A critical analysis of technology adoption in teaching by in-service teachers in Botswana during the Covid-19 pandemic

By

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ABSTRACT

Information and Communication Technologies (ICTs) have been growing immensely for over the years in almost every sector of the economy. Even though this is the case, a lot still needs to be achieved in the education sector. Facilitators in Botswana schools are still depending and relying on the traditional teaching pedagogies and are far from benefiting from the rewards ICTs are bringing to the classroom to enhance teaching and learning. This study critically analysed technology adoption and use in teaching by in-service teachers in Botswana during the Covid – 19 era. It also analysed the ICT infrastructure found and available in Botswana schools and assessed the facilitator's skills, knowledge confidence and their perceptions on ICT integration in teaching and learning. A mixed methods (quantitative and qualitative) approach was adopted and used to collect data for the study. The major findings of the study revealed that the integration of ICT teaching in Botswana schools during the Covid – 19 era showed some challenges in teaching and learning and yet was also beneficial. These challenges were influenced by several factors such as lack of ICT skills, lack of self-confidence in the usage of technology by teachers and lack of appropriate ICT tools for use in schools. The study recommends that all schools (government and public) should be equipped and installed with the right ICTs supporting infrastructure, resources, and that all teachers be trained on the right pedagogies on the integration of ICTs in teaching and learning. In addition, the schools-based curriculums should be designed and developed in a way that accommodates ICT integration in teaching all subjects areas taught in schools.

Keywords: *Technology adoption, Information and communication technology, technology integration, In-services teachers, Teachers ICT skills, Perceptions of ICT integration.*

DECLARATION

I, RODNIE KGALEMELO MAFA, declare that:

1. All the research carried out in this thesis, except where indicated, is my original work and has not been copied from anywhere.

2. This thesis has not been submitted for any examination for any degree at any University apart from the University of KwaZulu Natal, Edgewood Campus.

3. All the data, pictures, graphs, or any information are not for any other persons work unless otherwise has been specifically acknowledged.

4. Any other person's writings have been duly acknowledged and in cases where sources have been quoted, the words have been re-written, and quotations has been placed inside quotation marks and all the work has been acknowledged and referenced.

5. Any publication I have produced of which I am an author or co-author, I have indicated that in detail and have referenced such a publication.

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Signed

Researcher: Rodnie Kgalemelo Mafa [redacted] **Date:** 16 November 2022.

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DEDICATION

I dedicate this thesis to my lovely wife, Karabo Mafa, whose support and encouragement always gave me hope and confidence to finish my studies and graduate. Without her support and love, we could be singing a different song. I also dedicate this to my late mother, Ms. Agnes Mafa, and my beloved grandma, Sithembiso Mafa, *(May Angels in Heaven watch over you).* I wish you could be alive to see the man I have grown to be and the educational achievements I have attained, so far. To my daughters, Lame, Maatla, Lorato, Palesa, Sithembiso and Karabo, this should be a learning curve to all of you, and you too can do it and achieve higher than this.

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LIST OF ACRONYMS AND ABBREVIATIONS

BFTU – Botswana federation of trade unions

BGCSE – Botswana general certificate of secondary education

BI – Behavioral intention

CK – Content knowledge

EE - Effort expectancy

FC – Facilitating conditions

HM – Hedonic motivation

ICT – Information and communication technology

JCE – Junior certificate examination

MoBe – Ministry of Basic education

MoE – Ministry of education

MoESD – Ministry of education and skills development

OECD - Organization for Economic Cooperation and Development

PCK – Pedagogical content knowledge

PE – Performance expectancy

PK – Pedagogical knowledge

PV – Price value

SI – Social influence

SPSS – Statistical package for the social sciences

SSE -Secondary school education

TAM – Technology acceptance model

TCK – Technological content knowledge

TK – Technology knowledge

TPACK – Technological pedagogical content knowledge

TPCK – Technological pedagogical content knowledge

TPK – Technological pedagogical knowledge

UNICEF – United nations international children emergency fund

UTAUT– Unified theory of acceptance and use of technology

DEFINITION OF TERMS

1. Critical analysis: A critical analysis study asks the writer to make an argument about a particular book, essay, movie, etc. The goal is twofold: one, identify and explain the argument that the author is making, and two, provide own argument about that argument. One of the key directions of these assignments is often to avoid/ minimize summary, one is not writing a book report, but evaluating the author's argument (Adopted from J.L. Beyer, "Critically Analyzing an Academic Article or Book")

2. Technology: According to Skrbina (2015), technology is the application of scientific knowledge to the practical aims of human life or, as it is sometimes phrased, to the change and manipulation of the human environment.

3. Technology integration: Technology integration is the well-coordinated use of digital devices and cloud computing as tools for problem-solving, deeper learning, and understanding (Christensen, 2019).

4. Technology Adoption: is the acceptance and use of ICTs by a society. (Rampersad, 2012).

5. Information and Communication Technology (ICT): is the application and use of technology devices towards social, economic, and political development, with a particular emphasis on helping poor and marginalized people and communities (Ratheeswari, 2018).

6. ELearning: It is learning utilizing electronic technologies to access educational curriculum and content outside of a traditional classroom (Jabar Al-Atabi, Akram & Al-Noori, 2020).

LIST OF FIGURES

Figure 1.1: Botswana's household access to internet. Source: Statistics Botswana, 2019. 12
Figure 2.1: Botswana's education structure showing grade levels and age ranges. 40
Figure 3.1: TPACK Model, Source: Mishra and Koelher (2006)..... 50
Figure 3.2: Combination of the TPACK and the UTAUT-3 models (Source: own arrangement). 52
Figure 4.1: Botswana Covid-19 zonal map (Source: Government of Botswana, 2021)..... 64
Figure 4.2: Formula to derive the size of the sample. Source: Krejcie and Morgan (1970)..... 65
Figure 5.1: Responses to owning a mobile technology device. 81

LIST OF TABLES

Table 2.1: ICT Infrastructure in Botswana 39
Table 4.1: Participants of the study 66
Table 4.2: Data collection instruments and participants 70
Table 5.1 Participants of the study 76
Table 5.2: Gender of the respondents 78
Table 5.3: Age groups of the respondents 79
Table 5.4: Teaching subject 79
Table 5.5: Educational qualifications 80
Table 5.6: Computer training 81
Table 5.7: Cross tabulation of gender by computer training. 82
Table 5.7.1: Chi-square test on cross tabulation of gender by computer training. 82
Table 5.8: Cross tabulation gender by internet access. 83
Table 5.8.1: Chi –square test on cross tabulation by gender on internet access. 84
Table 5.9: Cross tabulation gender on how many hours per week on ICT tools use in teaching and learning related tasks during the Covid-19 pandemic. 85
Table 5.9.1: Chi –Square test on cross tabulation gender on how many hours per week on ICT tools use in teaching and learning related tasks during the Covid-19 pandemic. 85
Table 5.10: Teachers'level of ICT competencies 86
Table 5.11: Descriptive statistics of the UTAUT – 3 constructs 87
Table 5.12: Descriptive statistics of the TPACK constructs 88
Table 5.13: Correlations of TPACK and UTAUT- 3 constructs 89
Table 5.14: Percentage scores on actual use of ICTs tasks in teaching and learning roles. 91
Table 5.15: ICT related challenges. 93
Table 5.16: Perceptions on the use of technology in teaching and learning. 94
Table 5.17: Class X1 and Z1 descriptive statistics for the years 2019, 2020 and 2021 95
Table 5.18: Overall class (X1 & Z1) results comparison for the years 2019 to 2021 96
Table 5.19: BGCSE number of grades awarded at key grades A, C, E and G. 97
Table 5.19.1: BGCSE Number of Grades which are C or better 97
Table 5.19.2: BGCSE number of grades which are A or better. 98

Table 5.19.3: BGCSE Grades Awarded to Candidates in Government and Government Aided Schools and Private Candidates (including those from private schools), all syllabi. 99
Table 5.19.4: National JCE summary of overall grades from 2019 to 2021. 100
Table 6.1: Identified themes from the focus group interviews. 103
Table 6.2: Categories of themes..... 104

TABLE OF CONTENTS

ABSTRACT ii

DECLARATION iii

DEDICATION iv

ACKNOWLEDGEMENTS v

PUBLICATIONS vi

LIST OF ACRONYMS AND ABBREVIATIONS vii

DEFINITION OF TERMS ix

LIST OF FIGURES xi

LIST OF TABLES xii

TABLE OF CONTENTS xiv

CHAPTER 1: RESEARCH OVERVIEW 1

1.1 Introduction 1

1.2 Background of the study 2

1.3 Problem statement 5

1.4 Significance of the study 6

1.5 Research objectives 7

1.6 Research questions 7

1.7 Botswana context 8

1.8 Thesis organization 17

Chapter 2: LITERATURE REVIEW 18

2.1 Introduction 18

2.2 ICT tools in teaching and learning: Teachers' perceptions 22

2.3 Barriers to integrating ICTs in the classroom 33

2.4 ICT influence on learner's academic performance 37

2.5 TPACK and UTAUT-3 framework and perceived use of technology: Teachers' knowledge domains 41
2.6 Gaps in the literature 44
2.7 Conclusion 45
CHAPTER 3: CONCEPTUAL AND THEORETICAL FRAMEWORK 47
3.1 Introduction 47
3.2 Conceptual framework 47
3.2 Theories used 47
3.3 UTAUT-3 constructs 53
3.4 TPACK constructs 55
3.3 Conclusion 57
CHAPTER 4: METHODOLOGY 58
4.1 Introduction 58
4.2 Research paradigm 58
4.3 Research approach 59
4.4 Research design 60
4.5 The context of the study 61
4.5 Population and sample description 62
4.6 Data collection instruments 66
4.7 Data collection procedure 69
4.Reliability and validity of data 71
4.9 Ethical considerations 72
4.10 Data analysis 73
4.11 Limitations of the study 74
Conclusion 75

CHAPTER 5: QUANTITATIVE DATA ANALYSIS 76
5.1 Introduction 76
5.2 Data collected 76
5.3 Socio demographic 77
5.4 Conclusion 101
Chapter 6: QUALITATIVE DATA ANALYSIS 102
6.1 Introduction 102
6.2 Sampling procedure 102
6.3 Data collection 102
6.4 Data analysis 103
6.6 Conclusion on technology implications 126
6.7 Summary 127
Chapter 7: Discussions OF THE RESULTS 128
7.1 Introduction 128
7.2 Research Question 1: What are the perceptions of in-service teachers towards the use of ICT tools in teaching and learning in a Covid-19 environment? 128
7.3 Research Question 2: What are perceived as barriers for integrating ICTs into the virtual classroom in a COVID-19 environment and what strategies can be used to overcome these? .. 135
7.4 Research Question 3: Does the use of ICT by teachers influence learners' academic performance during the Covid-19 environment? 140
7.5 Research Question 4: How do teachers' knowledge domains of the TPACK and UTAUT-3 framework correlate with each other and the perceived use of technology? 144
7.6: Conclusions 146
CHAPTER 8: Conclusions and recommendations 147
8.1 Introduction 147
8.2 Conclusions 148

8.3: Recommendations 148
REFERENCES 151
APPENDICES 183
Appendix 1: Research Permit 183
Appendix 2: Ethical clearance 184
Appendix 3: Consent form to participate in the study 185
Appendix 4 : Quantitative questionnaire 188
Appendix 5: Focus group interview guide questions 199
Appendix 6: TURNITIN REPORT 200

CHAPTER 1: RESEARCH OVERVIEW

1.1 Introduction

The education system in Botswana is guided and influenced by the Revised National Policy of Education (RNPE) of 1994. In 2007, the government of Botswana introduced its national information communication technology (ICT) policy, called Maitlamo, which provides a roadmap to drive social, economic, cultural, and political transformation through the effective use of ICTs. The key goal for this policy was "for Botswana to become a sub-Saharan ICT hub to create an effective ICT growth hub in the region" (Government of Botswana, 2007). This has resulted in the Ministry of education (MoE) setting up computer laboratories in most schools around the country and introducing computer awareness subjects. This response was intended to support the aims and objectives of the Maitlamo policy and support the use of ICTs in curriculum delivery and learning. Another realisation and motivation for the policy was seen when the government was setting up computer rooms in most primary schools across the country.

