangulation was achieved through collecting data from TrEds and pre-service teachers. Furthermore, methods triangulation was achieved though using multiple methods of data collection comprising of interviews, observations, and focus group interviews. The multiple methods were used to construct a reality from the different perspectives to maximise the trustworthiness of the findings. The conceptual triangulation was achieved by using three conceptual constructs in the interpretation of the phenomena.

Throughout the study the researcher engaged with peer critical readers to scrutinise the study report (Korstjens & Moser, 2018a). The researcher engaged with fellow post graduate candidates, academics and the supervisor who offered constructive feedback on the research process and content. The study's conceptual framework was further presented at conferences and an article published (Tunjera & Chigona, 2017). Therefore, critical perspectives were fundamental in ensuring that the study was exposed to scrutiny and thoroughness.

In regards to this study, the above discussed descriptions on measures taken to enhance the trustworthiness build confidence in methods used, the data collected and the interpretation of it. The next section discusses the ethical considerations observed in the study.

4.9 Ethical consideration

Ethics are the norms or standards of conduct that distinguish between right and wrong. They help to determine the difference between acceptable and unacceptable behaviours while conducting a research study. Many of the difficulties inherent in qualitative research can be overcome by awareness and use of well-established ethical principles (Maxwell, 2013). Some important ethical concerns that should be taken into account while carrying out qualitative research are: anonymity, confidentiality and informed consent (Maxwell, 2013). Any research participants have the right to insist on confidentiality and anonymity at all times. According to Eynden and Brett, (2010), two important guidelines of research ethics are informed consent and the protection of research participant's identity.

In this study, the researcher ensured participating TrEd anonymity by not using their names but identified them using codes e.g. TrEd001. The researcher further explained to the participants that pseudonyms will be used to keep them anonymous. To further protect their identity as the research was conducted at a closely knit environment, the researcher made a point to address participants using gender neutral pronouns.

To conform to the University's research ethical codes, the research proposal was submitted to the Ethics and Higher Degrees Committees for ethical clearance. The purpose of ethical clearance is to ensure that the research process does not cause any harm to the human participants and that it protects their dignity. To reach the targeted participants, permission was sought from the department's gatekeepers, who facilitated the researcher's access to staff mailing list through the administrators. A survey questionnaire link was emailed to all TrEds in a staff mailing list.

Another measure taken in accordance to ethical conduct was to inform participants of the study's purpose, scope and what the results would be used for. In this study, this happened at the onset of participant selection through the online survey used as the initial sampling tool. The online survey also requested that TrEds indicate their willingness to participate in the study (Anney, 2014). The researcher informed participants of their rights as autonomous persons to voluntarily accept or refuse to participate in the study. As reported in this study, some of the TrEds that took part in the interview phase of data collection indicated that they were not willing to take part in the observations and the researcher obliged them.

Ethical standards prevent against the fabrication or falsifying of data and therefore, promote the pursuit of knowledge and truth which is the primary goal of research (Bulmer, 2008). To ensure this, the researcher employed member checking by giving participants to look at the transcribed interviews and approve that the correct details had been captured. Bresler's (1996) advices that privacy of respondents goes beyond protecting their identity but also extends to the reporting of what the researcher learnt from the participants. Therefore, the participants were made aware of their right to alter, elaborate, change or prohibit the use of information shared. To further safeguard the collected raw data (notes and recordings) and transcription, the researcher kept them in password protected folders to which only the researcher had access (Eynden & Brett, 2010)

As a researcher, it was vital to commit to protecting the rights and well-being of participants and the institution, ensuring that no-one was exposed to any harm, in terms of reputation or otherwise, as a result of this study. The researcher therefore made the necessary effort and commitment to maintain the informants' privacy, confidentiality and general research ethics principles during data collection and compilation of this study.

The next section provides the limitations and challenges of the study

4.10 Limitations of the study

The limitations of the study are defined as those characteristics of design or methodology that impacted or influenced the interpretation of the findings from the research (Lynch, 2013). The first limitation for the study was the use of case study as a research design. As discussed earlier in section 4.5, critics of the case study design argue its restrictive nature as its approach is context-dependant. However, the goal of case study research design and its offering of in-depth understanding of a phenomenon presented an outweighing benefit for this study. Case studies are also inductive in nature, thereby, in-depth observation of a small case can work its way to examine related issues (Shenton, 2004; Flyvberg, 2006). While it may prove challenging to generalise findings to other contexts researcher may however have a platform to formulate assumptions. While it may prove challenging to generalise findings to other contexts researcher may however have a platform to formulate assumptions. This study, therefore offers an in-depth analysis of the teaching with technology in the 21C phenomenon. Hence, it is expected that researchers working with similar phenomenon and contexts can relate to the findings of this study and expand on them in future studies.

The second limitation points to the number of participants in the study. The participating eight TrEds could be viewed as not representing the entire TrEds population of the institution. However, it only used the participants who volunteered and were willing to participate in the study. Therefore, this could impede the conclusion about the broader population in teacher preparation programme at the faculty. In an attempt to address this concern, the participants comprised of TrEds from across various fields. However, in qualitative studies, generalisation of data is not the main objective, but the thorough comprehension of a phenomena, the interpretive paradigm selected for this study further emphasises the importance of context, therefore the issue of generalisation is minimised.

4.11 Chapter Summary

This chapter discussed the methodology employed to collect and analyse data for the study. The interpretive philosophical orientation was elaborated and motivated for and the qualitative methodological orientation of the study was explained. Possible research study designs were discussed and the selection of the case study design was explored and supported for this study. The case studies enable an in-depth analysis of a small sample comprising of eight TrEds by making use of data collection tools including one-on-one and focus group interviews and observations for triangulation purposes. The chapter gave a detailed description of the TrEds and pre-service teachers participants involved in the study. It further elaborated the data analysis techniques used in the study. The chapter concluded with trustworthiness, ethical considerations and limitations of the study.

The next chapter presents the findings from the one-to-one interviews, which answered the research question: what digital strategies TrEds are using to prepare pre-service teachers to teaching with technology.

CHAPTER FIVE

FINDINGS AND DISCUSSIONS

5.1 Introduction

The study sought to explore and understand TrEds instructional strategies used in preparing pre-service teachers to teach with technology in the 21C. Drawing upon data collected from interviews and observations, this chapter aims to answer the main research question of the study: *What do TrEds need to effectively prepare pre-service teachers to teach with technology in the 21C?* To collect, analyse, interpret and discuss the findings, the researcher was guided by the conceptual framework as relating to literature (see Chapter 2 and 3). Nevertheless, the researcher remained receptive to data that did not necessarily fall within the confines of the conceptual framework.

In this study, eight TrEds were interviewed: three content experts, two professional studies experts and three educational theories experts. Six out of the eight TrEds were holders of doctorate qualifications, one was in the process of acquiring a Masters and the other a Doctorate. Of the eight, only four consented to being observed – one educational theories expert, one professional studies expert and two content experts. In addition to the eight TrEds, fifteen final year pre-service teachers were also interviewed in a focus group.

The findings are reported and discussed individually, but in actual fact they are interrelated in how they all rely greatly on the TrEd's technology and instructional strategies knowledge.

This chapter is organised into the following main sections and reports on instructional strategies TrEds employ:

Section 5.2 TrEds' knowledge for teaching with technology in the 21C

Section 5.3 TrEds' Technology-enhanced instructional strategies

Section 5.4 TrEds Professional development

Section 5.5 Technological challenges at institutional level

Section 5.6 Venue set-ups and available technology infrastructure

Section 5.7 Chapter Summary

Section 5.8 Conclusion

The next section presents the research findings on what knowledge TrEds have on teaching with technology strategies for the 21C.

5.2 TrEds' knowledge for teaching with technology strategies in the 21C

In the context of this study, TrEds' knowledge of teaching with technology strategies in the 21C implies their capacity to use and incorporate technology effectively into their teacher preparation programmes to achieve higher order thinking skills in the pre-service teachers. In other words, TrEd ability to prepare and plan how to utilise technology concurrently with a teaching strategy to address a specific content and context to achieve a targeted learning objective.

One-on-one semi-structured interviews conducted in the course of this investigation sought to understand TrEds' knowledge of TPACK; most questions inferred the vocabulary and precepts of TPACK framework constructs. Interview questions 1 - 4 were set to establish ways in which TrEds conceptualise, approach and relate to teaching with technology. The main aim of the research was to understand what technology enhanced instructional strategies were TrEds using in teacher preparation programmes. The researcher sought to understand if TrEds strategically prepare to teach with technology by identifying a technology to use in their lectures in the pursuit of their instructional goals.

The finding indicated that all of the participating TrEds were able to prepare their lecture delivery using technology to varying but mostly minimal extents. **Figure 5.1** shows that not all of the TrEds using technology are able to identify the appropriate technology to use for specific instructional context. Even less TrEds managed to use technology that matches with constructivist principles to facilitate 21C teaching and learning outcomes.

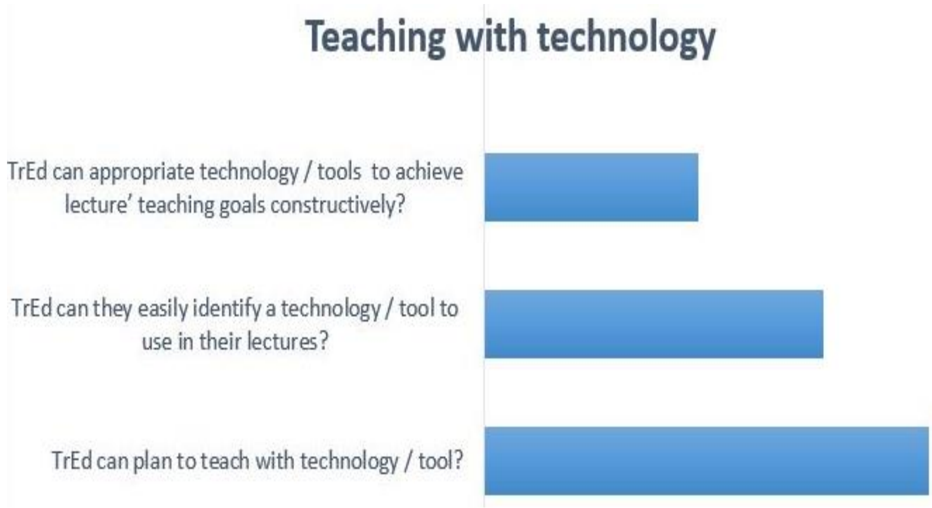

Figure 5.1: TrEds teaching with technology knowledge

Figure 5.1 shows that seven out of eight of the TrEds interviewed reported that they strategically prepare to teach with technology in their lectures. Six out of the eight highlighted that they can easily identify a relevant technology to use in their lectures. Two out of the eight claimed they can appropriate a technology to meet the lecture learning objectives. This follows that during the interview process only two participants claimed they were familiar with TPACK or SAMR models. From the observations, there were only two TrEds who were witnessed making use of their teaching activity directly related to 21C learning outcomes in the form of collaboration and project based activities. This suggests that the lack of adequate exposure to 21C teaching theory and technology integration frameworks is likely to translate into inadequate use of technology in teaching and as a result, teaching outcomes that are not aligned with 21C demands. This is in line with an argument forwarded by (Ouyang & Stanley, 2014) who in their study also found that the lack of knowledge of contemporary teaching with technology framework was one of the factors affecting the teaching with technology practice.

This finding also indicates that although TrEds acknowledge the importance of integrating technology in their teaching practice however, they do not have the knowledge and skill on how to use it to achieve 21C constructivist teaching and learning outcomes as highlighted by other researchers (Chigona, 2015a; Stokes-Beverley and Simoy, 2016). Therefore, 21C teaching with technology strategies require a holistic framework that is supported by a teaching philosophy that articulate the roles that technology can play in enhancing teaching practices.

TrEds limitation with regards to using modern technology is sometimes a result of simply not being exposed to such technology. This lack of technology knowledge can be seen in the extract from interview notes with TrEd007 who had been questioned on their proficiency in using digital technology:

> *I am not skilled on using technology; I use the computer for mainly sending emails, research and I occasionally use basic PowerPoint slides and YouTube in my lectures. … I require more training…*

In this case, the TrEd sees their limited knowledge of technology as a barrier to effectively integrate it into their practice, they can only use the technology as far as they understand it. The researcher observed that PowerPoint was widely used amongst the TrEds who participated in this study. However, the data collected in this study revealed that TrEds were using this technology resource to deliver lectures to enhance their traditional lecture instructional strategies. It was not being used in any transformative manner but merely to project lecture notes as the lecturer presented them. Researchers Choy et al. (2009) also observed similar patterns in their studies were PowerPoint was popularly used as a substitution for traditional means. The popularity of the PowerPoint application has been explained by Lari (2014) who mentioned that the PowerPoint presentation application is widely used because it is easy to master and convenient to users. The researcher deduced that TrEds are possibly limited in their integration of technology due to limited knowledge of technology and that they as a result gravitate towards easy to learn technological applications. Professional development designer in their interventions should therefore explore advanced features of PowerPoint and similar applications that can be infused with constructivist learner-centred instructional strategies.

The quote from TrEd007 above also highlights findings by other researchers (Oigara & Wallace, 2012) that show that TrEds mainly use technology for administrative purposes both personally and professionally (Sadeck & Cronjé, 2017), therefore their application of technology in their teaching practice is based on their interaction with it outside of the classroom. It is therefore possible that the TrEds might face a challenge in targeting 21C teaching outcomes if they do not consider technology use through the scope of teaching and learning purpose. This is due to the fact that in teaching and learning it is no longer an issue of only understanding how the technology works but how best in can be used in a specific context, with a specific teaching strategy for a targeted teaching and learning outcome (Gilakjani Lai-Mei, & Hairul, 2013).

Following the results that indicate that only a few educators can integrate technology to achieve teaching objectives for the 21C, one may interpret it based on literature reviews that argue that educators teach the way they were taught (Schleicher, 2014; Baran et al., 2011) – which in this case was by using traditional means. Three TrEds (TrEd005, TrEd007 and TrEd008) reported that they were trained into professional teaching before the advent of some of the technology and admitted to their inadequate teaching with technology skills for 21C. From the interview responses, the study revealed that TrEds' were either self-taught or attended workshops, where they were taught general technology application including web resources, application packages etc. They reported that these general applications are not relevant to their professional needs; therefore, they revert back to their familiar ways.

Another factor affecting TrEds' knowledge of teaching with technology strategies is the manner in which technology integration training may be presented. There is a concern that technology knowledge is being disseminated in isolation of professional teaching strategies (Angeli & Valanides, 2009). This suggested that current professional development may not be adequate; focusing instead upon management of the course and not dealing with critical pedagogic issues; as noted by one TrEd005:

> *… I have attended some staff development training, unfortunately, I didn't learn much to help me use technology in my lectures… I felt we must learn how to use technology to enhance learning not to do just uploading documents to BB…*

The TrEds could be exposed to the technology, but without a clear link on how they could best use it in their specific fields, they may not find it easy to integrate into their practice. This is in line with what (Tondeur et al., 2017) argue in their work, that for technology integration to be successful in teaching, there has to be a clear indication of its relevance to the TrEd. This implies the necessity of content and or subject specific technological staff development programmes. This suggests that TrEds must stay up to date on current educational technology solutions and strategies in order to create more sustainable 21C teacher preparation programmes (Stokes-Beverley and Simoy, 2016). TrEds in this study were limited in their teaching with technology practice: they often had a complex set of perceptions at odds with what was expected of them (Watson et al., 1998). This implies that most TrEds had general knowledge of technology which they mainly used for administration functions only, mostly because it was not relevant to their teaching needs.

The findings reveal that all the participating TrEds were using technology but in most cases, they did not make use of its full affordances to achieve 21C oriented teaching and learning outcomes. They were only able to utilise it to enhance teaching and learning activities, very little transformation took place. The TrEds, as observed, were using various technology resources in their practice however the question was on the effectiveness of their application of it. The proponents on the TPACK and SAMR technology integration models highlight the importance of using such models to direct the integration of technology for specific outcomes (Kriek et al., 2016; Ledford, 2016). In interacting with all the participating TrEds, the researcher gathered that there was a significant difference amongst the participants with regards to the adaptation of TPACK and SAMR models into their practice.

Most TrEds were operating outside of the guidance of any technology integration models, which is probably why they could integrate technology but not effectively for 21C teaching outcomes. During the course of the interviews some of the TrEds reported that they were not familiar with PCK, TPACK and SAMR models. Interestingly, TrEd004, when asked about their knowledge of PCK, expressed their discontent with making use of theories, they asked if it was necessary to make use of *"…such big unnecessary words…"* which they followed by asking what PCK was. This therefore shows that TrEds lack of theoretical knowledge is another factor contributing to their limited integration of technology.

The data suggested that TrEds who were exposed to these models readily used technology beyond substitution of traditional tools. TrEd001 and TrEd002 who had reported that they were familiar with the TPACK models due to their previous studies were the two participating TrEds who exhibited higher level technology enhanced teaching activities during lecture observations. Both had explored technology in education in their doctoral studies. One TrEd had used Shulman's PCK in her doctoral research and accordingly found it comparatively simple to adopt and adapt TPACK concepts imaginatively into her teaching. She states that:

> *I used PCK framework for my doctoral thesis, hence, TPACK was very easy for me to give it a go… also I used technology a lot then during my doctoral studies. My supervisor used it a lot… I use it in all my classes and my students love to use technology.*

The extract above reveals that TrEds who are exposed to the technological tools during their teacher training are prone to integrate it into their practice as well. This finding correlates with that of (Chigona, 2015b), who concluded that educators who are exposed to teaching with technology in their teacher preparation, tend to appreciate and use it in the ways it was modelled to them. Therefore, this shows the importance of understanding what 21C technology enhanced instructional strategies TrEds are currently using in their teacher preparation is critical, so that intervention programmes can be designed to meet 21C demands.

Apart from technology integration models, six of the eight TrEds gave no clear indication of their practices being informed by contemporary teaching theories. The researcher was looking for indications of any practices that were in accordance with theoretical influences such as constructivism which was the fundamental theory for this study's conceptual framework. The TrEds were mostly executing technology-integrated lectures using lecturer-centred approaches. Contemporary theories such as constructivism advocate for the implementation of student-centred approaches to teaching (Owusu, 2015).

The section that follows draws in on these two instructional strategies focusing on how the TrEds are using them together with technology in their practices.

5.3 TrEds' Technology-enhanced instructional strategies

Technology-enhanced instructional strategies in this study refers to the use of digital tools to maximise student comprehension of concepts and ability to construct new meaning. In other words, it is the TrEds application of technology-enhanced instructional strategies that support 21C teaching and learning outcomes, whether be it is F2F or virtual. This section then reports on instructional strategy themes that emerged from the one-on-one interviews and lecture observations.

5.3.1 Technology-enhanced Lecturer-centred instructional strategies

In this study, the term lecturer-centred instructional strategies refer to instructional approaches that are structured, sequenced and led by TrEds: involving lecturer-centred strategies is when the lecturer directs the learning and instructions to students. TrEds interviewed in this study indicated that they used technology to enhance rather than re-imagine their traditional lecturer-centred practices. Subsequently, pre-service teachers frequently became passive recipients of information. The results indicated a combination of TrEds' lack of confidence and knowledge of technology; especially in terms of constructivist strategies. Research indicates that educators who readily integrate technology into their instruction are more likely to possess constructivist-teaching styles (Judson, 2006). However, the results of this study revealed that TrEds although they were integrating technology, they mostly relied upon and sustained outdated traditional teaching styles, as presented below.

The observation analysis guided by the conceptual framework, however, indicated that the technology was mostly paired with lecturer-centred approaches, resulting in low level learning outcomes. This outcome was a result of inappropriate matching of technology knowledge and instructional strategy. The researcher observed that even when advanced and content specific technology was being used, the impact of it was diminished due to the TrEd employing lecture-centred approaches. The researcher observed the TrEd001 using Graphmatica in the Mathematics and TrEd007 topic specific simulations in Science. Content specific technology applications such as these have been argued to not effectively stimulate skill development is students due to their drill and practice (Martin, 2015). Researchers argue that drill and practice approaches limit the students' ability to apply concepts learnt once they are introduced to a different context (Tondeur et al., 2017). The outcome to this approach is ease of concept grasping and does not necessarily foster critical thinking. This approach in essence substitutes the TrEd and thereby maintains the traditional lecturer-centred approach. The technology use in this case still maintains the one-directional learning process. This therefore highlights the importance of applying technology integration models such as SAMR as they guide the integration of technology towards a specific outcome (Tondeur et al., 2017). TrEds can apply technology application with confidence that they will help their students develop 21C skills where they go beyond knowledge comprehension but they are able to apply it in varying contexts. The use of the SAMR model also encourages TrEds to implement student-centred approaches as the achievement of its high level outcomes is associated with this approach (Ledford, 2016).

TrEd008 used the Smartboard during most of the observation sessions. The researcher observed their knowledge of manipulating most functionalities of the Smartboard. The TrEd employed a lecturer-centred method as they addressed the pre-service teachers with reference to content displayed on the Smartboard, they also used the writing tool to draw a cell diagram, the same way they would have on a blackboard. The researcher's observation was that the TrEd exhibited basic skills for operating the Smartboard. The TrEd, however, did not utilise the advanced functions of the Smartboard that would have made for a more interactive lesson delivery. This suggests that although the TrEds have been trained on how the Smartboards work, they have not been trained through the scope of how to use it for the purpose and objectives of their specific contexts. They also are not using the affordances of the technology in a constructivist manner that encourages involving the pre-service teachers in the learning process. The use of technology in this case, though advanced, was limited in that it benefited the TrEd more in terms of convenience and therefore resulted in short term stimulation to the pre-service teachers. The researcher noticed that pre-service teachers were fascinated by TrEds use of Smartboard, however, there was no constructive engagement. According to Mcgrath, Karabas, Wills John, College and Rochelle (2011) argue that when proper stimulation takes place the student is motivated to pursue more knowledge even in their own time and capacity.

In a related study, Robinson and Hope, (2013) reveal that most content experts in teacher preparation institutions received no training in educational theory and teaching methods. Consistent with this observation is the need for professional training on effective teaching styles and the incorporation of technology. It is therefore, imperative that teacher preparation institutions must enforce as a requirement, that TrEds receive appropriate training on technology enhanced teaching theories, technology integration models and instructional strategies fit for 21C teaching and learning outcomes.

While TrEds made use of technologies in their teacher preparation programmes, data collected from the observations suggested that it was being used in isolation of the constructivist principles. The direct result of this was that TrEds continuously integrated technology with lecturer-centred approaches. Therefore, this emphasises the need for a model founded on constructivist principles combined with technology frameworks. This kind of model will assist TrEds to navigate from lecturer-centred approaches to student-centred ones in a bid to achieve 21C teaching with technology objectives.

From the results, the researcher acknowledged the existence of two main categories of technology-enhanced lecturer-centred instructional strategies used by TrEds:

(a) General purpose application technology

(b) Content-specific application technology

General purpose application technology is more generally referred to as productivity tools used to support instructional activities and general administration for productivity purposes (Roblyer & Doeing, 2014). Content-specific technology tools are designed for specific purposes within a specific discipline or content area (Roblyer & Doeing, 2014). The following subsections describe the two categories of technologies used by TrEds in lecturer-centred instructional strategies in this specific study.

5.3.1.1 TrEds using general purpose application technology

Most of the technology that participants reported and were observed to be using were general applications technologies. Such general purpose applications include, but are not limited to, Microsoft Office suite, and multimedia applications. The use of general applications demands creative adjustments and inventiveness on the part of the TrEds. For example, TrEd007 made use of PowerPoint to deliver a lesson, however, for improved comprehension they embedded a video that explained the concept they were teaching. This has been argued to aid the delivery and comprehension of the content by providing audio and visual elements to auditory and visual learners (Woolfitt, 2015; June, Yaacob, & Kheng, 2014). This therefore, emphasises the importance of TrEds' technological-content knowledge (TCK) in transforming a general purpose application into an effective tool for the teaching and learning objectives of particular content (Roblyer & Doering, 2014).

TrEds in this study mainly used general application technologies as substitution for traditional tools of teaching and learning. All TrEds in this study, mentioned that they use PowerPoint in all their lectures. This practice was confirmed by most pre-service teachers who recounted during the focus group interviews, that most of their TrEds religiously used PowerPoint in their lectures. The PowerPoint application plays a "medium" role where TrEds substitutes the static traditional presentation tools such as overhead projectors. The use of PowerPoint across the education discipline spectrum, on the other shows its advantage in terms adaptability as it can be used in different ways for varying objectives and purposes. For example, TrEd005 in this study used it as a direct substitute by simply copying text from a textbook and pasting it on a slide, while TrEd007 integrated it with another technology by embedding a video link onto a slide for greater teaching impact. This emphasises TrEd technology knowledge (TK), in that if they understand a general application's advanced functions, they are able to optimise it for outcomes beyond substitution and augmentation.

Another general application used was the Smartboard, which is an interactive whiteboard with a touch screen (Manny-Ikan, Dagan, Berger Tikochinski, & Zorman, 2011). Used effectively the smartboard has the advantage of allowing students to enjoy interactive learning as they can also use it access and share information. The Smartboard has its advantages in that it improves teacher and student as well as peer to peer collaboration and interaction in that they can simultaneously work on the Smartboard, were the TrEd can allow the pre-service teachers to also share their knowledge with the class by displaying it on the Smartboard. They also come with inbuilt online resources thereby giving them instant access to information. However, the TrEds observed in this study also mainly used it at substitution levels, mainly to project content. None of the TrEds during the observations used any of the advanced affordances of the Smartboard. TrEd006 managed to display their skill on the Smartboard by writing down and instantly capturing notes on the board. This therefore shows that the application is mainly being used for the convenience of the TrEds and not being utilised to the students' advantage.

The TrEds also had at their disposal the Blackboard (BB) Learning Management System which is a virtual learning environment on which TrEds and pre-service teacher can interact. This technology allows for information to be shared from the TrEds to the pre-service teachers as well as from peer to peer since synchronous discussions can take place in real-time on the chatrooms, videos can be uploaded and shared on this platform. The researcher however observed that this resource was mostly being utilised as a reservatory on which notes and class schedules and plans were being posted. While this is certainly a positive with regards to ease of access to information, the platform could have been used for more interactive and creative learning exercises such as group discussions, real time video conferencing and collaborative group presentations. Technology resources such as the BB have great benefits that allow for teaching and learning to take place continuously even outside of the classroom. Careful design of teaching activities such as collaborative group work can assist in developing 21C teaching and learning skills (Martin, 2015). To utilise a technology such as BB in the execution of the task, gives the pre-service teachers an opportunity to exercise their knowledge acquisition and sharing skills, interpersonal skills, negotiation skills and many others (Steyn, 2017).

This suggests that even general application technology can be purposed for high level 21C teaching and learning outcomes. It emphasises the importance of TrEds awareness of TPACK and SAMR principles as these can advise them on how technology can be used together with the appropriate teaching techniques that are relevant to that specific context for targeted outcomes.

5.3.1.2 The use of Content-Specific technology

Lecturer-centred instructional strategy enhanced through content-specific technologies applies when a lecturer uses subject or discipline-specific application technology in their instructional strategy to help students acquire and retain information better (Ching et al., 2013; Heimann, 2015; Kipsoi, Chang'ach & Sang, 2012). Content-specific technologies were favoured as being more advantageous in concept comprehension by TrEd001 who used such technology. In this study, TrEd001 in delivering a mathematics lectures, talked about using content-specific technologies to help pre-service teachers to master concepts. They stated:

> *... I use Graphmatica tutorial… I demonstrate how Graphmatica works ... this is an algebra-graphing tool, which allows a student to master functions and algebra interactively … Students (Pre-service teachers) can change variables and can describe and conjecture about changes in the graph…*

> *This has made many pre-service teachers understand functions more than when I verbally demonstrated.*

Content-specific technology applications such as Graphmatica are useful in that they allow the pre-service teacher to repetitively work on a concept until they grasp it, it allows them to acquire knowledge at their own pace. This design is useful in initial concept mastery in that the student has the opportunity to work on variety of tasks, changing up variables to see how it affects the results, until they grasp the concepts (Tondeur et al., 2017). The advantage with content-specific technology application is that they at least they relieve the TrEd of the responsibility of having to adapt the technology for the purpose of delivering content as they would have to do in the case of a general application.

While content-specific technology presents an advantage of improved content comprehension, the success of it however depends on the TrEd's in-depth knowledge of the technology and the ability to convey to the students how the technology is used (Kurt, 2014). A point of concern with content-specific technology is that they support the drill and practice approach which may result in students failure to apply acquired skill in context outside the technology (Roblyer & Doering, 2014). The drill and practice technique follows behaviourist principles in that the student mastery of knowledge is measured by their ability repeat what they have been taught, there is no room of their own interpretation or presentation of the knowledge, therefore this form of teaching and learning may be considered rigid. It is limited in terms of exploring alternative outcomes thereby restricting the development of creative and analytical thinking. However, for the purpose of grasping factual concepts, this approach may be preferable, although it limited on affordances that technology brings (Tondeur et al., 2017).

The role of the TrEd in this case is to complement this kind of technology with other teaching technology that allow the pre-service teachers to demonstrate their understanding as they would have experienced it. Applications like Graphmatica, however, come with an added advantage that outside of just the fixed demonstrations of concepts it allows the user to try out other exercise to test their application of the content. At the core of effective teaching with technology is the TrEds ability to purpose technology and teaching techniques for constructivist outcomes suitable for the 21C.

For teaching strategies that do encourage creativity and critical thinking as well as individual initiative, dialogue, even cognition development, TrEds need to implement more constructivist oriented teaching practices such as presented in the following section.

5.3.2 Technology-enhanced student-centred instructional strategies

Student-centred instructional strategies are teaching techniques that give students the opportunity to be drivers and active participants of their knowledge acquisition (Voogt & McKenney, 2017). The use of technology in this case, would be to use technology resources in order to facilitate pre-service teachers' participation in the knowledge acquisition process rather than having it dispensed to them by the TrEd. This way the pre-service teachers have the chance of developing 21C skills such as the 4Cs. Literature shows that the use of a student-centred approach is directly aligned to the development of higher order thinking skills (Israel et al., 2014).

5.3.2.1 Technology-enhanced collaboration instructional strategy

Collaborative teaching strategy enhanced with technology implies a teaching strategy where students use technology in pairs or groups to achieve learning goals. Studies report that 21C instructional strategies require a departure from traditional lecturer-centred approaches to student-centred instructional strategies such as technology-enhanced collaboration. In the 21C, technology-enhanced collaborative instructional strategies support the view that learning occurs effectively through interpersonal interactions (Lambropoulos, Faulkner & Culwin, 2012; Mustafa & Fatma, 2013; Goodwin et al., 2014).

In this study, TrEd00 was observed making use of collaboration during the course of a professional studies module. They tasked pre-service teachers to work in small groups to produce digital storytelling videos. In this case the TrEd recommended the use of the technology application PhotoStory 3. Students in this assignment were given room to decide how they wanted to present their outcomes; they also had the choice of making use of an alternative technology.