However, despite all these efforts by the government, the utilisation of these resources is very low in Botswana's schools. The emergence of the Covid-19 pandemic has changed the teaching dynamics. According to Sansa (2020), Covid-19 is the novel coronavirus, which is termed a 'severe respiratory syndrome coronavirus-2' (SARS-COV-2). As a result of Covid-19, teachers/ facilitators had no choice, but to teach online. Frustratingly, the Covid-19 pandemic resulted in most schools closed around the world for several months with efforts to try to contain and minimize its spread (World Bank, 2020a: 1).

1.2 Background of the study

The outbreak of the Covid-19 virus has caused the world to be dealing with an emerging and new crisis. Lockdowns forced the closing of schools everywhere, resulting in disruptions in teaching and learning (World Bank, 2020a:1). The World Bank (2020a) estimates that the closure of schools left 1.6 billion children and youths out of school. Botswana's president, Dr Mokgweetsi Eric Keabetswe Masisi, reminded teachers of the need to embrace and use technology for dissemination of information and social interaction, especially during the Covid-19 pandemic. In his message marking the occasion of the national Teachers' Day, which is celebrated annually on the first Friday of June in Botswana, the president described the occasion as "auspicious" as it recognises the contribution of teachers to the socio-economic development of Botswana. He further said: "I want to remind you (teachers) of the need to embrace Information and Communication Technology (ICT) for information dissemination and social interaction, especially in these difficult times caused by the Covid-19 pandemic", (http://www.xinhuanet.com). The government of Botswana closed schools on 20 March 2020, as a caution to minimise and contain the spread and transmission of the deadly virus. This closure forced facilitators to have no choice but to use technology for remote teaching during social distancing times (http://www.xinhuanet.com). During the Covid-19 pandemic, the use of technology in teaching and learning has grown rapidly in every country across the world (Brohi et al., 2020), despite the challenges brought as a result of using technology, such as: lack of sufficient and appropriate ICT resources, network and internet access, among many others.

Technology has and is changing how things are done, where facilitators/ teachers are encouraged and advised to use technology in their curriculum delivery, as this guarantees that learning goes beyond classroom contact (Thomas, Reyes, and Blumling, 2014). There is a keen interest to

critically analyse the adoption of technology and use by in-service teachers during the Covid-19 pandemic when schools were closed. In their study, Thomas, Reyes and Blumling (2014), concluded that technology use in teaching should be used and assessed on the different teaching pedagogies as well as the expected learning outcomes. The use of ICTs provided an opportunity for many countries to raise and improve the standards of education (Brohi et al., 2020). Since the outbreak of Covid-19, and the lockdowns which ensued, the discussions around online learning, as well as the use of television, radio, and mobile technology devices for learning have become very prominent in the education sector and many other sectors of the economies. Various organisations have come up with various strategies to mitigate against the loss of time due to lockdowns. Covid-19 has, therefore, acted as the driving force to instructors in utilising technology in teaching.

Most countries around the world now consider the use of technology as a vehicle towards improving their economic development. For this reason, they are making concerted efforts to invest much in technologies (ICTs). For example, the United States of America (USA) spends more than US$10 billion annually on educational technology in public schools (Brunk, 2008), while Australia spends around AUD$8 billion on the same (Lane, 2012). There are different definitions of ICTs, and for the purpose of this study, the definition from UNESCO has been adopted (2002, p.10) and defines ICT as “forms of technology that are used to transmit, process, store, create, display, share, or exchange information by electronic means.” The definition adopted by this study includes technologies ranging from such technologies as radio, television, compact disc (CD), digital versatile disc (DVD), flash drive, telephone (both analogue and digital), software, hardware, and means of communication ranging from wireless to cable media.

Services used with these technologies are also included ranging from videoconferencing, podcasts, emails, blogs, and many others. Since Covid-19 is a new occurrence, there are no works, to the best of the researcher's knowledge that investigate the adoption and use of ICTs in teaching in Botswana schools in the context of Covid-19. This motivated the current study, which critically analysed the adoption of ICT in teaching by in-service schoolteachers in Botswana. It examined their behaviours, and attitudes towards the use of ICTs in teaching and learning.

A study by Ghavifekr and Rosdy (2015) found that learners are not confident to use technology. Even if so, some learners have increased their technological knowhow in the year that the study was conducted when compared to the previous years. Even though a study by Oliver (2002) found that the education fraternity is relatively less influenced by the use of ICT as compared to other sectors, such as, among others, the commercial and trade sectors, studies (Freitas & Conole, 2010; Meier & Spada, 2008; Rana, 2018; Rana, Greenwood & Fox-Turnbull, 2019; Roth, 2009; Stensaker, Maassen, Borgan, Oftebro & Karseth, 2007) found that the fast-paced development of technology, its adoption and use has internationalised and commercialised tertiary education; thereby improving learning options, such as distance and part-time learning. Haddad and Faria (2014) emphasised that the effective use of ICT resources and services provides both the teacher and learner with opportunities to collaborate in an effective learning environment.

Internationally, higher education has been contextualised in a dynamic way due to the change and development in technology. Academics now operate in what Barnett (2000) terms "a world

of super complexity", which entails ICTs enabling one to do everything anywhere in the world with the need for technological and economic changes, involving a reorganisation of time and space (Unwin, 2007). Because of the changing nature of ICTs and the pressure from Covid-19, there is a demand for facilitators to adopt and use ICTs in the delivery of the curricula. This has placed teachers in a somewhat difficult situation with expectations of significant change within a very short and often unrealistic timeframe. The Covid-19 pandemic has brought life to a standstill across the world, with nearly all academic institutions closed, and the teachers having no other option, but to teach fully online, as noted. Covid-19 has also shown that teachers can succeed during such a crisis given the right technology to use and support system. Among the challenges of using technology in the delivery of curriculum is that "you cannot possibly keep up with the technology" (Bates & Poole, 2003, p. xiii). The paradox of technology enhanced education is that technology changes very rapidly and human beings change very slowly" (Bates & Poole, 2003). This, therefore, calls for the critical analysis of teachers' attitudes, behaviour, and the perceived ease of use of technology. Furthermore, the rapidly changing world forces people to be more reflexive and responsive to the changing times. This has been shown by Covid-19, which has shaped the way people do things, e.g., a new normal where educational institutions are being forced to use ICTs in teaching and learning.

1.3 Problem statement

In 2013, Buchanan, Sainter and Saunders (2013) found that the rate at which teachers fully adopt and use technology in their teaching was very low. Many educational teaching institutions in Botswana across the country have spent money over the years acquiring technology and updating it as and when a new one is introduced. This is done so that the existing technology is compatible with the new one (Li, 2014). The low acceptance and use of technologies in teaching emanates

from behavioural intentions, professional development, and ease of use. Implementing technology has also been a challenge to its actual use (Kitade, 2015). The Botswana government under the Ministry of education and skills development and other stake holders have done their best to support the adoption and use of technology in teaching and learning. Policies have also been enacted to help with the inclusion of technology in teaching. Even though this is the case, teachers are still not using technology because of the negativity they perceive it brings. Teachers are reluctant because there are both benefits and draw-backs in using technology (Dwivedi et al., 2020).

1.4 Significance of the study

The purpose of this study was to critically analyse ICT adoption in teaching by in-service schoolteachers in Botswana. The researcher examined the tools and pedagogy that teachers are using and assessed if these are appropriate for this type of total online teaching and learning. Prospective results in this study made the researcher and the concerned educational stakeholders (policy makers and implementers - government, policy administrators - education managers, teachers and other policy beneficiaries e.g., students, parents and sponsors) to question the best pedagogy to use in teaching. The study also highlighted the benefits of using ICTs to improve education in the country. The prospective findings also encouraged teaching and learning using ICT as it is the new normal influenced by Covid-19. The use of ICTs has advantages, such as conducting learning and teaching anywhere and anytime, enhanced learner inspiration, access to higher or novel learning styles, open doors for autonomous learning and adoption, better combination of ICT devices and expanded parental engagement (Hrastinski, 2008). This ensured that learning takes place beyond the classroom contacts. It also helped to ensure that learners

with special needs get special ICT tools tailor made to help them study any time. Furthermore, this study helped as an eye opener to the digital divide gap by helping stakeholders realise the need to provide resources and ICT tools for the less fortunate. Additionally, it contributed to the facilitators having high quality pedagogical lessons, since they had the confidence in using different technological tools and resources in teaching and learning. This, in turn, helped boost learner motivation, self-esteem, and confidence and enabled learners to access many subject related information resources.

1.5 Research objectives

The objectives of this study were:

1. To examine teachers' perceptions towards the use of ICT tools in their teaching.
2. To critically analyze the impact of challenges in the adoption and use of ICT in enhancing teaching for in-service schoolteachers in Botswana.
3. To critically analyze the impact of the adoption of ICT on teaching and learning in Botswana schools.
4. To examine teachers' knowledge domains in terms of TPACK and investigate any correlations between TPACK and UTAUT – 3 frameworks.

1.6 Research questions

To address the research objectives, the study sought to answer the following questions:

1. What are the perceptions of in-service teachers towards the use of ICT tools in teaching and learning in a Covid-19 environment?

2. What are perceived as barriers for integrating ICTs into the virtual classroom in a Covid-19 environment, and what strategies can be used to overcome these?
3. Does the use of ICT by teachers influence learners' academic performance during the Covid-19 environment?
4. How do the teachers' knowledge domains of the TPACK and UTAUT-3 framework correlate with each other and the perceived use of technology?

1.7 Botswana context

The foundation of any society is education (Mafa & Govender, 2016). Without education, Botswana would be unable to attain its long-term goal of being a productive and educated nation for all. In the budget speech presented in 2007, it was noted that knowledge was the most significant resource and component for socio-economic growth (Government of Botswana, 2007). This is in-line with Botswana's Vision 2016 goal to be an educated nation by 2016 (Government of Botswana, 2007). This shows that education is the centre of any country and its economic development. Botswana's Ministry of Education (Government of Botswana, 2006) noted that education is a prerequisite for human development, which, in turn, accelerates development and economic growth of a country.

This study critically analysed the use of technology in Botswana secondary schools during the Covid-19 pandemic. The Botswana Federation of Trade Unions (BFTU), as noted in the Revised National Policy on Education (RNPE) (1994) also stresses the benefits of education, and it aligns them to the development of the economy. This study, which critically analysed the use of technology in teaching and learning during the Covid - 19 pandemic, shows how education in

Botswana was affected during the pandemic, as well as the measures put in place to facilitate the adoption of technology during the study period.

1.7.1 Review of the RNPE of 1994

Education, as mentioned previously, is the foundation and basis for any country's development and in achieving its long-term goals. In 1994, the government of Botswana came up with the RNPE. One of its aims was to provide training and 'imparting' knowledge to Botswana and those who live in it (Government of Botswana, 1994). The policy was succeeded by the development of programmes and procedures to implement the policy objectives. In 2007, the Botswana government came up with the Maitlamo policy, an ICT strategy, in which the objective was to integrate technology in teaching and learning. The RNPE was to cover a period of twenty years (BFTU, 2007) of which there was to be an evaluation to further improve the education sector in the following years.

The Botswana formal education system, as noted in the RNPE, runs from pre-primary, primary, to secondary (junior and senior schools) and finally tertiary (as in most developing countries). The RNPE stresses the need of teaching computer studies and ICTs to all learners across all levels in the country. As a result of the recommendation from the RNPE, computer awareness (which was, and still is, not examined) was introduced in junior secondary schools. However, computer studies was introduced as an optional subject in senior secondary schools and being examined. This was done so that technology can be integrated in teaching and learning throughout all the levels of education; thereby bringing benefits such as personalised learning and learning beyond time limits. In tertiary institutions, technology led teaching was and is

offered to all first-year entrants. This has also made the researcher keen to critically analyse the use of technology, particularly during the Covid-19 pandemic. Before the pandemic, blended methods were used, whereas during the pandemic, schools across the globe were closed to curb infections and yet left with no choice but to integrate technology in teaching and learning.