This highlight the benefit of collaborative peer projects as indicated by (Nsamenang & Tchombe, 2011) in that the students are given a choice on how best they want to interact with knowledge, how they wish to interpret it as informed by their context. In their groups the pre-service teachers in this case would have had to discuss amongst themselves and agree on which application they intended to use. The ones who were more knowledgeable of the applications had to assist their peers in becoming familiar with its functions. As argued by researchers Le, Janssen and Wubbels (2018), collaborative tasks are useful in developing interpersonal, negotiation as well as decision-making skills. This emphasises Vygotsky's notion, that the idea of collaborative learning is based upon the achievements a student can make when aided by peers (Vygotsky, 1978). In such an activity there is a sense of responsibility by the students and they take an active role in helping each other to achieve the shared objective of a task (Hanson-Smith, 1997). The researcher deduces that the use of technology-enhanced collaborations exposes the pre-service teachers to a wider range of technology knowledge as shared amongst peers, it is also an opportunity to showcase both their existing and newly acquired technology knowledge.

The issue of pre-service teachers having choice of technology to use is beneficial in that they already are being given the opportunity to exercise technological pedagogical knowledge (TPK). They have the opportunity to decide which technology would best suit the outcomes of their task or which one would be more efficient. In this case the pre-service teachers decided to use other applications apart from PhotoStory by realising their functions which they deemed more adequate for their use. The advantage of such tasks extends to the TrEds as well as the teaching and learning process becomes a reciprocative one. TrEds may also be exposed to new and unfamiliar technologies by their students, as the students have the freedom to discover and employ technologies that facilitate their learning process. The TrEd's exposure to technology tools and resources is therefore also broadened when making use of collaborative teaching strategies.

The use of teamwork and collaboration contributes to the development of investigative skills as the students direct their own searches and construction of knowledge (Care, Kim, Vista & Anderson, 2018). The advantage of this kind of exercise is that it allows the student to build on their existing knowledge, which motivate the desire for further learning. In this study, on different occasions TrEds would give an instruction on what tasks need to be completed and the students collaboratively agreed on relevant and convenient technologies to use. At times they opted for alternative ones to the ones recommended by the TrEd. This therefore supports the notion that when students have direct influence on how they learn as advocated by constructivist, it stimulates the desire to learn more, critical thinking, as well as decision making (ibid).

The same DST project had very interesting outcomes as observed by the researcher. The pre-service teachers were given the topic of interest – social inclusion, and had to present a video story on how they experienced this. The pre-service teachers did not only stop at using various other technology applications, but they told various real life stories on their experience with the topic. The presentations also varied in nature, from first person narratives to third person narratives, the structure of the videos. The teams showed their creativity in various ways. This speaks into the constructivist principle that holds the notion that teaching and learning activities should facilitate for multiple learning outcomes (Steyn, 2017). Behaviourist notions would be more specific in terms of outcomes of learning, there would be a rigid list of how the students express their acquired knowledge (Bates, 2015), anything outside of that would be discarded, it takes no note of contextual and individual influences.

Participating TrEds were observed on how they were using technology to enhance collaborative learning. The findings reveal that TrEd001 and TrEd007 preferred the use of content-specific instructional software. TrEd007 used YouTube video, that simulates natural science concepts and processes. According to TrEd007, before using simulated videos, he used to struggle to make students comprehend abstract concepts such as respiratory system. Similarly, TrEd001 used the Graphmatica instructional software in what was a group learning process on graphs concepts in a Mathematics lecture. What was interesting to note, was that, although students had been placed in groups, as was also facilitated by the venue's group sitting set-up which, the TrEd as well as the technology (due to its drill and practice nature as argued earlier), were mostly in control of the teaching process. The pre-service teachers were in groups; yes, however, they were not afforded the opportunity to interact peer to peer and direct their own knowledge acquisition. This implies that although ideally, collaborative tasks are designed to yield high level learning outcomes (Le et al., 2018), in this case, due to the TrEd's decision to pair it with a lecturer-centred approach, it did not yield expected results.

This is a typical example of the kind of results that can be expected when educators have not fully domesticated the use of TPACK. In this particular scenario, the educator had the technology knowledge as well as the content knowledge, however, their choice of a teaching strategy confined the learning outcomes to augmentation level. It is for this reason that collaboration can be seen on both the modification and augmentation levels. The SAMR model clearly shows in this case the importance of choosing a student-centred approach over a lecturer centred one by highlighting how that decision affects the outcome of the learning activity.

Collaborative tasks are useful in developing interpersonal skills, negotiation skills as well as a sense of responsibility and accountability and this applies mostly to the team leader. For example, TrEd003 stated that twelve pre-service teachers underwent peer facilitator mentoring for a group project. The peer leaders had a clear grasp of the goals of the project and guidelines. The TrEd averred that the peer facilitator's role was to assist the group to achieve its objectives; by ensuring that it had the resources it needed and by encouraging and supporting the group members who needed to understand the leaders' roles and accept their directions. This instructional strategy sets a foundation for a pre-service teacher to start practicing their implementation of TCK as well as TPK. In this case, the pre-service teacher appointed as team leaders directed decision making on what technologies to use and for what purpose, for example, they created a WhatsApp group for team members to communicate. The rest of the team members are equally exposed to the opportunity of decision making and negotiation as this was a team decision they needed to agree on. Sousa et al. (2015) argues that team work helps students respect each other and creates cross-cultural and cross-racial friendship: however, this arrangement requires time for working together and for communication. Communication can on the other hand be accelerated by the use of technology thereby formulating relationship much quicker. For example, TrEd003 highlighted that:

> *The peer leaders created WhatsApp groups to speed up collaboration on set activities and as they worked with each other to increase proficient with the goals of DST project and the technologies used.*

The TrEd explained that social media helped the pre-service teachers to communicate and share ideas efficiently during the course of the digital story telling (DST) project. Through the use of technology, the pre-service teachers were able to communicate outside of the confines of the classroom, the technology allowed them a virtual social interaction. The SAMR model advocates for the use of technology to achieve teaching activities that have been previously challenging to achieve (Kihoza et al., 2016; Romrell et al., 2014), in this case it was used to make communication and knowledge sharing take place regardless of geographical placements. According to Sousa et al. (2015), collaborative group learning promotes social interaction, this was evidenced in this particular projects, through the use of technology to communicate, to share information and negotiating to agree on the best well to present a collective assignment.

One of the principles of the constructivist theory is that TrEds must design learning activities that build-on pre-service teachers existing knowledge, (Henrie, 2016; Mcgrath et al., 2011). For instance, several studies reveal that young adults identify and align themselves more with social media for interaction (Anderson & Elloumi, 2008). It is therefore important that the TrEd is aware of these platforms and how they operate, such that they can structure learning activities around them with the added advantage of improved collaboration since activity is built on students shared technological interest and/or knowledge. Evidently in this study results indicated that TrEds needed to be more aware of platforms that pre-service teachers are predominantly using. Most pre-service teachers relied on WhatsApp because of its affordability and accessibility (Bouhnik, Denshen & Gan, 2014; Russell, 2012). This concept of gravitating towards familiar technology resources may be used to explain why pre-service teachers opted for alternative technological means than ones prescribed by the TrEd in certain cases. It highlights the importance of TrEds being fully aware of technologies that pre-service teachers are privy to.

The TrEd's knowledge on pre-service teachers' similar interests, for example, technological interest and real-life experiences, can assist in developing collaborative tasks in such a way that gaps created by diversity are quickly bridged or can even be beneficial in their knowledge development with regards to varying context. Below is an extract from the TrEd giving their perspective on how technology was used in bridging pre-service teachers' differences:

> *My class is a diverse class, culture, personal perspectives and background of the students; I consider the WhatsApp collaborative groups' reduced the personal difference and build a community that had the same goal to achieve. But the social communications helped build trust…*

TrEd specified the diverse nature of her class; especially in terms of culture, personal perspectives and background, which sometimes hindered team collaboration. Pre-service teachers in this study built up trust with each other, which was crucial for group collaboration. The use of social interaction applications for teaching purposes allowed the students to work from a point a common interest, in this case the widely used WhatsApp application. Pre-service teachers using social media enabled the DST project success. The findings of this study showed that technology easily enhanced the social skills needed to achieve the goals of a collaborative activity. Similar research suggests that students' social interactions help achieve collaboration goals at large scales i.e. larger groups as opposed to students working in pairs (Mcgrath et al., 2011; Sultan, 2014; Church & de Oliveira, 2013). TrEds would benefit by knowing what technology applications or platforms pre-service teachers find appealing. Pre-service teachers have an equal opportunity to interact with peers on the BB LMS as they do on WhatsApp, however, they may be more interactive on one instead of the other for various reasons such as familiarity, ease of access and perhaps the informality of it (Chikuni, 2016). This knowledge could assist TrEds in designing the best possible teaching activities that pre-service teachers can fully engage with.

Collaborative learning activities are versatile in nature and therefore have the capacity to achieve outcomes that were unattainable using traditional lecturer-directed means. Collaborative instructional strategy integrated with the right kind of technology creates room for students to be exposed to a richer learning experience (Forni, Holcombe &Huang, 2013). For example, in this study, TrEd003 designed a learning activity that was a collaboration between students at the research site with students in a teacher preparation institution in United States of America. What made this learning activity rich, was the fact that students on both ends were exposed to a social phenomenon and how it manifests in different contexts. Therefore, the students are equipped to debate the social constructs at an international platform by drawing reference and comparison from information acquired from their international counterparts. Technology-enhanced collaboration gives the students access to information they normally would not have access to (Balaji & Chakrabarti, 2010). It allows them to get an idea of how their experiences relate to those of others in different contexts. Once again, technology is used, in this case, to bridge the diversity gap and enriches the students' knowledge pool.

This teaching strategy used by TrEd002 resulted in achieving modification levels based on the SAMR model, due to its ability to transform student engagement and the way they acquire, process and analyse new information. In their study (Lin, Wang & Lin, 2012) concluded that when students are actively engaged in learning with technology, it provides an opportunity of deeper understanding of content. This finding supports the constructivist core principle that learners actively construct their own knowledge and meaning from their experiences. TrEd's designing of technology-enhanced activities for collaborative learning directly boosted the development of 21C skills.

Most TrEds interviewed, agreed on the affordances of digital technology for collaborative group projects with regards to enhancing communication. However, only two of the observed TrEds exploited digital technology such as social media platforms for group collaboration in class activities. This highlights the fact that TrEds may be aware of technology enhanced activities and their benefits in theory, however, there is still a discrepancy when it comes to practical applications of these. It is possible that this may be due to the fact that TrEds may be finding it challenging to adapt the technological affordances of such strategies into their specific contexts. In other words, they may know how it works theoretically but then find it difficult to implement practically. This points to a possible need for either faculty or subject specific technology application training for TrEds.

Due to its functionality in terms of processing large amount of information and sometimes over an extended period of time, collaboration is typically used in conjunction with project-based instructional strategies (Koç, 2005). The finding in this study also showed that TrEds made use of project-based instructional strategies together with collaboration or teamwork approaches.

5.3.3 Technology-enhanced Project-based instructional strategies

The construction of meaning through project-based learning (PBL) is an approach that facilitates real life problem-solving activities among students. It is viewed as a process that is problem oriented and encourages collaboration in that it requires the student to investigate that context. This further implies that the student is reliant on other sources of information familiar with that context (Baran et al., 2011). This instructional strategy exemplifies a constructivist approach to teaching and learning as the student has direct input on how they acquire knowledge.

Technology-enhanced, project-based strategy uses real-world situations: students are provided with resources and instruction as they develop content knowledge and substantial problem-solving skills (Baran et al., 2011). For example, TrEd002 in this study designed a project based learning activity that allowed pre-service teachers to investigate socio-economic patterns in a specific community, to do that they collaborated with high school students that were part of that community. The success of this projects was facilitated by the use of certain technologies such as WhatsApp to communicate and google application GoogleDocs for synchronous sharing and capturing of information. Students had to use their findings to work on a feasible solution that they would build or design based on theoretical influences. Interestingly, the TrEd in this case upon realising that the pre-service teachers were using WhatsApp to interact, decided to use the WhatsApp communications as part of the assessment on the final portfolios. Once again highlighting the benefit, to both educator and student alike, of student-centred approaches.

TrEd003 with the DST project also requested the pre-service teachers to address the topic of social inclusion based on their real life experiences. The researcher was present at the presentation of these DTSs and noted the authenticity of the presentations. The pre-service teachers shared very personal and emotional accounts of the topic. The level of engagement in this project may be attributed to the fact that the stories the students were telling were personal stories, that addressed real life struggles they had experienced. (Drake, 2017) argues that students develop a sense of responsibility and an accountability when they have to work on projects that are applicable to real life situations. According to Tiantong and Teemuangsai, (2013), the project-based strategy engages students actively and purposefully through their critical thinking and reasoning skills as they will be able to see the tangible result of their contribution. The application of knowledge acquired is key in that it exhibits the development of higher order thinking skills. The Bloom taxonomy model shows that once the student is able to apply what they have learnt they are at an advanced stage of learning (Kurt, 2014; Drake, 2017), they have gone beyond the stages of merely understanding and remembering it.

Technology was used in these cases as a facilitative and creative tool, with regards to accurate data collection processing and presentation. The researcher also observed that in the DST project, pre-service teachers became creators of content using the technological tools. This student-centred approach provides an opportunity for autonomous decision making as students in this example were not told what technology to use rather, they made an informed deduction on what technologies or strategies would best meet their project objectives. It is important for TrEds to consider the benefits of using this strategy in their disciplines i.e. disciplines that require analytical thinking, problem solving and continuous innovative upgrades.

In both cases team members would use technology to consult with others whenever they needed moral, technical and project related help. According to (Tiba et al., 2015), the project based activities tend to be beneficial as they have the potential to (i) motivate and engage learners, (ii) promote voice/self-expression, and (iii) promote collaborative learning and acquisition of multiple skills. As presented, the TrEds only set the goals of what was to be learned, the pre-service teachers themselves, then collaboratively applied their pre-existing and newly-acquired technology knowledge to present their knowledge and solutions on these real life scenarios. This technology-enhanced approach emphasises the constructivist principles that learning should not take place outside of contextual influences, it should rather take into consideration all existing knowledge (Drake, 2017). All these benefits make this approach suitable for the development of 21C skills.

The project-based learning affords transformed teaching and learning processes as well as outcomes. This may be attributed to the autonomous approach that allows pre-service teachers to make their own decisions on how they learn and how they express their understanding of acquired knowledge. This teaching approach is rich in terms of its affordance of choice to the pre-service teachers. Choice with regards to how they wish to explore a concept, how they experience it and how they present it. There was also choice with regards to what technology to use. This approach is also effective with regards to technology integration in that there are numerous sources of technology knowledge. The educator, the students and third party (online sources, peers and knowledgeable others) sources all contribute to the technology knowledge used. Exposure to technology unfolds almost in a snowball fashion.

5.3.4 Technology-enhanced Digital Simulation instructional strategies

Technology-enhanced digital simulations are a powerful instructional tool that allows educators to provide students with an authentic and rich learning environment. A simulation is the creation of logical abstract concepts in a human observable form to enhance the understanding of a certain phenomenon (Mustafa & Fatma, 2013). Simulation instructional strategies fit well with the principles of constructivist student-centred learning and teaching as they increase comprehension through students' experiential learning (Makransky, Thisgaard & Gadegaard, 2016). Digital simulation enables the digital experimentation representation of a physical system. In this study, digital included any digital animations and illustrations of concepts. The benefits of digital simulation, is that students can watch the simulations over and over again until they are able to engage in the habits of critical and evaluative thinking themselves. This approach is supported by studies that reveal repetition as an effective way to master new knowledge or a desired skill (Makransky et al., 2016). Furthermore, simulations are demonstrative in nature as students can be exposed to processes in motion as compared to abstract learning.

In this study, TrEd007 used a digital simulation was to demonstrate to students how the respiratory system functions as observed in a natural science lecture. The TrEd reported that the digital simulations provided opportunities for pre-service teacher to learn difficult and abstract concepts in more elaborate and simplified ways. Another advantage offered by digital simulations is that the pre-service teachers are able to learn a concept through the practical demonstration of a process instead of learning in an abstract manner, i.e. merely reading about the process. This teaching method is argued to stimulate analytical thinking in students aided by the visual aspect of the simulation (Long, Albright, McMillan, Shockley, & Price, 2018). Although some researchers acknowledge that TrEds might use these at the expense of hands-on experience (Kotsampopoulos, Lehfuss, Lauss, Nletterie & Hatziargyriou, 2015), the however see its value removing the danger element in the learning environment, allowing students the opportunity to experiment without posing danger to themselves or others (ibid).

Simulations are mostly used as a safer, risk free option or alternative to exploring what could be high risk life scenarios. Fields that normally use digital simulation include nursing, aviation etc. Evidently in this study, a digital simulation was used in a science subject. However, there are also social science simulations although these are not used as frequently (Rieber, 2005). Digital simulations have pedagogical benefits such as increasing student interest, actively involving the student, reinforcing abstract concepts and motivating students to be explorative (Makransky et al., 2016).

Of all the observed TrEds, only one made use of the digital simulation teaching strategy. The limited use of digital simulation in the current study, raises serious concerns on the relevance and applicability of the current teacher preparation programmes. The study therefore, sees a need to expand TrEds exposure to such technologies by taking part in teaching with technology event, seminars, workshops, field trips etc. Evidently, in a follow up discussion, TrEd007 use of digital simulation instructional strategies was learned from a Science Fair where they got some of the links and simulation on Compact Disks (CDs).

Critical questions that TrEds should ask are whether the simulation helps the students to achieve the intended learning outcomes; does the simulation offer appropriate realism that helps students understand and assimilate new knowledge in an authentic manner. This way, the pre-service teachers have the opportunity to test out various outcomes, this opens up their minds to new possibilities they previously would not have been able to envision.

Simulations have the potential to prepare students for what they will encounter in a real life scenario since it allows them to explore by varying factors to investigate the changing outcome. The student is therefore motivated to learn all alternatives with the understanding of what the implication is to real life experiences. Researchers posit that, when course content shows relevance, it helps students to better understand concepts: students are more able to develop into engaged, motivated and self-regulated individuals (Khalil & Elkhider, 2016; Shifflet & Weilbacher, 2015; Kramarski & Michalsky, 2010).

TrEd007 mentioned the importance of simulations in his science classes:

> *I am not a techno (laughing)… a friend showed me how to use video simulated experiments before real experiments…I download YouTube simulated videos…I have witnessed my students build confidence prior to physical experiment, when digital animated simulations are used…learning is social, learning science is also social...*

The TrEd pointed to YouTube content-specific instructional video simulations that assisted them in the presentation of abstract scientific concepts or experiments. However, there has been arguments on how this approach remains one directional as student engagement remained limited (Henrie, 2016). In other words, digital simulations are considered as directed instruction rather than facilitators of students' active knowledge generation through hands-on practice. In response to this argument, proponents claim that they offer self-contained and self-paced units of instruction (Davidson, Richardson, & Jones, 2014; Gibson et al., 2014). In addition, as mentioned earlier, it is up to the TrEd to ask relevant questions in order to decide on whether a certain simulation will meet their teaching and learning objectives, thereby emphasising TrEd's TPACK.

In conclusion, all the TrEds in this study were using technology in conjunction with various teaching strategies, however most were used without a theoretical guide and were mostly lecturer-directed instructional strategy. Only a few TrEds indicated a knowledge of technology integration models and this was because they had been exposed to them during the course of their studies. Therefore, emphasising the importance of incorporating these models as well as contemporary teaching theories in training and development as will be discussed below.

5.4 TrEds Professional development

Irrespective of having attended staff development workshops facilitated by the institution, participating TrEds reported that either they did not benefit from the workshops or they did not know how to tailor the technologies for their specific disciplines. TrEd005 was a typical example as they reported that:

> *… I have attended some staff development training, unfortunately, I didn't learn much to help me use technology in my lectures…*

Therefore, although they might be aware of a basic technology function, most of them could not appropriate it to achieve teaching goals effectively as indicated in Figure 5.1. This highlights the importance of professional development interventions that familiarise TrEds with technology integration models such as TPACK and SAMR. A TPACKed educator is one who not only knows the technology affordances, they are able to match these affordances with the right kind of teaching strategy in the delivery of specific content or concepts. The objective is not to consider these elements in isolation but to be able to assess how they complement each other. A model such as the SAMR model has even greater benefits in that it directs the use of technology towards an outcome, it gives more focus on the output of integrating technology (Henrie, 2016). Therefore, professional development plans should not merely focus on presenting new technologies to TrEds, that is just *the what* and it does not offer *the how*. This leaves them with technology knowledge they cannot appropriate for teaching objectives. Researchers have found that, the lack of technology integration in teaching is not always a result of the lack of technological resources or knowledge but rather a lack of implementation skills (Cloete, 2017). This may explain findings made by (Fredrickson, Vu, & Crow., 2014), in a cross-national study where they found that the abundance of technology in classrooms did not directly translate into abundant technology use.

In responding to factors that either affect or effect the use of technology in teaching, most TrEds responded that although technological interventions were made available they usually were general in nature. In other words, the TrEds felt that they were inadequately prepared to teach with digital technologies for their specific contexts. This was validated by the pre-service teachers who, during the focus groups, reported that they felt TrEds were not using technology appropriately in their practice. The majority of TrEds interviewed expressed the need for professional development programmes that meet their professional needs. TrEd005 had this to say:

> *I personally think the professional development I attended fell short of my expectation… yes I need to learn the technology… but I expect to be guided on what tool … makes it easy for them (students) to comprehend concepts… unfortunately I felt the PD were too general…*

This points to the fact that TrEds require technology integration guidance that is specific to their respective disciplines. It is possible that certain technology resources may be more suitable for certain disciplines than they are for others (Oigara & Wallace, 2012). Different technology affordances may also impact content delivery in unequal measures. The researcher acknowledges the fact that such an exercise where technology resources are tailored for all available disciplines may prove to be time consuming and daunting. The solution is to equip TrEds with the right kind of framework to operate in which allows them to manipulate even general technology applications for the achievement of their teaching objectives.

While collecting the information of the participants of this study, the researcher noticed that some of the TrEds were content knowledge experts who are not necessarily trained in professional teaching knowledge required for effective knowledge dispensation. This is a common practice in higher education where content experts are taken on as TrEds. The problem that this creates is that these TrEds may struggle with their implementation of content knowledge dispensation – they may not be fully equipped on the know-how of knowledge sharing. Shulman (1986:9) argues that in such cases the TrEd is then not fully equipped with knowledge of "…*the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations – in a word, the ways of representing and formulating the subject that make it comprehensible to others*." This therefore implies that although they understand the content (CK), they may not have the knowledge and skill on how to breakdown complex concepts into meaningful, coherent and easy to learn units (PK). This points out to the need for TrEds that have gone through professional studies or at least have some qualification in Education. This approach would address the issue highlighted earlier of TrEds that are not TPACKed as the educators are well informed on their content areas but do not fully comprehend what teaching practices work best for their content areas and in extension how to optimise available technology resources in content delivery.

TrEds reported to feeling inadequately prepared to teach with technology, therefore most of them continued to fall back on familiar traditional means of teaching. This highlights the need to bridge the TrEds from their old and familiar teaching approaches into the 21C ones. Considering that most of the TrEds were themselves trained prior to the advent of teaching with technology they are making use of strategies that they have been exposed to but have overtime become ineffective to the 21C context. Referring to Table 4.1, most TrEds have been practising for an average of 10 years implying that they have been using techniques that were relevant to when they started teaching. During that time, most of the teaching theories that were being implemented in institutions were behaviouristic in nature, teaching success was measured by how much the learner could remember and repeat; a certain and specific outcome indicated that teaching objectives had been accomplished (Smeda, Dakich, & Sharda, 2014). This therefore suggests that TrEd professional training should incorporate constructivist interventions such that 21C teaching with technology can be easily practiced.

The other factor that was raised was around training delivery. TrEds reported that the logistics around professional development training workshops were badly managed with regards to timing and training venue locations. Considering that the participating TrEds were from the faculty of education and followed a different schedule from the other faculties, they felt that workshops were arranged during times that clashed with their faculty's teaching schedule – a result of collective or general intervention deployment. The same was argued with regards to venue locations which considering teaching schedules became difficult to access due to time constraints. This implies the need for a decentralised professional development programmes. This highlights the importance of have training programmes managed at faculty levels as it would assist in avoiding such discrepancies. The advantage of decentralised professional development programmes is not only towards managing logistics but also speaks into training relevance. A training programme arranged by a faculty is highly likely to be tailored for them, thereby moving away from the general ones. On the point of relevance TrEds also reported that technology training facilitators were not educators, therefore, they promoted the product but were not able to show how it could be tailored for specific fields. The result of this was that although technology was made available it remained unused. The concern around having non-educators as training facilitators is that the technology experts focus on promoting the technology and its general functions but fail to show how it can improve content comprehension. This is demotivating to the TrEds as they cannot relate to the technological expert. Researchers have found that TrEds are more open to leaning how to use certain technologies when mentored by a tech savvy colleague than by technology expert (Fredrickson et al., 2014). In this study this was exhibited by TrEd007 who mentioned that they had use of a digital simulation after being exposed to it by a colleague and seeing its benefit to their own teaching objectives. To emphasise on the point of relevance, TrEds in this study testified were even accepting of technologies introduced by the pre-service teachers as they could immediately see its benefit to teaching and learning.

The difficulties in integrating technology as reported in this study, were attributed partly to shortfalls in professional development programmes. As indicated by the results, TrEds were making use of technology but without considering its effectiveness in content delivery for development of 21C skills. This was traced back to the fact that technology was being deployed from a general perspective without bearing in mind faculty specific teaching and learning needs. TrEds were not made aware of how to use the technology in their specific disciplines, so they used the technology at its very basic functions or not at all. The few TrEds that were able to optimise technologies at their disposal were able to do so as they had been exposed to PCK/TPACK models in their own studies. This highlights the importance of incorporating contemporary technology integration models into teaching with technology interventions.

To this point we have presented technology integration findings, mostly at TrEd individual level – how TrEds experience teaching with technology. However, during the investigation TrEds continuously stressed institutional policies and structures that presented challenges in how they make use of technology in teaching and learning. Professional development challenges as presented above are one of the many symptoms of these structural limitations. The next section highlights the findings on technological challenges as they occur at institutional levels

5.5 Technological challenges at institutional level

TrEds in this study indicated various challenges that they have in integrating technology in their teaching practises. This section focuses more on challenges that TrEds brought up that need to be tackled at institutional levels as they usually boil down to and manifest in individual technological difficulties and frustrations. Ananiadou and Rizza (2010) explain how the failure of TrEds to model technology in their practice could be a direct result of gaps in policy, quality control or practical implementation strategies.

TrEds expressed concerns on the institution's ability to avail effective technical support personnel to assist them on technological problems that arise. TrEds mentioned that on several occasions they have had technological issues which the onsite technicians have been unable to troubleshoot and therefore resolve. Khan, Hasan and Clement (2012) report that educators in Bangladesh faced similar challenges of few qualified technology personnel. Drawbacks such as these may result in TrEds having no motivation to utilise technology due to a general disgruntlement as they sit with unresolved technological problems. TrEd001 expressed their discontentment caused by a technical problem with a Smartboard that they were using intensively for the benefit of the students. Neither the onsite technician nor the supervisors at headquarters had enough knowledge of the technology to resolve the matter, TrEd001 therefore had to resort to using the traditional whiteboard. This therefore implies that, similar to the need for proper training when addressing professional development matters as previously discussed, it is equally vital to have fully trained and equipped IT support staff, as they are the immediate assistance available to TrEds. The other challenge is that the onsite IT support staff do not have administrative permission to resolve network challenges; although they might be able to solve an arising problem, they do not have the right to effect it. The institution policy and structure dictates that they must contact headquarters where an individual who has the right permission can effect it. This is a bureaucratic issue, as decisions and therefore technical rectifications are delayed and sometimes not effected.

Additionally, TrEds reported that the IT support staff were not trained to foresee possible technical problems and prevent them before they arise, they can only assist once a technical error has occurred. A factor possibly contributing to the lack of foresight was that there was very little maintenance taking place. The TrEds reported that they were not aware of, neither had they seen any evidence of a scheduled routine check of the available technology resources.

During the researcher's observation of technological infrastructure and resources, they observed that some of the hardware and software technology resources were outdated. For examples most of the PCs were still running on Windows 10, Microsoft office was a 2007 version. Some of the PCs themselves were also an older model of Pentium PCs. The problem created by this lag in technological trends is that when new applications are introduced, TrEds are unable or struggle to make use of them as the existing technology proves to be incompatible due to being outdated.

Another factor that was observed to affect the integration of technology was venue set-ups as well as the availability of technology infrastructure. The section that follows discusses findings made by the researcher with regards to the physical facilities at the research site.

5.6 Venue set-ups and available technology infrastructure

The researcher embarked upon a physical campus tour with a technical staff member who highlighted the teaching and learning technology infrastructure at the selected University of Technology. During the tour, the researcher took pictures and noted the conditions, accessibility, quantities and capacity of these technologies. The purpose of this exercise was for the researcher to become more acquainted with the context in which teaching with technology was taking place. The findings of this exercise gave an insight of the affordances of the physical set-up of the research site to technology integration. The researcher was also exposed to the available technology resources as availed to TrEd, both hardware and software.

5.6.1 Lecture venues and available hardware resource

The main building, in which the observations were conducted, had twenty-five traditional lecture rooms; three lecture theatres; four computer labs; three science laboratories; and one library complex at the faculty of education campus selected for this study. Each lecture room had a seating capacity of between 30-150 students and the lecture theatre seating capacities ranged from 70-100. The four computer labs in the faculty had a seating capacity of 60-150. The science labs and library capacity ranged from 30-50 and 300-500 respectively.

5.6.1.1 Lecture rooms

At the site of the study there were twenty-five lecture rooms: each had a projector mounted on the ceiling and a whiteboard that served as both writing and projector screen. In front of the lecture room there was a podium or lecturer's console set close to the front wall to enable access to the projector connections and power plugs for laptops.

Most lecture rooms were arranged in an orthodox, authoritarian oriented style. Desks and chairs were set in rows facing the front. There was a single power plug in the front next to the lecturer's desk. This architectural arrangement reinforces an instructional attitude of behaviourism, one that promotes traditional lecturer-centred approaches were teaching and learning is a one-way process (He, Cermusca, & Abdous, 2010). In some lecture rooms, there was a chair and desk combination designed for individual sitting only thereby teamwork and collaborative exercises were not supported in these venues.

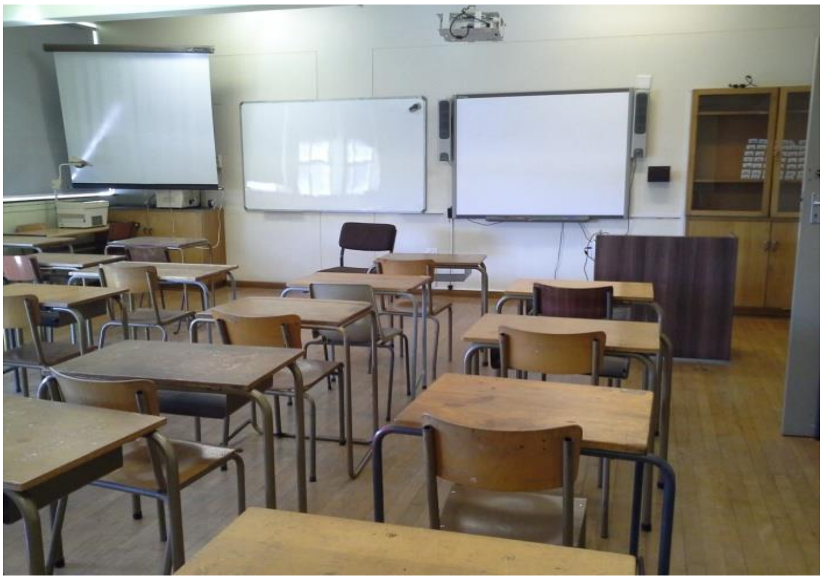

Figure 5.2 Single seating lecture classroom setup

Figure 5.2 above shows a lecture room with a Smartboard mounted setup, with single student desk arranged in rows and columns. This set-up creates a teacher controlled environment and students are isolated in an undefined space where interaction is not encouraged. The rows lecture room set-up is not conducive for conversations and discussions to take place therefore students are inclined to become passive participants as the TrEd is at the centre of learning.

Figure 5.3: Mathematics room with a Smartboard and cluster setup

In Figure 5.3 desks are joined to create nests around which chairs are placed; ready for group sitting set-up. This arrangement allows for improved student to student interaction and the TrEd can easily move around from group to group. This kind of set-up broadens the range of options of teaching activities that the TrEd can employ (Simmons, Carpenter, Crenshaw, & Hinton, 2015). This set up promotes a gravitation towards more learner-centred teaching approaches. As it can be observed from Figure 5.3, the placement of the TrEds desk is placed away from the centre of the classroom and more towards the corner of the room, suggesting that the TrEd, in this case, can hold more of a facilitative role and interject wherever necessary.

Five of the twenty-five lecture rooms were equipped with Smartboards. The rest of the lecture rooms had a projector and a display screen at the front of the room. Although the Smartboard was not available in all lecture rooms, TrEds were able to accomplish the same teaching objectives through the use of PowerPoint. This suggests that the availability of Smartboards did not necessary provide any advantage due to underutilisation. The TrEds with the Smartboard facility had the advantage of using the extended functions of the Smartboard as compared to the projector, however, they did not use them. For example, all participating TrEds were observed using the Smartboard as a mere projection screen. The researcher therefore made a deduction that it is possible the TrEds were perhaps not well prepared to appropriate this technology for student-centred teaching outcomes.

As indicated earlier, outdated facilities constrain TrEds to fall back upon the strategies of unilateral information transfer which were passed on to them by their educators. This observation is in line with what other studies have argued, that educators face challenges to utilise the opportunities provided by interactive digital technology; due to the physical traditional architecture of their teaching venue and a strong inclination among educators to repeat the habits of their own training (Attwell & Hughes, 2010; Guðmundsdóttir, Dalaaker, Egeberg, Edvard & Hultman, 2014). This points to a need for institutions to support TrEds integration of technology by upgrading to more modern and constructivist lecture room set-ups. In a video on *Teaching methods for inspiring students for the future* by Joe Ruhl (2015), he highlights how he has switched his classroom setup to accommodate different forms of interactive learning; the students choose which learning activity they are comfortable with, in groups or individually, some employ hands on techniques, others will sit and watch online video tutorials. He has created a physical environment that allows for modern student-centred activities to take place.

5.6.1.2 Lecture theatre venues

The three lecture theatres had fixed sitting, all facing the stage and in the same direction as in conventional setups. At the front of the lecture theatre, there was a wooden podium close to the front wall with a network and a power plug mounted on the podium and a data projector attached to the ceiling. The network connectors were mounted on the podium; although not always functioning and rarely used by the participating TrEds. The reasons for not using the network connectors ranged from the connectors not working, use of the projector and PowerPoint presentation only, or use of Wi-Fi as an alternative. A whiteboard and a projector display screen were mounted in the front. In all three of the lecture theatres, the projector screens were operated by remote control. However, the remote controls as observed were usually missing therefore creating a challenge for TrEds to make use of the projection facilities. Figures 5.4 and 5.5 are examples of the set-ups of the lecture theatres.

Figure 5.4: Lecture theatre venue3

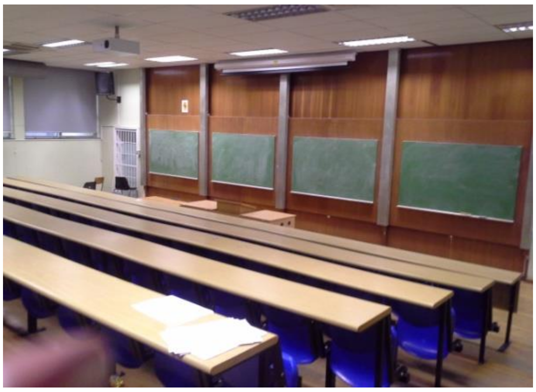

Figure 5.5: Lecture Theatre venue1

Figure 5.4: Lecture theatre venue shows the side glass walls which provide adequate

sunlight but no blinds were mounted to control the light which affected visibility. Figure 5.5 is a 200-seater lecture theatre with fixed swivel seats. The lecture theatres were designed for large audiences therefore audio and visual facilities were in place. Similar to the lecture rooms, TrEds using lecture theatres were mostly using the technological facilities for substitution purposes. For example, TrEd005 was making use of PowerPoint and the projector, however, they did not fully utilise the functions of the technology as the content of the slides was visibly copied from other sources and pasted on a slide. This entails that TrEds were making use of technology but without achieving optimum use, a problem that can be remedied by employing technology integration models such as SAMR that focus on outcomes of technology use (Keane et al., 2013). The following section reports on the science laboratory setup.

5.6.1.3 Science Laboratory venues

The six science laboratories on the campus were used specifically for natural science, physics, biology and chemistry courses. Figures 5.6 and 5.7 are examples of the set-up of the science laboratories. The labs are set-up in a traditional front facing sitting with the TrEds desk at the front facing the class. However, the student working area is fitted with resources for experiment e.g. gas-taps and other science equipment designed to facilitate group work. In some of the science laboratories there were Smartboards and projectors mounted. Apart from these digital devices, the laboratories were furnished with science apparatus and resources. The provision of experimental resources allows the learner a hands on approach to learning, researcher have reported the benefit of hands-on learning to comprehension of concepts (Ottenbreit-Leftwich, Brush, Strycker, Gronseth, Roman, et al., 2012). However, the researcher observed that the science apparatus provided were not fitting for 21C class as they were older models, highlighting a need for up to date technological resources. Research shows that there is value in keeping up-to-date with technological advances as this helps students to stay relevant in an increasingly globalised community (Ravenscroft, 2010; Schleicher, 2014)

Both the set-up and the technology resources available in these labs are adaptive to the main use of a typical science lab which inherently is for hand-on demonstrations and not mere oral presentations. The demonstrations are facilitated by the Smartboards in the labs since they come with built-in digital simulations. As observed, TrEd007 in a natural science lecture made use of a simulation to demonstrate the respiratory system using the Smartboard application.

Figure 5.6: Biology Laboratory

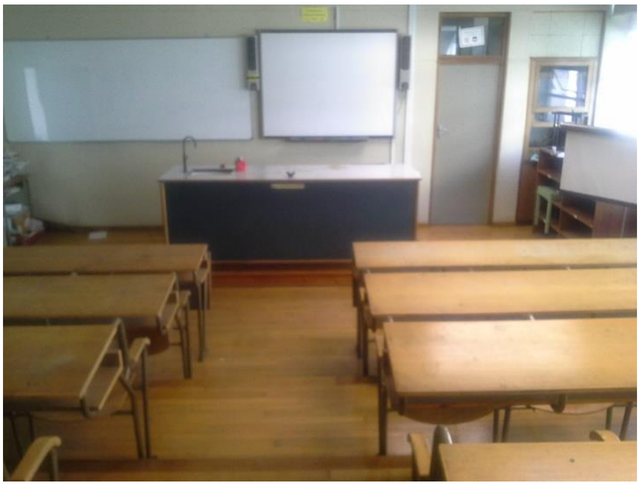

Figure 5.7: Science lecture theatre venue

Figures 5.6 and 5.7 shows the smartboard set-up in a science laboratory.

In one of the science labs, the researcher observed a personal computer (PC) that looked unused as it was not set-up for use, it was placed in a corner covered in dust (Figure 5.8).

Figure 5.8: Science Laboratory

This could be considered as being indicative of failure to utilise available resources as well as the poor maintenance of technological resources. As observed, the technology conducive for science labs is available, the set-up also supports hands-on, demonstrative as well as collaborative learning activities. The challenge, however, is for the TrEds to fully exploit the technology to better enhance their instructional strategies.

5.6.1.4 Computer laboratories

During the period of investigation for this study, six computer rooms were examined. Three are used by both students and lecturers for teaching and three laboratories were reserved for students' general purposes and were located close to the students' residence. The labs had PCs that ranged from 60-150 in quantity and were all connected to the internet. The teaching and learning computer laboratories had a PC designated for the TrEd's use that was connected to the projector.

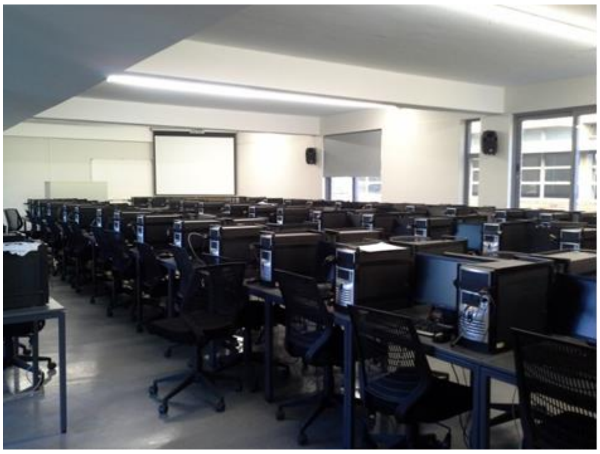

Figure 5.9: Computer lab setup

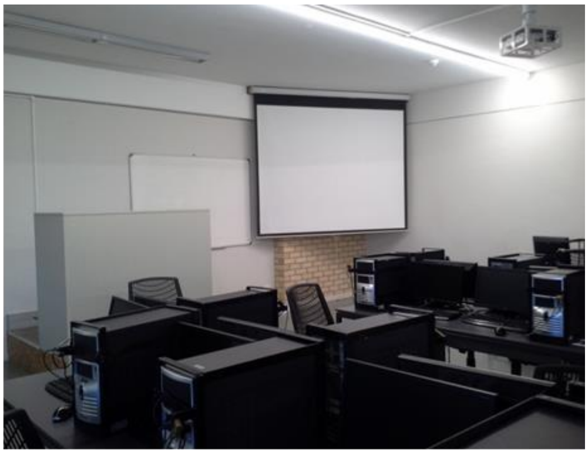

Figure 5.10: Computer Lab front view setting

Figure 5.9: Computer lab setup and 5.10 show the new computer laboratories constructed during the years 2015/16. All the computer rooms exhibited the same arrangements; except for the number of the computers as per the size of the rooms. Interestingly, the teaching and learning labs were reserved for CAT (Computer Applications Technologies) and IT (Information Technology) students only. This directly limits access to technological resources for TrEds in other disciplines as it is possible that they may also design a learning activity that could make use of computer labs, lack of access limits their options.

The computer room arrangement, particularly with the lecturer's podium in the front of the laboratory, accentuates the design of lecture-centred instruction that limits student interaction and group work activities (i) among students and (ii) between lecturer and students. Although the computer rooms were well ventilated, having 120 computers in a 1200m2 space limited student mobility. This restrictive and conformist learning space invites TrEds to take charge and endorses the priorities of authoritarian tuition in which knowledge is seen to be possessed by one central figure that dispenses it to students (Haitham, 2017). Knowledge in this case, is not constructed and re-interpreted but is regarded as a finished product to be passed down from one knowledgeable authority to those in need of it.

5.6.1.5 The library

Figure 5.11: Computers section in the library

The library is customarily the information heart of any higher education institution. 21C libraries complement their traditional hardcopy books with electronic resources. The library in this study was recently restructured and reconfigured: it had a computer section with 10 cubicles intended to house 10 PCs connected to the internet (see Figure 5.11: Computers section in the library). However, none of the cubicles had been fitted with computers except one which was not connected. The librarian was waiting the deployment of the computers by the centralised ITCs. The faculty technician stated that all hardware and software was coordinated at the central ITCs office. The researcher observed most students using textbooks, a few with personal laptops were seen working in breakout cubicles. This suggests that lack of digital resources and facilities in the library, students are left with no option but to use outdated textbooks. Empirical studies have established that 21C students frequently use online library materials than textbook sources (Nnadozie & Nwosu, 2016).

The institution's library's website offered support on digital resource searches, interlibrary loan facilities and a wide range of support on sourcing digital resources. The downside was that in the physical library there were no computers installed for students to access the website from within the library, this suggests no or limited resourcing of technological resources into the library. In the current library arrangement, access to technology was unavailable as there were no visible computers for students to access digital resources. The following section presents a description of the selected institution's hardware and software resources available to TrEds and pre-service teachers.

Table 5.1 provides a list of the hardware technologies found in each type of lecture venue reported above. The letter ‘Y’ shows where technology resources were available and ‘N’ indicates their absence. The technologies were maintained by the technical personnel on campus.

Table 5.1: List of available hardware for teaching and learning per venue

	Lecture room	Lecture Theatre	Computer Laboratories	Science laboratories	Library
Lecturer PC / Laptop	Y	Y	Y	Y	Y
LCD Projector	Y	Y	Y	Y	Y
Projection screen	Y	Y	Y	Y	Y
Sound System Wired	N	Y	N	N	Y
Microphone	N	Y	N	N	Y
Wi-Fi and / or internet points	Y	Y	Y	Y	Y
Smartboards	Y	N	N	Y	Y
Input Cables (VGA with 3.5mm audio, HDMI & Aux Video)	Y	Y	Y	Y	Y
Student internet enabled computer laboratories	N	N	Y	N	N

Table 5.4 lists the available hardware technology in all lecture venues across the campus. It shows that there comprised one standard form of technology in all venues i.e. projector and Smartboard or projector and screen. The institution's Technical Services Department (CTS) distributes technology resources to all the campuses. Set-up and installation are conducted by technical personnel stationed at each campus. The specification of the available hardware resources technology in the various lecture venues is standard i.e. Pentium 4 processors, a maximum of 500MB hard drive and 250MB RAM processor speed of 2 megahertz.

As highlighted earlier, the TrEds reported that the available technology was not maintained and continuously malfunctioned. TrEd001 who demonstrated high level skills of using technology; explained the frustration they experienced when the Smartboard broke down. They revealed that because their students were enjoying and showing comprehension of Mathematics, they were even prepared to personally fund the repair works. In their study, on educators' motivation on integration of ICTs into pedagogy, Chigona et al. (2014), suggest that availability of technical support motivates educators to use technology in their practice. In their study, Ertmer et al. (2007), reported that educators are reluctant to use technology if it is not easily accessible. The researcher's observation indicated that the technology equipment available was very old and scarcely maintained therefore TrEds consistently experienced technical faults that resulted in them having a resigned attitude towards use of technology. Czerniewicz and Brown (2009) in their study also raised concerns on poor maintained equipment and its negative impact on educators drive to integrate technology into their teaching practices.

To sum up, the availability of technology resources, in this case, fully functional hardware for teaching, encourages and supports TrEds to practice technological knowledge. However, this was not the case for most TrEds in this study, as availability of technology did not directly result in successful integration due to poor technical maintenance and support.

5.6.2 Software resources accessible to TrEds

Software are programs designed for end-users, either for specific use or general purpose. During the interviews, TrEds explained that the process of requesting content-specific programs such as geogebra, graphmatica etc., as tedious and discouraging. This was due to the bureaucratic process of having to request them from the central ITC which was located on a different campus. Others raised concerns of outdated applications even for administrative work and their irrelevance with regards to teaching and learning programmes as the outdated applications made it impossible to update some application functionality as they were incompatible. In most cases, these outdated applications would not open files from later versions of the application. Similar findings were reported in a study by (Tiba, 2018), who observed that software is an enabling factor for educators to use technology.

The study site is supported by a central ITCs that provides various software packages for teaching. The researcher gathered that the MS Office application was popular amongst TrEds, therefore Computer and Telecommunication Services (CTS) had installed it in all lecture rooms, lecture theatres, science laboratories and on all the computers in the computer laboratories. Table 5.5 below lists available software supplied by the CTS to all computers on the campus under study.

Table 5.2: A list of the software installed in campus computers.

Main category	Sub-category	Lectures observable strategies
Microsoft Operation and Application Software	Microsoft Windows 10	
	MS Office suite 2010	All TrEds used PowerPoint to display content and students were taking notes/others were using their phones to capture the slides. One lecturer projected a word processing document which had typed notes and students were writing notes others used their phones to capture the screens.
	MS Photo story	The TrEd demonstrated how the MS Photo story works and students had to produce their individual digital stories using the program.
Internet	Web 2.0	It was significant that one TrEd opened a blog and used the discussions to explore learners' understanding of the content.
	Internet Explorer Google Chrome Firefox	Information resource
Learning Management System (LMS)	Blackboard	Institution's LMS for the engagement between lecturer and students – uploading assignment tasks, lecture activities, notes, PowerPoint presentation, assessing, posting notices and so forth.
Programming	Delphi	The programming software is used by Information Technology pre-service teachers
	Net beans IDE for Java EE Developers	
	SQL Client	
Social media	YouTube	For a life sciences TrEd, the lecturer had a YouTube video that illustrated a concept and the demonstration an experiment
	WhatsApp	TrEds and students engaged with each other using the WhatsApp messaging system, posting notices, seeking help or notifying others on change of venue or lectures
	Facebook	One TrEd mentioned that she had a class Facebook account.

The tertiary institution of technology selected for this study provided basic and standard technology resources, there were few content-specific applications that TrEds could use in their teacher preparation programmes. This shortcoming implies that pre-service teachers graduate without a thorough knowledge of content-specific applications found in their discipline areas. One pre-service teacher voiced their concerns that schools expect them to be fully familiar with technology because they are graduated from a higher education institution of technology yet that was not the reality. This disjunction between pre-service teacher preparation and employer expectation requires restructuring of …. and provision of relevant technology resources; specifically, to meet the requirements that train and equip pre-service teachers with 21C skills. The next section reports upon the institution's network online connectivity.

5.6.3 Connectivity and online resources

During the course of the observations, the researcher noticed the constant struggle both TrEds and pre-service teachers had with connectivity issues. Both wireless and non-wireless networks proved problematic as users could not easily connect to them, when they managed to, it was slow and difficult to use. This poor connectivity directly resulted in poor motivation to use available applications and usually forced TrEds to revert back to old traditional means of teaching. For example, TrEd006 tried to access some information from an online source during class, however, due to slow connectivity, they were not successful in making use of that resource and ended up having to give a verbal explanation of what they had intended to show. The researcher observed from the TrEds body language that the TrEd struggled to explain the concept, highlighting how the failure to access the online source compromised the delivery of this lesson. It also made it impossible to easily access online teaching and learning resources. Both lecturers and students expressed frustration about technology infrastructure; including access to technology devices, reliability of Internet connectivity and access to technical support in resolving these problems.

The need to easily access online resources is specifically crucial at the institution on which this research was conducted as it is for many other 21C institutions of higher education. This is due to the fact that the institution has a number of online resources and function that require for network connectivity to always be at its best. The institution employs a Learning Management System – Blackboard (BB) that empowers TrEds and pre-service teachers to experience online learning and affords them access to its resources at any time and from various locations. Lecturers use this digital platform to post announcements, upload course resources, assessments, grading and provide feedback in real time. TrEds can initiate virtual discussion forums and track students' access and usage of various resources. This emphasises the importance of having access to these digital resources at all times for both

TrEds as well as the students, (Henrie, 2016) as it facilitates teaching and learning to actively continue to take place outside of the classroom. Students ability to connect and conduct their own research, engage in discussions as well as explore online resources removes the dependency on the TrEds to be the main and sole source of information (Henrie, 2016).

The institution's library also encourages the need to have fully functional services as it provides many online resources to assist both TrEds and pre-service teachers in their research activities. The library subscribes to a variety of online databases and academic journals that enable TrEds' and students to have free access to a wide variety of educational resources. The library system allows staff and students to request access to other local universities; through the inter-library loan system. These operational requirements of the institution are key in providing 21C constructivist learning outcomes. They imply that there can be no compromise with regards to provision of quality network services, its impact is vast and affects numerous activities.

The problem behind the connectivity issue is that the infrastructure set-up does not have the right kind of capacity to sustain the demand on the resource. The IT technicians responsible for setting up this facility need to ensure that they install resources that have the proper capacity considering they are supplying an educational institution with numerous users. The frustration both TrEds and students had was that this was an ongoing problem which IT technicians had continuously failed to resolve. To bridge the gap in terms of moving towards technology-enhanced teaching strategies, there is a demand for decision makers to commit to considerable investments in terms of infrastructure and technical personnel development (Ledford, 2016). Limited access to technology infrastructure is likely to discourage TrEds implementation of teaching with technology initiatives in the 21C. In support to this, researchers (Kozma, 2011; Lindqvist, 2015) suggest that free and open access to functional technology infrastructure positively influences TrEds' use of technology that supports delivery of their lessons. Considering that the main goal of 21C education is to develop students that possess knowledge that is highly critical and applicable at a global scale (Stanley, 2017), there is a demand that their resources toward knowledge acquisition be of the same aptitude – from global sources. The immediate channel to these resources is internet access.

From the above exploration on the existing hardware and software resources available to TrEds for teaching and learning at the selected faculty, the available facilities are inadequate and poorly maintained. There is an urgent need to expand the technological capacity to meet the demands the 21C imposes on TrEds with regards to instructional strategies.

Additionally, there is need for an upgrade with regards to up-to-date technologies as well as technical support. However, the potential of existing technology infrastructure and resources can be realised only if the TrEds are empowered and supported to use the technology in a constructivism directed manner. The challenge is for TrEds to adopt a framework that directs them towards the implementation of student-centred strategies, that way they can utilise the available technology resources more intentionally for a specific purpose.

5.7 Chapter summary

The chapter presented the findings of the study with regards to teaching with technology strategies employed by TrEds. It outlines what technology-enhanced instructional strategies TrEds used in preparing pre-service teachers to teach with technology. The findings revealed how TrEds interacted with, and largely sustained, traditional instructional strategies. The researcher sought to explain these practices by relating to the conceptual framework of the study. The findings underscored the commonly-held views that TrEds are inadequately modelling the practice of teaching with technology in their teacher preparation programmes. The main finding shows that TrEds are making use of technology however, they were not using it to its optimum level. The concern remained on how effectively they are using it in relation to teaching strategies i.e. student and or lecturer-centred strategies.

The discussion around this area highlighted that this was mainly due to the lack of uptake of contemporary teaching and learning theories as well as technology integration models. The result of this limited integration of technology into teaching was highlighted by the pre-service teachers who reported that they also felt inadequately prepared to teach with technology as TrEds were not able to demonstrate this for them. The important fact to note is that both the TrEds and the pre-service teachers realise the importance of integrating technology with teaching practices, the challenge is on how to effect it. The researcher found that, vital in addressing that concern, was making available to TrEds relevant technology resources, specifically to meet their need as dictated by the different disciplines. However, the researcher argues that when TrEds are fully equipped with the knowledge of technology integration models such as SAMR and TPACK they can make use of general technology application and achieve equal outcomes.

An interesting observation was that TrEds during the interviews considered themselves as using the technology constructively – but observing them in their natural setting revealed that they were limited in optimising the affordances of technology that supports transformative student-centred teaching strategies. This limitation, the researcher deduced, was a practical manifestation of their acknowledgement that although they were aware of teaching theory, they did not consult any of their principles in learning activity design. Professional development was highlighted as being essential in achieving the implementation of teaching with technology strategies in teacher preparation programmes in the 21C. However, the researcher posits that professional development should be progressing equally at individual and faculty levels to ensure that the integration of technology occurs continuously and in a manner that is relevant to the TrEd in their particular discipline.

The findings of this study highlighted that the greater concern around the issue of teaching with technology was not, TrEds using technology, but how they were making use of it. The researcher concludes that the discrepancy highlighted by the findings, where TrEds perceptions of their technology integration skills is not matched by their practice as observed, is due to the fact that TrEds practice in terms of technology integration, did not have any theoretical influences. This therefore suggests the implementation of professional development programmes that expose TrEds to such models and theories so that their practice may be grounded on tried and tested 21C technology integration interventions.

Two of the TrEds in the study who had some knowledge of the TPACK model were able to integrate technology in a more constructivist manner as compared to the other participating TrEds. However, the researcher noted that even in these cases sometimes the technology was paired with a lecturer-centred teaching strategy. This may be attributed to the fact that the TPACK model is designed to focus mainly on the technology aspect and how to best use it in relation to pedagogy and content, in other words it is teacher centric. What TPACK lacks, is a link or guide to teaching and learning outcomes. The SAMR model, on the other hand is designed to direct technology integration to a specific teaching and learning outcome. Its higher level outcomes, modification and redefinition, are linked to the constructivist principle of student-centred teaching activities such as collaboration, project based assignments as well as simulations.

These findings draw to the conclusion that although TPACK and SAMR models are useful, there is a need to implement them in a constructivist scope to ensure the development of 21C skills. This is because the models on their own can be applied but the outcomes of technology integration can still be limited. The researcher therefore presents, in the next chapter, a holistic model that incorporates all the elements of TPACK, SAMR and the constructivist learning theory, to ensure a more practical and fitting approach to teaching with technology for the 21C.

CHAPTER SIX

THE CONTIS MODEL

6.1 Introduction

Following the findings, discussion and reflections of the study, this chapter presents the proposed ConTIS model, which is an amalgam of constructivist theory underpinnings with TPACK and SAMR models. The model stands to answer the main research question of this study which is: *What do TrEds need to effectively prepare pre-service teachers to teach with technology in the 21C?* The researcher accompanied the model with an evaluation checklist to aid TrEds in locating their teaching with technology skills level. An interesting finding from this study was the fact that what TrEds thought were technology rich lessons, in fact, are rated at the lowest SAMR category of substitution. This proves that the main focus for TrEds to date, has been to make use of technology without a concern on how effective the technology is in relation to teaching strategies and content towards achieving teaching objectives.

The proposed ConTIS (constructivist Technological Instructional strategies) model enables TrEds to be constantly aware of the level which they are performing at in terms of successful technology integration. Additionally, they can evaluate their current teaching practices and explore various opportunities with the guide of constructivist principles in conjunction with TPACK and SAMR models (refer to Chapters 3). This will help to improve their approach to teaching with technology strategies in a continuous personalised, sustainable and viable manner. The proposed model is also designed for universal use as it can be used across disciplines.

This chapter is arranged into the following main sections based on central questions running through this study:

Section 6.2 Overview of the proposed process model

Section 6.3 The Adapted Conceptual Framework

Section 6.4 The elaborated ConTIS Model

Section 6.5 Importance of the ConTIS model

Section 6.6 Chapter Summary

6.2 Overview of the ConTIS process model

Morris (2012) alludes to the need for educators to model 21C teaching and learning strategies with emerging technology (Chapter 2). The proposed process model contributes to the urgent need for TrEds at teacher preparation institutions to effectively help model 21C teaching practices using technology. TrEds have considerable opportunities at hand if they are equipped to deal with such new thinking and if they are confident in and able to apply the technology knowledge. The ConTIS model's integrative approach facilitates the 21C awareness, diagnosis and correction of teaching with technology strategies in an affordable, effective and efficient way. This chapter sets out and explicates the uses and benefits of an integrative model that accelerates the process of improvement towards achieving teaching with technology competency. The model also presents the benefit of being useful at a TrEd individual level (self-diagnosis, self-evaluation) as well as at organisational level (departmental wide diagnosis and evaluation) so as to come up with appropriate interventions which ideally should feed into each other, i.e. the department objectives should dictate what individual TrEd should work towards, in reciprocation, the individual TrEd needs should advice departmental intervention. The researcher also anticipates that the ConTIS process model could simplify and act as a guide for digital instructional intervention projects in TrEds' professional development.

The teacher preparation institutions should therefore undertake to implement dedicated and determined programmes on teaching with technology education. The teacher preparation institutions have every chance of progressing and becoming competitive as TrEds are equipped with a passion, confidence, competence and imagination to appropriate and re-invent the latest 21C technology enhanced teaching trends. The proposed ConTIS model is an important link in a chain of re-engineering an education which has been held back by retrograde and traditional philosophies. This model could therefore facilitate for currently used trends, which as observed in this study, are outdated and inadequate to matchup with modern developments, in light of the 21C demands.

To date the challenge has been the scarcity of models that are not standalone interventions to teaching with technology practices (refer Chapters 2). The other challenge has been the lack of technological intervention informed by contemporary teaching and learning theories. This study also found that TrEds mostly used traditional teaching strategies in their teacher preparation programmes with technology at a basic substitution low level. It is therefore the researcher's privilege to present a more holistic approach to the existing challenges. The proposed ConTIS process model provides a structure for TrEds to achieve 21C teaching objectives since it has the advantage of being grounded on innovative constructivist technological & pedagogical content knowledge.

The researcher is of the belief that the model can even succeed in national level intervention to the education sector in terms of technology integration. Exposing TrEds' to the technological pedagogical tools for teaching is a crucial step in the macrocosm of educational faculties in South Africa as well as national development of fourth industrial revolution technological skills, awareness and progress. Exposing teachers to such a key programme allows a national dispersal of knowledge and a key opportunity to accelerate technological knowledge in the country.

The proposed ConTIS model allows for the TrEds to explore possible approaches to effective teaching with technology and at the same time be able to continuously keep track of their progress towards their development on modern day teaching practices. The ConTIS model outlines the technology-mediated instructional strategies that align with both the lecturer-directed and student-centred learning activity.

To prepare the reader to fully comprehend the ConTIS model, the following section gives an outline of the initial visual abstract influenced by the three constructs (Constructivism, TPACK & SAMR) on which the model was expanded.

6.3 The Adapted Conceptual Framework

The conceptual framework as presented in chapter 3 implied that TrEds technology integration is achieved in a linear fashion i.e. one can only be considered to be fully competent once they have reached redefinition level. However, in this section the researcher shows that the progression is non-linear as an educator can intentionally manipulate the technological, pedagogical and content knowledge to achieve any of the levels. The key factor here is the educator's ability to balance all TPACK elements to their intended teaching outcomes. The conceptual framework presented in this chapter does not deviate from the former one in Chapter 3 (see Figure 3.1), it is only elaborated based on the findings of this study, thus, the **Conceptual Framework (**Figure 6.1 below**)**.

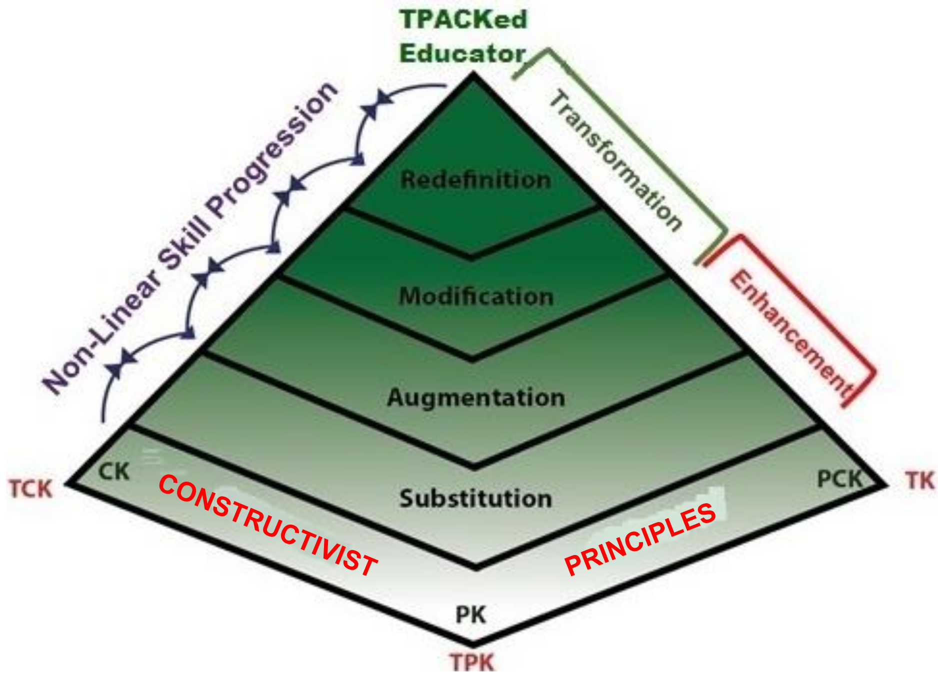

Figure 6.1: ConTIS model

As observed in this study, an educator who was able to integrate their knowledge of teaching strategies and content with the right kind of technology (which they should also be well versed in) can successfully achieve their intended levels of teaching objectives depending on the context. The term TPACKed educator [1]is coined uniquely in this study to signify such an educator who creates a learning environment that accords with the expectations of 21C teaching and learning.