Mafa and Govender (2016) noted that technology has changed the way people live and interact with one another and that the computer education curriculum adopted in secondary schools strives to provide leaners with computer skills that could be of benefit to their future endeavours. This has influenced the Botswana Ministry of Communication, Science and Technology to draw up policies such as the national ICT policy (*Maitlamo*) which recommended that everyone in Botswana should have access to ICT resources to make it 'a better place to school, work and live' (Government of Botswana, 2007). Since the enactment of these policies, they have never been fully implemented. Therefore, there is a strong need to critically analyse the adoption and use of ICTs during the Covid-19 pandemic.

1.7.2 Internet use and digital access among young people

Digital technology has changed lives in almost every sector and industry. In most rural and urban communities, there is now access to the network and internet (if not, then low bandwidths). In a study by Smith, Raine and & Zickuhr (2011), it is noted and asserted that young people in the ages between 18 and 35 have access to digital technologies and access to the internet. Internet access in Botswana has improved compared to the years from 2013 to 2016 (Statistics Botswana, 2019). Most households, sectors, private and public industries now have internet connection and access to digital technologies (Statistics Botswana, 2019). Almost all secondary schools in Botswana have computer labs, computer studies teachers and access to the internet, for example,

in most secondary schools, teachers and learners use projectors during lessons. This familiarity reduces fear in using ICTs in curriculum deliveries. Learners also have access to mobile technology devices (Mafa and Govender, 2018), and some have access to these devices from their parents and or guardians.

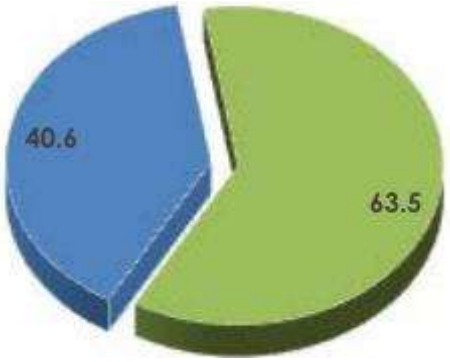
The use of ICTs in schools and homes partly respond to the objectives of the national ICT policy which states that "everyone must have access to use of technology by the year 2016" (Botswana ICT Policy, 2004). It is, however, important to note that it is not everyone who has access to ICTs in Botswana. Most learners spent more time using the internet than in the previous years. This is supported by Panayides and Walker (2012), who found in their study that, on average, most of the learners spent about one to three hours using the internet for purposes known to them. Robinson (2005) attests that leaners spend an average of two hours per day being online. Many children now grow up surrounded by technology. Thus, technology has shaped how they live and react to situations around them. They have had access to applications and have used them from a young age. One can, therefore, argue that technology shapes how one lives, and this depends on access and availability (Organisation for Economic Co-operation Development, 2012).

When the outbreak of Covid-19 was first announced and countries enforced lockdown measures to restrict movements, most children already had access to technology (Strielkowski, 2016). The only missing factor was how to best use it for the benefit of their education as schools had to close (Strielkowski, 2020). Strielkowski, (2020) further noted that there were disruptions in online learning since facilitators were not prepared to use technology in teaching even though

they were exposed to technology usage before. Effective use of technology in teaching and learning entails good online course design, and appropriate use of methodologies to engage and ensure learners actively participate. Teachers need to know how to effectively use and interact within the online environment, as well as the correct application environment (Bozkurt & Sharma, 2020). This works well with proper designing of online instruction (Branch & Dousay, 2015). This study, therefore considered all these factors into consideration: the fact that learners have access to technology from a young age, teachers' use of digital technological gadgets, policies enacted by the governments to support the use of technology in teaching and learning, to critically analyse technology use during the Covid-19 pandemic in Botswana schools.

1.7.3 Internet access to household in Botswana

In Botswana, households' access to the internet stands at about 41% (Botswana ICT Survey, 2014). Internet services providers, such as Mascom, Orange, Bofinet and BeMobile, play a crucial role in making sure that internet access is available across Botswana. According to Statistics Botswana (2019), household access to internet in Botswana stands at 63.5%, which is a significant improvement compared to the years before 2014. Figure 1.1 shows households' access to internet in Botswana in the year 2019.



key: Green – Internet access 2019
Blue – Internet access 2014

Figure 1.1: Botswana's household access to internet. Source: Statistics Botswana, 2019.

1.7.4 The Covid-19 pandemic and education

In 2020, 30,086,319 positive cases of Covid-19 were recorded. Of these cases, 21,833,645 recovered while 945,962 succumbed to the virus (Woldometer, 2020). This forced governments around the world to close schools and adhere to the set health protocols, as advised by the World Health Organisation (WHO). As such, the use of technology was the only way of continuing with teaching and learning. This is supported by *Medical News Today* (2020), which noted that researchers believed that the corona virus was spreading rapidly. This affected many countries education systems because educators had to adhere to strict health care protocols set by the health systems in their countries.

This was done to enable the governments to focus on improving the health systems and minimise transmission of the disease. For instance, the acquisition of medical and personal protective equipment, setting up new hospitals, laboratories, conducting studies to identity how the virus spreads, taking care of the infected, training more health workers, development of vaccines to mitigate the virus, as well as creating global awareness on how best to take care of oneself and prevent infections (Haleem et al, 2020). As a result, many were forced to close educational institutions and change the delivery of curriculum because the virus had taken a different toll in its widespread destruction (UNESCO, 2020a). This agrees with a report from UNESCO (2020b), which reported that 87% of the world's student population was affected by the closure of educational institutions due to the Covid-19 pandemic.

A study by Niranjan (2020) concluded that Covid-19 has not only affected the economies and day to day living conditions of the people, but has also impacted emotions, mental and physical well-being of countries and their economies around the world. This has led to poor business and

lack of cash flow injections. Other sectors, such as cultural festivities, entertainment and tourism, among many, were also affected (Evans, 2020). The closures of educational institutions due to lockdowns have led to educational leaders and stakeholders to resort to online distance learning. This was a new development for many developing countries, which had never leaned on since they had always resorted to traditional teaching pedagogies. Distance learning platforms, educational applications, and resources were aimed at helping parents, learners, and teachers (UNESCO, 2020a). UNESCO (2020b) also reported that the closure of schools because of Covid-19 affected parents across the world too. Parents not only had to source technological gadgets, but also had to pay for access to internet and tutors to assist their children. These affected households in that most of the workforce had lost their jobs, while some had their salaries reduced. This, therefore, did put a lot of pressure on the parents because they had to move with time during a difficult period.

These developments brought out by the pandemic were introduced to help, but due to lack of resources, such as internet connectivity, lower bandwidths, lack of proper ICT teaching resources, no knowledge of eLearning, how to structure content online, being technophobic, and the lack of skills on distance learning, have made it difficult for teachers to effectively deliver curriculum content through distance learning in developing countries (Mustafa, 2020). Mustafa (2020) also found out that some developing countries were forced to deliver curriculum content through mediums such as radio and television, but it was difficult for the recipients in the remote areas to get the content due to lack of network connectivity to transmit content. Additionally, some impoverished families did not have access to any such resources to make use of this learning in their respective homes. Most developing countries relied on developed nations for

donations of resources, such as ICT equipment, radio wave extensions and study guides, for the poorest social backgrounds (Mustafa, 2020).

In this study, the impact of how the Covid-19 pandemic affected the education system, especially the repercussions on the children, learners, facilitators, and parents, have been examined. Solutions on how to keep the education system running during the Covid-19 pandemic, and the challenges faced are also discussed.

1.7.5 School closures effects on children

Even though school's closures were meant to prevent further spread of the virus by the learners and teachers, it affected their education, more especially those in the remotest areas and from low-income households. Before the Covid-19 pandemic, developing countries were still struggling to improve their education to ensure that it is at par with developed countries (Kaffenberger, 2020). This posed pressure and challenges to most of the learners around the world (Kaffenberger, 2020). Most learners were frustrated because they were worried about the impact Covid-19 would have on their exit years (Elikai and Schuhmann, 2019). In addition to the above factors, facilitators in some developing countries found it difficult to cope and adjust to the use of technology in teaching and learning as this was a new phenomenon (Snilstveit et al., 2015).

Biswas et al. (2020) found that 86 percent of learners in Bangladesh had access to a television learning programme during the Covid-19 pandemic, but only half engaged with the programme due to lack of access to resources in most rural arrears. In a similar study in Malawi by Chikoti et al. (2020), a survey was conducted and found that the uptake of remote learning during the

pandemic was very low because of the differences in socio-economic background. Only about 25 percent leaners participated in remote learning, and only seven percent from the poorest communities and households did so. In Argentina, a study revealed that learning through short message service and phone calls yielded positive results because there was a randomised parental engagement in children's learning (Angrist et al., 2020). One can, therefore, conclude that Covid-19 pandemic adversely affected low-income countries more than the developed countries.

1.7.6 Effects of school closures on facilitators

Teachers, as with learners and parents, were affected by the school closures due to Covid-19. The sudden closure resulted in the teaching and learning to be done online. Understandably, this affected the quality of teaching because the majority were using ICTs with little requisite skills (Murgatrotd, 2020). Access to internet during the pandemic was also a challenge, hence teachers could not successfully collaborate and interrelate with their learners online. This therefore made them resort to asynchronous communication (Ali, 2018). The Organisation for Economic Co-operation and Development (OECD) (2020) stated that in sub-Saharan Africa, 64 percent of primary school teachers received pre-service training required in ICT whereas in secondary schools, about 50 percent did. This training excluded technology teaching and was only a basic ICT teaching course.

All the above are reasons for this study which did to some extent address some of the issues mentioned.

1.8 Thesis organization

This thesis is made up of eight chapters. Chapter one introduces the study. It gives an insight into the Botswana educational context, discusses the significance of the study, research objectives and research questions. Chapter two reviews the literature and identifies the gaps in the literature. Chapter three discusses the conceptual framework, that is, the theories adopted for this study. Chapter four discusses the research methodologies. Chapter five presents quantitative data analysis while chapter six presents qualitative data analysis. Chapter seven presents the discussion of the results and finally chapter eight discusses the conclusion and the recommendations from the study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Chapter two reviews the adoption and integration of ICTs in teaching by in-service teachers. The literature reviewed is discussed under the following four subtopics:

1. ICT tools in teaching and learning: Teachers' Perceptions
2. Barriers to integrating ICTs in the classroom
3. ICT influence on learners' academic performance
4. TPACK and UTAUT-3 framework and perceived use of technology: Teachers' knowledge domains.

2.1.1 ICT defined

According to Cirera, Lage and Sabetti (2016), ICT refers to any electronic information processing machines, such as mobile technology devices, computers, internet and its resources, which can be used to capture, store process and distribute results in digital platforms. This is supported by Goktas (2006), who stated that ICT is the use of computer equipment and services, networks, internet and its resources to input, process, store and display results through digital channels. In this study, the above definitions have been adopted.

2.1.2 ICT integration in education

Technology adoption in teaching and learning, including all digital media platforms, tools and resources, which is also referred to as eLearning, has been the central point in the development

and improvement of initiatives that support education in developing and developed countries (UNICEF, 2017). Due to the Covid-19 pandemic, the education system was adversely affected. Teachers and learners were forced to adapt to new ways of teaching through online learning in response to the lockdowns and movement restrictions imposed by different governments (De Vincenzi, 2020).

ICT adoption in teaching and learning is of great importance to access available and up-to-date content and keep up with modern developmental trends, both in the education sector and other sectors of the economy. Digital libraries and other resources are available where leaners and facilitators can gain access to and share information 24/7 without any time limit. This can only be possible and realised using ICTs (Knezek & Christensen, 2016). The integration of technology into teaching provides more advantages in the teaching and learning process for teachers to interact with their learners in a digitalised space (Lawrence & Tar, 2018). According to Bai, Wang and Chai (2019) and Rana et al. (2019), studies have concluded that it is enough to use ICTs in daily lives to see how effective they can be, and when used with new and emerging technologies, how best they can enhance teaching and learning across the education sector in a country. The use of ICTs in Botswana depends on who owns and can use it. In most schools, teachers are technophobic regarding the use of technology and ICTs in teaching and learning (Mafa & Govender, 2016). In addition to the above, Crook (2011) agrees that ICTs, as a communication pathway and channel, enable collaboration between the facilitator and the leaner. Collaboration can be either synchronous or asynchronous. In addition to the above, according to Statistics Botswana (2008), mobile ownership in Botswana is very low. For those households who have access to a mobile device, it means that learners from those households may have access to such devices from their parents or guardians. In this study, the researcher is keen to

find out and critically analyse how these devices and other technologies were adopted and used during the Covid-19 pandemic.