The framework is split into two sections enhancement and transformation levels. Typical to enhancement level is the use lecturer-directed instructional strategies respectively transformation level is aligned with student-centred teaching approaches. The adapted framework therefore dictates that TrEds, in order to achieve transformation, should employ student-centred instructional strategies and likewise, use lecturer-directed strategies to achieve enhancement.

The process model devised in this research project is applicable to any teacher preparation programme, in that it has not been designed for a specific field. The findings of the study revealed that TrEds were inadequately employing teaching with technology in their pre-

[1] TPACKed is a neologism coined for the purposes of this thesis: it provides a useful term for those TrEds who have successfully proceeded to a level of proficiency in the SAMR/TPACK/constructivist paradigm devised in this research.

service teachers programmes. A major reason for this gap is that TrEds prior training did not expose them to the current digital technologies and student-centred teaching approaches (see Chapter 2 and 7). Therefore, to help guide TrEds towards effective teaching with technology in the 21C, the researcher developed the ConTIS model in order to explore and guide TrEds on how to model the characteristic of a TPACKed educator as indicated on Figure 6.1. An important point to note is that TrEd's teaching with technology is a non-linear activity because each teaching and learning objectives of the teaching and learning varies as well as the environment. Koehler and Mishra (2009:62) explain:

> *An approach is needed that treats teaching as an interaction between what teachers know and how they apply what they know in the unique circumstances or contexts within their classrooms. There is no 'one best way' to integrate technology into the curriculum. Rather, integration efforts should be creatively designed or structured for particular subject matter ideas in specific classroom contexts.*

There is no "one best way" to teaching with technology: relevantly, the educator's timely and effective adoption and ownership of technology integration is facilitated uniquely by the process model that evolved and was formulated by this research. It is developed to suit the specific requirements of educators at a tertiary level, and given that so little has been perfected in this unique and potentially crucial area, the proposed model is therefore an opportunity for new dialogue in the field of educational technology.

The researcher envisioned that underlying any teaching and learning activity, should be a learning theory underpinning that informs how activities are setup. As indicated in Chapter 2, this important aspect is missing in the TPACK framework. Therefore, building any teaching and learning intervention in education, should be guided and built towards meeting teaching and learning goals in the 21C. In other words, the first port of call should be; What teaching and learning goal needs to be addressed? What is the teaching and learning theory trend influencing intervention? What affordances does the technology to be used have? How can its affordances help address the current needs of teaching and learning in meeting 21C demand?

In educational practices, educators define learning objectives that the students' needs to achieve by the end of every lecture: the goal has to be clearly articulated as well as the means of attaining them. Constructivist paradigms in this study strongly and consistently aligned with 4Cs: teacher-centred tuition accorded with the basic reiteration of acquired knowledge. TPACK provides educators' professional teaching knowledge for effective teaching in a modern day classroom, whereas SAMR suggest teaching and learning activities that are supported with digital technology that facilitate planning for technology integrated teaching and learning at various levels.

SAMR is prototypical to the teaching with technology and concerned in particular with pedagogical engagement. In the context of this study, SAMR model is critical in the structuring of a viable and reliable grid for a process model. Below the ConTIS model is unpacked in relation to TPACK and SAMR models. The model is founded on the philosophy that content determines the pedagogy, which, in turn, exploits relevant technology.

Chapter 7 revealed that TrEds at the current study site were limited in integrating technology in their teaching practice. The ConTIS model therefore has the potential to facilitate TrEds' professional development as it is founded on the constructivist theory, with the TPACK and SAMR constructs. The next section presents the ConTIS model, an expansion of the Adapted Conceptual Framework.

6.4 The ConTIS model

The proposed ConTIS process model developed by synthesising inductively generated information with conceptual guidelines deduced from this study is summarised, discussed and represented below. The design of the ConTIS model was informed by the engagement with literature and the study's findings of teaching with technology in the 21C. The visual representations of what is discussed in section 6.3 above, is elaborated in **Figure 6.2** below.

TrEds bring in teaching knowledge they already possess and which works for them: so, for professional development there is need to support their move from known traditional lecture-centred to the modern day student-centred teaching strategies. This study revealed that all the participating TrEds used technology but not effectively for the 21C teaching and learning environment. When preparing for professional development, many designers focus their efforts on what needs to be conveyed in most cases in an authoritarian way: often without accessing TrEds' pre-existing knowledge which could build a scaffold to move them from that pre-existing 20th century teaching knowledge to the anticipated new 21C knowledge they are expected to be practicing. When pre-existing knowledge is not engaged, TrEds fail to grasp new perceptions and their relevance: most give up or form some resistance altogether. The SAMR framework highlights the process flow from using technology to enhancing current teaching practices to using it to transform them.

Before TrEds holistically transform their instructional strategies with technology, they have to have knowledge of available resources and how best they can utilise them to improve their current practice. To achieve constructivist-oriented outcomes, the process of TrEd construction of TPACK principles emphasises the affordances that the technology brings to teaching and learning in relation to constructivist teaching strategies and content. The more the technology engages with student-centred strategies, the better it redefines the TPACK constructs for effective teaching. For example, TrEd knowledge of the functionality of a Smartboard entails how the technology can be used to meet the learning goals.

The findings reveal that TrEds in this study were not exposed to a model with constructivist principles; which led them to fall back on traditional and familiar teaching strategies that are the antithesis of the 21C orientation for student-centric strategies. Setting up a system that helps them to evaluate how each technology available can be used in constructivist-oriented teaching strategies becomes critical. Gibson et al. (2014) argue that professional development training that exclusively targets existing TrEds' technology integration knowledge in their current practices has been shown to be one effective way to enhance TrEds' incentive to develop and improve their use of technology. Therefore, professional development guided by the ConTIS process model should help move TrEds from their current low levels to higher ones where technology stimulates student-centred strategies. The advantage of employing ConTIS model is that TrEds can assist them in achieving transformational levels which includes present-day virtual reality and artificial intelligence advancement, which are unattainable when using traditional teaching strategies.

The ConTIS process model developed in this study is presented as a grid (see Figure 6 2). The two vertical axes are defined by SAMR and Constructivist Priorities; while the horizontal axis at the top is held by TPACK constructs. This grid representing the process model, devised in the course of this research, enables a TrEd to plot their pedagogical and content elements in an informed and reliable way. They should be able to identify the level they are currently at and what measures they can take to achieve another.

Figure 6.2 is the proposed ConTIS model that substantially assists TrEds to develop and evaluate their technology-enhanced instructional strategies as well as offers institutions a platform on which to build professional development interventions.

As discussed in chapter 2 and the finding from this study, the researcher found the need for a model built on constructivist principles as these instrumental in achieving the 4Cs as demanded by the 21C environment. The two frameworks chosen by the researcher TPACK and SAMR, were deemed an appropriate combination as they one is incorporate all elements of teacher knowledge and the other acts as a guide on how that knowledge can be used to achieve effective teaching with technology strategies in the 21C.

The researcher presents a discussion on each TPACK constructs in relation to each SAMR construct, with constructivist principles as a key underlying factor. The objective of this discussion is to give a clear picture on how each SAMR construct can be a vehicle in progressing TrEds in becoming TPACKed. It is important to note, that the achievement of the lower levels of the SAMR model, in this case is by no means an indication of incompetence. But the researcher takes the approach that the TrEd is directed by the desired outcome on what level to strategically aim for in a specific context.

The ConTis model is designed to serve as a self-diagnostic and evaluation tool for TrEds and the designers of professional development interventions. The way the model is laid out allows for a TrEd to pinpoint where they currently stand on the model by considering the manner in which they are integrating technology and the outcomes they are currently achieving. The model not only informs them of their current standing but helps them map their way to advanced stages of technology integration. The designers of interventions may likewise to identify collective gaps for TrEds within a faculty and use it to shape faculty-specific technology interventions.

	TK knowledge of a technology and what it can do for teaching and learning	TPK Knowledge of technology that enriches teaching strategies	TCK Knowledge on content-specific technology that support constructivist content delivery	TPACK Knowledge of technology, what it can do and how to use it to teach specific content	
R	Educator's knowledge on technology that creates innovative ideas to teaching and learning	Educator's knowledge on technology that produces innovative constructivist teaching and learning methods	Educator's knowledge of content specific technology that reconceptualises students' comprehension of learning concepts	Educator knowledge to design innovative and appropriate 21C teaching activities that transform content learning	Supports student centred strategies Transforms instruction
M	Educator's knowledge of technology that goes beyond traditional linear teaching into flexible teaching	Educator's knowledge of technology affordances that offers effective ways to reach diverse students	Educator's knowledge of content-specific technology that can help accomplish content/concept understanding	Educator designs appropriate teaching activities supported with technology resulting in constructivist enriched quality and relevance for deeper content learning	
A	Educators knowledge of what technology can do to assist in captivating learning activities that results in improved engagement	Educators knowledge of how a technology works to complements strategies in achieving stimulating teaching and learning activities	Educators knowledge of content-specific technology that can be used to support illustrative content delivery	Educators knowledge of complementary technology and teaching strategies that ease comprehension of concepts in a teaching and learning activity	Supports Teacher centred strategies Enhances instructions
S	Educator's basic technology knowledge for convenient use	Educators use basic technology knowledge to supports traditional teaching methods.	Educators fundamental knowledge of content-specific technology that enhances concept proficiency	Educators basic technology knowledge that compliments teaching strategy in facilitating content presentation	

Figure 6.2 The Constructivist Technological Instructional Strategies model

6.4.1 SAMR levels in relation to TK and constructivist theory

TrEds require adequate understanding of technology affordances that effectively applies for teaching and learning; in as much as they recognise when technology can enhance or hinder the achievement of teaching and learning goals, and to continually acclimatise to fluctuations, innovations and alterations in technology (Harris, Mishra and Koehler, 2009). Relating SAMR construct to teaching with technology knowledge was aimed at understanding the progression levels TrEds are integration technology. thereby presenting a clear picture of what steps they could take to achieve higher level of technology integration resulting in high level teaching and learning outcomes.

This study revealed that the majority of TrEds' TK was mainly focused on general purposes applications that enhance their traditional teaching approaches yet few were able to elaborate the instructional goals of the technology they employed as well as content goals. TrEds indicated that they regularly relied upon technology to accomplish a variety of old-style lecture-centred teaching strategies and the accomplishment of administrative duties. In this study, the SAMR model was used to facilitate TrEds to identify the levels of progression they go through in incorporating technology that help achieve their teaching and learning goals and teaching activities (see Chapter 5). Therefore, in the next section, the researcher elaborates the relationship between each TPACK construct with each of the SAMR levels (see **Figure 6.2** above).

6.4.1.1 Substitution - Technological Knowledge (S-TK)

Substitution as explained by Puentedura (2009) is the use of technology as a direct alternative to traditional teaching tools, without optimising the technology's functionalities for new forms of teaching and learning. TrEds initial primary application of technology simply uses the basic functions of a technology therefore they are limited with regards to what they can do change their routine traditional teaching activities. For example, using PowerPoint basic functions for the presentation of plain texts and static images proves to be a direct replacement of traditional static technologies in this case transparent paper with PowerPoint slides, this brings no added benefit to the actual teaching and learning strategy. Therefore, the modern technology is applied with little effectiveness, and supports one-directional teaching strategies.

6.4.1.2 Augmentation - Technological Knowledge (A-TK)

A-TK is concerned with technology's improved, more slightly advanced educational affordances, such as multi-media that incorporates motion graphics and videos. With the A-TK level, the technology provides improvement over what could have been achieved with non-digital technologies. TrEds with slightly advanced technology knowledge can use it beyond simple and direct alternative. At this level the teaching strategy employed is able to transcend remembrance and understanding to actually being able to apply acquired knowledge. Therefore, this level of technology knowledge affords the TrEd to create a more stimulating teaching and learning environment (Chuang & Tsao, 2013).

6.4.1.3 Modification - Technological Knowledge (M-TK)

At M-TK the educator's technology knowledge facilitates for learning to continue to take place outside of the physical classroom through asynchronous communication and collaboration with each other. In this study, a TrEd employed project based learning activity that required students to work collaboratively outside of the lecture hours. To facilitate communication, the students made use of WhatsApp for information sharing. Geographical separation of pre-service teachers created transactional distance but technology granted pre-service teachers autonomy and proximity as they explored ways to learn by using self-directed, independent peer-to-peer discovery learning strategies (Moore, 1993, 2002).

Another characteristic of M-TK is that, since it is typically paired with student-centred teaching strategies, it makes room for multiple teaching outcomes. In this case, the student is given the opportunity to achieve their knowledge construction and portray it in their own way to show how they understand the subject. Continuing with the project based example, the TrEd requested students to use digital storytelling to create videos that showed how best they understood or their experience of inclusivity in education (Chapter 5).

Apart from multiple teaching and learning outcome, M-TK also presence the freedom to choose from a range of technologies, i.e. the TrEd does not necessary prescribe the technology to be used. The pre-service teachers, as in the example, can choose which technology best assists in achieving the learning objectives. At this level, learning activities were redesigned to optimally exploit the technology at students' disposal. This indicates the constructivist principle that the teaching process should not be one-directional.

6.4.1.4 Redefinition - Technological Knowledge (R-TK)

The R-TK level, the technology knowledge allows for teaching and learning outcomes that were previously impractical can now be achieved. For example, in this study, in a project based teaching strategy, the TrEd created an environment that required the students to use a technology that would allow them to work simultaneously on the in teams, from different geographical location.

The other characteristic of R-TK is that it provides a platform for students to use acquired knowledge in an authentic real life scenario. For example, another observed case, from this study, a TrEd created a learning activity, in which students had to select a relevant and convenient technology to collect data in real time as events occurred. The pre-service teacher educators were collaborating with high school learners living in the community they were interested in studying. The high school learners would collect information and report back to the pre-service educators though the use of various instant technologies that included WhatsApp, Google Sheets and Google Docs. TrEd created an environment where technologies could be used innovatively to connect, to share knowledge and opinions instantly.

Additionally, authentic learning activities can be far reaching as they can go from class to global audience. For example, in this study, pre-service teachers shared their DST videos with pre-service teacher in United States of America who were also doing the same project. This allowed them conduct a discussion on social constructs based on real-life personal experienced across continents. The videos were also shared on YouTube a global platform from where they received instant views and comments, allowing for learning to continue with contributions from other sources. In this instance within this study, technology transformed the learning: pre-service teachers broke down the classroom walls and opened themselves up to diverse real audiences in real-time (refer to Chapter 5).

To sum up the SAMR in relation to TK, it is important to note that the effects of using technology knowledge at enhancement or transformation levels is dependent on the nature of the specific task for which it is being used. Therefore, emphasis should be placed on the objective of learning first and the relevant technology knowledge thereof.

The next section, looks at the pairing of technology and teaching strategies and how they progress on the SAMR levels.

6.4.2 SAMR levels in relation to the TPK

This section relates TPK construct at the various levels of the SAMR model. TPK involves educators acquiring, processing, maintaining and deploying the technology knowledge that appropriately supports particular constructivist teaching strategies.

6.4.2.1 Substitution - Technological Pedagogical Knowledge (S-TPK)

As mentioned in chapter 2, educator's pedagogical knowledge comprises strategies which an educator demonstrates to enhance learning, inter alia: choosing appropriate methodology, ability to incorporate contextual issues, best way to react to students' learning difficulties, misconceptions and preconceptions. It follows that TPK entails TrEd's knowledge of technology to support their planned lesson strategies. TPK when applied at the SAMR's *substitution* level implies that the TrEd is using technology yet at an insignificant functionality level. This study shows that TrEds operating at this level applied lecturer-directed approaches. TrEds were using traditional pedagogy teaching methods that enhance student understanding supported by technology. TrEds directed and controlled all the learning activities, while students remained passive recipients of information.

One TrEd in this study employed a PowerPoint slide with a picture that had visual enhancement of the concept in a lesson. The picture was used to enhance what the students must learn: in the same way she could have used a picture on paper. The technology's functionality improved the visual appeal or size of the picture but the strategy remained lecturer-directed and one directional, it did not engage the student. The TrEds integration of technology in this case had little or no benefit in terms of constructivist outcomes as the lecturer remained the sole source of knowledge.

The teaching outcome at this level is influenced by TrEds use of basic function of technology, which therefore fails to add any value to the teaching strategy. The limited technology knowledge creates a restriction on the TrEd to employ student centred method, which takes control away from the TrEd; this is a result of TrEds lack of confidence in their technology knowledge (Rachel, Cobcroft, Towers, Smith & Bruns, 2006).

At this level, in this study, TrEds adopted digital technology as a tool that enhanced learning, which the researcher observed as a good initial point: they indicated an aim to gradually progress towards more engaging SAMR enhancement and ultimately transformation level as a TPACKed educator. What they would need is a practical guide on how to make the progression, to help the educator to achieve the higher levels the ConTIS model can guide them towards technologies with more rewarding functionalities that move away from mere replacement of traditional means by helping to facilitate the application of knowledge as addressed in the following section that discusses augmentation in relation to TPK.

6.4.2.2 Augmentation - Technological Pedagogical Knowledge (A-TPK)

At A-TPK level, the educator uses their slightly advanced technology knowledge to enhance teaching and learning. The advanced technology gives them access to more developed functions of the technology. This knowledge allows the TrEd to make a more informed decision on how to integrate the technology with their teaching strategy of preference. For example, the educator may integrate technology to create an enhanced learning experience that goes beyond visual texts by incorporating motion graphics and visual effects.

In this study an example that showed A-TPK was provided by the TrEd who utilised the animated visual text/graphic and hyperlinking functionalities of the PowerPoint technology. On different occasions, this TrEd employed hyperlinking, embedding a video and a content website which they accessed directly from PowerPoint. In this regard, the technology's functionality improved teaching outcomes in that it allowed students to access other digital sources of information other that the lecturer, the use of animations was instrumental in stimulating the mind (Liakopoulou, 2011; Kihoza et al., 2016). It is important to highlight the advantage that multiple technology knowledge provides as it gives the educator the ability to optimise a technology by integrating it with a compatible other, which in turn enriches the teaching strategy. Such lessons can create enhanced learning experience for the students however since the strategy employed is still lecturer-centred it still hinders advancement into transformation of teaching outcomes (Puentedura, 2009).

For TPK at substitution and augmentation levels, scholars advise that technology acts as no more than a tool which marginally supports the traditional, lecturer-led instructional strategies; possibly increasing some students' understanding of concepts (Hamilton et al., 2016; Romrell et al., 2014; Lubega et al., 2014). At these levels, educators are holding onto their pre-conceived non-constructivist notions: teaching practices and technology are used as a means to a predetermined end there is no room for new discoveries. The next section elaborates upon TPK at modification level as a transformational initial stage.

6.4.2.3 Modification - Technological Pedagogical Knowledge (M-TPK)

The SAMR framework is not about technology per se but focuses upon learning concepts and processes that help TrEds achieve a targeted teaching objective. At substitution and augmentation levels, technology is used to support lecturer-directed instructional strategies to enliven students' comprehension of content. On the other hand, to achieve modification levels, student centred approaches are more instrumental.

M-TPK suggests that students are given a chance to construct knowledge; the onus being upon the students to source, engage with content, and evaluate what best will help them achieve the learning goals. In this context, the lecturer becomes more a facilitator of the learning activity and students actively construct knowledge.

Using the initial example of teaching with PowerPoint, instead of lecturers creating the content, an educator can assign students to go online to use digital sources of information to research and create the own understanding of the concept. At this point the TrEd has the option to prescribe a technology or allow the students to make own decision on which technology best assists in their exploration. At this juncture, students actively construct knowledge from online resources in pairs or in groups of a manageable size. The students are then tasked to present at the end of the lesson using PowerPoint.

At this M-TPK level, the teaching strategies has been redesigned: students are now creators of knowledge, guided by the educator and the learning outcome is no longer uniform in that can present their shared understanding of acquired knowledge but in varying ways. At this modification level, learning has been transformed with technology supporting constructivist student-centred strategies including group collaboration, guided discovery, project based learning etc.

6.4.2.4 Redefinition - Technological Pedagogical Knowledge (R-TPK)

The redefinition level entails technology which provides opportunities for the creation of new tasks which, due to the application of traditional teaching means were previously unattainable. In physical classroom setting where face-to-face learning occurs, constructivist teaching strategies can be employed to accentuate the teaching and learning process by using real-time technology that facilitates collaborative virtual learning. This advanced technology affords asynchronous and/or synchronous cyber platforms. At this level, both students and TrEds have abundant access to effective devices and infrastructure for learning and teaching.

One of the TrEds in this study tasked students with a project they had to work on outside of the classroom, therefore, students virtually and collaboratively contributed to the group presentation by using Google Slides to chat, comment and make suggestions. Their final group presentation was posted on a class blog – a class Learning Management System (LMS). Learning activities of this nature exhibit a collaboration of technology and a teaching strategy that allows the student explore various technologies at their disposal to facilitate their acquisition of knowledge. This autonomous search for information allows the student the opportunity to not just receive knowledge but be able to analyse and critique it based on its applicability to real life situations.

To sum up on TPK in relation to SAMR, it is important to note that the TrEd is the driver of targeted outcomes which they can achieve but carefully pairing a relevant technology with the compatible teaching strategy. The level reached in terms of SAMR principles is greatly influenced by the educator's knowledge on when to make use of lecturer-directed approaches and when to employ student-centred ones instead. The transformation levels are scarcely reached due to educator's hesitance to give up control over learning activities (Groff, 2013), however, this can be managed by the TrEd taking on a more facilitative role, they can be present, either physically or virtually, during the learning process, to guide and ensure that learners stay within the range of targeted objectives.

An important factor to the achievement of teaching with technology in the 21C, is the TrEd's ability to make use of content-specific technology or general application technology that is a viable match to facilitate content delivery. The implication thereof is that the TrEd must have a balanced knowledge of technology and content as elaborated on in the section that follows.

6.4.3 SAMR levels in relation to TCK

TCK is an understanding of the manner in which technology and content can influence, benefit and constrain each other in the delivery of learning objectives. In terms of TCK, no more than two TrEds in this study understood how to apply content with both general purpose application and content-specific application technologies. Below are the levels of TCK linked to each component of the SAMR framework.

6.4.3.1 Substitution - Technological Content Knowledge (S-TCK)

At this level, content is moved from static technology such as blackboard or hard copy textbooks, to digital technology in the form of soft copy (digital form). TrEds in this study used general technology such as word processing documents, electronic textbooks, pdf files and PowerPoint to displays content. The content is displayed in a digital form but is still static since it is a replica of the traditional static technology.

Most TrEds in this study acknowledged that they uploaded notes and handouts on the institution's BB-LMS. In such cases, the hand-outs could have been distributed to the pre-service teachers as hard copy and would have resulted in similar outcomes. This level outcome can be attributed to the educator's limited technology knowledge which hinders then from the foresight of how it will not be effective in allowing the student to not only regurgitate the content but be able to understand and possibly identify and apply it in a different scenario. As indicated in the results, all TrEds were using PowerPoint, some slides which had text and were read through as they would have been from a blackboard or paper, thus technology in this case added no benefit to content delivery.

In most cases in this study, the strategies deployed were lecturer-led and students passively received the content directly from the TrEd or textbook. S-TCK tends to be lecturer- centric; where the TrEd guides all aspects of content delivery. There is limited direct benefit to students, since they are not actively involved in the construction of knowledge. In one lecture observation, the pre-service teachers struggled to follow the lecture and were disengaged because the lecturer had too much text on a single slide and was reading through without elaboration and engagement.

Interestingly, in this lecture, a student was observed recording the proceedings of the lecture. The researcher perceived that the student was using technology in a way that would allow them to revisit the lecture in their own time and possibly share use it collaboratively with other sources of information. It is therefore evident that the student in this case has realised how they can utilise of technology, in this case mobile recording, in understanding content. However, the student in this case also uses technology at a substitution level as the recording is now just another digital presentation of the same lecture that was not engaging, therefore there is very little improvement on content comprehension unless studied in conjunction with other external sources.

6.4.3.2 Augmentation - Technological Content Knowledge (A-TCK)

A-TCK occurs when technology is used with some visible functional improvement: the educator can incorporate some form of audio/visual/motion technology. For example, a participating TrEd assimilated a video that explained a science concept to the pre-service teachers; enhancing pre-service teacher's understanding of the concept. PowerPoint presentation of the content was enhanced with visual and motion functionalities. Similarly, another observed TrEd used a content-specific graphing calculator (Gramatica) in her Mathematics classes. The technology improved the concept of creating graphs: it changes style and colours of axes and grids on graphs. Gramatica provided ways to display information visually and the diagrammatic result of student's input. Gramatica technology in this case allowed pre-service teachers to explore key graphic curricular issues as well as offer drill and practice for concept mastery, and simulations of what happens when values are altered. Drill and practise application are however considered to be a traditional means of teaching (Davidson, Richardson & Jones, 2014; Chigona, 2015) contrary to constructivist principles.

Significantly pre-service teachers began to be more engaged in the learning activities. Although pre-service teachers actively engaged with content through the video or simulation, it still remained lecturer-centric as TrEds reserved control of the learning activities. A-TCK enhances pre-service teachers' mastery of concepts by utilising technology that speaks into the content. In this scenario, TrEds presented and explained concepts as students mastered with limited engagement, thereby denying them the opportunity to explore the content and develop their own understanding. A point of concern with content-specific technologies such as Gramatica is that they build dependence whereby the student struggles to apply the concept outside of that specific technology or in real life scenarios, for example the pre-service teachers practised the concepts as presented only by the application thereby restricting their ability to critically analyse content.

6.4.3.3 Modification - Technological Content Knowledge (M-TCK)

In this study, M-TCK technology made a significant functional change in pre-service teachers' ability to comprehend content. Following the notion that content drives the technology to be used: the learning activity is improved through the affordances that technology brings to learning the concept better. For example, a TrEd in this study used a YouTube video to present a digital simulation of the respiratory system. This use of simulation allowed the content to be presented in a demonstrative manner to increase content comprehension. The simulation gives a visual understanding compared to abstract teaching were the student reads or receives verbal explanation of a process. The visual effects allow for the student to develop an opinion on the content thereby becoming equipped to debate its elements, this is facilitated by their in-depth understanding of the content.

Two of the participating TrEds in their class projects assigned pre-service teachers to accomplish a task in teams and as individuals. Pre-service teachers created their own modes of interaction and engagement with content. They used WhatsApp, YouTube, Photoshop and other technology resources to accomplish their assigned tasks. The technology function afforded peer-to-peer engagement because they aimed to accomplish their tasks. The activity was more student-centred learning since pre-service teachers were self-taught and discovered concepts on their own, and later shared information with each other using technologies. Typical of the modification level of SAMR, the students in these cases are presented with a range of possible technologies they could use, their ability to match a certain technology at a certain point of content facilitation already shows the advantage student centred approaches have towards contributing to the 4Cs particularly critical thinking in this case.

6.4.3.4 Redefinition - Technological Content Knowledge (R-TCK)

At this level of the ConTIS model, technology allows for learning tasks to be completed that were previously unachievable due to traditional functional limitations.

The use of content-specific technology allows for in-depth comprehension of content such that the student is able to apply the learned knowledge in a real life scenario. Case in point, in this study, only one TrEd used simulations to demonstrate a science concept. As a follow up exercise, he gave the students a practical task in which they had to apply what they had learnt from the simulation in a real life context. As observed the students were able to replicate what they had learnt. Also, during the exercise, the students were able to engage in discussions and debates indicative of their deep understanding of the concepts, they could even guide each other towards the learning outcome.

Wieman & Perkins, (2006) in their study reported that simulations and applications are frequently more effective than abstract learning. They posit that students learn the content through repetition in self-paced learning. Other researchers argue that integrating digital simulations with real life applications increases the effectiveness of instruction.

To sum up TCK and SAMR, the educator needs to have a thorough understanding of the content they wish to relay, they need to be aware of all the affordances the technology at their or the student's disposal can accentuate the mastery of said content. Knowing what level, they wish to attain the educator can make an informed decision as to which technology to utilise for certain content in specific contexts.

From here on, what the educator can aspire to achieve, is the ability to not only match technology with content, but be able to put together compatible technological, pedagogical and content knowledge in order to purposively achieve a certain level of the model. This is explained in detail in the section that follows.

6.4.4 SAMR levels in relation to the TPACK

The TPACK model provides educators with an understanding of what is expected to effectively integrate technology while the SAMR model assesses whether or not the technology is transforming the learning experience of their students. This research therefore makes use of both frameworks to develop the ConTIS model which serves to guide the educator on how to logical progress through the levels each. The level of

SAMR model reached is evidence of the educator’s application of TK, TCK and TPK in their lectures. The question that needs to be answered is how effective the technology is in meeting the lecture objectives. The goal of combining TPACK and SAMR grounded within the constructivist paradigm is to help educators to realise their desired level on the SAMR model by deliberately designing teaching actively that achieve the desired outcomes. The educator at this level is confident in all elements of TPACK such that they can manipulate them to achieve both high and low levels of SAMR depending on the needs of that specific context. The TrEd is expected to model constructivist teaching with technology practises that promote the 4Cs.

In the following subsections, the researcher holistically discusses each element of the SAMR model as applied with TPACK. Mishra and Kohler (2006), coined the acronym TPACK as a framework that guides the knowledge constructs that educators need to effectively teach with technology. Figure 6.1 of the conceptual framework guiding this study shows that the effectiveness of digital technologies should be grounded upon the constructivist paradigm rather than a behaviourist one; implying that the ‘teaching with technology’ strategies should be student-centred. SAMR offers a review of the logical process that educators follow to adopt technology into their teaching practices. Guided by these three important constructs, the researcher advances the ConTIS process model which aims to guide and help educators evaluate whether their current teaching practices help model and transform teaching with technology.

This study carries the notion that a TPACKed educator can achieve even the low levels of the SAMR model, provided that their objective demands such a level, it is therefore not considered an indication of incompetence. The section that follows discussed how educators can interrelate substitution with TPACK.

6.4.4.1 S-TPACK (Substitution-TPACK)

At this level, technology is used to meet both content and pedagogical needs but directly substitutes traditional approaches. Researchers demonstrate concern when technology is applied without the necessary depth of background knowledge (Wali, 2006; Tiba et al., 2015; Tunjera & Chigona, 2017). One TrEd used a PowerPoint to display content of the concept on slides; the use of PowerPoint in this case explained the concept successfully, however, it did not succeed any more than would have reading from a textbook. The TrEd used the PowerPoint at the introduction of a concept. From the observation, the researcher deduces that the TrEd aimed at retaining control over the lecture thereby making use of basic function of a technology such as text animation paired with lecture-centred teaching strategy. The TrEd's ability to integrate technology and teaching strategy for that low level complexity of the content therefore illustrated S-TPACK.