Albayrak and Yildirim (2015) agreed that the integration of technology in teaching and learning helps to realise lifelong learning skills and promotes collaboration between the facilitator and learners. It also enables the realisation of new skills and professional development. This is supported by Dysthe, Lillejord, Wasson and Vines, (2010), and Kirkwood (2014), who noted that the integration of ICT in teaching and learning, if used and implemented properly, can yield positive results, more especially in the delivery of curriculum. Several studies by Khan, Hossain, Hasan and Clement (2012) and Kozma and Vota (2014), carried out in developing countries, also showed that the introduction and execution of ICT policies in the delivery of curriculum was necessitated by the lack of key ICT infrastructure, resources and setups, lack of capital to acquire appropriate ICT tools, and an unskilled personnel on the use of ICTs in education. Adoption is not only the choice to accept an innovation, but also the extent to which that innovation is integrated into an appropriate context. Teachers had no choice, but to adopt the use of technology during the Covid-19 pandemic. This also led to the professional development of their teaching. In addition, social adoption became part of teaching since teachers had to adapt to the use of technology with their peers during peer teaching and online classes.

Facilitators who attended technology teaching lessons are in a better position to use it effectively in their delivery of curriculum than those who did not (Johnson, Adams, & Haywood, 2011). Even though that is the case, many facilitators and concerned stakeholders have succumbed to the pressure that Covid-19 has affected learning, and they feared to attend lessons physically

because of fear of contracting the disease (Lemke & Silverman, 2020). Lawrence and Tar (2018) contended that ICTs are of paramount importance in the education system. Since the emergence of Covid-19, there is a growing need to use ICTs in teaching and learning to impart skills and knowledge to the learners (Knezek & Christensen, 2016). The adoption of ICT and integration in teaching and learning has gained momentum in most countries around the world (Kauffman & Kauffman, 2017).

In a study by Valencia et. al. (2016), they listed aspects of ICT integration which included digital libraries, digital search engines and web 2.0 tools, amongst others. Aguiar, Velázquez and Aguiar (2019), on the other hand, included aspects such as competence, motivation and being proactive. This study revealed how competent in-service teachers in Botswana schools were with regard to the use of technology in teaching. Similarly, Melo (2018) noted that for one to integrate technology in teaching and learning, they must be knowledgeable on how to use and communicate with such resources, and how to get learners to get acquainted and receive knowledge through ICTs. Today's digital age affects all aspects of human life and different sectors (Ga`ová, Mi`ík & 'Tofková, 2018). Ocaña, Valenzuela and Garro (2019) added to this view and argued that modern digital trends require one to be literate on the use of digital technologies and ICTs. This would ensure that one can effectively adapt and adopt technology in teaching. Results in chapters five and six of this study helped to show how literate teachers were during the adoption and use of ICTs in teaching and learning during the Covid-19 pandemic. Fernandez, Fernandez and Cebreiro (2018) maintained that the unavailability of correct and appropriate ICT resources is the main obstacle to its adoption and successful implementation in teaching and learning.

2.2 ICT tools in teaching and learning: Teachers' Perceptions

Studies from the International Computer and Information Literacy Study (ICILS, 2013; Fraillon et al., 2014) have shown that teachers in many developing and developed countries use ICTs on a minimal basis even though given the increasing benefits of ICT adoption and use in education. Many studies have revealed that ICT use in education remains little to no use (Teo, 2009). For example, in Europe, the OECD noted the use of ICTs in teaching and learning in Poland, Ireland, Belgium and Germany was below average (OECD, 2015). The reason could be that teachers are regarded as the only ones vested to change the frame of how learning should go about (Donnelly et al., 2011). Without support from other stakeholders, the use of ICTs in teaching and learning will remain a dream and implementation will never take place.

Studies by Shaunessy (2007) and Aduwa-Ogiegbaeni (2008) have concluded that young teachers are more likely to use technology in their teaching compared to older ones. This is because young teachers are introduced to ICT at a young age. The effective use of ICTs in teaching and learning requires a teacher to be competent and literate in digital technologies (Trainee Teachers' Addendum, 2017). Agyei and Voogt (2011a) indicated that in most cases, learners learn according to instruction from the instructors, hence there is no room for personalised learning. They observed that if the teacher uses ICT in his/ her class, there is likelihood that learners will use technology for learning purposes. In a study that looked at teachers' perceptions on the use and application of technology in teaching mathematics, Buabeng- Andoh (2012) found and concluded that the respondents found the integration of ICT in teaching important since ICT resources helped one to get more content online than physical, unlike using YouTube and other educational search engines. This would ensure the enrichment of course content from online

resources and also improve the teaching and learning process. Teachers' general perceptions regarding the integration of ICT in teaching were positive, but no such study has been done in the context of Botswana during the Covid-19 pandemic. Tella et. al. (2007) investigated teachers' use of ICT with a population of 700 respondents. Their findings found teaching using ICTs to be useful as it made their job easier. Generally, this means that technology adoption in teaching is very useful, and if used properly, can reap benefits and rewards in teaching.

2.2.1 E-learning usage during Covid-19 pandemic

The outbreak of Covid-19 forced learning to be fully online. However, both distance and online learning are not new to the education sector. eLearning platforms had to be adopted to cater for the time lost during lockdowns around the world. eLearning systems are relatively cheap to acquire and are freely assessable on the internet as one can download and customize them. Ulker and Yil,az (2016) argued that systems such as Moodle, Google classroom, blackboard, col campus and others are free sources of information because they are available 24/7, and are very cheap and would provide an interactive platform. eLearning systems enable learners to interact and collaborate with their peers and facilitators online. Using these platforms, learners have access to curricula material from different locations at any time because they can be accessed using mobile technology devices (Mafa & Govender, 2018). Ülker and Yılmaz (2016) agreed that eLearning works best with the use of a learning management system because the learning management systems are organised and can manage learning activities well. These activities include student course enrolment, assignments, writing of tests and examinations, submission of assignments and lesson materials (Haghshenas 2019).

This has seen many educational institutions and schools adopting the use of eLearning due to the challenges brought by Covid-19. Some encountered challenges from moving from a traditional based teaching pedagogy to online distance learning pedagogies. Osman (2015) believed that by moving from traditional teaching pedagogies to online distance pedagogies gives learners access to the content in the learning management systems 24/7 without time limits. This can be achieved with improved internet connectivity, higher bandwidths, and access to resources (Idris & Osman 2015).

eLearning success depends on the readiness and acceptance of use by the recipients (learners) and the teachers (facilitators) (Almaiah & Jalil, 2014; Almaiah & Alismaiel 2019). This means that the lack of usage of these systems derails success of the system, its realisation and benefits. It is very important, therefore, that there is a learning management system in place which will be used effectively to impart knowledge to the learners (Shawai & Almaiah, 2018). If the learning management system is not used to benefit its intended target, this usually leads to money being wasted. Thus, willingness and acceptance of use should be key in the use of any eLearning system (Naveed et al., 2017). This study has shown the rate of acceptance on the use of technology in teaching and learning (see results section). There is currently not enough research on this topic, especially where learners take part in eLearning. Their perceptions and views have not been adequately studied (Tarhini et al., 2017; Almaiah & Alamri, 2018). Studies on the adoption of eLearning in teaching and learning can help better understand the needs of the learners, facilitators and this would eventually lead to a successful uptake and adoption of ICTs (El-Masri & Tarhini, 2017; Alksasbeh et al., 2019).

Some studies have tried to address the adoption of eLearning in many countries around the world (but not in Botswana). For example, Almaiah and Man (2016) have used the Technology Acceptance Model (TAM) and investigated factors that affected the eLearning system among the Malaysian learners. The study found and concluded that there were advantages from the system used. In the United Arab Emirates (UAE), a case study which used the Technology Acceptance Model - 3 (TAM-3) for a quantitative investigation by Salloum et al. (2019) indicated that innovativeness, quality, trust, and knowledge sharing were major influencers, which led to achieving better use and acceptance of eLearning among the learners at the time. Al-Gahtani's (2016) study, which investigated the factors influencing learners' eLearning acceptance and use based on TAM - 3, found the following factors which determined acceptance and use: perceptions of external control, perceived use and self-efficacy. However, in Saudi Arabia, factors such as communal influence, self-confidence and perceived usefulness were not associated with acceptance of use. Almaiah et al. (2016a) proposed a new context using the Delphi method, which was used to examine eLearning success factors in Saudi Arabia. Their study found majority of factors which contributed to the success of eLearning use and grouped them in four domains. Motshegwe (2018) investigated the use of ICTs for enhanced teaching and found that ICT use in teaching and learning has led to the change in the facilitator's role among university staff and learners and that facilitators use available technologies in the institution because they appreciate the role technology plays in education. Bellaaj et al. (2015) used the UTAUT (Unified theory of acceptance and use of technology) model in their study and argued that effort expectance had a strong influence on the use of eLearning systems at the University of Tabuk in Saudi Arabia. In a related study conducted in Azerbaijan, Chang et al. (2017) found that subjective norms and experience in use and enjoyment influenced willingness to use

eLearning in teaching and learning. Abdullah and Ward (2016) also examined issues influencing eLearning acceptance using the TAM and found that self-efficacy, personal norms, satisfaction, concern and experience using technology had a substantial influence on learners' acceptance of use of eLearning. Similarly, Alhabeeb and Rowley (2017) and Motshegwe (2018) concluded that familiarity with technologies used for learning and technical infrastructure were among the factors which influenced the successful use and acceptance of technologies used in teaching in Saudi Arabia and Botswana universities respectively. These studies contributed significantly to persuading the researcher to adopt the UTAUT – 3 model and the Technological Pedagogical Content Knowledge (TPACK) models which are discussed in chapter three in this study.

2.2.2 Teachers' integration of ICT into teaching

Teachers' integration of ICT into teaching has been well investigated in many countries. A study by Kaleli-Yilmaz (2015) investigated teachers' integration of technology into teaching and learning and found that technology use by teachers was limited to no avail because they have little to no knowledge on how to integrate technology in their teaching. Similarly, So and Kim (2009) investigated what constituted the knowledge basis of pre-service teachers related to pedagogy and technological integration. They concluded that lack of technology use and available resources contributed to its integration and use in teaching. On the other hand, Agyei and Voogt (2011b) examined pre-service mathematics education facilitators, exploring their influence on computer attitudes, competencies and access to ICT and they reported low levels on the use of ICT in teaching and learning.

2.2.3 ICT integration in the classroom – a pedagogical change

The main challenge in teaching with technology is the reluctance by teachers to do away with traditional methods of teaching and adopt and integrate ICTs use in teaching (Mafa & Govender, 2018). Effective use and implementation of technology use requires a positive attitude, ICT competence and technological pedagogical knowledge (Fullan & Langworthy, 2014). Adoption and use of technology in teaching and learning requires changes in the professional attitude and role of a teacher, from content delivery and transition to collaboration between the teacher and the learners' use of appropriate ICT resources (Fullan & Langworthy, 2014).

Eitan (2006) believes that a teacher should support and encourage the development of a leaner on digital platforms used during teaching and learning. The teachers are intermediaries and ensure that the learner consumes appropriate content. The teachers scrutinise proper content for the learner and constructs new knowledge (Barak & Ben Tzvi, 2012) which the leaner will use in the future to transform oneself. The teacher is supposed to impact knowledge, organise and map concepts to be learnt considering the expected learning outcomes (Barak & Ben Tzvi, 2012). Additionally, continued training and coaching of teachers to use ICTs in their teaching should be done more often. This can also lead to professional development and encourages them to move away from traditional teaching pedagogies to integration of technology in teaching (Magen-Nagar & Peled, 2012).

2.2.4 Teachers' professional development

ICT adoption covered in pre-service and in-service teachers' professional development is the core to adoption and use in teaching. This is supported by Baylor and Ritchie (2002), who

stressed that ICT training has an influence in its adoption and use. A study by Becker (2000), in which he investigated teachers' use of ICT, concluded that lack of technical expertise and pedagogical technological knowledge are some of the factors that hinder the adoption and use of ICT among teachers. In a similar study by Kramarski and Michalski (2010), the results revealed that teachers lack ICT knowledge and training. The results of the current study show that this was the case with Botswana's teachers during the Covid-19 pandemic (see chapter five and six). Agyei and Voogt (2011b) investigated teachers' overall perceptions on ICT integration and willingness to take an ICT professional development programme. The results revealed that the majority of teachers (98%) were willing to take an ICT professional development programme and integrate ICT instruction delivery in their teaching. This shows that professional development training is key to ICT adoption and use in teaching.

Training on ICT use and adoption by teachers can generate several benefits, such as improved access to learner content resources by both the teacher and the leaner. This may lead to a potentially significant improvement in the leaners' academic performance. However, ICT use in teaching and learning has led to little improvement of academic results in Indonesia. This was seen after the government efforts to train professional development ICT programmes for teachers across the country in Indonesia (Luschei, 2017). Some benefits of ICT use in teaching and learning include, among others, improved teacher-learner collaboration, leaner-efficient personalised learning, improved reading skills, improved research competency, problem solving and improved learner participation and creativity (Mohammed & Abjulghani, 2017). Many studies in developed countries have revealed that teachers in those countries enjoy the benefits of ICT use in teaching and have developed a positive attitude towards the use of ICT, both at the

teacher and leaner level (Qasem & Viswanathappa, 2016). It has been reported that professional development training in ICT use by teachers is a contributing factor to such an improvement and success of teachers in their profession (Ottenbreit-Leftwich et al., 2018). In some countries, there is an indication of unwillingness by teachers to use ICT, but motivation should be included in the subject in the technological educational context (Tallvid, 2016).

ICT professional development programmes must include, among others, computer essential skills, use of a variety of different technologies in instructional design, online course creation, introduction to eLearning, making and taking informed ICT decisions, and knowledge generation related to performance using different ICT tools. This would ensure that the teacher is well rounded and ready to use technology in their class (Afifi & Alamri, 2014). A study by Plešec, Gas-parič and Pečar (2016) showed that online discussion between learners and teachers yielded positive results as it helped them to plan their lessons on time and this had a positive effect on the learner perception in adapting and engaging in an online class. This shows that proper ICT professional development of teachers can turn around education compared to traditional methods of teaching.

Mwendwa (2017) stressed that the training of teachers on ICT will help them build appropriate skills needed for pedagogical instruction in the classroom. Professional training builds confidence to use and reap the required benefits (Danner, 2014). A Kenyan study by Laaria (2013) on the use of ICT in schools concluded that with government support and provision of appropriate and required teaching resources, and professional development programmes, ICT adoption can lead to improved education with quality standards and making teachers globally

competitive, thus broadening their scope and enforcing capacity building. This showed that professional capacity building and professional development programmes are a benefit to the teachers' profession and a benefit to the leaner too.

2.2.5 Technology adoption theories

Many researchers in developed countries have suggested different theories for evaluation acceptance, integration and use of technology leading to individual acceptance, behavioural intention, and integration of ICT in teaching. These theories include TAM, Theory of Reasoned Action, Theory of Planned Behaviour, UTAUT, and Diffusion of Innovations.

The TAM seems to be the leading theory used most frequently in information usage. It is widely used to measure individual's acceptance of use of technology and technology acceptance based on the following factors: perceived ease of use and perceived usefulness. Considering the attributes and pressure from the Covid-19 pandemic, the conceptual frameworks for this study were drawn from the TPACK and UTAUT-3 by Farooq et al. (2017). These two were merged and used for this study so that the researcher can determine whether aspects of TPACK have any influence on teachers' perceptions about the constructs of UTAUT-3, which leads to behavioural intention, and consequently technology use in teaching. The UTAUT offers a well-validated explanation in clarifying the behavioural intention of accepting and evolving technology. There are, however, gaps in understanding the factors of the components in the model.

2.2.6 Digital collaboration tools: Web 2.0 tools

Surendra (2012) defined web 2.0 as a diversity of applications that allow creation of and sharing of material content online. Web technology tools and the above mentioned differ in how they

were created and the reason they were created. These applications can be downloaded freely online and do not require payments compared to many applications found on different websites online (Wiki, 2016). These digital technologies, such as short message service (SMS), wikis, blogs and other social networking sites (Facebook, Twitter, Instagram and many others) are always used synchronously and synchronously enabling communication between parties. These can also be used in education to be of service in situations where learning management systems can be afforded (Lindmark, 2009). These technologies enable easy communication and use less data and internet charges to access. They can be used in educational settings, coupled with email, discussion boards, and forums, where interaction between the learners and the teacher can take place (http://en.wikipedia.org/wiki/Web_2.0 - cite_note-10). ICT integration and use in teaching and learning should be user-friendly, effective in doing the job and both parties at one end should receive communication instantly (Mahdi & Al-Dera, 2013). Generally, using the term "Web 2.0" is broader and more neutral in the field of education. In addition, Pascu et al., (2008), defined Web 2.0 as a composition of innovative applications and technologies that are set to benefit the user.

Much literature has surfaced on digital technologies use in education (Sung et al., 2016). Digital technologies and web 2.0 tools and above have offered and still offer various purposes in education compared to old traditional teaching pedagogies (Faber et al., 2017). For example, evidence has shown that these technologies can be used as effective tools to improve teaching and learning and they ensure easy and smooth collaboration (Kurvinen et al., 2020). They can be used to access the learning process leading to improvement of one's professional development and growth in teaching (Laakso et al., 2018). Learning management systems, such as Google

Classroom, Modular Object-Oriented Design Learning Environment (Moodle), Blackboard, WebCT and others, are available at the disposal to teachers online to use and customise to their needs (Laakso et al., 2018) and improve instruction delivery.

2.2.7 Factors influencing the use of digital technologies

Literature has identified different factors influencing the use of digital technologies in the school setting (Laakso et al., 2018). Some have identified challenges in technology integration in education, which are related to lack of skills in the digital world and the digital divide among teachers (Durff & Carter 2019). Barriers are classified as internal or external. External barriers are generally linked with lack of access or having limited resources, limited training, and no support to use of resources, lack of confidence, belief perceived use of technology (Ertmer et al., 2012). This was supported by a model discovered by Christensen and Knezek (2008), in which they distinguished three major elements; integration of technology, willingness to use technology in delivering curriculums, and access to suitable technology to use (Instefjord & Munthe, 2017).

In the literature reviewed by Ertmer and Ottenbreit-Leftwich (2010), they showed that teachers' attitudes towards the use of technology was the indicator which predicted actual use. In a related study by Pittman and Gaines (2015), results showed that teachers who were competent in ICT use had the confidence to use it for several reasons related to their teaching, i.e.: lesson planning, instruction delivery, leaner feedback, and many others. This was in agreement with a study carried out by Instefjord and Munthe (2017) who concluded that perceived ease of use of technology is important in technology adoption, integration and use, while Teo et al. (2016) clarified perceived usefulness as the degree to which facilitators perceive or believe that using

ICTs will have an influence in teaching and learning. In this study, all factors of the UTAUT-3 and TPACK are looked at critically and the extent at which technology was adopted and used in Botswana secondary schools is analysed.

2.2.8 Acceptance to use technology

Teachers should be prepared to accept, integrate and use technology in order for schools to adopt to the digital era (Albion et al., 2015). Brigas et al. (2016) and Pittman and Gaines (2015) have concluded in their study that only a handful of teachers have shown positive attitudes towards the use of technology and its benefits in their classrooms, while majority were not interested to adopt and use it in their teaching. This was a result of issues teachers perceived and related to lack of appropriate ICT skills and professional development programmes on the use of technology in teaching and learning. This was supported by (Aslan & Zhu, 2016) who concluded that majority of teachers were not confident in technology use. In this study, being competent in technology use is defined as one's ability to use ICTs for the benefit of themselves and the learner (Spante et al., 2018). Ilomäki et al. (2016) separated digital competence into four parts; ICT skills to operate a particular technology, competence, ability to use and apply the use of ICTs in different work areas, one's ability to evaluate technology used per context, and the digital space participation. All these four parts were examined in this study.

2.3 Barriers to integrating ICTs in the classroom

The Covid-19 pandemic has forced suspension of physical contact during learning forcing learning to migrate online (Ribeiro, 2020). Teachers found themselves with no choice, but to adopt online teaching. Online teaching, as described by Rieley (2020), is the use of ICTs and

web 2.0 tools to deliver curriculum content in a virtual environment. Learning online takes two forms (synchronous or asynchronous) (Singh & Thurman, 2019). Synchronous online is an interactive session between the instructor and the learner in actual time, while asynchronous is a situation where instructors and learners can meet at different times and leave comments or responses which when the other party goes online, they can respond to (Thurman, 2019). Educational institutions had to choose the best methods to adopt, and under which circumstance imposed by the Covid-19 pandemic. Some were successful with this migration to online learning, while others encountered challenges both of adoption and use (Liguori & Winkler, 2020). This was because this migration forced compulsory alterations to the syllabuses, attitudes and the way assessments were done (Ribeiro, 2020; Hodges et al., 2020; Manfuso,2020).

Majority of teachers were not competent enough to use technology in teaching and learning (Manfuso, 2020). They lacked ICT skills to deliver curriculums online, and to simply operate and use a computer. (Dhawan, 2020) has shown in his research that technical skills in designing and delivering and online class are key to the teacher as they help one to effectively execute their job well. He further added that challenges such as no training on the use of technology, low bandwidths, poor to no access to network and the internet were major because without them, one cannot effectively conduct and online class.

This study unpacked the extent to which teachers received any tuition on the use of ICTs during their training and to what extent they used that to benefit their recipients. Adoption to use and perceived usefulness are key to the use of ICTs in teaching and learning (Almaiah et al., 2016b). Eltahir (2019) has shown that the adoption of technology use in developing countries was a

major challenge because these countries are still struggling with adoption due to the digital divide between developed and developing countries. Majority of the studies focused on challenges in using ICT in education delivery, for example, Kanwal and Rehman (2017) in their study concluded that poor internet connect and poor to low speed were among the challenges. Another study in Kenya by Tarus et al. (2015) found using eLearning management system as a challenge in their study. These included lack of infrastructure, lack of technology skills and funds to purchase appropriate resources. A similar study by Mulhanga and Lima (2017) found factors such as poor and un - interactive design of the interface and lack of ICT skills as the main cause which hinders the successful implementation and use of educational learning management systems. Kenan's et al. (2013)'s study in Lybia found that problems related to culture, political, and socio-economic factors were the major reasons in failing to use ICTs. Other challenges related to organizational management, technical know-how, culture, and implementation were also identified as key to unsuccessful implementation and use of eLearning systems (Chen & Tseng, 2012).

2.3.1 Pedagogical barriers

These barriers are often tackled during undergraduate teachers' training, but if not properly dealt with, at that stage, could pose a challenge in the field of work since one will have challenges in disseminating instruction (Coats, 2018). During training at college, teachers who used technology in their learning are more likely to use it with their learners when they graduate and join the teaching profession (Taylor, 2017). These barriers are associated and related to one's attitudes and beliefs, culture, and the magnitude at which the instruction is delivered. Van Braak, et al. (2017) noted that technology integration in teaching and learning depends on the teachers'

belief in pedagogy, whether they are learner-centred, or teacher-centred. Deng et al. (2014) defined teacher-centricity as the association with traditional methods of teaching; dictating the lesson content to the learners and not giving the learners enough time to express themselves to understand concepts better on the own. They consider student-centricity as the correct pedagogical instruction as it gives the learners room to express themselves and be constructive in their work, thus building on new knowledge. Markauskaite and Goodyear (2014) stressed that barriers in pedagogy were tied to teaching. For instance, beliefs in teaching and learning emanate from learning at a young age from primary through secondary to tertiary education until graduation. This is where new experiences are put into action. These beliefs and experiences are the ones which shape and dictate how one should disseminate instruction in a classroom environment without limiting the participation of learners (Peacock et al., 2018).

2.3.4 Challenges to develop ICT skilled teachers

Studies have shown that lack of technology competent teachers is often associated with educational leaders. For instance, if a leader is technophobic, there are lower chances that teachers will be taken for ICT upskilling classes or programmes. If, however, a leader is ICT conversant, the higher the chances that teachers would be well-equipped and fully developed in using ICT in their teaching learners (Alawidi & Aldhafeeri, 2017). Most teachers in developing countries are less ICT skilled than those in developed countries. This can be attributed to lack of funding in training and up-skilling of teachers on how to integrate ICT into their teaching. In this regard, they are consequently forced to resort to the traditional teacher pedagogies where pen and paper are more common in the classroom.