The outcome at this level would typically be that the student is able to memorise the content, to comprehend and possibly be able to apply it. Basing on the researcher's deduction that the TrEds was introducing a concept and therefore needed to reserve control over the lecture, the educator's priority would be to ensure students remembering and comprehension.

6.4.4.2 A-TPACK (Augmentation-TPACK)

At the A-TPACK level, technology use moves a step up from being a supplement of traditional strategies to adding value to the learning activity due to improved functionality. At this level, all elements of TPACK are used to extend the outcome on traditional methods. In one observation, a TrEd used a PowerPoint in conjunction with an embedded video to improve on stimulation and engagement of the students. The engagement was exhibited by the TrEd, pausing the video from time-to-time to discuss with students. The use of the video improved the comprehension of content through visual and auditory aids, thereby equipping the student to be able take part in discussion (McKnight et al., 2016; Ledford, 2016).

An educator aiming to achieve student comprehension of content to such a level that they are able to apply acquired knowledge would make use of their TPACK understanding to design teaching activities that are stimulating and engaging to afford broader understanding of concepts. At this level, the TrEd was confident and used the technology appropriately but continued to employ a behaviourist paradigm, which impeded development of 4Cs characteristics in the pre-service teachers. TPACK was used to support lecturer-directed instructional strategies. Video technology, with its limited functional affordances, supplemented the traditional hands-on activities, however since it was used from a lecture-centred approach, the outcome remained at enhancement level.

In pursuit to achieving transformation of teaching and learning approaches, the TrEd may use TPACK understanding to facilitate learning activities that may achieve new and multiple outcomes. The section below goes into detail in how the TrEd can progress to this level.

6.4.4.3 M-TPACK (Modification-TPACK)

M-TPACK strategies used at this level move a step higher; from lecturer-directed to student-centred teaching and learning. In this instance, TrEd's domestication of TPACK principles grounded on constructivist underpinnings allow for the design of teaching and learning activities that build on students' existing knowledge, thereby focusing on knowledge development rather than regurgitation. For example, a TrEd in this example made use of a project-based tack that would allow students to go and acquire knowledge in their own time and use it to address a given concept. Activities of this nature do not use prescribed methods or technology instead the based on what they already know decide on their own what technology and other sources of information should be used in understanding the concepts. This autonomous approaches to technology integration and meaning making fosters the development of the 4Cs.

M-TPACK allows an open learning environment accessible to students anytime and anywhere. This student-centric setting aligns well with constructivist learning pedagogy which maintains that students learn best when they actively participate and build their own knowledge; rather than acting as passive knowledge receivers. For example, in this study, a TrEd in her project that focused on the community's social economic strata, the pre-service teacher in order to facilitate instant communication and effective data collection, selected a range of technologies that would best suit the achievement of teaching and learning objectives. Narayan (2011) argue that project based learning develops students sense of responsibility with regards to decision making therefore giving them a sense of ownership of the problem. The students are motivated by their direct contribution towards social concerns. Apart from the 4Cs, other benefits to constructivist-based learning activities are the development of student confidence in their abilities and self-worth, valuable characteristics in the 21C environment.

At M-TPACK level the educator is able to play a more facilitative role in learning. A teaching activity one may employ is that of reflective exercises as employed by a TrEd in this study, who after a digital story telling activity, tasked the pre-service teacher to reflect on the process of the project by focusing on how they could apply it in other contexts. This kind of activity fosters self-evaluation on how the student went about acquiring knowledge and allows for possible revisions and analysis of process.

Once this level of the model is mastered, the TrEd is able to use their TPACK understanding to design previously unattainable teaching and learning activities as well as high level outcomes as expanded on below.

6.4.4 R-TPACK (Redefinition-TPACK)

This is the highest level in the ConTIS model; when TrEds are able to facilitate the students' independent construction of knowledge. Teaching with technology leads to task redesign that can go beyond the status quo by creating room for new discoveries that accommodates students' new interpretation of information. This kind of outcome is achieved by the TrEd's ability to integrate technology with teaching strategies that formulates conducive environment for students to participate in their knowledge acquisition.

For example, the TrEd in this study, prescribed students to use Photo story 3 to create digital storytelling videos, however, the students went explored other video making technologies that they found easier to use or richer in functionalities such as movie maker. This demonstrates that the students afforded opportunity to make decisions towards how they learn and what tools to use motivates their desire for further learning This outcome can be further explained by Bhattacharjee (2015) argument that real world case based learning activities foster constructivist learning outcomes since the activity in the mentioned example was also based on students' real life experiences.

Familiarising TrEds with TPACK and SAMR, within a constructivist paradigm, provides a strong foundation upon which to build the skills needed to teach with technology. Pre-service teachers access to a wide variety of technology tools, unlimited access to online resources and communities (LMS, blogs, mobile learning), and the ability to publish new content online is critical in this 21C environment. Proponents of the 21C educational development wish to integrate technology into the learning environment and envision a similar impact in teaching and learning as it has affected the greater society. Providing a framework for TrEds constructively to integrate technology into teacher preparation programmes creates many opportunities and deepens their pre-service teacher understanding of technology-enhanced strategies.

6.5 The importance of the ConTIS model

Based on the detailed discussion of the ConTIS model in this chapter, allows for continuous and targeted professional development, which not only improves educator teaching ability but also accentuates the students learning experience. Most importantly, it is clear how essential it is for TrEds to have a detailed guide on how to move from one level to another by strategically matching technology and teaching techniques for effective content delivery. The purpose of TrEds is to improve their instructional in order to improve learning outcomes. Therefore, assessing TrEds professional development needs, can lead to more successful professional development programmes.

To assist the TrEd in making the progression, the researcher presents the ConTis model evaluation checklist that presents crucial questions the TrEd can ask themselves at each stage (see Appendix G). The checklist questions where developed on the teaching and learning outcomes (comprehension, application, analysis, critical thinking, creativity) expected at each of the SAMR levels and how that is achieved based on the teaching strategies and TPACK elements applied. The responses to these questions should help the TrEd to identify the level they are performing at as well as the developmental needs. TrEds evaluating their own teaching practices is important. In that it is one way in which they can increase their effectiveness in their teaching with technology.

6.6 Chapter Summary

The chapter encapsulates the development of the ConTIS process model. Development of this model was informed by the research findings and discussion of the study in Chapters 5 and 6, as well as literature germane to the topic. From the findings and discussion thereof, it became clear that the TrEds observed in this study had limited knowledge of effective teaching with technology: their use of technology was in isolation and rarely considered it value to a teaching technique and content. Therefore, as an intervention the presented ConTIS process model comes in to assist educators in locating their current technology integration level and mapping out a way to optimum technology integration.

The chapter that follows presents the contribution of this study to existing body of knowledge as well as possible future research areas founded on this model. It also addresses the implications of the study’s findings to policy and teacher preparation programme development. Recommendations for future studies will also be presented.

CHAPTER SEVEN

STUDY CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

This study had the main aim of exploring and understanding TrEds teaching with technology instructional strategies for the 21C. The main research question was formulated as follows: “What do TrEds need to effectively prepare pre-service teachers to teach with technology in the 21C?” This chapter therefore presents an overview of the research and highlights the conclusions drawn, which point to the resources, knowledge and teaching techniques TrEds require in order to effectively prepare pre-service teachers to teach with technology in the 21C. The chapter also discussed the implications of the findings for teacher training stakeholders. The researcher, after a reflection on the manner in which the research was conducted as well as its findings, presents the limitations of the study and gives recommendations on how future studies may be conducted in order to cater to the limitations of the current study. Recommendations are also given with regards to how the findings and the presented ConTIS model can be applied by both TrEds as well as teacher training institutions.

This chapter is presented in the following sections:

Section 7.2 Overview of the study

Section 7.3 The study’s contribution to the body of knowledge

Section 7.4 Implications of the study

Section 7.5 Recommendations

Section 7.6 Further Research

Section 7.7 Reflection

Section 7.8 Concluding Remarks

7.2 Overview of the study

The motivation for this research study stemmed from the mandate placed on TrEds in the 21C – to effectively employ teaching with technology strategies. With policy makers and government institutions investing in and advocating for technology integration in educational institutions, it was alarming that studies in the area continue to highlight a lack in TrEds to successfully incorporate effective teaching with technology strategies (Ndlovu & Lawrence, 2012; Chigona, 2015b). Even more worrying is that this short coming continues to prevail even after various technology integration frameworks have been designed to assist TrEds in this area.

This study observed, scrutinised, recorded and analysed the technological instructional strategies used by TrEds at a selected University of Technology in order to assess how they were implementing such strategies in their pre-service teacher preparation programmes. The results revealed that most TrEds incorporated technology at basic levels and largely within the traditional, lecturer-centred instructional paradigms with which they were familiar and had themselves been taught as pre-service teachers. The challenge that this finding presented was that TrEds urgently required direction in how to equip pre-service teachers for teaching with technology at the level demanded by the 21C environment. The researcher's original contribution to the body of knowledge was the formulation of the theory informed ConTis model. The model is designed to assist educators and possibly institutions alike in mapping their progression from low to high level technology integration or even a purposive regression based on the contextual need.

The researcher launched this research study by getting immersed in the literature surrounding this phenomenon. The aim was to understand the relevant contemporary theories and frameworks that guided TrEds, as well as the role of the TrEds themselves in their teaching with technology practice. The arguments and concerns raised in the existing literature proved essential in later substantiating the findings of this research study (refer to Chapter 6). The outcome of this literature review was the researcher's development of the conceptual framework used throughout this study; the conceptual framework was a mash of learning theory and technology integration models. This construct was used to make sense of the data collected from the study.

The researcher approached this research study in an exploratory manner, the objective was to uncover as much knowledge as was possible on this phenomenon. This objective informed the researcher's decision in employing a qualitative approach to the study. The use of multiple data collection tools allowed for an overall investigation of TrEd practices. The use of purposive sampling among others, ensured that the data collected remained relevant and was from first-hand accounts. Due to its qualitative nature the researcher acknowledged that it may be a challenge to generalize the findings from the data collected onto other contexts outside of the one in which the study was conducted, researchers are however presented with a vast and detailed platform on which to base future studies.

For this study the researcher adopted (i) the theoretical emphasis of constructivism founded by John Dewey (Green & Condy, 2016), (ii) the TPACK model formulated by Mishra and Koehler (2006) and (iii) the SAMR structure of Puentedura (2009) not only to interpret and understand the data collected but also to create the ConTis model by which one may understand, interpret and categorise the teaching with technology phenomenon in TrEds. Constructivism supports the acquisition and accumulation of knowledge through interacting with one’s social context. Used in education, it implies that students learn best when they have the chance to participate in and contribute to their learning process. The importance of basing the model on the constructivist theory was the guiding principle of the theory which places emphasis on student engagement in knowledge acquisition. The model reflects this sentiment by indicating that high level teaching activities and outcomes are achieved by using technology in such a way that allows the students’ autonomy and input to knowledge acquisition.

According to Mishra and Koehler (2006) the TPACK framework interrelates technology, content and specific pedagogical strategies. TPACK focuses on the unique affordances of technology in transforming teaching and learning in a constructive and holistic manner. The framework highlights the importance of using technology strategically in consideration of the content and the teaching strategy employed. The study’s findings reported that most TrEds were making decisions on technology use in isolation of the other factors. The research study, in the discussion section, makes an important note that the interaction of these elements is not in any specific order, i.e. the TrEd does not choose the technology first then choose which strategy is best for the content, the TrEds approach is to consider all elements collectively to ensure they complement each other in achieving desired outcome.

The SAMR model reviews the process of integrating technology from low order enhancement to high order transformation levels. The model indicates what outcomes may be achieved by moving from using technology just as an alternative for traditional methods to designing teaching and learning activities that may have been previously inconceivable. The data collected in this study indicated that participants were operating outside of the guidance of the model; some were not even aware of the frameworks. The resulting scenario, was one of educators that repeatedly used technology only as a substitute to outdated methods, the technology was rarely optimised. Through empirical research and in-depth study of relevant literature, the researcher came to the realisation that models such as SAMR and TPACK only informed TrEds of the facts around input and output at various stages. There was no universal guide on the progression from one stage to the next, thus the formulation of the ConTis model (refer to Chapter 6) to remedy this issue.

The unique synthesis of these frameworks with constructivist priorities devised in this research, fosters, sets out and facilitates access to constructivist technology-enhanced instructional strategies that meet digital age learning goals. It is important for educators to successfully model the advanced use and integration of technology to facilitate the development of the 4Cs as they are crucial to possess in the 21C environment. Educators run the risk of becoming irrelevant in this vastly digitalised era which is characterised by a range of new technologies that are fusing the physical, digital and biological worlds, impacting all disciplines (Delich, Kelly & McIntosh, 2008). The section below, presents the studies contributions towards achieving teaching with technology strategies that facilitate 21C learning outcomes.

This research summary presents an overview of how the study's research questions were answered. The table 7.1. below highlights the main finding for each research questions.

Table 7.0.1: Research question's main findings summary

Question	Main finding
1. What do TrEds need to effectively prepare pre-service teachers to teach with technology in the 21C?	TrEds require a holistic model that not only informs them on what measures to take but how to implement these. The study presents the ConTIS model accompanied by an evaluating checklist (see Chapter 6)

1.1 What instructional strategies do TrEds currently employ when preparing pre-service teachers to teach with digital technology in the 21C?	The findings indicated that both lecturer-centred and student-centre teaching strategies were employed, however lecturer-centred teaching strategy was more prevalent, thereby compromising the outcomes of teaching with technology in the 21C.
1.2 How are TrEds currently implementing the technology-enhanced instructional strategies in preparing pre-service teachers to teach with digital technology in the 21C?	This question was mainly addressed by the observation findings. The findings highlighted the discrepancy between TrEds' perception (interview responses) on how effective their technology integration was and the actual level (observations) at which they were performing.
1.3 Are the existing technology integration models that TrEds use effective in developing teaching with technology in the 21C?	The findings revealed that most of the TrEds were not familiar with technology integration models and therefore did not relate to any model. The few that had been exposed to PCK model were able to some degree design creative teaching and learning activities using technology.

7.3 The study's contribution to the body of knowledge

The main purpose of any research study is to add to the body of knowledge. This study's contribution to the body of knowledge was to the practice as well as to theory. One of study's contribution to the body of knowledge is the conceptual model formulated for this study which incorporates critical aspects that inform teaching practices in the 21C, i.e. constructivist teaching and learning theory, TPACK and SAMR models. From the literature review conducted for this study it was evident that within the field of teacher preparation programmes in higher education, there are not many studies that explore how TrEds prepare pre-service teachers to teach with technology holistically. The available literature main reports on technology integration in a disjointed manner. The use of a single models continues to fall short it terms of advanced technology integration. For example, the underlying assumptions of the TPACK and SAMR models highlight how they are incomplete in isolation of each other. TPACK is pedagogy driven whilst SAMR is technology driven, which therefore, implies that they each fall short in addressing the strength of the other (refer to Chapter 2).

How this contribution extends itself to practice is by presenting a holistic and universally applicable platform that presents TrEd with a self-diagnostic and evaluative guide. The model unpacks the relevant use of technology for specific outcomes by addressing technology and instructional strategies concurrently. Not only is the TrEd informed on how to effectively integrate technology, pedagogy and content knowledge, they are made aware of how to direct this for specific teaching and learning outcomes. The awareness of attainable teaching and learning outcomes gives the TrEd control over their practice as they can purposefully aim for low level outcomes to meet context influenced teaching and learning objectives as argued in Chapter 6, the progression on the model is not linear.

The technology frameworks that researchers present, lack strategies to assist TrEds on how to achieve the prescribed measures. This study adds significantly to the existing body of knowledge and literature about current TrEds practices and proffers an affordable, practical and reliable process model to enable educators to self-evaluate their practices and elevate their professional development.

There are a number of studies about integrating technology into teaching and learning but there is lack of well-documented constructivist technological instructional strategies that holistically interrelate content, current pedagogical strategies and the ever-evolving technologies. In particular, there is lack of studies that directly interrogate TrEds' practices as agents of change in teaching and learning. Therefore, this study addresses this gap and provides an informed intervention. The findings of this study enhance understanding of TrEd current teaching with technology practices by providing an in-depth analysis of issues affecting their practice. This study adds to current knowledge of TrEd technology enhanced constructivist instructional strategies in teacher preparation programmes; an important area that has been neglected so far. This was evidenced in this research by TrEds claims that although they were aware of and understood learning theories, their practice was not necessarily built on them. The resultant finding of this was that even when TrEds made use of advanced technology, their outcomes were limited due to use of lecture-centred teaching strategy. The constructivist underpinnings of the conceptual framework ensure that the TrEd achieves the 4Cs as demanded by the 21C learning environment.

7.4 Implications of the study

Having discussed the main findings and contributions of this study, it is important to outline the implications of it. The researcher found the implication mainly to affect TrEd professional development from two aspects namely from a policy making and a practice point of view. The section below addresses what the impact of the findings of this study have on policies guiding professional development as well as TrEd day to day practises.

7.4.1 Professional Development policies

The implications of this study address institutional policy-makers in relation to issues that emanate from the study; specifically issues that deal with professional development in relation to availability and accessibility of technological resources.

Teacher preparation institutions should align their objectives with the current and future needs of the schools to which pre-service teachers will be deployed. It is important that policies are designed to cater for existing teaching with technology needs as well as anticipated future demands. They must create an educator-enabling legislative and policy framework informed by various stakeholders; such as the Department of Education, the international board UNESCO that endorses and supports integration of ICTs in teaching and learning. The findings of this research indicated that TrEds professional development was not as effective as it could be due to the fact that the policy makers in this area are not practicing professional educators. The design of professional development policies and plans is therefore lacking as it is not advised by contemporary teaching theories. The other concern in this area was that technologies being introduced to institutions are mostly general technologies that may not necessarily be useful to TrEds and their respective fields. It is therefore essential that policy makers revise who comprises the various boards of decision makers with regards to technology integration, as technology experts may fail to appreciate the real impact of their technological designs on day to day teaching practices.

The results of the study imply that institutions may have to draft policies that regulate and insist on the designing of teaching and learning activities informed by learning theories such as the constructivist theory – theories that are relevant to the demands of this vast digital information era. The findings of the study indicated that very few TrEds were making the effort to build their teaching activities and objectives on contemporary learning theories. This approach results in TrEds failing to effectively model teaching with technology techniques appropriate for the 21C to the pre-service teachers. The findings of this study also highlight the important role that TrEds play in shaping pre-service teachers' acquisition of constructivist technological instructional strategies. It is important for TrEds to undergo sound professional development that equips them with relevant skills that meet the requirements of a digital classroom.

However, for this to take place in a consistent manner, policy makers in institutions may have to consider drafting policies that regulate TrEds' practice in this regard. Regulating professional development practices ensures that TrEds progress in their practice at a monitored pace. With regards to TrEd professional development it is important that faculty policies be laid out in such a way that they also cater for TrEd different levels of technology knowledge and integration. When employing interventions, it may prove ineffective to not consider the varying needs between educators across faculties and within faculties as well. There should be measures put in place to ensure individual upskilling. The results of the study indicated that TrEds were operating at varying levels of technology integration knowledge and skills.

Another implication for professional development policies is that they should regulate infrastructure resource set-up and management. This allows for the institution and all other stakeholders to operate within a defined framework with regards to technology resource standards. Four essential technological infrastructure components capable of supporting transformational learning experiences include the following: (i) ubiquitous connectivity, (ii) powerful learning devices, (iii) high-quality digital learning content and (iv) Responsible Use Policies (RUPs) (See Chapter 2). The findings of this study reveal that technology infrastructure and resources were neither adequate nor up to the desired standard. A good example is that most TrEds were observed to be making use of outdated software in particular Microsoft office package. This therefore indicates that there is no regulation in place with regards to the use of up-to-date applications. The available technology resources were also observed as either not functioning or slow.

The findings report show that the slow speed of the current network infrastructure is frustrating to both TrEds and students. High speed connectivity ensures that all TrEds and pre-service teachers benefit from digital access to educational content. Currently, the low, unreliable wireless connections affect the ability of the network to provide pre-service teachers with an enhanced educational experience. Most pre-service teachers have smartphones therefore providing high speed connectivity would empower them and support the inclusiveness for which the institution is advocating therefore, BYOD strategies and technology-based lesson plans are integrated into teaching and learning.

The findings revealed that currently technicians are not trained to deal with technical issues but rely upon the major campuses for support. This reliance discourages TrEds and pre-service teachers who sometimes have longer periods of waiting for technical issues to be resolved. Investing in technology infrastructure provides TrEds and pre-service teachers with additional teaching and learning opportunities. The Centre for Digital Education (2013: 7) reports that *"technology tools have also helped students shift away from antiquated learning techniques such as recall and memorisation and move toward synthesising and creating content in an interactive and collaborative manner".*

Institutions should approach ITC services in such a way that the service is decentralised and that on-site technicians are fully skilled to support TrEds in their varying disciplines and resultantly, needs. The technology available, resources and infrastructural support should be implemented to effect the different teaching and learning objectives in teacher preparation. In this study, the on-site technicians were observed to be inadequately equipped to assist TrEds which therefore meant that support came from an off-site technician centred at the University's central office – a time consuming process. The ITC should consult with each faculty because the needs for different departments are not similar. Professional development in each faculty should be treated independently. To ensure that the faculty has an equitable, effective, digital learning environment and that all pre-service teachers and TrEds have access to technology, they need to participate fully in connected learning strategies that develop technology enhanced skills. To ensure that technology supports learning successfully, technology resource management need trained technical support persons.

To sum up, the implications of this study's finding to institutions is that TrEds professional development needs to be well regulated to ensure that their progression is monitored as well as standards must be set to give TrEds benchmarks on the level at which they should be performing in their teaching with technology practices. The study highlights the importance of revising existing policies or introduce new ones that address specific areas such as technical support, intervention implementation and faculty specific requirement regulations.

7.4.2 TrEds teaching with technology practice

This study recognised the significant role that TrEds play in developing pre-service teachers' experiences with the teaching with technology phenomenon as well as the limitations of their endeavours. The previous section addressed areas that may be affected at an organisational level, this section addresses the implications of this study's findings at individual TrEd level. TrEds in this study did not always fully understand the need to model 21C teaching with technology techniques to pre-service teachers' acquisition of effective constructivist technological instructional strategies. This section discusses the implications of this study for TrEds; in relation to issues of constructivism, TPACK and SAMR perspectives.

During the study, TrEds' constructivist technological pedagogical engagements were put to the test, and observations revealed that most were challenged in this area. TrEds managed to modify their existing traditional instructional strategies but only to a limited extent.

The implication of the study's findings on TrEds' practice is that it emphasises the gap between the TrEds beliefs with regards to their level of technology integration and the actual level at which they are performing in relation to the ConTIS model. During interview TrEds expressed their competency in technology integration whereas the researcher observed that in practise they were only substituting traditional means. The study findings highlight the need for TrEds to move towards student centred approaches. The model is a holistic approach to how TrEds should be integrating technology as it is built on a learning theory and technology integration frameworks. The gap could be bridged by TrEds awareness of the outcomes they are yielding compared to the ones they should be achieving in a 21C learning environment. The ConTis model guides TrEds in designing teaching and learning activities that are based on the constructivist theory and can therefore be more confident in their ability to employ 21C knowledge acquisition approaches. The model therefore serves as a diagnostic and evaluative tool for individual TrEds as they are able to reflect on their practice in order to determine whether or not they are meeting intended constructivist objectives. The call to maintain constructivist, technology-enhanced instructional strategies was diminished in this study by old methodologies and outdated habits. This study is therefore relevant as it offers an important contribution to educational technology-improved practices in teacher preparation programmes by means of the ConTIS process model: a goal-oriented professional model that guides towards practical application and integration of technology for TrEds.

The presentation of the ConTIS model in this study implies that TrEds are able to own their technology integration professional development. The discussion section of this study argues against the implementation of general technology interventions due to the resulting resistance to using what will be deemed by educators as irrelevant technology. The model therefore present TrEds with the platform to self-regulate their progression towards advanced technology integration. The impact of this model is such that it can shape TrEd day to day practices.

The section that follows presents recommendations to TrEd practices by offering up practical steps to take in order to improve technology integration.

7.5 Recommendations

In this section the study puts forward practical steps that should be taken by institutions as well as TrEds to bridge teaching with technology gaps identified in this study. The researcher recommends that institutions and educators alike adopt the ConTis model into their practices to help design improved and effective teaching with technology strategies. The sections that follow present tangible suggestions for institutions and TrEds in their pursuit of 21C teaching and learning outcomes.

7.5.1 institutional technology integration developments

It is of the utmost importance that the faculty adopts a research-based and evaluative approach in their initiative of teaching with technology in constructive and sustainable ways. The findings of this study show how TrEds engage in technology-enhanced teaching and learning practices without a guideline from the institutions policies therefore there is no defined benchmark on which TrEds technology knowledge is assessed, reviewed and managed. Considering that the 21C presents a vast amount of digital information, technology literacy is vital for TrEds to have and institutions need to ensure that its educators have at least the basic required technology knowledge and these basic requirements should be consistently evaluated.

One of the factors identified as compromising the adoption of certain technologies by TrEds is the failure to match technological interventions with the specific needs of TrEds as influenced by their different disciplines. TrEds in this study revealed that they sometimes attend technology workshops which they feel are too general and have no direct benefit to their practise. The researcher therefore recommends that it is essential that institution policies introduce for each faculty, a technology integration unit, that ensures that technology introduced is relevant, up-to-date and effective for that discipline (see Chapter 5).

As new technologies continue to emerge and permeate into higher education institutions, faculties must have a departmental policy in place that enforces faculty specific technology integration across all teacher preparation programmes. The effect of this will be a reduction in technology integration resistance from TrEds, which currently occurs due to technologies which they find irrelevant for their practice. In support of the suggestion that TrEds should be involved in technology integration policy making, De Silva (2016: 170) observes that "educators with a well-developed pedagogy of subject matter had a more intuitive understanding of selecting appropriate technologies..." This therefore implies that involving TrEds in the designing of interventions allows for technologies that carry value for the TrEd and in turn the pre-service teachers, to be implemented.

Most TrEds in this study were designing teaching activities outside of the influence of any contemporary learning theories, this resulted in them falling back on familiar traditional lecturer-centred approaches. The researcher therefore recommends that institutions develop policies that clearly state their adopted learning theory and technology integration model(s) of choice that ensures that learning outcomes are aligned with 21C demands. The stipulation of theories and frameworks affords institutions the opportunity to drive learning outcomes at institutional levels and avoids the discord presented by TrEds using different and sometimes ineffective approaches. The researcher advocates for institution policies reflective of 21C teaching practises that are not restrictive and one-directional but utilise technology for the achievement of new and innovative teaching and learning activities. The proposed ConTIS model recognises that without learning theories driving the change, technology integration will not be relevant and effective to constructivist outcomes. A reliable process model holds the key to progress within this highly specialised area of teacher preparation.

Technology possesses a progressively greater significance if it is focused on regeneration and transformation. In order for faculties of education to realise this influence, a description and vision of how technology can be integrated into the pedagogy of teacher preparation programmes is needed. TrEds have to build on pre-service teachers existing technology knowledge in navigating the affordances technology offers. This approach will enable them to develop the requisite knowledge and skills within their content areas; as well as to attain the needed 21C educator attributes.

In testing the unique ConTIS process model that was developed by the researcher, the recommendation is that educational faculties should be apprised of the information to start the integration of technology into respective modules as informed by the institution policy in this regard. It is essential that a systemic and decentralised process is followed at phase level, and that the expansion of technology is not simply done on an uncoordinated basis. A phased approach may be used so that technology roll-out occurs systematically from the overall institutional goals. The phased approach implies that continuous feedback on the effectiveness of the use of technology becomes part of professional development used in the planning of the subsequent years.

The faculty holistically needs to support and account for 21C skills of TrEds in order to enhance the teaching and learning strategies, and to transform it systematically. It is therefore necessary to implement systematic and gradual upgrades to current technology infrastructure and then position it as enablers that can be developed to meet the needs of a 21C education faculty. All information systems and knowledge digital resources should be linked to a rapid and stable network infrastructure which proved not to be the case at this research’s study site. Institutions stand to benefit from an active pursue of updated technologies, consistently evaluating and amending its infrastructure to accommodate and allow for the implementation of updated and progressive technologies. This objective should be systematically applied such that TrEds are able to align their own technology integration with that of the institution by constantly evaluating their skills and knowledge on technology resources.

Institutions and or faculties of education should acknowledge successes in the integration of technology by TrEds. There is an opportunity to incentivise faculties and TrEds through rewarding successful and excellent technology integration pursuits. This will motivate TrEds to continuously work on the development of their teaching with technology practice. To sum up, institutions should take a policy driven approach to successful integration of technology in teacher preparation programmes, they should make clear to TrEds what is required of them in this regard. There needs to be a systematic approach in terms of implementing, managing and evaluating teaching with technology practices and this is possible through well informed and structured teaching with technology policies.

7.5.2 Professional development for TrEds

The presented ConTIS model can be beneficial to TrEds individual development as it offers a guide on what TrEds can practically implement in their individual teaching practices to move them from traditional to 21C teaching with technology practice. The researcher advises that TrEds make use of the model for personal development such that they do not necessarily have to wait for institutional engineered professional development programmes, that way personal development in this areas becomes an ongoing exercise applied in their day to day.

The researcher proposes that TrEds adapt the process model developed in this research as they move from enhancement to transformation levels. The ConTIS model and the evaluation checklist that accompanies it provides practical questions that TrEds should use to evaluate and be aware of the level at which they are performing and navigate their way to the desired level. In constructivist settings, regardless of the course being taught, technology integration brings a shared and immersive experience. TrEds should ensure that they: (i) maximise technology interactive affordances by incorporating technology mediated through such means as group discussions, quizzes, debates and (ii) ensure that presentation work is always included in their lecture plans. In light of this study, TrEds need to be vigilant, attentive, technologically skilled, and innovative.

In the pursuit of continuous development in technology integration knowledge TrEds in their sections or units should organise weekly/monthly seminars and/or workshops that focus on discussing their constructivist technological instructional strategies and current students' needs. This approach creates what is more like a support group where technology knowledge can be shared. It enables TrEds to share experiences within their smaller units; improving their overall technological skills. This is the platform that TrEds can also use to discuss the affordances and therefore relevance of certain technologies for their discipline. The findings of this study, echo what other researchers argued previously, that TrEds are more receptive to technology knowledge as dispensed by their colleagues (Zhang, Liu, & Wang, 2017). By this means, TrEds are able to identify what works within their specific content areas and levels; allowing them to experiment and address the discipline and pre-service teachers' needs within their units or areas of expertise. This kind of smaller teamwork is a Japanese model of lecturer-led research in which a triad of lecturers works together to target an identified area of development in their students' learning (Stigler & Hiebert, 2016). For example, three mathematics TrEds can meet and undertake a lesson study on how to model technology appropriately in their mathematics lectures: "For TrEds, lesson study provides a dynamic means of sharing new content and teaching approaches." Fundamentally, "If teachers improve their content knowledge and practice through lesson study, then it follows that their pre-service teachers will have greater opportunities to increase their understanding and improve their teaching practices" (ibid). Lesson study provides TrEds a collaborative approach to solving problems with difficult lessons or methodologies.