The following have been found as factors which contributes to the challenges related with developing competent ICT teachers. Majority of teachers are subjected to basic computer applications course as an introductory ICT course at tertiary institutions. Integrated of ICT in teaching and learning in this course is trained as this is just an awareness course. This is because curriculums dictate how teachers should teach and it excludes ICT use in teaching and learning. Technophobia is another issue as teachers fear the use of technology since some are not familiar with its use (Mafa & Govender, 2018), resulting in them resorting to traditional teacher centred pedagogies. Lack of capital to purchase ICT resources and acquire infrastructure also hinders adoption and use.

2.4 ICT influence on learners' academic performance

Developing countries, such as Indonesia, have tried, over the years, to improve the education system and student learning outcomes. This has seen the training of teachers on the use of ICT and different digital technologies. Indonesia tried to improve its teachers' training programmes to include ICT training and address teachers' poor self-confidence (Allen et al., 2018). Despite all these efforts aimed at improving education, there has been little improvement in the student's results. In a similar study by Mafa and Govender (2018), in which they investigated the use of mobile technologies in teaching and learning in a developing country, the results revealed that the effective use of mobile technology devices can yield positive results. In most countries, studies on ICT influence on academic performance showed little to no improvement in academic performance.

2.4.1 ICT Education in Botswana

Botswana's national ICT policy (*Maitlamo*) shows the vision and intent of the country to support the integration and use of ICTs in all sectors across the country. The World Factbook (2007) supports this by noting that Botswana has the largest personal computer ownership in Africa as shown in table 1. This makes the researcher concludes that most households in Botswana have access to technology of some kind. The Botswana Ministry of Education and Skills Development set up computer laboratories at junior and senior secondary schools and installed computers in order to promote ICT in teaching and learning (Government of Botswana, 2020). The government also introduced computer lessons from pre-primary to senior secondary schools.

Dyman and Oesmann (2006) concluded in their study that Botswana's ICT infrastructure and resources are good, but not fully utilised. They also concluded that only five percent of the population had access to the use of the internet and its resources. Location also showed a disparity in use since in most rural or remote areas, there is poor network reception compared to urban areas where there are enough resources, such as network coverage and high bandwidths (Government of Botswana, 2014). Table 2.1 presents the state of the national information communication technology infrastructure in Botswana.

Table 2.1: ICT Infrastructure in Botswana

Indicator	
Fixed line subscribers	67.7 per 1000 persons (2004)
Mobile subscribers	708 per 1000 persons
Dial up subscribers	6000 (2005)
Broadband subscribers	0 (2004)
Internet users	7167 (2004)
Television broadcast stations	1
Radio stations	41

2.4.2 Education system in Botswana

The secondary education system in Botswana comprises three years of junior secondary school education (JCE) and two years of general certificate of senior secondary school education (BGCSE). This study focused on the adoption and use of ICTs in secondary schools (both JCE and BGSCE) during the Covid-19 pandemic. This is because most secondary schools are equipped with ICTs which have been not in use for some time. Therefore, there was a need to analyse if teachers did take advantage of this or not. The National Policy on Education (NPE) of 1977 was introduced to make Botswana's education open to all unlike during the British colonial rule where education was largely reserved for the elites (Government of Botswana, 1994). The NPE was replaced by the Revised national Policy on Education (RNPE) in 1994. The RNPE included and addressed issues such as free access to education for all and the provision of quality education for all (Government of Botswana, 1994). Figure 2.1 shows the education system in Botswana's grade levels.

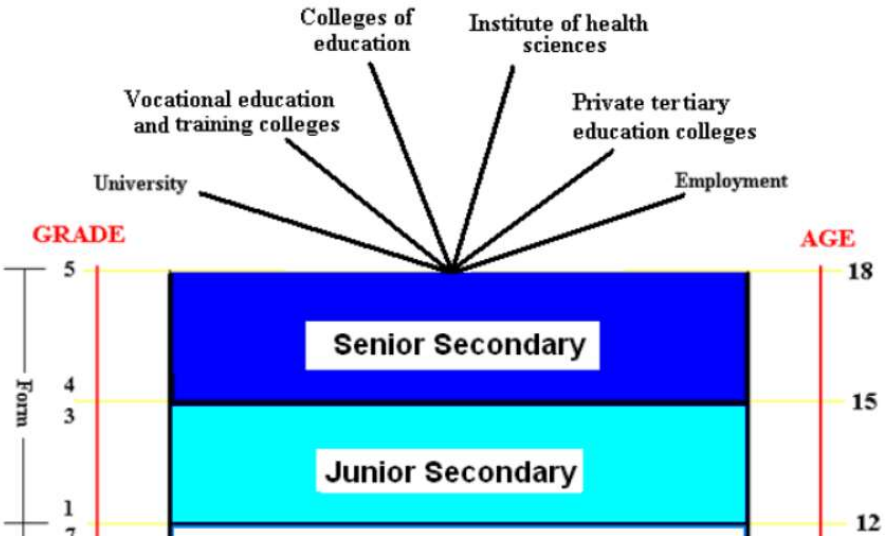


Figure 2.1: Botswana's education structure showing grade levels and age ranges.

2.4.3 Governments and education institutions response to the COVID-19 pandemic

When Covid-19 first surfaced worldwide after being discovered in China in the Hubei province, countries had to impose strict measures on their populations to control and minimise further spread and infections. The World Health Organisation (WHO) was at the centre advising on what was best for countries to do to minimise the risks. Governments took to radios, online media, television, and digital technologies to educate the people on what was happening and what measures were needed to protect oneself. This led to a complete standstill and eventually all educational institutions closed to protect the learners and educators. Lockdowns were implemented around the world, a situation which saw teaching being forced to go fully online and educators were left with no choice, but to use technology. The lockdowns, health care protocols, such as social distancing, stay at home and sanitisation, helped reduce the transition of the virus (Flaxman et al., 2020).

UNESCO (2020) confirmed that the closure of educational institutions had consequences on the teaching and learning, especially that some instructors were technophobic. This also deprived the youth opportunities for growth and development because they were confined to restricted spaces because of complete lockdowns. In some instances, the learners had opportunities for personalised learning, which is learning without any time limit and interruption from peers because of the introduction of digital learning systems (Mafa & Govender, 2016). eLearning tools started emerging and were used to plan, manage, deliver curriculums, and track learning processes. Furthermore, as noted in other studies, eLearning tools helped facilitators, schools, and learners to collaborate during schools' closure when there was no physical contact (Mafa & Govender, 2016). Additionally, most of these tools were freely accessible from the internet provided one had enough and dedicated resources to ensure continuous learning (Wise, 2018; Rana et al., 2019).

2.5 TPACK and UTAUT-3 framework and perceived use of technology: Teachers' knowledge domains

According to the Technological Pedagogical Content Knowledge (TPACK) model, integration of ICT into the instruction delivery requires the three bodies of knowledge: pedagogy, knowledge and technology. This means a change in any body of knowledge will affect the others (Koehler & Mishra, 2008). Literature has shown beyond reasonable doubt that teachers who have undergone technology skills training are more likely and motivated to adopt, use and implement ICT in the professional practice (Koehler & Mishra, 2009). For effective ICT integration, teachers need to be further developed in their pedagogical skills. This means they are skilled enough and can then integrate ICT to their already existing skills (Vgoot & Mckenny, 2017). Koehler and Mishra (2009) have, in turn, noted that if a teacher is competent in using ICT, it

does not mean that they can effectively utilise it in the professional practice. It depends on the devotion one has in using ICT in their teaching. One can be less competent yet use ICT more effectively than those who have developed their pedagogical skills. In addition to the above observational sentiments from Koehler and Mishra (2009), teachers require content knowledge based on what they teach and should be able to decide which are the best ICT tools they can effectively use in their instructional delivery, and thereby help learners achieve the expected learning outcome and goals (Hughes, 2004). The sentimental quotation of Chai, Koh and Tsai (2010) that "a better understanding of the relationships between TPACK constructs can inform the design of ICT programs for pre-service" (p.71) makes the TPACK model a proper fit for this study.

Based on the foregoing and in addition to Shulman's pedagogical reasoning and action model, one can conclude that the technological pedagogical content knowledge model describes the functional abilities of teachers' knowledge enough to effectively integrate information communication technologies in the instructional delivery process (Baran et al., 2011). The TPACK model extends outside the three components and represents ICT knowledge that is significant for integrating ICT in the classroom. In addition to the knowledge that is required, there must also be an understanding of how the three components interact (Koehler & Mishra, 2006), so that one can effectively use them. Colleges of education and universities are not just educational institutions which prepare teachers of tomorrow; they are also responsible for guiding and instructing teachers who are responsible enough to prepare future teachers. This, on its own, should convince concerned role players and stakeholders in education to encourage facilitators of these teachers, and support them with enough resources to include technology

teaching in the classroom. This should be encouraged so that they produce ICT competent teachers who are competitive globally and have proper goals, knowledge, ICT competence and attitudes (Buabeng-Andoh, 2012).

Course outlines and syllabuses should be changed via the education ministries, and curriculum design, development and evaluation, which are progressive and envisioned for the future, i.e. include technology integration in teaching and learning. Governments should support teachers and school with appropriate ICT resources so they would be able to carry out their mandate effectively. It is also imperative for teachers to develop a positive attitude towards integrating ICT in the teaching and learning process. This should go together with the UTAUT - 3 to offer a well-validated solution to explaining the behavioural intention of adopting an emerging technology. For the purpose of this study, the two are merged so that the researcher can determine whether aspects of TPACK have any influence on teachers' perceptions and the constructs of UTAUT-3, which would lead to behavioural intention, and consequently technology use in teaching.

2.5.1 UTAUT and TPACK constructs relationship

The UTAUT – 3 model is concerned with technology acceptance, while TPACK is about content knowledge, technology, and pedagogy. The researcher used the Pearson's coefficient of correlation to find out if there is a significant relationship between the UTAUT – 3 and TPACK constructs (see chapter five). The relations were looked at on the UTAUT – 3 constructs; performance expectancy, effort expectation, social influence and facilitating conditions to see if they are significantly related to TPACK constructs; content knowledge and pedagogical content.

The UTAUT -3 was used to analyse the behavioural intention change in technology adoption by in-service secondary school teachers in Botswana during the Covid-19 pandemic.

2.6 Gaps in the literature

ICTs are still playing a major role in teaching and learning (as observed above). The reviewed literature shows a gap in understanding the best pedagogical approach in an online class, and issues teachers found during the Covid-19 pandemic. The findings of this study contributes to the body of knowledge on the pedagogies and best practices of teaching and how the challenges experienced during the Covid-19 pandemic can be addressed using ICTs. Education stakeholders can benefit from these discussions and results to improve attitude and knowledge towards the adoption, use and implementation of ICTs in teaching and learning currently and in the future.

In Botswana, facilitators at universities and colleges of education are trained how to use technology in their curriculum. They submit assignments and communicate directly with their supervisors using ICTs during their term of study. Upon the completion of their studies and when they resume duties at their respective schools, the learners under their care are deprived of the privilege of technology-use, as the teachers revert to the traditional methods of learning. As a result, academic performance remains static or even drops. Cairncross and Pöysti (2014), Fisseha (2011), Kaffash *et al.* (2010) and Oliver (2002) are among researchers who made a contribution and emphasized on computer-based technology adoption and use. This means that with the right technology and the correct pedagogy, the use of ICT in teaching in Botswana schools can bear fruits and bring about more advantages. Rana (2013) argued that even though there is access to a range of internet facilities, the teachers' pedagogical-centred methods and lack of current

pedagogical skills to integrate new technologies in teaching and the learning process are the main hindrances to adopting ICT in teaching. There is a definite lack of modern pedagogical skills and use of technology. Andersson and Grönlund (2009) also argued that technological competence in teachers and lack of motivation were also the main challenges adding to the existing ones at the policy formulation and implementation level.