The findings of this research highlighted concerns of staff development in terms of time constraints. TrEds noted that there is a clash in timetable between some staff development times and lecture times. This was attributed to the centralised university calendar which disregards the fact that the faculty of education operates on a different schedule to all the other faculties. This therefore emphasise the need to decentralise professional development and manage it at faculty level. Within the faculty, the approach should also be systematic. The researcher recommends that regular designated time blocks be set aside for technology integration practices and other initiatives. The implementation of small team initiatives is also beneficial in remedying this problem, as development can take place in a more manageable way at it takes place within the unit.

The researcher was tactful in formulating the ConTis model by using a contemporary learning theory combined with TPACK and SAMR constructs. This affords TrEd knowledge from both technological and pedagogical perspectives. The use of the model will assist in improving TrEds' confidence in the technology-enhanced teaching strategy they employ. Knowledge within both TPACK and SAMR frameworks describe the knowledge that teachers should possess (see chapter 3). If TrEds wish to be effective, it is imperative that these frameworks as well as the contemporary constructivist learning theory drives their understanding and implementation of technology-enhanced teaching strategies.

7.6 Reflection

The suggestions presented in the preceding section of future study form part of the researcher's reflection on this study but particularly on how the design of the study as well as its context may be revised and or altered for future studies. In this section, however, the researcher goes through some pivotal moments before and during the conducting of this study that greatly influenced how the research study unfolded.

The greatest factor behind the researcher's pursuit of the phenomenon of teaching with technology was their background as an educator in the IT field. Encounters with students and other educators often probed questions such as "How can we as educators help students to become critical thinkers? How can we get them excited about learning? How do we shape them into being contributors to the modern society and not just partakers?" The researcher holds the belief that education is a fundamental right to all and beyond that, it is a fundamental tool in equipping students on how to navigate themselves through the unending stream of information as afforded by the digitised era. Now, technology eases access to this information, it's on our fingertips, however, as with anything there has to be a responsibility on the part of the receiver of knowledge to test the truthfulness and applicability of all this knowledge. This is a skill that educators need to harness and impart on their students, to question facts, to test them and to develop or redefine them. As was highlighted in this research study, this skill can be developed when educators become purposeful about how they utilise technology in their teaching practise as well as the use of student-centred approaches to teaching and learning that allow for the development of the 4Cs.

Over the years and equally during this research study, it has been an interesting factor to note that students, in the case of this study, pre-service teachers, sometimes possess technology knowledge that the TrEds do not themselves possess. The researcher, on reflection, considers that perhaps it may be necessary to draw in a bit more on that issue such that it can become a way to ease teaching and learning, and that educators do not see this as a point of intimidation but rather an opportunity to both educator and student. The approach the TrEds should take should come from an understanding that ultimately the entire teaching and learning process should be to the benefit of the student. They should have an appreciation of the impact of the digital era on their students within and even outside the learning environment.

As with any research study, the researcher at times grows weary and exhausted. What always gave a boost of energy for the researcher was the realisation of just how relevant this research was to the field of education in the 21C. In attending numerous seminars and sometimes during informal conversations with colleagues, it became clearer how teaching with technology was such a challenge in the real lives of educators from day to day, whether this was realised or not. At one of the workshops attended, the researcher was greatly disturbed by the argument raised by a colleague. They were arguing that some of the students do not have the necessary basic knowledge of technology and that they would be too overwhelmed if the TrEds suddenly started using advanced technology, therefore they had no option but to use inferior technology or basic functions of technology so as not to alienate the student. While the researcher could understand the frustration of what the colleague argued, there was also an unsettling feeling that educators should not have to comply to inferior standards, that it should be their objectives to push for better outcomes systematically. The designing of pre-service teacher preparation programmes that model and instil the skill of teaching with technology will ensure that overtime challenges such as technologically challenged students will not be a deterrent to effective technology integration. The researcher's reflection on this issue prompted their recommendation for institutional policy that governs and manages TrEds use of technology in teacher preparation, there should be a framework to which TrEds comply that advocates for student-centred, technology-enhanced teaching practices.

The research study emphasises the employment of student-centred approaches, building on their existing knowledge and making use of collaborative tasks such that students learn from their peers. As indicated above, some students have technology knowledge that surpasses that of the TrEd, it now becomes imperative for the TrEd to identify the kind of learning activities that allow for both technologically advanced and challenged students to thrive. If educators comply to challenges presented without figuring out a way to overcome them, the gap on technology integration will not be easily bridged, if at all.

7.7 Further Research

The study aimed to explore TrEds' instructional strategies in preparing pre-service teachers to teach with technology. There is limited research undertaken in pre-service teacher preparation institutions to explore TrEds application of constructivist technological instructional strategies at a higher education institution in the South African context. In considering the context of the research, the researcher presents the following suggestions for further research.

7.7.1 Use different Research design

This study uses a single case study design, it is therefore suggested that further research can be conducted using a different form of case studies, such as longitudinal case study design which could be extend over a longer period of time. Longitudinal studies using large data sets may refine and further define the process model put forward in this study. The implementation of this type of case study allows the researcher to explore the phenomena over a much extended period of time which would allow for a more detailed investigation. Future studies would further benefit higher education across disciplines to foster and achieve transformational technology enhanced initiatives in TrEds.

Future studies may employ a comparative case study that examines TrEds of the same discipline but from different institutions. The focus for this study was on TrEds within the multi-discipline context of teacher preparation, however they were from the same faculty therefore there is an uninvestigated possibility of different finding from another faculty. Such studies could highlight issues about TrEd experiences that were not reflected in this study as this study was based on findings from the one institution. The comparative approach would allow for TrEd practice to be explored across contexts.

7.7.2 Data collection methods

This study used data collection instruments that are commonly employed in qualitative case study research. Interviews were the main source of data and observations and FGI were undertaken as secondary sources for validation purposes. Although these methods rendered rich data about TrEds instructional strategies in teacher preparation to teach with technology, other methods such as document analysis, or TrEds writing personal reflective journals could have been used. The use of reflective journals and document analysis would perhaps uncover other aspects of the phenomenon by taking a look at TrEds thought processes and documented patterns – they could be used for further scrutiny of the phenomenon in question. This could also assist in balancing out any possible biases in what TrEds reported in interviews or demonstrated in the observations which may not have been reflective of their usual practices outside of the study.

7.7.3 Pilot investigation of the ConTIS model

The researcher recommends that future studies conduct a practical investigation on the ConTIS model to evaluate its effectiveness. The researcher formulated this model on a rich literature review and indicated gaps in teaching with technology as discovered in the study's findings. There is still a need to an empirical investigation into the effectiveness of the model. The researcher recommends testing it out in different contexts.

7.8 Concluding Remarks

The researcher set out to investigate what teaching with technology strategies TrEds were using and the manner in which they were applying these. During the exploration of this phenomenon it became evident that most TrEds were using technology without the guidance of any specific learning theories or technology integration frameworks. The findings of this study revealed that teaching and learning strategies employed by TrEds consisted mainly of lectures that permitted little constructivist student-centred outcomes. Similarly, Hanson-Smith notes that:

> *…because of the poor preparations of pre-service teachers on how to integrate computers in their teaching and learning process, and [because of a lack of] appropriate support and direction, ... working with computers has become a passive activity with little constructive learning (Hanson-Smith, 1997: pp).*

While there was a consensus among TrEds on the relevance of teaching with technology, what was lacking, was the know-how and sometimes interest of optimising available technology resources. By means of a comprehensive qualitative approach to data collection, the researcher managed to identify contributing factors to teaching with technology practices as reported by interviewees and as observed by the researcher. The main factors identified included the vicious cycle of *teaching as one was taught*, limited technology knowledge, failure to match technology, pedagogy and content knowledge for advanced teaching and learning outcomes and institutional shortcomings with regards to technology resources supply, implementation and management. The few TrEds who were influenced by technology integration models also encountered challenges due to use of these models in isolation which meant that even though they were aware of *what* needed to be done for effective technology integration, they had no practical guide on *how* to progress towards those objectives. Similarly, Cloete (2017) suggest that limited and inadequate professional development prevents TrEds from using available technology in their teacher preparation programmes. Various studies by researchers such as Chai et al., (2013); Lee, (2014) and Chigona, (2015) have also shown that pre-service teachers are in fact inadequately prepared to use instructional technology and that they are unable to integrate technology into their teaching practice.

The researcher presented the ConTIS process model to provide TrEds with a solution to this problem of not knowing how to progress towards high level teaching and learning outcomes. Formulated during the course of this research, the model is a combination of the principles of the constructivist learning theory with TPACK and SAMR frameworks of technology integration. The model was purposefully designed in such a way that it can be used at an individual as well as institutional level to advise TrEd professional development. Applying constructivist-learning theory with TPACK and SAMR principles is crucial; particularly in pre-service teachers' training institutions as there is need to model to pre-service teachers the best possible ways in which to integrate technology. The use of constructivist approaches allows for pre-service teachers to not only have the ability to imitate what has been modelled to them, but to continuously evaluate and redesign learning activities as informed by changing contexts and ever developing technology affordances.

It is the researcher's belief that the findings of this study contributed to the body of knowledge from a theoretical and practice point of view by setting up a foundation on which further research may be conducted. There is need to put the ConTis model to the test to evaluate its practical effectiveness and to assess if it truly reduces the limitations of singular and isolated technology interventions. It will also be interesting to discover what the findings would be if the study were to be replicated in a different context and perhaps conducted with some alterations to the data collection process.

It is the researcher's hope that the findings of this study may influence policy-making in teacher pre-service institutions; that it will highlight the imperative need to handle teaching with technology more delicately and systematically.

REFERENCES

Abadzi, H. 2012. *Effective Teacher Training in Low-Income Countries: The Power of Observational Learning Research*. http://documents.worldbank.org/curated/en/2012/11/18042910/effective-teacher-training-low-income-countries-power-observational-learning-research.

Agbo, I.S. 2015. Factors Influencing the Use of Information and Communication Technology (ICT) in Teaching and Learning Computer Studies in Ohaukwu Local Government Area of Ebonyi State-Nigeria. *Journal of Education and Practice*, 6(7): 71–86. http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ1083136&site=ehost-live.

Akyeampong, K., Pryor, J., Westbrook, J. & Lussier, K. 2011. *Teacher Preparation and Continuing Professional Development in Africa*. Sussex. https://app.box.com/sierraleoneeducationdocs/1/187375169/1412848487/1.

Alahmari, A. & Kyei-blankson, L. 2016. Adopting and Implementing an E-Learning System for Teaching and Learning in Saudi Public K-12 Schools : The Benefits , Challenges , and Concerns. *World Journal on Educational Research*, 3(1): 11–32.

Alberta Education. 2017. Guide to Education. : 1–148. papers3://publication/uuid/917AD11C-9736-4808-A337-BD6A7121091F.

Aldoobie, N. 2015. Technology integration and learning theory. *American International Journal of Contemporary Research*, 5(6): 114–118.

Alessi, S.M. & Trollip, S.R. 2001. *Multimedia for learning : methods and development*. 3rd ed. Boston: Boston (Mass.) : Allyn and Bacon, 2001.

Ally, M. & Tsinakos, A. 2014. *Increasing Access through Mobile Learning*. M. Ally & A. Tsinakos, eds. Athabasca: Commonwealth of Learning and Athabasca University, Vancouver. http://www.col.org/PublicationDocuments/pub_Mobile Learning_web.pdf.

Amarin, N.Z. & Ghishan, R.I. 2013. Learning with technology from a constructivist point of view. *International Journal of Business, Humanities and Technology*, 3(1): 52–57. http://www.ijbhtnet.com/journals/Vol_3_No_1_January_2013/7.pdf.

Amineh, R.J. & Asl, H.D. 2015. Review of Constructivism and Social Constructivism. *Journal of Social Sciences, Literature and Languages*, 1(1): 9–16.

Amuko, S., Miheso-O’Connor, M. & Ndeuthi, S. 2015. Opportunities and Challenges: Integration of ICT in Teaching and Learning Mathematics in Secondary Schools, Nairobi, Kenya. In A. M. Bwire, M. S. Nyagisere, J. O. Masingila, & H. O. Ayot, eds. *Proceedings of the 4th International Conference on Education*. 6–12.

Ananiadou, K. & Rizza, C. 2010. ICT in Initial Teacher Training : First Findings and Conclusions of an Oecd Study. In *Proceedings of EDULEARN10 Conference.* Barcelona: 5621–5632.

Anderson, T. & Elloumi, F. 2008. *Theory and Practice of Online Learning*. T. Anderson & F. Elloumi, eds. Athabasca,: Athabasca University. http://www.iadl.org.uk/res/forms/tpol_book.pdf.

Angeli, C. & Valanides, N. 2009. Epistemological and methodological issues for the conceptualization, development, and assessment of ICT – TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers & Education*, 52(1): 154–168. http://dx.doi.org/10.1016/j.compedu.2008.07.006.

Anney, V.N. 2014. Ensuring Quality of Qualitative Through Trustworthiness. *Journal of Emerging Trends in Educational Research and Policy Studies (JETERAPS)*, 5(2): 272–281. https://pdfs.semanticscholar.org/1419/f7b54e6b7f1215717a5056e0709f8946745b.pdf.

Ashe, D. & Bibi, S. 2011. Unpacking TPACK and students’ approaches to learning: Applying knowledge in pieces to higher education teaching and learning. *ASCILITE 2011 - The Australasian Society for Computers in Learning in Tertiary Education*: 128–132.

Attwell, G. & Hughes, J. 2010. *Pedagogic Approaches to Using Technology for Learning Literature Review*.

Babbie, E. 2013. *Qualitative Research*. E. Babbie, ed.

Balaji, M.S. & Chakrabarti, D. 2010. Student Interactions in Online Discussion Forum: Empirical Research from ‘ Media Richness Theory ’ Perspective. *Journal of Interactive Online Learning*, 9(1): 1–22.

Balanskat, A., Bannister, D., Hertz, B., Sigillò, E., Vuorikari, R. & Institute for Prospective Technological Studies. 2013. *Overview and analysis of 1:1 learning initiatives in Europe.* S. Bocconi, A. Balanskat, P. Kampylis, & Y. Punie, eds. Luxembourg: European Union, 2013 ©.

Banks, T., Jackson, D. & Harper, B. 2014. Responding to the call to prepare highly effective teacher candidates in the United States: The curriculum redesign effort in advancing teacher education. *Higher Education Studies*, 4(2): 9–19. http://www.ccsenet.org/journal/index.php/hes/article/view/34058.

Baran, E., Canbazoglu Bilici, S., Albayrak Sari, A. & Tondeur, J. 2017. Investigating the impact of teacher education strategies on preservice teachers' TPACK. *British Journal of Educational Technology*, 00(00).

Baran, E., Chuang, H.-H. & Thompson, A. 2011. TPACK: An Emerging Research and Development Tool for Teacher Educators. *Turkish Online Journal of Educational Technology*, 10(4): 370–377. http://www.scopus.com/inward/record.url?eid=2-s2.0-80054031727&partnerID=40&md5=65418555ce0f8e322d098a72915fb12f.

Bates, C., Droste, C., Cuba, L. & Swingle, J. 2008. One-On-One Interviews : A Qualitative Assessment Approach. : 1–14. www.liberalarts.wabash.edu.

Bates, T.A.W. 2015. *Teaching in a Digital Age: Guidelines for designing teaching and learning for a digital age.* British Columbia. http://opentextbc.ca/teachinginadigitalage/.

Benbasat, I., Goldstein, D.K. & Mead, M. 1987. The case research strategy in studies of information systems. *MIS Quarterly: Management Information Systems*, 11(3): 369–386.

Berrett, B., Murphy, J. & Sullivan, J. 2012. *Administrator Insights and Reflections: Technology Integration in Schools*. http://nsuworks.nova.edu/tqr/vol17/iss1/10.

Bhalla, J. 2013. Computer Use by School Teachers in Teaching-learning Process. *Journal of Education and Training Studies*, 1(2): 174–185.

Bhattacharjee, J. 2015. Constructivist Approach to Learning--An Effective Approach of Teaching Learning. *International Research Journal of Interdisciplinary & Multidisciplinary Studies*, 1(4): 65–74. http://www.irjims.com.

Biggerstaff, D.L. & Thompson, A.R. 2008. Interpretative Phenomenological Analysis

(IPA): A Qualitative Methodology of Choice in Healthcare Research. *Qualitative Research in Psychology 5*, 5: 173–183.

Biku, T., Demas, T., Woldehawariat, N., Getahun, M. & Mekonnen, A. 2018. The effect of teaching without pedagogical training in St Paul's Hospital Millennium. *Advances in Medical Education and Practice*.

Blaxter, L., Hughes, C. & Tight, M. 2010. *How to Research*. forth. Berkshire: McGraw Hill House.

Blazer, C. 2008. *Literature Review Educational Technology*. Miami, Florida.

Bomah, K.B. 2015. Digital Divide : Effects on Education Development in Africa . , (December 2014): 0–20.

Boudourides, M.A. 2003. Constructivism, Education, Science, and Technology. *Canadian Journal of Learning and Technology*, 29(3).

Bouhnik, D., Deshen, M. & Gan, R. 2014. WhatsApp Goes to School : Mobile Instant Messaging between Teachers and Students. *Journal of Information Technology Education: Research*, 13: 217–231.

Bryman, A. 2016. *Social Research Method, Ch1. The nature and process of social research*. 5th ed. Oxford UK: Oxford University Press.

Buabeng-Andoh, C. 2012. Factors influencing teachers ' adoption and integration of information and communication technology into teaching : A review of the literature Charles Buabeng-Andoh. *International Journal of Education and Development using Information and Communication Technology*, 8(1): 136–155.

Bulmer, M. 2008. The Ethics of Social Research. In N. Gilbert, ed. *Researching social life*. London: SAGE Publications: 59–89.

Butler-Adam, J. 2018. The Fourth Industrial Revolution and education. *South African Journal of Science*, 114(5–6).

Byrd, N. (2017). Technology-Based Professional Development for Teaching and Learning in K-12 Classrooms. Doctoral study. Walden University. Minnesota

Callary, B., Rathwell, S. & Young, B.W. 2015. Insights on the Process of Using Interpretive Phenomenological Analysis in a Sport Coaching Research Project. *The Qualitative Report*, 20(1): 63–75.

http://www.nova.edu/ssss/QR/QR20/2/callary1.pdf.

Campus, M. 2019. Teacher Educators ' Instructional Strategies in Preparing Pre - Service Teachers to Teach with Digital Technology in the 21 st Century. , (August).

Cao, Y., Ajjan, H. & Hong, P. 2013. Using social media applications for educational outcomes in college teaching: A structural equation analysis. *British Journal of Educational Technology*, 44(4): 581–593. http://doi.wiley.com/10.1111/bjet.12066 13 June 2013.

Care, E., Kim, H., Vista, A. & Anderson, K. 2018. *Education System Alignment for 21st Century Skills*. https://www.brookings.edu/wp-content/uploads/2018/11/Education-system-alignment-for-21st-century-skills-012819.pdf.

Chai, C.S., Koh, J.H.L. & Tsai, C.-C. 2013. A Review of Technological Pedagogical Content Knowledge. *Educational Technology and Society*, 16(2): 31–51.

Chai, C.S., Ng, E.M.W., Li, W., Homh, H.-Y. & Koh, J.H.L. 2013. Validating and modelling technological pedagogical content knowledge framework among Asian preservice teachers. *Australasian Journal of Educational Technology*, 29(1): 41–53.

Chen, Y.H., Jang, S.J. & Chen, P.J. 2015. Using wikis and collaborative learning for science teachers' professional development. *Journal of Computer Assisted Learning*, 31(4): 330–344.

Chigona, A. 2015a. Pedagogical shift in the twenty-first century: preparing teachers to teach with new technologies. *Africa Education Review*, 12(3): 478–492.

Chigona, A. 2015b. Quality of Teacher Education for 21st Century Classrooms. In L. D. Mogari, ed. *Towards Effective Teaching and Meaningful Learning in Mathematics, Science and Technology*. Limpopo: Unisa Press: 451–457.

Chigona, A. 2013. Using multimedia technology to build a community of practice : Pre-service teachers ' and digital storytelling in South Africa Agnes Chigona Cape Peninsula University of Technology , South Africa. *International Journal of Education and Development using Information and Communication Technology*, 9(3): 17–27.

Chigona, A. & Chigona, W. 2013. South African pre-service teachers' under-preparedness to teach with Information Communication Technologies. *IEEE Xplore*: 239–243. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6644381.

Chigona, A., Chigona, W. & Davids, Z. 2014. Educators ' motivation on integration of ICTs into pedagogy : case of disadvantaged areas. *South African Journal of Education*, 34(3).

Chikuni, P.R. 2016. *The Relationship Between Policy-Making Processes And E-Learning Policy Discourses In Higher Education Institutions In South Africa By Patricia Rudo Chikuni A thesis submitted in fulfillment of the requirements for the Degree of Doctor of Philosophy in Inf*. University of Cape Town.

Chitiyo, G., Taukeni, S. & Chitiyo, M. 2015. The Observation. In C. Okeke & M. Van Wyk, eds. *Educational reseach: An african persepective*. Cape town: Oxford University Press South Africa: 280–294.

Chittleborough, G. 2014. Learning How to Teach Chemistry with Technology: Pre-Service Teachers' Experiences with Integrating Technology into Their Learning and Teaching. *Journal of Science Teacher Education*, 25(4): 373–393. http://link.springer.com/10.1007/s10972-014-9387-y.

Choy, D., Wong, A.F.L. & Gao, P. 2009. Student teachers' intentions and actions on integrating technology into their classrooms during student teaching: A singapore study. *Journal of Research on Technology in Education*, 42(2): 175–195.

Chuang, Y. & Tsao, C. 2013. Enhancing nursing students ' medication knowledge : The effect of learning materials delivered by short message service. *Computers & Education*, 61: 168–175. http://dx.doi.org/10.1016/j.compedu.2012.09.013.

Church, K. & de Oliveira, R. 2013. What's Up with Whatsapp?: Comparing Mobile Instant Messaging Behaviors with Traditional SMS. In *Proceedings of the 15th International Conference on Human-computer Interaction with Mobile Devices and Services*. 352–361. http://doi.acm.org/10.1145/2493190.2493225.

Clark, K. & Waaili, S. Al. 2010. *Needs Assessment Report*.

Clarke, B. 2013. Using thematic analysis in psychology. *Journal of Chemical Information and Modeling*, 53(9): 1689–1699.

Cloete, A.L. 2017. Technology and education: Challenges and opportunities. *HTS*

Teologiese Studies / Theological Studies, 73(4): 1–7.

Coffield, F. 2008. *Just suppose teaching and learning became the first priority...* J. Warner, ed. London: Learning and Skills Network. http://www.itslifejimbutnotasweknowit.org.uk/files/Coffield_IfOnly.pdf.

Cohen, L., Manion, L. & Morrison, K. 2007. *Research Methods in Education*.

Cohen, L., Manion, L. & Morrison, K. 2011. *Research Methods in Education (7th Edition)*. 7th ed. Abington: Routledge. http://www.bioscience.heacademy.ac.uk/journal/vol10/beej-10-r1.htm.

Cousin, G. 2010. *New approaches to qualitative research : wisdom and uncertainty*. M. Savin-Baden & C. H. Major, eds. New York: Routledge.

Creswell, J.W. 1998. *Qualitative inquiry & research design: Choosing among five approaches*. 1st ed. CA: SAGE Publications.

Creswell, J.W. 2007. *Qualitative inquiry and research design: Choosing among five approaches*. 2nd ed. CA: Thousand Oaks, Sage.

Creswell, J.W. 2008. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. 3rd ed. V. Knight, ed. SAGE Publications.

Creswell, J.W. 2003. *Research Design*. C. Laughton, D. Veronica, D. E., & A. J. Sobczak, eds. SAGE Publications.

Creswell, J.W. & Miller, D.L. 2000. Determining validity in qualitative research. *Theory into Practice*, 39(3): 124–130. https://www.google.no/search?q=creswell+reliability+and+validity&rlz=1C5CHFA_enGB720GB722&oq=cresweell+reliabilit&aqs=chrome.1.69i57j0l2.12649j0j8&sourceid=chrome&ie=UTF-8#q=creswell+reliability+and+validity&start=10.

Cropley, A.J. 2015. *Introduction to Qualitative Research Methods*. L. Riga, ed. Hamburg: University of Hamburg.

Culén, A.L. 2010. Data Analysis , Interpretation and Presentation. : 2–28. http://www.uio.no/studier/emner/matnat/ifi/INF4260/h10/undervisningsmateriale/DataAnalysis.pdf.

Culp, K.M., Honey, M. & Mandinach, E. 2005. A retrospective on twenty years of education technology policy. *Journal of Educational Computing Research*, 32(3):

279–307. http://www.nationaledtechplan.org.

Czerniewicz, L. & Brown, C. 2009. A study of the relationship between institutional policy , organisational culture and e-learning use in four South African universities. *Computers & Education Education*, 53: 121–131.

Dalia, H. & Chowdhury, M.O. 2017. Information Technology (IT) and Teaching Method: An Assessment on the Students of Social Science Faculty and Business Faculty of University of Dhaka. *Journal of Information Engineering and Applications*, 7(8). www.iiste.org.

Danermark, B., Ekström, M., Jakobsen, L. & Karlsson, J.C. 2001. *Explaining society: An Introduction to Critical Realism in the Social Sciences*. 3rd ed. M. Archer, R. Bhaskar, A. Collier, T. Lawson, & A. Norrie, eds. London: Routledge UK.

Darling-Hammond, L., Hyler, M.E. & Gardner, M. 2017. *Effective Teacher Profesional Development*. Palo Alto CA. https://learningpolicyinstitute.org/product/teacher-prof-dev.

Davidson, L.Y.J., Richardson, M. & Jones, D. 2014. Teachers' perspective on using technology as an instructional tool. *Research in Higher Education Journal*, 24: 1–25.

Deacon, R. 2014. The Initial Teacher Education Research Project The Initial Professional Development of Teachers : A Literature Review Roger Deacon. *A literature review*.

Delich, P., Kelly, K. & McIntosh, D. 2008. Emerging Technologies in E-learning. In S. Hirtz, D. G. Harper, & S. Mackenzie, eds. *Education for a Digital World : Advice , Guidelines , and Effective Practice from Around the Globe*. Vancouver, British Columbia: BCcampus and Commonwealth of Learning: 5–22.

Denise A. Schmidt, Baran, E., Thompson, A.D., Koehler, M.J., Mishra, P. & Shin, T. 2010. Survey of Preservice Teachers' Knowledge of Teaching and Technology. : 1–8.

Denzin, N.K. & Lincoln, Y.S. 2011. *The SAGE Handbook of Qualitative Research*. CA: SAGE Publications.

Department of Basic Education. *Department of Basic Education*. Pretoria.

Department of Education. 2007. *The National Policy Framework for Teacher Education and Development in South Africa*. South Africa: Government Gazette Staatskoerant.

Dionys, D. 2012. Introduction of ICT and multimedia into Cambodia's teacher training centres. *Australasian Journal of Educational Technology*, 28(6): 1068–1073.

Divaharan, S. 2011. Learning new technology tools in pre-service teacher education: A model for instructional approach. *Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education*: 352–363.

Donovan, L. & Green, T. 2014. *Creating a 21st Century Teaching and Learning Environment*. Huntington Beach: Shell Educational Publishing.

Drake, J.R. 2017. A Critical Analysis of Active Learning and an Alternative Pedagogical Framework for Introductory Information Systems Courses. *Journal of Information Technology Education: Innovations in Practice*, 11: 039–052.

Drost, E.A. 2011. Validity and reliability in social science research. *Education Research and Perspectives*, 38(1): 105–123.

Eatough, V. & Smith, J.A. 2007. Interpretative Phenomenological Analysis. In *The SAGE Handbook of Qualitative Research in Psychology*. 179–194. http://sk.sagepub.com/reference/hdbk_qualpsych/n11.xml.

Elfil, M. & Negida, A. 2017. Sampling methods in Clinical Research; an Educational Review. *Emergency*, 5(1): e52. http://www.ncbi.nlm.nih.gov/pubmed/28286859%0Ahttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC5325924.

Ertmer, P.A. 1999. Addressing first- and second-order barriers to change: Strategies for technology integration. *Educational Technology Research and Development*, 47(4): 47–61.

Ertmer, P.A. 2005. Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research and Development*, 53(4): 25–39. http://link.springer.com/10.1007/BF02504683.

Ertmer, P.A. 2005. Teacher Pedagogical Beliefs and Classroom Technology Use: A Critical Link. : 1–36.

Ertmer, P.A., Ottenbreit-leftwich, A. & York, C.S. 2007. Perceptions Influencing Success. *Journal of Computing in Teacher Education*, 23(2): 55–61.

Ertmer, P.A. & Ottenbreit-Leftwich, A.T. 2010. Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education*, 42(3): 255–284.

Eynden, V. Van Den & Brett, B.M. 2010. *Research Ethics and Data Confidentiality: Informed Consent.* Cape Town.

Flyvberg, B. 2006. Five Misunderstandings About Case-Study Research. *Qualitative Inquiry*, 12(2): 219–245. http://qix.sagepub.com/content/12/2/219.abstract.

Forni, K., Holcombe, C. & Huang, C. 2013. Elearning Engagement and interactivity. : 1–21. www.eLearningGuild.com.

Foulger, T.S., Graziano, K.J., Schmidt-Crawford, D.A. & Slykhuis, D.A. 2017. Teacher Educator Technology Competencies. *Jlournal of Technology and Teacher Education*, 25: 413–448.

Fredrickson, S., Vu, P. & Crow, S.R. 2014. Availability and Use of Digital Technologies in P-12 Classrooms of Selected Countries. *Issues and Trends in Educational Technology*, 2(1). https://journals.uair.arizona.edu/index.php/itet/article/view/17933/17904.

Fry, H., Ketteridge, S. & Marshall, S. 2009. *A Handbook for Teaching and Learning in Higher Education*.

Fu, J.S. 2013. ICT in Education : A Critical Literature Review and Its Implications. *International Journal of Education and Development using Information and Communication Technology*, 9(1): 112–125.

Garofalo, J. & Trinter, C. 2013. Using Simulations to Foster Preservice Mathematics Teachers' Self-Assessment, Learning, and Reflections on Teaching. *Mathematics Teacher Educator*, 1(2): 162.

Gibson, P.A., Stringer, K., Cotten, S.R., Simoni, Z., Neal, L.J.O. & Howell-moroney, M. 2014. Changing teachers, changing students? The impact of a teacher-focused intervention on students' computer usage, attitudes, and anxiety. *Computers & Education*, 71: 165–174. http://dx.doi.org/10.1016/j.compedu.2013.10.002.

Gilakjani, P.A., Lai-Mei, L. & Hairul, N.I. 2013. Teachers' Use of Technology and Constructivism. *International Journal of Modern Education and Computer Science*, 4: 49–63. http://www.mecs-press.org/ijmecs/ijmecs-v5-n4/v5n4-7.html.

Given, L.M. & Saumure, K. 2008. Trustworthiness. In L. M. Given, ed. *The SAGE Encyclopedia of Qualitative Research Methods*.

Gomes Sr, G. 2017. *Teacher Preparation: Perceptions of Preparedness for High-Needs Urban Schools A Qualitative Study*. http://libguides.sjfc.edu/citations.