Laurillard (2010) emphasised that technology use can improve learning and relative academic performance, while Karagiannidis et al. (2014) argued that acceptance of use of technology would promote the development of digital technologies and bring educational benefits. Since many studies have regarded ICTs as the solution to curbing educational problems, the issue of access has resulted in the poor pedagogical use of applications in teaching and learning. This study determined whether teachers are using the correct pedagogies in their teaching and what are some of the issues they are faced with because of the Covid-19 pandemic.

2.7 Conclusion

Review of related literature helped the researcher to conclude that research on technology acceptance, use and understanding of TPACK and UTAUT-3 models respectively is limited in Botswana; hence the use of TPACK and UTAUT-3 models as the theoretical frameworks of this study. Some studies on ICT integration have used either some of the constructs from either UTAUT or TPACK models, but not both. This study attempted to address the research gap by investigating technology adoption in teaching among secondary schools in Botswana during the Covid-19 pandemic. The conceptual frameworks drawn from the TPACK and the UTAUT-3 were used by Farooq et al. (2017). This helped the researcher to determine whether aspects of

TPACK have any influence on teachers' perceptions about the constructs of UTAUT-3, which lead to behavioural intention, and consequently technology use in teaching. Most studies have concentrated on pre-service teachers (Anderson & Maninger, 2007; Chen, 2010; Groulx & Maninger, 2011; Sadaf et al., 2012; Teo, 2009). This study, however, have attempted to fill the gap in the literature by concentrating on in-service schools teachers. The following chapter discusses the study's theoretical frameworks.

CHAPTER 3: CONCEPTUAL AND THEORETICAL FRAMEWORK

3.1 Introduction

This chapter discusses the conceptual frameworks adopted in this study. Two frameworks, the TPACK (technological pedagogical content knowledge) and the UTAUT-3 (universal theory of acceptance of use of technology) - 3, have been adopted in this study.

3.2 Conceptual framework

This study was motivated by the fact that most schools around the world were closed during the Covid-19 pandemic to minimise the spread of the virus (UNESCO, 2020) and this has affected teaching. Due to this, technology use in teaching became a topical issue and the only way to deliver curriculums (Lurvnik, 2020). This led to the shift to remote learning, which is seen as a good opportunity for teachers and learners to become stronger, more creative, and innovative (Yokozeki, 2020). Virtual learning environments have proven to increase enrolment, quality of education, and access to education irrespective of geographical area (Law, Geng & Li, 2019). Various literature (Karunaratne & Byungura, 2017; Mabusela & Adams, 2017) suggest that Africa needs such learning systems in order to enhance the quality and access to education.

3.2 Theories used

Considering the pressure from the Covid-19 pandemic, the conceptual framework for this study was drawn from TPACK and UTAUT-3 by Farooq et al. (2017). These two were merged and used in this study so that the researcher could determine whether aspects of TPACK have any influence on teachers' perceptions about the constructs of UTAUT-3, which lead to behavioural intention, and technology use in teaching.

While the UTAUT offers a well-validated solution to explaining the behavioural intention of adopting an emerging technology, there are research gaps in understanding the determinants of the components in the model. By extending the previous model and applying it in the context of adoption of a student response system, this study explored the underlying factors that influenced the core components of UTAUT-3. These are: effort expectancy, performance expectancy, social influence, and facilitating conditions. Three constructs, namely: Hedonic Motivation (HM), Price Value (PV), and Habit (HB) were added by Venkatesh et al. (2012) to extend the model accepted in this study. This study examined the impact of teachers' knowledge on the evaluation of those components. Incorporating the concepts of TPACK, this study investigated the association of teachers' knowledge and the major components in UTAUT-3, and the actual use of technology in teaching. The findings confirmed that teachers' knowledge domains are relevant to the perception on performance expectancy, effort expectancy, and facilitating conditions. In terms of theoretical implication, the current study extends the UTAUT by integrating the key concepts of TPACK in explaining the adoption of an emerging technology. The higher education setting utilises more pedagogical strategies incorporating technology, with significant advancement of information technology in the recent decade. The ubiquity of e-learning technology opens new arrays of possibilities in innovative teaching practices to engage learners in learning. Nevertheless, teachers' attitudes towards use of technology in the classroom are very important in adopting and use ICTs in the classroom. Previous studies pointed out that teacher attitudes are important factors in determining technology usage (Stols et al., 2015; Ekman, Lundin, & Svensson, 2015).

There are no academic studies on the topic in the Botswana educational setting. The findings of this study contributed to how facilitators/teachers in Botswana could be trained in proper use of ICT in teaching and learning in secondary schools. It also provides a clear and theoretical understanding on the accepted and correct role of TPACK, and UTAUT-3 play in the acceptance and the use technology in teaching. Furthermore, aligning more with the context of teaching in specific disciplines, the current study is also interested in considering the relationship between TPACK knowledge, which is a subtle knowledge involving the use of technology, and the key constructs of UTAUT.

The disruption related to the Covid-19 pandemic has forced teachers and education stakeholders to rethink the education sector, curriculum design, and delivery using technology. Technology has stepped into the breach, replacing face-to-face interaction, and continues to play a key role in educating future generations using technology. In a world where knowledge is a mouse-click away, the role of the educator must change to move with the changing times and adjust to 'the new normal'. For a while now, facilitators were reluctant to use technology in instructional design. The Covid-19 pandemic might just be the disruption and little push that the sector needed to rethink how they educate the future generations. In this fourth industrial revolution (4IR), young people needed technology to communicate and collaborate with their peers during the pandemic. In a Covid-19 environment, it is possible that teachers must know more about technology and ICT tools that are applicable to a totally online environment. This could influence their perceptions when assessing their knowledge domains in TPACK. Likewise, it could influence their perceptions about their performance expectancy and their effort expectancy.

3.2.1 TPACK framework

TPACK knowledge involves the interactions among content, pedagogy, and technology knowledge. It is more than just the knowledge of all the three constructs but highlights the adoption of technology in establishing new epistemologies on existing knowledge (Koehler & Mishra, 2009). We posit that not only can the knowledge on technology influence one's perception on the usefulness and ease of use of an emerging technology, but also the knowledge on how to use the technology in a specific setting plays a significant role. Sarker and Valacich (2010) note that one must first use a technology before they can achieve the desired outcomes, such as improvement in employee productivity and task/job performance in organisations

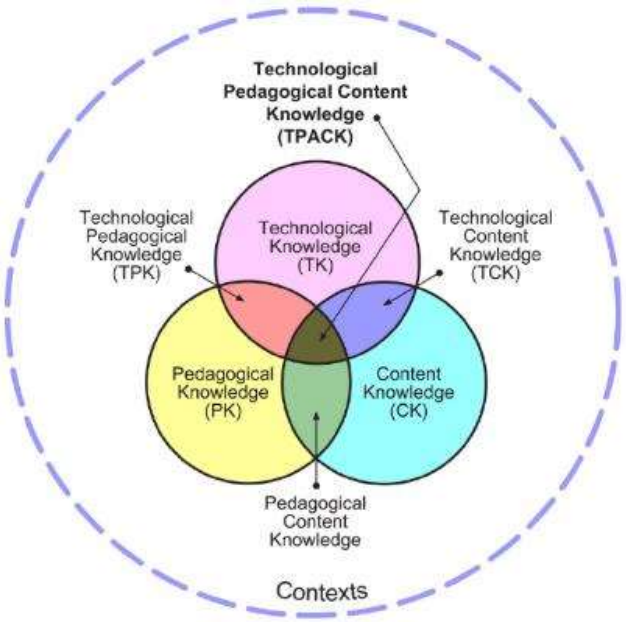


Figure 3.1: TPACK Model, Source: Mishra and Koelher (2006).

TPACK describes the knowledge required by a teacher for effective integration of technology (Koelher, 2006). The TPACK framework emphasises how the connections among teachers' understanding of content, pedagogy, and technology interact with one another to produce

effective teaching. Figure 1.3 helps to illustrate this concept. The TPACK framework builds on Shulman's pedagogical content knowledge (PCK) model, which was later developed by Mishra and Koelher (2006). Under PCK, the infusion of technology into the society became quite prevalent. Because learners are now able to use ICT tools on a daily basis, this influences the way some specific subjects are taught, and the content knowledge itself (Voogt et al., 2013; Jonassen, Wilson & Peck, 2008). The integration of technology into learning has added complexity to the fundamental knowledge of what constitutes the teachers' professional knowledge base (Mishra & Koelher, 2006). The Technological Knowledge (TK) consists of understanding the standard technologies, such as books and chalk, and more advanced technologies, such as the internet and software, which are also used in teaching and learning.

TPK can be regarded as "an understanding of how teaching and learning changes when particular technologies are used" (Mishra & Koehler, 2008, p. 9). This implies knowledge about pedagogical constraints, and the potential of technological tools when used in different ways and situations in a specific subject or disciplinary context. Put together and integrated, PCK, TCK, and TPK constitute TPACK. Although the TPACK framework has been well received in the field of educational technology, it requires further clarification (Graham, 2011), which this study's aimed to investigate. The lack of clear definitions for the different concepts of the TPACK framework and the difficulty of separating the different domains of the framework are some of the issues that have been highlighted in previous researches (Angeli & Valanides, 2009; Archambault & Barnett, 2010).

3.2.2 UTAUT-3 framework

UTAUT identifies four key factors (performance expectancy, effort expectancy, social influence, and facilitating conditions) and four moderators (age, gender, experience, and voluntariness) related to predicting behavioural intention to use a technology and actual technology used primarily in organisational contexts (Venkatesh et al., 2003). Three constructs, namely, Hedonic Motivation (HM), Price Value (PV), and Habit (HB) were added by Venkatesh et al. (2012) to extend the model to UTAUT-3, which has been accepted for this study. Studies on academic staff adoption of technology have achieved a lower explanatory value with alternative technology acceptance models, such as TAM, and UTAUT (Dwivedi et al., 2017). This has led to the realisation of UTAUT-3 model, which consists of a new variable, "personal innovativeness in IT" in addition to all UTAUT predictors. Venkatesh et al., (2003) found that performance expectancy, effort expectancy, and social influence have an influence and behavioural intention to use, while technology use is determined by behavioural intention and facilitating conditions. Figure 3.2 explains that TPACK influences UTAUT as the researcher tries to find out if there is a correlation between TPACK, UTAUT-3 and perception on the actual use of technology in teaching during the Covid-19 pandemic.

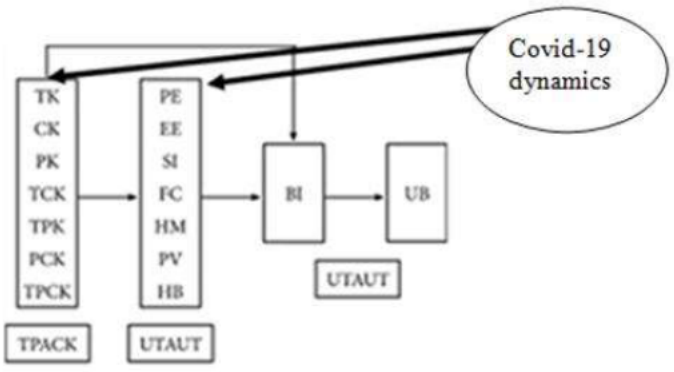


Figure 3.2: Combination of the TPACK and the UTAUT-3 models (Source: own arrangement).

3.3 UTAUT-3 constructs

The following section discusses UTAUT- 3 constructs in detail.

3.3.1 Performance expectancy (PE)

PE has been associated with the individual believing that using a particular system will assist them in attaining job performance (Hattingh et al., 2020). In this study, the researcher tested for significant correlations and impact of PE on Behavioural Intention (BI) and Actual Use (AU) in the use of technology in teaching during the Covid-19 pandemic.

3.3.2 Effort expectancy (EE)

EE refers to the level of ease associated with an individual's adoption of technology (Arenas-Gaitan et al., 2015). In this study, EE refers to the degree to which a teacher perceives that using technology in teaching will be free from effort and eventually adopt its use (Al-Hujran, Al-Lozi, & Al-Debei, 2014). Previous studies by Magsamen-Conrad et al. (2015), De Sena Abrahao, Moriguchi, and Andrade (2016), and Chauhan and Jaiswal (2016) argued that BI was strongly influenced by EE. In the current study, the researcher tested for significant correlations and impact of effort expectancy (EE) and BI on the adoption of technology in teaching during the Covid-19 pandemic.