Goodchild, T. & Speed, E. 2018. Technology enhanced learning as transformative innovation: a note on the enduring myth of TEL. *Teaching in Higher Education*, 0(0): 1–16. https://doi.org/10.1080/13562517.2018.1518900.

Goodwin, A.L., Smith, L., Souto-Manning, M., Cheruvu, R., Tan, M.Y., Reed, R. & Taveras, L. 2014. What Should Teacher Educators Know and Be Able to Do? Perspectives From Practicing Teacher Educators. *Journal of Teacher Education*: 1–19. http://jte.sagepub.com/cgi/doi/10.1177/0022487114535266.

Green, L. & Condy, J. 2016. Philosophical enquiry as a pedagogical tool to implement the CAPS curriculum: Final-year pre-service teachers' perceptions. *South African Journal of Education*, 36(1): 1–8.

Gregory, J. & Salmon, G. 2013. Professional development for online university teaching. *Distance Education*, 34(3): 256–270. http://www.tandfonline.com/doi/abs/10.1080/01587919.2013.835771 17 July 2014.

Groff, J. 2013. Technology-rich innovative learning environments. : 1–30.

Guðmundsdóttir, G.B., Dalaaker, D., Egeberg, G., Edvard, O. & Hultman, K. 2014. Interactive Technology. Traditional Practice? *Nordic Journal of Digital Literacy*, 9(1): 23–43.

Haitham, A. 2017. *Students' Experiences of Learning English as a Foreign Language: A Case Study of an Undergraduate EFL Programme at a Saudi University*. University of Sussex.

Hajhosseini, M., Zandi, S., Shabanan, S.H. & Madani, Y. 2016. Critical thinking and social interaction in active learning: A conceptual analysis of class discussion from Iranian students' perspective. *Cogent Education*, 3(1): 1–9.

http://dx.doi.org/10.1080/2331186X.2016.1175051.

Hamilton, E.R., Rosenberg, J.M. & Akcaoglu, M. 2016. The Substitution Augmentation Modification Redefinition (SAMR) Model: a Critical Review and Suggestions for its Use. *TechTrends*, 60: 433–441. http://link.springer.com/10.1007/s11528-016-0091-y.

Hammersley, M. 2007. The issue of quality in qualitative research. *International Journal of Research & Method in Education*, 30(3): 287–305. http://www.tandfonline.com/doi/abs/10.1080/17437270701614782.

Hanson-Smith, E. 1997. *Technology in the classroom: Practice and promise in the 21st century*.

Harder, N. 2018. The Value of Simulation in Health Care: The Obvious, the Tangential, and the Obscure. *Clinical Simulation in Nursing*, 15: 73–74. https://doi.org/10.1016/j.ecns.2017.12.004.

Hardman, J. & Amory, A. 2015. Introduction to Cultural-Historical Activity Theory and tool mediation. In V. Bozalek, D. Ng'ambi, D. Wood, J. Herrington, J. Hardman, & A. Amory, eds. *Activity Theory , Authentic Learning*. Routledge: 9–21.

Harris, J., Mishra, P. & Koehler, M. 2009. Teachers' Technological Pedagogical Content Knowledge and Learning Activity Types: Curriculum-based Technology Integration Reframed. *Journal of Research on Technology in Education*, 41(4): 393–416.

Hartman, H. & Lange, V.L. 2012. *Instructional Scaffolding*. http://www.scopus.com/inward/record.url?eid=2-s2.0-84883305589&partnerID=tZOtx3y1.

He, W., Cernusca, D. & Abdous, M. 2010. Exploring cloud computing for distance learning. *Online Journal of Distance Learning Administration*, 14: 1–5. http://www.westga.edu/~distance/ojdla/fall143/he_cernusca_abdous.pdf.

Heimann, S. 2015. Sample Survey. *QuestionPro*: 1–38.

Henrie, C.R. 2016. *Measuring Student Engagement in Technology- Mediated Learning Environments*. Brigham Young University. https://scholarsarchive.byu.edu/cgi/viewcontent.cgi?referer=https://www.google.co.za/&httpsredir=1&article=6948&context=etd.

Henriksen, D., Mishra, P. & Fisser, P. 2016. Infusing Creativity and Technology in 21st Century Education : A Systemic View for Change. *Journal of Educational Technology & Society*, 19(3): 27–37.

Herrington, J. & Herrington, A. 2006. Authentic Learning Environments in Higher Education Edited by Anthony Herrington and Jan Herrington Hersley : PA : Information Science Publishing , 2006. *Turkish Online Journal of Distance Education*, 7(1): 175–180.

Hilton, J.T. 2016. A Case Study of the Application of SAMR and TPACK for Reflection on Technology Integration into Two Social Studies Classrooms. *The Social Studies*, 107(2): 68–73. http://www.tandfonline.com/doi/full/10.1080/00377996.2015.1124376.

Hine, P. 2011. *UNESCO ICT COMPETENCY FRAMEWORK FOR TEACHERS*. 2nd ed. P. Hine, ed. United Nations Educational, Scientific and Cultural Organization.

Hughes, J. 2005. The Role of Teacher Knowledge and Learning Experiences in Forming Technology-Integrated Pedagogy. *Journal of Technology & Teacher Education*, 13(2): 277–302. http://www.editlib.org/d/_6587.pdf.

Hughes, J., Thomas, R. & Scharber, C. 2006. Assessing technology integration: The RAT–replacement, amplification, and transformation-framework. *Society for Information Technology & Teacher Education International Conference*, 2006(c): 1616–1620.

Hur, J.W., Cullen, T. & Brush, T. 2010. Teaching for application : A model for assisting pre-service teachers with technology integration. *Journal of Technology and Teacher Education*, 18(1): 161–182.

Israel, M., Marino, M., Delisio, L. & Serianni, B. 2014. *Innovation Configuration Supporting Content Learning Through Technology for K-12 Students With Disabilities*. http://ceedar.education.ufl.edu/tools/innovation-configurations/.

Jackson, E. 2013. Choosing a Methodology: Philosophical Underpinning. *Practitioner Research in Higher Education Journal*, 7(71): 49–62.

Jaipal-Jamani, K. & Figg, C. 2015. A case study of a TPACK-based approach to teacher professional development: Teaching science with blogs. *Contemporary Issues in Technology and Teacher Education*, 15(2): 161–200.

John-Steiner, V. & Holbrook, M. 1996. Sociocultural approaches to learning and development: A Vygotskian framework. *Educational Psychologist*, 31(3–4): 191–206. https://www.tandfonline.com/action/showCitFormats?doi=10.1080%2F00461520.1996.9653266 16 December 2016.

Johnson, L., Adams Becker, S., Estrada, V. & Freeman, A. 2014. *Games and Gamification*. http://www.nmc.org/publications/2014-horizon-report-higher-ed.

Johnson, B. & Mcelroy, T.M. 2012. The Changing Role of the Teacher in the 21st Century By. http://teachers.net/gazette/ wordpress/dr-brad-johnson-tammy-maxsonmcelroy/changing-role-of-the-teacher/3/.

Johnson, L., Becker, A.S., Cummins, M., Estrada, V., Freeman, A. & Ludgate, H. 2013. *NMC Horizon Report 2013 Higher Education Edition*. Austin, Texas: The New Media Consortium.

Jonassen, D.H. 1999. Constructivist learning environments on the web: engaging students in meaningful learning. In *Educational Technology Conference and Exhibition: Thinking Schools, Learning Nation*.

Jori, B.S. 2014. *Changing the Narrative of Teacher Preparation: A Case Study of Faculty Methods at an Urban Teacher Residency*. George Mason University.

June, S., Yaacob, A. & Kheng, Y.K. 2014. Assessing the use of youtube videos and interactive activities as a critical thinking stimulator for tertiary students: An action research. *International Education Studies*, 7(8): 56–67.

Kadzera, C.M. 2006. Use of instructional technologies in teacher training colleges in Malawi. *A doctoral Dissertation*. http://scholar.lib.vt.edu/theses/available/etd-05152006-174707/.

Katitia, D.M.O. 2015. Teacher Education Preparation Program for the 21st Century. Which Way Forward for Kenya?. *Journal of Education and Practice*, 6(24): 57–63.

Keane, T., Keane, W.F. & Blicblau, A.S. 2013. The Use of Educational Technologies to Equip Students with 21 st Century Skills. *X World Conference on Computers in Education July 2-5*, (2010): 74–82.

Keengwe, J. & Onchwari, G. 2009. Technology and early childhood education: A technology integration professional development model for practicing teachers.

Early Childhood Education Journal, 37(3): 209–218.

Keengwe, J., Onchwari, G. & Agamba, J. 2014. Promoting effective e-learning practices through the constructivist pedagogy. *Education and Information Technologies*, 19(4): 887–898.

Khalil, M.K. & Elkhider, I.A. 2016. Applying learning theories and instructional design models for effective instruction. *Advanced Physical Education*, 40: 147–156.

Khan, M.S.H., Hasan, M. & Clement, C.K. 2012. Barriers to the Introduction of ICT into Education in Developing Countries: The Example of Bangladesh. *International Journal of Instruction*, 5(2): 61–80. http://www.e-iji.net/dosyalar/iji_2012_2_4.pdf.

Kihoza, P., Zlotnikova, I., Bada, J. & Kalegele, K. 2016. Classroom ICT integration in Tanzania : Opportunities and challenges from the perspectives of TPACK and SAMR models. *interational Journal of Education ad Development using Information and Communication Technology*, 12(1): 107–128.

Kimathi, F. & Rusznyak, L. 2018. Advancing professional teaching in South Africa: Lessons learnt from policy frameworks that have regulated teachers' work. *Education as Change*, 22(3): 1–25.

Kipsoi, E.J., Chang'ach, J.K. & Sang, H.C. 2012. Challenges Facing Adoption of Information Communication Technology (ICT) In Educational Management in Schools in Kenya. *Journal of Sociological Research*, 3(1): 18–28.

Kivunja, C. 2014. Innovative Pedagogies in Higher Education to Become Effective Teachers of 21 st Century Skills : Unpacking the Learning and Innovations Skills Domain of the New Learning Paradigm. *International Journal of Higher Education*, 3(4): 37–48. www.sciedu.ca/ijhe.

Kivunja, C. & Kuyini, A.B. 2017. Understanding and Applying Research Paradigms in Educational Contexts. *International Journal of Higher Education*, 6(5): 26.

Knapik, M. 2006. The qualitative research interview: Participants' responsive participation in knowledge making. *International Journal of Qualitative Methods*, 5(3): 77–93.

Koç, M. 2005. Implications of Learning Theories for Effective Technology Integration and Pre-service Teacher Training : A Critical Literature Review. *Journal of Turkish Science Education*, 2(1): 2–18.

Koehler, M.J. & Mishra, P. 2009. What is Technological Pedagogical Content Knowledge (TPACK)? *Contemporary Issues in Technology and Teacher Education*, 9: 60–70. http://punya.educ.msu.edu/wp-content/uploads/2014/01/BUJoE.V193.3.KoehlerMishraCain.pdf.

Koehler, M.J., Mishra, P. & Cain, W. 2017. What is Technological Pedagogical Content Knowledge (TPACK)? *Journal of Education*, 193(3): 13–19.

Koehler, M.J., Mishra, P., Kereluik, K., Shin, T.S. & Graham, C.R. 2014. The Technological Pedagogical Content Knowledge Framework. In *Handbook of Research on Educational Communications and Technology*. New York: 101–111.

Koh, J.H.L. & Sing, C.C. 2011. Modeling pre-service teachers ' technological pedagogical content knowledge (TPACK) perceptions : The influence of demographic factors and TPACK constructs. In *Ascilite 2011*. 735–746.

Kolb, A.Y., Kolb, D.A., Passarelli, A. & Sharma, G. 2014. On Becoming an Experiential Educator: The Educator Role Profile . *Simulation & Gaming* , 45(2): 204–234. http://sag.sagepub.com/content/45/2/204.abstract.

Kong, S.C. & Song, Y. 2013. A principle-based pedagogical design framework for developing constructivist learning in a seamless learning environment: A teacher development model for learning and teaching in digital classrooms. *British Journal of Educational Technology*, 44(6): 209–212.

Korstjens, I. & Moser, A. 2018a. Series : Practical guidance to qualitative research . Part 4 : Trustworthiness and publishing. *European Journal of General Practice*, 0(0): 120–124. https://doi.org/10.1080/13814788.2017.1375092.

Korstjens, I. & Moser, A. 2018b. Series: Practical guidance to qualitative research. Part 4: Trustworthiness and publishing. *European Journal of General Practice*, 24(1): 120–124. https://doi.org/10.1080/13814788.2017.1375092.

Kotsampopoulos, P.C., Lehfuss, F., Lauss, G.F., Bletterie, B. & Hatziargyriou, N.D. 2015. The limitations of digital simulation and the advantages of PHIL testing in studying distributed generation provision of ancillary services. *IEEE Transactions on Industrial Electronics*, 62(9): 5502–5515.

Kozma, R.B. 2011. Transforming Education : The Power of ICT Policies. https://unesdoc.unesco.org/ark:/48223/pf0000211842.

Kramarski, B. & Michalsky, T. 2010. Preparing preservice teachers for self-regulated learning in the context of technological pedagogical content knowledge. *Learning and Instruction*, 20(5): 434–447. http://dx.doi.org/10.1016/j.learninstruc.2009.05.003.

Kriek, J., Ayene, M. & Coetzee, A. 2016. A modified model of TPACK and SAMR in teaching for understanding. In 23–28. https://www.learntechlib.org/p/171644/.

Kumar, R. 2011. *Research Methodology: a step-by-step guide for beginners*. 3rd ed. London: SAGE Publications India Pvt Ltd.

Kurt, G. 2014. TPACK in practice : A qualitative study on technology integrated lesson planning and implementation of Turkish pre-service teachers of English. *in Foreign Language Education and Applied Linguistics ELT Research Journal*, 3(3): 153–166.

De La Paz, S. & Hernández-Ramos, P. 2015. Technology-Enhanced Project-Based Learning: Effects on Historical Thinking. *Journal of Special Education Technology*, 28(4): 1–14.

Lambropoulos, N., Faulkner, X. & Culwin, F. 2012. Supporting social awareness in collaborative e-learning. *British Journal of Educational Technology*, 43(2): 295–306.

Lange, C., Costley, J. & Han, S.L. 2016. Informal cooperative learning in small groups: The effect of scaffolding on participation. *Issues in Educational Research*, 26(2): 260–279.

Lari, F.S. 2014. The Impact of Using PowerPoint Presentations on Students' Learning and Motivation in Secondary Schools. *Procedia - Social and Behavioral Sciences*, 98: 1672–1677. https://linkinghub.elsevier.com/retrieve/pii/S1877042814026834.

Laurillard, D. & McAndrew, P. 2003. Reusing Online Resources : A Sustainable Approach to eLearning: a basis for generic learning activities. In A. Littlejohn & Simon Buckingham Shum, eds. *Reusing online resources: a sustainable approach to e-learning*. London: 81–93.

Lawless, K.A. & Pellegrino, J.W. 2007. Professional development in integrating technology into teaching and learning: knowns, unknowns, and ways to pursue better questions and answers. *Review of Educational Research*, 77(4): 575–614.

Le, H., Janssen, J. & Wubbels, T. 2018. Collaborative learning practices: teacher and student perceived obstacles to effective student collaboration. *Cambridge Journal of Education*, 48(1): 103–122.

Ledford, D.M. 2016. *Development of a professional learning framework to improve teacher practice in technology integration*. Boise State University. http://www.americanbanker.com/issues/179_124/which-city-is-the-next-big-fintech-hub-new-york-stakes-its-claim-1068345-1.html%5Cnhttp://www.ncbi.nlm.nih.gov/pubmed/15003161%5Cnhttp://cid.oxfordjournals.org/lookup/doi/10.1093/cid/cir991%5Cnhttp://www.scielo.

Lee, K.S. 2014. Pre-Service Teachers ' Technological Pedagogical Knowledge : A Continuum of Views on Effective Technology Integration. , 29(2): 1–18.

Leggat, P. 2015. *Modern Learning Environments, 21st Century Learning & Curriculum and Future Focused Learning*. https://www.google.co.nz/search?q=new+zealand+curriculum+and+pedagogy&rlz=1C5CHFA_enNZ657NZ657&oq=new+zealand+curriculum+and+pedagogy&aqs=chrome..69i57j0.15571j0j7&sourceid=chrome&ie=UTF-8#safe=strict&q=new+zealand+curriculum+and+pedagogy+and+ILE.

Leung, L. 2015. Validity, reliability, and generalizability in qualitative research. *Journal of Family Medicine and Primary Care*, 4(3): 324–327.

Lewis, C. 2016. How does lesson study improve mathematics instruction? *ZDM - Mathematics Education*, 48(4): 571–580.

Liakopoulou, M. 2011. The Professional Competence of Teachers: Which qualities, attitudes, skills and knowledge contribute to a teacher's effectiveness? *International Journal of Humanities and Social Science*, 1(21): 66–78.

Lim, C.P. & Chai, C.S. 2011. Building the ICT capacity of the next generation of teachers in Asia. *Educational Media Internationa*, 48(2): 69–83.

Lim, C.P., Zhao, Y., Tondeur, J., Chai, C.S. & Tsai, C.-C. 2013. Bridging the Gap: Technology Trends and Use of Technology in Schools. *Educational Technology & Society*, 16(2): 59–68. http://0-eds.b.ebscohost.com.librarycatalog.fresno.edu/eds/detail/detail?vid=7&sid=aebae372-3463-46d6-8dab-

85d3d61da0f8@sessionmgr112&hid=107&bdata=JkF1dGhUeXBlPWlwLHVpZCx1cmwmc2l0ZT1lZHMtbGl2ZQ==#db=aph&AN=96335650.

Lin, T.-C., Tsai, C.-C., Chai, C.S. & Lee, M.-H. 2012. Identifying Science Teachers' Perceptions of Technological Pedagogical and Content Knowledge (TPACK). *Journal of Science Education and Technology*, 22(3): 325–336. http://link.springer.com/10.1007/s10956-012-9396-6 10 June 2013.

Lincoln, Y.S. & Guba, E.G. 1985a. Establishing Trustworthness. In *Naturalistic Inquiry*. Beverly Hills, CA: SAGE Publications: 289–327.

Lincoln, Y.S. & Guba, E.G. 1985b. Ethic: The failure of Positivist Science. *Review of Higher Education*, 12(3): 221–240.

Lindqvist, H.M. 2015. *Conditions for Technology Enhanced Learning and Educational Change [Elektronisk resurs]: A case study of a 1:1 initiative*. Umeå University. http://umu.diva-portal.org/smash/get/diva2:859735/FULLTEXT01.pdf%5Cnhttp://urn.kb.se/resolve?urn=urn:nbn:se:umu:diva-109887.

Liu, S.H. 2013. Exploring the instructional strategies of elementary school teachers when developing technological, pedagogical, and content knowledge via a collaborative professional development program. *International Education Studies*, 6(11): 58–68.

LLA. 2014. *Coaching & Mentoring Handbook*. London: London Leadership Academy. http://www.londonleadershipacademy.nhs.uk/sites/default/files/coaching mentoring hanbook final version-April2014.pdf.

Lock, J. V & Redmond, P. 2010. Transforming pre-service teacher curriculum: Observation through a TPACK lens. *ASCILITE 2010 - The Australasian Society for Computers in Learning in Tertiary Education*: 559–564. http://eprints.usq.edu.au/9179%5Cnhttp://www.scopus.com/inward/record.url?eid=2-s2.0-84870728198&partnerID=40&md5=f21d28eb84ec945e1d896c6bb5e2c5f8.

Lombe, A. 2010. *Using podcasts to mediate reflective learning: a case of a postgraduate programme at a higher education institution*. University of Cape town.

Long, M.W., Albright, G., McMillan, J., Shockley, K.M. & Price, O.A. 2018. Enhancing Educator Engagement in School Mental Health Care Through Digital Simulation Professional Development. *Journal of School Health*, 88(9): 651–659.

Love, C. 2015. SAMR_ A model without evidence – Charlie Love. *Learning, Technology, ICT, Games and More*. https://charlielove.org/?p=10025 28 June 2019.

Lubega, J.T., Annet, M.K. & Muyinda, P.B. 2014. Adoption of the SAMR Model to Asses ICT Pedagogical Adoption: A Case of Makerere University. *International Journal of e-Education, e-Business, e-Management and e-Learning*, 4(2): 107.

Lubke, J.K. 2013. An historical Review of TPACK: Implication for New literacies Researchers and teacher educators. In *LIteracy Research Association*. Dallas: University of Tennessee-Knoxville.

Lynch, T. 2013. Writing Up Qualitative Research: Methodology. *English Language Teaching Center*, 2461(2): 1–9. http://dx.doi.org/10.1016/j.enpol.2013.05.099%5Cnhttp://linkinghub.elsevier.com/retrieve/pii/S0165188910000680%5Cnhttp://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Chapter+29#0%5Cnhttp://faculty.wcas.northwestern.edu/~lchrist/course/assignment.

Lyon, L.J. 2015. Development of teaching expertise viewed through the Dreyfus model of skill acquisition. *Journal of the Scholarship of Teaching and Learning*, 15(1): 88–105.

Mäkitalo, N., Pääkkö, J., Raatikainen, M., Myllärniemi, V., Aaltonen, T., Leppänen, T., Männistö, T. & Mikkonen, T. 2012. Social devices: collaborative co-located interactions in a mobile cloud. In *Proceedings of the 11th International Conference on Mobile and Ubiquitous Multimedia*. 10:1–10:10. http://doi.acm.org/10.1145/2406367.2406380.

Makransky, G., Thisgaard, M.W. & Gadegaard, H. 2016. Virtual simulations as preparation for lab exercises: Assessing learning of key laboratory skills in microbiology and improvement of essential non-cognitive skills. *PLoS ONE*, 11(6): 1–11.

Manny-Ikan, E., Dagan, O., Berger Tikochinski, T. & Zorman, R. 2011. Using the

Interactive White Board in Teaching and Learning – An Evaluation of the SMART CLASSROOM Pilot Project. *Interdisciplinary Journal of e-Skills and Lifelong Learning*, 7: 249–273.

Maor, D. 2013. Does the use of the TPACK model enhance digital pedagogies: We don't understand the present so how can we imagine the future? In *Electric Dreams*. Sydney: 30th Ascilite: 531–540.

Martin, B. 2015. Successful Implementation of TPACK in Teacher Preparation Programs. *International Journal on Integrating Technology in Education (IJITE)*, 4(1): 17–26.

Masethe, M.A., Masethe, H.D. & Odunaike, S.A. 2017. Scoping Review of Learning Theories in the 21 st Century. In *Proceedings of the World Congress on Engineering and Computer Science*.

Masters, J. 2013. Scaffolding pre-service teachers representing their learning journeys with eportfolios. *Journal of Learning Design*, 6(1): 1–9. https://ezp.lib.unimelb.edu.au/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=ehh&AN=91559141&scope=site%5Cnhttps://www.jld.edu.au/article/download/1/124.

Maxwell, J.A. 2008. Designing a Qualitative Study. In L. Bickman & D. . Rog, eds. *The Sage handbook of applied social research methods. London*. London: Sage: 214–253. http://www.corwin.com/upm-data/23772_Ch7.pdf.

Maxwell, J.A. 2013. *Qualitative Research Design An Interactive Approach An Interactive Approach - Joseph A*. V. Knight, L. Habb, K. Kosclelak, L. Libby, C. Bowman, & A. Hutchnison, eds. Washington DC: Sage.

Mcgrath, J., Karabas, G., Willis, J., John, S., College, F. & Rochelle, N. 2011. From TPACK Concept to TPACK Practice : An Analysis of the Suitability and Usefulness of the Concept as a Guide in the Real World of Teacher Development. *International Journal of Technology in Teaching and Learning*, 7(1): 1–23.

McKenzie, J. 1999. Scaffolding for Success. *The Educational Technology Journal*. http://fno.org/dec99/scaffold.html 11 July 2016.

McKnight, K., O'Malley, K., Ruzic, R., Horsley, M., Franey, J.J. & Bassett, K. 2016. Teaching in a digital age: How educators use technology to improve student learning. *Journal of Research on Technology in Education*, 48(3): 194–211.

McMillan, J.H. & Schumacher, S. 2001. *Research in Education. A Conceptual Introduction*. 5th ed. New York: Longman.

Merriam, S.B. 2002. *Introduction to qualitative research*. Josse Bass - John Wiley& Sons.

Merriam, S.B. 1998. *Qualitative Research and Case Study Applications in Education*. San Francisco California: Jossey-Bass.

Miles, M.B., Huberman, M.A. & Saldaña, J. 2014. *Qualitative Data Analysis A Methods Sourcebook*. 3rd ed. London: Zeitschrift Fur Personalforschung.

Milton, M. 2013. Digital literacy and digital pedagogies for teaching literacy : Pre-service teachers ' experience on teaching rounds . *Journal of Literacy and Technology*, 14(1): 72–97.

Mishra, P. & Koehler, M.J. 2006. Technological Pedagogical Content Knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6): 1017–1054.

Moeini, H. 2008. Identifying Needs A Missing Part in Teacher Training Programs. *International journal of media, technology and lifelong learning*, 4(1): 1–12.

Mohapi, T. 2017. How do we get Africa's youth ready for the fourth industrial revolution? *Mail & Guardian*: 3. http://www.telkomfoundation.co.za/news/tech-in-the-classroom_2017-07-21.pdf.

Mooij, T. & Smeets, E. 2001. Modelling and supporting ICT implementation in secondary schools. *Computers and Education*, 36(3): 265–281.

Moore, M.G. 2002. *Information and Communication Technologies in Distance Learning*.

Moore, M.G. 1993. Theory of transactional distance. In D. Keegan, ed. *Theoretical Principles of Distance Education*. London: Routledge: 22–38.

Morris, N. 2012. *Learning and teaching with emerging technologies : Preservice pedagogy and classroom realities*. University of Windsor.

Mukhari, S.S. 2016. Teachers' Experience of Information and Communication Technology use for Teaching and Learning in Urban Schools. : 315.

Mumtaz, S. 2000. Factors affecting teachers' use of information and communications technology: A review of the literature. *Journal of Information Technology for Teacher Education*, 9(3): 319–342.

Mustafa, E. & Fatma, N.E. 2013. Instructional technology as a tool in creating constructivist classrooms. *Procedia -Social and Behavioral Sciences*, 93: 1441–1445. http://dx.doi.org/10.1016/j.sbspro.2013.10.060.

Musungwini, S., Zhou, G.T. & Ruvinga, C. 2014. Harnessing Social Media for Business Success . Case Study of Zimbabwe. *International Journal of Computer Science and Business Informatics IJCSBI.ORG*, 11(1): 80–89. http://www.ijcsbi.org/index.php/ijcsbi/article/download/326/96.

Narayan, V.L. 2011. *Pedagogical implications of Second Life in education: Educators ' and residents ' perception*. Unitec Institute of Technology. Auckland, New Zealand.

Ndlovu, N.S. & Lawrence, D. 2012. The quality of ICT use in South African classrooms. : 27.

Neal, G. & Eckersley, B. 2014. *Immersing pre-service teachers in site-based teacher school-university partnerships*.

Neo, M., Neo, T.-K. & Tan, X.-L.G. 2007. A constructivist approach to learning an interactive multimedia course: Malaysian students' perspectives. *Australasian Journal of Educational Technology*, 23(4): 470–89.

Ng'ambi, D. 2013. Effective and ineffective uses of emerging technologies: Towards a transformative pedagogical model. *British Journal of Educational Technology*, 44(4): 652–661. http://doi.wiley.com/10.1111/bjet.12053 13 June 2013.

Ng'ambi, D. 2006. ICT and Economic Development in Africa: The Role of Higher Education Institutions. In *ICT and Economic Development in Africa: The role of Higher Education Institutions*. University of Cape Town: 1–33.

Ng'ambi, D. & Bozalek, V. 2013. Editorial: Emerging technologies and changing learning/teaching practices. *British Journal of Educational Technology*, 44(4): 531–535. http://doi.wiley.com/10.1111/bjet.12061 24 January 2014.

Nguyen, C.T. 2015. the Interconnection Between Interpretivist Paradigm and Qualitative Methods in Education. *American Journal of Educational Science*, 1(2):

4399–4403.

Niess, M.L. 2008. Mathematics Teachers Developing Technology, Pedagogy and Content Knowledge (TPACK). *Society for Information Technology & Teacher Education International Conference*, 2008(1): 5297–5304. http://www.editlib.org/p/28121/.

Nnadozie, C.O. & Nwosu, C.C. 2016. Analysis of Final Year Students' Satisfaction with Information Resources and Services in Four Nigerian Federal University Libraries. *International Journal of Advanced Library and Information Science*, 4(1): 333–345.

Noor-Ul-Amin, S. 2013. An Effective use of ICT for Education and Learning by Drawing on Worldwide Knowledge , Research , and Experience : ICT as a Change Agent for Education. , (1999): 1–13.

Nsamenang, B.A. & Tchombe, T.M.S. 2011. *Handbook of African Educational Theories and Practices A Generative Teacher Education Curriculum*.

OECD. 2017. *The OECD Handbook for Innovative Learning Environments*. Paris: OECD Publishing. http://www.oecd-ilibrary.org/education/the-oecd-handbook-for-innovative-learning-environments_9789264277274-en.

Oigara, J.N. & Wallace, N. 2012. Modeling , Training , and Mentoring Teacher Candidates to Use SMART Board Technology. *Issues in Informing Science and Information Technology*, 9: 297–315.

Oleson, A., & Hora, M. T. (2013). Teaching the way they were taught? Revisiting the sources of teaching knowledge and the role of prior experience in shaping faculty teaching practices. Higher Education, 68(1), 29–45. Doi:10.1007/s10734-013-9678-9

Ottenbreit-Leftwich, A.T., Brush, T.A., Strycker, J., Gronseth, S., Roman, T., Abaci, S., Vanleusen, P., Shin, S., Easterling, W. & Plucker, J. 2012. Preparation versus practice: How do teacher education programs and practicing teachers align in their use of technology to support teaching and learning? *Computers and Education*, 59(2): 399–411.

Ouyang, J.R. & Stanley, N. 2014. Theories and Research in Educational Technology and Distance Learning Instruction through Blackboard. *Universal Journal of*

Educational Research, 2(2): 161–172. http://www.hrpub.org.

Owusu, J. 2015. *The Impact of constructivist-based teaching method on secondary school learners' errors in Algeria*. UNIVERSITY OF SOUTH AFRICA.

Palak, D. & Walls, R.T. 2009. Teachers' Beliefs and Technology Practices. *Journal of Research on Technology in Education*, 41(4): 417–441.

Parker, I. 2005. *Qualitative Psychology: Introducing Radical Research*. first. Berkshire: Open University Press.

Partnership for 21st Century Learning. 2016. *Framework for 21st Century Learning*. Washington, DC. http://www.p21.org/our-work/p21-framework.

Partnership for 21st Century Learning. 2015. P21 Partnership for 21st Century Learning. *Partnership for 21st Century Learning*: 9. http://www.p21.org/documents/P21_Framework_Definitions.pdf.

Patton, M.Q. 2005. Diverse and creative uses of cases for teaching. *New Directions for Evaluation*: 91–100. http://doi.wiley.com/10.1002/ev.146.

Pearlman, B. 2008. Designing New Learning Environments to Support 21st Century Skills. *21st Century Skills. Rethinking how students learn*: 116–147. http://www.designshare.com/images/chap6_designing_new_learning_environments.pdf.

Penprase, B.E. 2018. *The Fourth Industrial Revolution and Higher Education*. N. W. Gleason, ed. Boston: Palgrave Macmillan.

Pietkiewicz, I. & Smith, J.A. 2012. A practical guide to using Interpretative Phenomenological Analysis in qualitative research psychology. *Czasopismo Psychologiczne (Psychological Journal)*, 18(2): 361–369.

Pramod, K.M.P.. & Madhumalathi, M.N. 2016. A Study On The ICT Awareness Among Teacher Educators: With Focus On Education. *International Journal of Informative & Futuristic Research*, 3(8): 2781–2785.

Price, H. and. 2013. Cross-Culture and Technology Integration: Examining the Impact of a TPACK-focused Collaborative Project on Pre-service Teachers and Teacher Education Faculty. *Journal of the Research Center for Educational Technology*, 9: 131–155.

Puentedura, R.R. 2009. Learning , Technology , and the SAMR Model : Goals , Processes , and Practice.

Rachel, S., Cobcroft, R., Towers, S., Smith, J. & Bruns, A. 2006. Mobile Learning in Review: Opportunities and Challenges For Learners, Teachers, and Institutions. In *Online learning and teaching conference*. Queensland University of Technology, Brisbane.: 21–30. http://eprints.qut.edu.au.

Rajesh, S. & Michael, J. 2015. Effectiveness of Social Media in Education. *International Journal of Innovative Research in Advanced Engineering*, 10(2): 2349–2163. http://ijirae.com/volumes/Vol2/iss10/06.OCAE10094.pdf.

Rana, N. 2012. A study to access teacher educators' attitudes towards technology integration in classrooms. *MIER Journal of Educational Studies, Trends & Practices*, 2(2): 190–205.

Ravenscroft, A. 2010. Dialogue and Connectivism: A New Approach to Understanding and Promoting Dialogue-Rich Networked Learning Dialogue and Connectivism : A New Approach to Networked Learning. In C. Siemens, GeorgGráinne, ed. *Connectivism: Design and delivery of social networked learning.*

Richardson, V. 2003. Constructivist Pedagogy. *Teachers College Record*, 105(9): 1623–1640. http://doi.wiley.com/10.1046/j.1467-9620.2003.00303.x.

Rieber, L.P. 2005. Multimedia learning in games, simulations and microworlds. In R. E. Mayer, ed. *The Cambridge Handbook of Multimedia Learning*. New York: Cambridge University Press: 549–567. http://search.proquest.com/docview/302776922?accountid=13771.

Robinson, M. 1999. Initial Teacher Education in a Changing South Africa: Experiences, reflections and challenges. *Journal of Education for Teaching*, 25(3): 191–201.

Robinson, S.R. & Kay, K. 2010. *21st Century Kowledge and skills in Educator Preparation*. http://www.p21.org/storage/documents/aacte_p21_whitepaper2010.pdf.

Robinson, T.E. & Hope, W.C. 2013. Teaching in higher education: is there a need for training in pedagogy in graduate degree programs? *Research in Higher Education Journal*, 21: 1–11. http://0-

search.ebscohost.com.edlis.ied.edu.hk/login.aspx?direct=true&db=ehh&AN=90440371&site=eds-live&scope=site&groupid=Test.

Roblyer, M.D. & Doering, A.H. 2014. *Integrating Educational Technology into Teaching.* Sixth. Essex: Pearson Education. www.pearsoned.co.za.

Roehl, A.M.Y., Reddy, S.L. & Shannon, G.J. 2013. The Flipped Classroom : An Opportunity To Engage Millennial Students Through Active Learning Strategies. *Journal of family & Consumer Sciences*, 105(2): 44–50.

Romrell, D., Kidder, L.C. & Wood, E. 2014. The SAMR model as a framework for evaluating mLearning. *Journal of Asynchronous Learning Network*, 18(2): 1–15.

Romrell, D., Kidder, L.C. & Wood, E. 2014. The SAMR Model as a Framework for Evaluating mLearning. , (August).

Russell, J. 2012. WhatsApp swots up in India with unlimited deal for college-going Reliance customers. *thenextweb.com*. http://thenextweb.com/in/2012/09/26/whatsapp-swots-india-unlimited-deal-college-going-reliance-customers/.

Ryan, G. 2018. Introduction to positivism, interpretivism and critical theory. *Nurse Researcher*, 25(4): 14–20.

Ryan, K.E., Gandha, T., Culbertson, M.J. & Carlson, C. 2014. Focus Group Evidence: Implications for Design and Analysis. *American Journal of Evaluation*, 35(3): 328–345. http://aje.sagepub.com/cgi/doi/10.1177/1098214013508300.

Saad milad M., Barbar Aziz M. & Abourjeily Suzanne A.R. 2012. Introduction of TPACK-XL: A Transformative View of ICT-TPCK for Building Pre-Service Teacher Knowledge Base. *Turkish Journal of Teacher Education*, 1(2): 41–60. http://www.tujted.com/index.php/tujted/article/view/6.

Sadeck, O. & Cronjé, J. 2017. A Continuum of Teachers ’ e-Learning Practices. *The Electronic Journal of e-Learning*, 15(5): 395–408.

Şahin, M. 2012. Pros and cons of connectivism as a learning theory. *International Journal of Physical and Social Sciences*, 2(4): 237–454. https://www.ijmra.us/project doc/IJPSS_APRIL2012/IJMRA-PSS1296.pdf.

Sánchez, Castro Juan, J. & Alemán, E.C. 2011. Teachers’ opinion survey on the use of ICT tools to support attendance-based teaching. *Computers and Education*, 56(3): 911–915.

Sang, G., Tondeur, J., Chai, C.S. & Dong, Y. 2014. Validation and profile of Chinese pre-service teachers ' technological pedagogical content knowledge scale. *Asia-Pacific Journal of Teacher Education*: 37–41.

Scheepers, D. 2015. Professional development for teaching with technology. *Contemporary Issues in Technology and Teacher Education*, 15(3): 368–394. http://repository.up.ac.za/bitstream/handle/2263/50950/Scheepers_Professional_2015.pdf?sequence=1.

Schleicher, A. 2014. 21st Century Education for Student Success and Economic Development. *Transforming Education for the Next Generation A Practical Guide to Learning and Teaching with Technology*: 1–10. https://www.intel.com/content/dam/www/public/us/en/documents/guides/transforming-education-next-generation-guide.pdf.

Schmidt, D.A., Baran, E., Thompson, A.D., Mishra, P., Koehler, M.J. & Shin, T.S. 2009. Technological Pedagogical Content Knowledge (TPACK): The Development and Validation of an Assessment Instrument for Preservice Teachers. *Journal of Research on Technology in Education*, 42(2): 123–149.

Schrum, L. & Levin, B.B. 2013. Teachers' Technology Professional Development: Lessons Learned from Exemplary Schools. *TechTrends*, 57(1): 38–42.

Scotland, J. 2012. Exploring the Philosophical Underpinnings of Research : Relating Ontology and Epistemology to the Methodology and Methods of the Scientific , Interpretive , and Critical Research Paradigms. *English language teaching*, 5(9): 9–16.

Scott, L.A., Gentry, R. & Virginia, R. 2014. Making preservice teachers better : Examining the impact of a practicum in a teacher preparation program. *Educational Research and Reviews*, 9(10): 294–301.

Serdyukov, P. 2017. Innovation in education: what works, what doesn't, and what to do about it? *Journal of Research in Innovative Teaching & Learning*, 10(1): 4–33.

Shabani, K., Khatib, M. & Ebadi, S. 2010. Vygotsky ' s Zone of Proximal Development : Instructional Implications and Teachers ' Professional

Development. *English language*, 3(4): 237–248.

Shaikh, Z.A. & Khoja, S.A. 2012. Role of Teacher in Personal Learning Environments. *Digital Education Review*, (21): 23–32.

Shenton, A.K. 2004. Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information*, 22(2): 63–75.

Shifflet, R. & Weilbacher, G. 2015. Teacher beliefs and their influence on technology use : A case study. *Contemporary Issues in Technology and Teacher Education*, 15(3): 368–394.

Shulman, L.E.E.S. 1986. Those who understand: Knowledge Growth in Teaching. *Educational Researcher*, 15(2): 4–14. www.jstor.org/stable/1175860.

Shulman, L.S. 1987. Knowledge and teaching: foundations of the new reform.pdf. *Harvard Educational Review*, 57: 1–21.

Siemens, G. 2004. Connectivism : *International Journal of Instructional Technology and Distance Learning*, 2(1): 3–10.

Sife, A.S., Lwoga, E.T. & Sanga, C. 2007. *New technologies for teaching and learning: Challenges for higher learning institutions in developing countries*.

Simmons, K., Carpenter, L., Crenshaw, S. & Hinton, V. 2015. Exploration of Classroom Seating Arrangement and Student Behavior in a Second Grade Classroom. *Georgia Educational Researcher*, 12(1).

Smeda, N., Dakich, E. & Sharda, N. 2014. The effectiveness of digital storytelling in the classrooms: a comprehensive study. *Smart Learning Environments*, 1(1): 6. http://www.slejournal.com/content/1/1/6.

Sousa, R.M., Alves, A.C., Figueiredo, J., Pereira, R.M.S., Fernandes, S., Cardoso, E. & Carvalho, M.A. 2015. Teacher’s experiences in PBL: implications for practice. *European Journal of Engineering Education*, 41(2): 123–141.

South African Government DoE. 2000. *Norms and Standards for Educators*. South Africa: Government Gazette.

Stanford University. 2012. Using ATLAS.ti for Qualitative Data Analysis. http://www.stanford.edu/.

Stanley, T.L. 2017. *Increasing students’ critical thinking and improving performance in* *elementary social studies classroom*. Capella University.

Steyn, G.M. 2017. Transformative learning through teacher collaboration : a case study. *Koers- Bulletin for Christian Scholarship*, 82(1): 1–15.

Stigler, J.W. & Hiebert, J. 2016. Lesson study, improvement, and the importing of cultural routines. *ZDM - Mathematics Education*, 48(4): 581–587.

Stokes-Beverley, C. & Simoy, I. 2016. *Advancing Educational Technology in Teacher Preparation : Policy Brief*. Washington DC.

Strecker, S., Kundisch, D., Lehner, F., Leimeister, J.M. & Schubert, P. 2018. Higher Education and the Opportunities and Challenges of Educational Technology. *Business and Information Systems Engineering*, 60(2): 181–189.

Sultan, A.J. 2014. Addiction to mobile text messaging applications is nothing to 'lol' about. *Social Science Journal*, 51: 57–69.

Summak, M.S. & Samancıoğlu, M. 2011. *Assessment of technology integration in vocational education and training schools*.

Sung, Y., Chang, K. & Liu, T. 2016. The effects of integrating mobile devices with teaching and learning on students ' learning performance : A meta-analysis and research synthesis. *Computers & Education*, 94: 252–275. http://dx.doi.org/10.1016/j.compedu.2015.11.008.

Sutherland, R., Robertson, S. & John, P. 2009. *Improving Classroom Learning with ICT*. A. Pollard, ed. London: Routledge UK.

Teo, T. & Milutinovic, V. 2015. Modelling the intention to use technology for teaching mathematics among pre-service teachers in Serbia. *Australasian Journal of Educational Technology*, 31(4): 363–380.

Ternier, S., Klemke, R., Kalz, M. & Specht, M. 2012. ARLearn : Augmented Reality Meets Augmented Virtuality. , 18(15): 2143–2164.

Thomas, P. 2010. Research Methodology and Design. : 291–334. http://umkn-dsp01.unisa.ac.za/handle/10500/4245.

Tiantong, M. & Teemuangsai, S. 2013. The four scaffolding modules for collaborative problem-based learning through the computer network on moodle lms for the computer programming course. *International Education Studies*, 6(5): 47–55.

Tiba, C., Condy, J., Chigona, A. & Tunjera, N. 2015. Digital storytelling as a tool for teaching: Perceptions of pre-service. *The Journal for Transdisciplinary Research in Southern Africa*, 11(1): 82–97.

Tiba, C.A. 2018. *The Ability of Newly Qualified Teachers to Integrate Technology into their Pedagogical Practice*. Cape Peninsula University of Technology.

Tlhapane, S.M. & Simelane, S. 2010. Technology-enhanced problem-based learning methodology in geographically dispersed learners of tshwane university of technology. *Knowledge Management and E-Learning*, 2(1): 68–83.

Tondeur, J., Van Braak, J., Sang, G., Voogt, J., Fisser, P. & Ottenbreit-Leftwich, A. 2012. Preparing pre-service teachers to integrate technology in education: A synthesis of qualitative evidence. In *Computers and Education*. 134–144.

Tondeur, J., Pareja Roblin, N., van Braak, J., Voogt, J. & Prestridge, S. 2017. Preparing beginning teachers for technology integration in education: ready for take-off? *Technology, Pedagogy and Education*, 26(2): 157–177. http://dx.doi.org/10.1080/1475939X.2016.1193556.

Tondeur, J., Scherer, R., Baran, E., Siddiq, F., Valtonen, T. & Sointu, E. 2019. Teacher educators as gatekeepers: Preparing the next generation of teachers for technology integration in education. *British Journal of Educational Technology*, 50(3): 1189–1209.

Tucker, R. & Morris, G. 2011. Anytime, anywhere, anyplace: Articulating the meaning of flexible delivery in built environment education. *British Journal of Educational Technology*, 42(6): 904–915. http://doi.wiley.com/10.1111/j.1467-8535.2010.01138.x 4 February 2013.

Tuli, F. 2010. Review Article The Basis of Distinction Between Qualitative and Quantitative Research in Social Science : Reflection on Ontological , Epistemological and Methodological Perspectives. *Jounal of Education and Science*, 6(1): 97–108.

Tunjera, N. & Chigona, A. 2017. Technology Skills Acquisition in a Pre-service teacher Digital Storytelling Project. In D. Jon & S. Mishra, eds. *E-Learn: World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2017*. Vancouver, British Columbia: Association for the Advancement of

Computing in Education (AACE): 672–680.

Tunjera, N., Mukabeta, T., Ramirez, I. & Zinyeka, G. 2014. Using a Mobile Application to Increase Interaction amongst Students in an Open and Distance Learning Programme in Zimbabwe : A Cultural Historical Activity Learning. Educational Technology Research & Development. *Journal of Education and Human Development.*, 3(1): 573–592.

Turner, D.W. 2010. Qualitative Interview Design : A Practical Guide for Novice Investigators. *The Qualitative Report*, 15(3): 754–760. http://www.nova.edu/ssss/QR/QR15-3/qid.pdf.

Uerz, D., Volman, M. & Kral, M. 2018. Teacher educators' competences in fostering student teachers' proficiency in teaching and learning with technology: An overview of relevant research literature. *Teaching and Teacher Education*, 70(2): 12–23. https://doi.org/10.1016/j.tate.2017.11.005.

UNESCO. 2010. Educating for a Sustainable Future A Transdisciplinary Vision for Concerted Action. *UNESCO Teaching And Learning for a Sustainable Future*. www.unesco.org/education/tlsf/mods/theme_a/.../mod01t05s01.htm 24 April 2014.

Van der Berg, S., Taylor, S., Gustafsson, M., Spaull, N. & Armstrong, P. 2011. Improving Education Quality in South Africa. Western Cape. http://dx.doi.org/10.1787/5k452klfn9ls-en%5CnOECD.

Voogt, J. & McKenney, S. 2017. TPACK in teacher education: are we preparing teachers to use technology for early literacy? *Technology, Pedagogy and Education*, 26(1): 69–83. http://dx.doi.org/10.1080/1475939X.2016.1174730.

Vygotsky, L. 1978. Interaction between Learning and Development. In M. Gauvain & M. Cole, eds. *Mind and Society*. Cambridge: Harvard University Press: 79–91.

Wagner, E.D. 1997. Interactivity: From Agents to Outcomes. *New Directions for Teaching and Learning*, 1997(71): 19–26. http://doi.wiley.com/10.1002/tl.7103.

Wali, E.A. 2008. Reinterpreting Mobile Learning : an Activity Theoretic Analysis of the Use of Portable Devices in Higher Education. , (November).

WCED. 2012. *WCED vision for e-Education*. Western Cape Education Department. http://wced.pgwc.gov.za/home/lgsp.html#../documents/e-Vision/WCED-Vision-for-E-Education.pdf.

Westbrook, J., Durrani, N., Brown, R., Orr, D., Pryor, J., Boddy, J. & Salvi, F. 2013. *Pedagogy, curriculum, teaching practices and teacher education in developing countries. Education rigorous literature review.* Sussex. http://r4d.dfid.gov.uk/Output/195891/Default.aspx.

Westera, W. 2010. Technology-Enhanced Learning : Review and Prospects. *Serdica Journal of Computing*, 4: 159–182.

Wieman, C.E. & Perkins, K.K. 2006. A powerful tool for teaching science. *Nature Physics*, 2(5): 290–292.

Woolfitt, Z. 2015. *The effective use of video in higher education*. Inholland University of Applied Sciences. https://www.inholland.nl/media/10230/the-effective-use-of-video-in-higher-education-woolfitt-october-2015.pdf.

Yaman, İ. 2014. *EFL Students' Attitudes Towards the Development of Speaking Skills Via Project-Based Learning: an Omnipresent Learning Perspective*. GAZİ UNIVERSITY.

Yin, R. 2013. How to Start Your Analysis , Your Analytic Choices , and How They Work. *Case Study Research: Design and Methods*: 127–164.

Zhang, S., Liu, Q. & Wang, Q. 2017. A study of peer coaching in teachers' online professional learning communities. *Universal Access in the Information Society*, 16(2): 337–347.

Zhu, X.-C. & Du, Z.-H. 2003. Numerical study of the three-dimensional flow in the axial flow rotor with tip clearance. *Shanghai Jiaotong Daxue Xuebao/Journal of Shanghai Jiaotong University*, 37(9): 1480–1483. https://www.scopus.com/inward/record.uri?eid=2-s2.0-0442280256&partnerID=40&md5=739099216f499408c64468877cb2f500.

APPENDICES

Appendix A: Letter of permission to conduct the research study

Cape Peninsula University of Technology

***For office use only	
Date submitted	31 July 2015
Meeting date	03 Aug 2015
Approval	P/Y√/N
Ethical Clearance number	EFEC 4-8/2015

FACULTY OF EDUCATION

RESEARCH ETHICS APPLICATION FORM

1 Applicant and project details

Name(s) of applicant(s):	Nyarai Tunjera
Project/study Title:	Teacher educators' pedagogical strategies for the preparation of pre-service teachers to teach with digital technology
Is this a staff research project, i.e. not for degree purposes?	No
If for degree purposes:	**Degree:** D.Ed **Supervisor(s):** Dr. Agnes Chigona
Funding sources:	Self-funding but applying for URF funding

Signatures:

Researcher/Applicant:	[signature]	Supervisor or Senior investigator (if applicable):	[signature]
Date:	04/08/2015	Date:	04/08/2015

Comments by Education Faculty Ethics Committee:

Approved: X	**Referred back:**	**Approved subject to adaptations:**
Chairperson: CM Kwenda	[signature]	**Date: 6 August 2015**

Approval Certificate/Reference: EFEC 4-8/2015

Appendix B: Research study Information sheet

Information sheet for participants

Title of Research Study: **Teacher Educators' Instructional Strategies in Preparing Pre-Service Teachers to Teach with Digital Technology in the 21st Century**

Dear Participant

Thank you for volunteering to participate in this research study aiming to document instructional strategies that teacher educators use to prepare pre-service teachers to teach with technology.

Please take time to read the following information that explains what participating in this research study involves. Participation is voluntary below is an explanation of what is involved in the research study. You are also being asked to sign a consent form if you still want to continue participating in this research study.

You are welcome to phone me if you would like any further information.

What you will be involved in;

The purpose of the research study is to examine teacher educators' pedagogical strategies in the teacher preparation to teach with digital technology. In this research study, you will be asked to firstly participate in a one-on-one interview, to share with the researcher what pedagogical strategies you are using and how you implement them during the teacher preparation to teach with digital technology. The interview will take approximately [30 min]. If you choose to take part, you can organise a location for the interview convenient to you. The one-on-one interview will be followed by a series of lesson observations and finally focus group interviews. The interviews will be recorded digitally and interviewees will be provided with paper copies of the final transcripts [and, if desired, a softcopy of the audio recording]. The verbose transcripts and sound files will be made available for member checking before the analysis.

Secondly, I will follow up the interviews with lecture observations as part of data collection observing what pedagogical strategies you are using and how you implement them during the teacher preparation to teach with digital technology.

Finally, to triangulate my data methods, final year (fourth year) pre-service teachers you would have taught will be interviewed.

The information gained from this research will be used to create a localised model that other teacher educators will use in the teacher preparation to teach with digital technology. The results of this research study may also inform policy makers.

Time commitment

The research study interview typically takes approximately thirty minutes and observation varies on the participant's lecture schedules.

The interview will be recorded on audio tape and then transcribed verbose onto a computer. The audio tapes will be stored in a locked secure place at all times and the computer data will be protected from intrusion also. Your response will be treated with full confidentiality and anyone who takes part in the research will be identified only by code numbers or pseudo names. A copy of the interview transcript will be shared with you if you wish. The interviews will be analysed interpretatively by using a computer package Atlas.ti. At the end of the research I will write a report and the results may be published in peer reviewed journals and conference presentations. Participant responses may be described in research reports; however, all possible precautions will be taken to disguise participants. This research study has been reviewed and approved by the Research Ethics Committee.

Please do not hesitate to contact me (nztunjera@gmail.com or 021 959 5890 / 5646) or my supervisor (Dr Agnes Chigona on chigonaa@cput.ac.za or 021 680 1689) if you need further information and clarifications.

Thanking you in anticipation,

Yours sincerely,

Nyarai Tunjera

021 680 Ext. 6628

nztunjera@gmail.com

Appendix C: Participates Consent form

I have read the Information Sheet and have had details of the research study explained to me. My questions have been answered to my satisfaction and I understand that I may ask further questions at any time.

I understand I have the right to withdraw from the research study at any time and to decline to answer any particular questions.

I agree to provide information to the researcher[s] on the understanding that my name will not be used without my permission. The information will only be used for this research and for publications that might arise from this research project.

I agree/do not agree to the interview being recorded [audio/visual].

I understand that I have the right to ask for the recording equipment to be turned off at any time during the interview.

I confirm I am over 16 years of age.

I agree to participate in this research study under the conditions set out in the Information Sheet.

By signing below, you are agreeing that:

(1) you have read and understood the Participant Information Sheet,

(2) questions about your participation in this research study have been answered satisfactorily,

(3) and you are taking part in this research study voluntarily (without coercion).

Name: ________________ Signed: _______________ Date: ___________

This information will be confidentially used by researcher and kept under lock and key and will not be shared with anyone. Participant will be assigned codes during data cleaning. The information will be destroyed after successful completion of this research study.

Appendix D: Survey Questionnaire used to conveniently select participants

Thank you for taking time to complete this questionnaire. Please answer each question to the best of your knowledge. Your thoughtfulness and candid responses will be greatly appreciated. Your individual name or identification number will not at any time be associated with your responses. Your responses will be kept completely confidential.

Area of Specialization that you are currently employed for (Put an X all that applies)

1. Educational Theories	
2. Professional Studies	
3. Curriculum Studies	
4. Philosophy of education	
5. Psychology of education	
6. Sociology of education	
7. Mathematics educator	
8. Languages Educator	
9. Science Educator	
10. ICT Educator	
11. History educator	
12. Other (specify) ____________	

Indicate the Phase you work under FET ☐ GET ☐ FP ☐ ALL the above ☐

Technology is a broad concept that can mean a lot of different things. For the purpose of this questionnaire, Technology is referring to digital technology/technologies. That is, the digital tools we use such as computers, laptops, iPods, handhelds, interactive whiteboards, software programs, etc. Please answer all of the questions and if you are uncertain of or neutral about your response you may always select "Neither Agree or Disagree"

	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
TK (Technology Knowledge)					
1. I know how to solve my own technical problems.					
2. I can learn technology easily.					
3. I keep up with important new technologies in education.					
4. I frequently play around the technology for teaching.					
5. I know about a lot of different technologies for teaching.					
6. I have the technical skills I need to use technology.					
TCK (Technological Content Knowledge)					
7. I know about technologies that I can use for understanding and doing mathematics.					
8. I know about technologies that I					

can use for understanding and doing literacy.					
9. I know about technologies that I can use for understanding and doing science.					
10. I know about technologies that I can use for understanding and doing social studies.					
11. I know about technologies that I can use for understanding in my content area.					
TPK (Technological Pedagogical Knowledge)					
12. I can choose technologies that enhance the teaching approaches for a lesson.					
13. I can choose technologies that enhance students' learning for a lesson.					
14. My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom.					
15. I am thinking critically about how to use technology in my classroom.					
16. I can adapt the use of the technologies that I am learning about to different teaching activities.					
17. I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn.					
18. I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom.					
19. I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at my school and/or district.					
20. I can choose technologies that enhance the content for a lesson.					
TPACK (Technology Pedagogy and Content Knowledge)					
21. I can teach lessons that appropriately combine					

mathematics, technologies and teaching approaches.					
22. I can teach lessons that appropriately combine literacy, technologies and teaching approaches.					
23. I can teach lessons that appropriately combine science, technologies and teaching approaches.					
24. I can teach lessons that appropriately combine social studies, technologies and teaching approaches.					

Appendix E: Semi-structured one on one interview questions to TrEds

Title of thesis: Teacher Educators' 21C instructional strategies for the preparation of pre-service teachers to teach with digital technology

Questions	**Non-verbal expressions**
What qualification do you hold – What lecturer level are you - Junior lecturer / Senior lecturer / Dr. / Associate Professor / Professor	
What's your area subject expertise / teaching What phases were you teaching	
How proficient are you on using digital technology	
What digital pedagogical strategies are you currently using in your teacher preparation programmes When do you use these strategies / and why?	
How did you acquire the skill mentioned above? At what proficient level can you say you are at digital pedagogical strategies	
How do you use these strategies in your practices? Explain how you acquired these digital pedagogy strategies	
What can you say about the **Pedagogical Content Knowledge (PCK) / Technological Pedagogical And Content Knowledge (TPACK)** in relationship to your current practices	
What can you say about your confidence to **integrate digital pedagogy** in your teacher preparation programmes	

From your own observation do you think teacher preparation institutions are **adequately preparing** future teacher to use TPACK for teaching.	
21C is said to be a digital age. Do you think TrEds are **effectively modelling** pre-service teachers to use digital pedagogical knowledge in facilitating learning	
In the faculty, do you have staff development workshops on emerging technologies in education? Yes – explain what was covered No – why not	
Do you use the institution's Blackboard LMS? Yes – explain how you are using it No – why not	
What would motivate you to use digital pedagogies more	
Do you relate to Shulman's concept of PCK in your programmes Yes / No – explain? What of the TPACK notion – explain?	

Appendix F: Venue and Technology resources observation guide

Item / Question	Notes
1. Venue description, set-up	
2. Technology available for TrEds (Hardware)	
3. Application software available to TrEds	
4. Network capacity Wi-Fi LAN / WAN	

Appendix G: Lecture Observations Guide

Participant: ________ **Subject:** _________ **Venue** _______ **Date** ________

Type of activity: Lecture ☐ **Lab session** ☐ **Other**_____________

Notes

* presentation tool; Knowledge building tool; Communication tool; Content exploration tool; Pedagogical strategy tool

* Critical thinking; Creativity and innovation; Communication and collaboration; Research and information

* Discussion; Listening / note taking; Independent / Group / pair work; Research / project work

* Technology used by teacher educator / pre-service teachers

TrEd Instructional strategies	SAMR	TK	TCK	TPK	TPACK	Notes
Direct Teacher-Centred Instructional strategies	R					
	M					
	A					
	S					
Collaboration Instructional strategies	R					
	M					
	A					
	S					

Demonstration Instructional strategies	R					
	M					
	A					
	S					
Project-Based Instructional strategies	R					
	M					
	A					
	S					

Appendix H: Pre-service Teachers Focus Group Interview guide

Phase: _________ Date _________

After your teacher training

Question	Notes
1. What can you say about the teacher training programme and your preparedness to teach with digital technology?	
2. Do you think your institution has done enough to equip you with knowledge to teach with technology in your future classrooms?	
3. What can you say about "teacher educators"; ➢ Technology knowledge ➢ Technology pedagogical knowledge ➢ Technology content knowledge ➢ Personal enthusiasm to teach with digital technology	
4. How would you wish your institution could have done to improve your knowledge on teaching with digital technology?	
5. What is your opinion on teaching with digital technology in real classroom context?	
6. Do you think teacher educators had pedagogically prepare you to teach with digital technology	

Appendix I: ConTIS model TrEd evaluation checklist

		Question	Yes	No	Comment
Redefinition	1	Did the use of technology allow for redesign of learning activity			
	2	Did the use of technology allow the student to develop own meaning of content			
	3	Did the use of technology allow for multiple teaching outcomes			
	4	Did the use of technology enabled student autonomous			
	5	Did the use of technology allow for virtual synchronous communication			
	6	Did the use of technology allowed engagement with multiple knowledge sources			
	7	Did the use of technology facilitate application of knowledge in authentic environment			
Modification	1	Was the use of technology integrated within a student-centred teaching strategy			
	2	Did the use of technology allow for concept / process demonstration			
	3	Did the use of technology allow for students to critique acquired knowledge			
	4	Did the use of technology allow for learning to continue to take place outside the classroom			
	5	Did the use of technology facilitate clarity on students misconceptions of content			
Augmentation	1	Did the use of technology have any improved functionality over the traditional teaching method			
	2	Did the use of technology paired with lecturer-centred teaching strategy			

	3	Did the use of technology allow for the application of content comprehension			
	4	Did the use of technology allow for analysis of content			
Substitution	1	Did you use technology to convenience you (lecturer) more than the students			
	2	Did you use technology to facilitate lecture delivery			
	3	Did you use technology to facilitate content comprehension			
	4	Did you use technology improved student engagement in learning activities			
	5	Could you have achieved the same teaching experience without technology			
	6	Did the use of technology utilized lecturer-centred teaching strategy			
	7	How familiar is the educator with the technology			

Appendix J: Declaration of Language Editing 1

The D.Ed. by Nyarai Tunjera – in the faculty of Education, Cape Peninsula University of Technology has been edited by Dr Matthew Curr.

Mowbray Campus
Highbury Road
Mowbray 7700

15 October, 2019

To whom it may concern

Re: Language editing of D.Ed. thesis

I hereby confirm that I have edited the thesis titled **Teacher Educators' Instructional Strategies in Preparing Pre-Service Teachers to Teach with Digital Technology in the 21st Century,** submitted by Nyarai Tunjera, a D.Ed. candidate.

Kind regards,

Dr Matthew Curr
curr@sybaweb.co.za
083 862 1905

Appendix K: Declaration of Language Editing 2

Proofreading and Editing

Assignments, Business projects,
Honours / Masters / Doctorate / PhD
Fast, Affordable, and Professional
Cell: +27 60 825 7463
Email: masteryread@gmail.com

09 October, 2019

To whom it may concern,

RE: Letter of confirmation of language editing for D.Ed. Thesis

I hereby confirm that I have language-edited the thesis: **Teacher educators' instructional strategies in preparing pre-service teachers to teach with digital technology in the 21st Century**, submitted by Nyarai Tunjera.

Thank you,

Chenge Mutongwizo
BSocSc Honours in Organisational Psychology (UCT)