3.3.3 Social influence (SI)

SI is seen by Chen and Hwang (2019) and Fianu et al. (2018) as a social norm in the theory of reasoned action (TRA) model. It is defined as the extent to which an individual perceives that 'important' others believe he or she ought to use the new system. In this study, the researcher

tested for significant correlations and impact of SI on BI and AU in technology teaching during the Covid-19 pandemic.

3.3.4 Facilitating conditions (FC)

FC denotes' insights into the availability of organisational resources and technical support affecting the adoption of a mobile learning system (Al-Hujran et al., 2014). This factor also gauges teachers' confidence of their possession of knowledge essential for the utilisation of technology in teaching (Jackman, 2014) during the Covid-19 pandemic. In this study, the researcher tested for significant correlations and impact of FC on the BIs of Botswana school teachers' acceptance of use of technology in their teaching.

3.3.5 Behavior intention (BI)

According to Taiwo (2019), BI, in the context of technology, is the degree to which people are willing to perform a specific behaviour towards the use of that technology. Williams, Rana, and Dwivedi (2015) found that BI and AU relationship is significant. In fact, BI was a good predictor of AU. In this study, the researcher tested for significant correlations and impact of BI influence on AU in the use of technology by secondary school teachers in Botswana.

3.3.5 Hedonic motivation (HM)

According to Venkatesh et al. (2012), HM can be described as the pleasure derived from the adoption of a technology. In line with the theory of motivation, HM is pivotal in influencing technology adoption among users (Yang, 2013). In this study, the researcher tested for

significant correlations and the impact of HM on BI to warrant the utilisation of technology teaching in Botswana by secondary school teachers during the Covid-19 pandemic.

3.3.6 Price Value (PV)

Venkatesh et al. (2012) explained PV as the individual's insights regarding the trade-off between perceived benefits received and monetary cost paid for adopting the technology. In contrast with the organisational use setting, individual consumers generally endure the monetary cost of using a particular technology (Yang, 2013). The findings of Nair, Ali, and Leong (2015), Sung and Sung (2015) and Xu (2014) showed that BI is significantly influenced by PV.

3.3.7 Habit (HT)

Venkatesh et al. (2012) posited that HT refers to an individuals' degree of inclination to execute behaviours automatically in the learning process. Past studies, conducted by Harsono and Suryana (2014), Escobar-Rodriguez, Carvajal-Trujillo, and Monge-Lozano (2014), and Yeh and Tseng (2017), concluded that HT exerts positive influence on BI. In the current study, the researcher tested for significant correlations and impact of HT and BI in supporting technology teaching in ones' habitat as seen during the Covid-19 pandemic.

3.4 TPACK constructs

The TPACK constructs are discussed in the following section.

3.4.1 Content knowledge (CK)

CK is defined as the teachers' knowledge about the subject matter to be learnt or taught (Shulman, 1986). As Shulman (1986) notes, this knowledge includes knowledge of concepts, theories, ideas, organisational frameworks, knowledge of evidence and proof, as well as established practices and approaches toward developing such knowledge.

3.4.2 Pedagogical knowledge (PK)

Koehler and Mishra (2009) defined PK as teachers knowledge about the process and methods involved to effectively impact knowledge on the learners.

3.4.3 Technology knowledge (TK)

TK is defined as knowledge on certain ways of thinking about, and working with technology, tools and resources. This includes understanding information technology broadly enough to apply it productively at work and in everyday life, being able to recognise when information technology can assist or impede the achievement of a goal and being able to continually adapt to changes in information technology (Koehler & Mishra, 2009).

3.4.4 Pedagogical content knowledge (PCK)

Shulman's conceptualisation of PCK is the concept of change in the focus for teaching. Specifically, according to Shulman (1986), this transformation occurs as the teacher interprets the subject matter, finds multiple ways to represent it, and adapts and tailors the instructional materials to alternative conceptions and learners' prior knowledge. PCK covers the core business

of teaching, learning, curriculum, assessment and reporting, such as the conditions that promote learning and the links among curriculum, assessment, and pedagogy (Koehler & Mishra, 2009).

3.4.5 Technological content knowledge (TCK)

Teachers are required to understand certain and specific technologies which will help them execute some functions in their domains of teaching and how change in technology can impact their subjects in the (Koehler & Mishra, 2009).

3.4.6 Technological pedagogical knowledge (TPK):

This includes knowledge on the right technological pedagogies to use in effective designs of the curriculum deliveries and ICT tools required for effective use in teaching (Koehler & Mishra, 2009).

3.3 Conclusion

In respect to TPACK, teachers need to be highly skilled in teaching with technology. TPACK is the basis of effective teaching with technology, requiring an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways. This is to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that learners face; knowledge of learners' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones (Koehler & Mishra, 2009).

CHAPTER 4: METHODOLOGY

4.1 Introduction

This chapter discusses the methodology, research design, research paradigm, research approach, sampling procedure, sample, data collection instruments, validity and reliability adopted in this study. It also discusses ethical considerations, data analysis and the limitations of the study. A mixed methods research approach was used to collect data to critically analyze the adoption and use of technology during the Covid-19 pandemic among secondary school teachers, and how technology can be used to achieve better results.

4.2 Research paradigm

Lincoln, Susan and Egon (2011) defined a research paradigm as the use of abstract ideas and beliefs that guide and inform the researcher. Pragmatism has been adopted as a paradigm for this study. Pragmatism has been identified to be the best fit for conducting mixed methods research (Howe, 1988; Tashakkori &Teddlie, 1998; Patton, 2002; Maxcy, 2003; Teddlie &Tashakkori, 2003, 2006,2009; Johnson & Onwuegbuzie, 2004; Onwuegbuzie &Johnson, 2006; Morgan, 2007; Denscombe, 2008; Scott & Briggs, 2009; Johnson and Gray, 2010; Creswell & Plano Clark, 2011). According to Feilzer (2010, p. 8), "pragmatism is a deconstructive paradigm that advocates the use of mixed methods in research, sidesteps the contentious issues of truth and reality" and "focuses instead on 'what works' as the truth regarding the research questions under investigation" (Tashakkori & Teddlie 2003b, p. 713). Pragmatism comprises thoughts, approaches, principals, or a combination of the above to describe an explanation to a research problem (Morgan, 2007).

Pragmatism give focus to what can be accomplished based on positivistic principal of absolute truth or reality. It is closely aligned to the mixed-methods approach, which has been adopted in this study. Pragmatists believe that there cannot be only one reality (Morgan, 2007). Morgan (2014a) identifies three widely shared ideas of pragmatism that highlight that a pragmatist focuses on the nature of experience unlike other philosophies that emphasise nature of reality. First, "actions can't be separated from situations and contexts where they occur" (Morgan, 2014, p. 26). The credence about pragmatism is that this it stresses more on learning experiences and action. This proves quite relevant to this study.

As noted above, this study used a mixed methods research approach, which is a combination of both quantitative and qualitative research methods. Both qualitative and quantitative data is collected and analyzed to address the research questions (Creswell, 2009). Creswell (2014) agrees that both methods can be used together to better understand the problem being studied, as is the case with the current study.

4.3 Research approach

Mixed method research was adopted in this study. This involved the collection and analysis of quantitative and qualitative data (Tashakkori & Creswell, 2007). The mixed methods approach gives greater insights on the topic under study, answer the research questions, recognise new research questions, and recommends variations to subsequent research designs (Creswell & Clark, 2011). Mixed methods research mitigates the challenges and problems natural in a mono-method research approach (Onwuegbuzie & Johnson, 2006; Teddlie & Tashakkori, 2009). Teddlie and Tashakkori (2009) agree that merging the data collected from the questionnaires and

interviews brings the rewards of the depth and breadth connected with these dual methods. In this study, questionnaire and interview data were collected to minimise bias and generalisation. Mixed method research eliminates the downsides of a qualitative research which tries to test theories and hypothesis used in previous studies. Similarly, the problems of quantitative research, such as the reductionist research models that may overlook important concepts that could be recognized using qualitative research methods to produce a new theory. In utilising mixed methods research approach, investigators can use quantitative figures to test and check the validity of qualitative data.

Quantitative research studies the relations among variables and can establish reason and consequence in circumstances that are highly controlled. Quantitative research is a representation of the numbers and manipulation of observations for the purpose of explaining the phenomena reflected by those observations. Cohen and Manion (1980) defined quantitative research as a form of social research that took empirical methods into account, while a qualitative approach gathers knowledge in understanding ones behaviour and what causes such. Mixed-methods adoption and use in this made sure that there were no 'gaps' during data collection.

4.4 Research design

A research design is a plan to study a scientific problem. This study adopted a descriptive design because of its uniqueness. The research design is a framework that gives a clear understanding of the study's research questions. This study is descriptive, and it is concerned with answering the following research questions: (1) What are the perceptions of in-service science teachers towards the use of ICT tools in teaching and learning in a Covid-19 environment? (2) What are perceived

as barriers to integrating ICTs into the virtual classroom in a Covid-19 environment and what strategies can be used to overcome these? (3) Does the use of ICTs by teachers influence learner's academic performance during the Covid-19 environment? (4) How do the teachers' knowledge domains of the TPACK and UTAUT-3 framework correlate with each other and the perceived use of technology? This study also summaries data on variation, percentage, and correlation between variables. Borg and Gall (1989) agree that descriptive research can include multiple variables for analysis since it requires one variable only. For instance, a descriptive study may require and use methods of analysis if there is a correlation between a range of variables using tests such as Pearson's Product Moment correlation, regression, or numerous regression investigation.

4.5 The context of the study

The study was carried out in Botswana among selected schoolteachers teaching any subject under the Botswana secondary schools' curriculum. All the teachers were eligible to participate in the study. This was because the researcher believed and assumed that all teachers were equipped with and were using technology in their teaching during the Covid-19 pandemic. A total of 350 questionnaires were distributed to the selected sample in all regional education centers sampled to participate in the study. The questionnaires were delivered right at the school door and were given to the heads of department, who later distributed them to the sampled respondents. This was done to adhere to the social distancing measures to avoid contracting and spreading corona virus. All the questionnaires were quarantined for a maximum period of 14 days before the researcher could work on them. Focus group interviews were set up with several

respondents from the sample. Six focus group discussions, containing five members each, were conducted virtually and physically.

4.5 Population and sample description

4.5.1 Population description

Creswell (2012) noted that a target population consists of a group or subset of individuals or communities with a common characteristic which the research identifies and study. For this study, the target populations were Botswana in-service teachers. The following were provided as guidelines for successfully selecting the size of the sample. For populations within one less than 100, the sample is considered not enough, so the research should use the whole population, and if the population size is more than 500, the researchers must use at least 50% of the total population. In instances where the size of the population is between 500 and 1,500, then a 20% of the total sample makes enough sample for that study. Based on these guidelines by Leedy and Omrod (2005), the total sample for this study was 350. This is where the focus group interviews sample was drawn. Figure 4.1 shows the geographical map of Botswana Covid-19 zonal maps demarcated during the Covid- 19 period.

4.5.2 Sampling procedure

A convenience sample was adopted and used in this study. It is one of the types of non-probability sampling methods where a sample is taken from a group of people, who are easily available to contact or reach. According to Henry (1990), this method is extremely speedy, easy, readily available, and cost effective, making it attractive to most researchers. The convenience sample helped the researcher to gather data that would not have been possible using probability

sampling techniques. The sampling procedure used ensured that strata of a given population is each adequately represented within the whole sample population. Considering the above, a convenience sample method was used in selecting the sample for this study. The following were strategies used in selecting and recruiting participants to the study. The study was introduced in a way which allows all the respondents and participants ample time to consider being part of the study or not. There was no pressure, and no one was forced to participate in the study. Telephonic appointments were made with the heads of department – staff development in all the sampled schools to provide timelines on when to drop the qualitative questionnaires for distribution to the selected sample per school. A research permit from the Ministry of Basic Education, ethical clearance from the University of KwaZulu Natal and a document detaining the significance of the study accompanied each questionnaire distributed. This was done to eliminate doubt and biasness to the study sample. Virtual and physical focus group interviews were organised well in time so that the sample had ample time to prepare for them. Figure 4.1 shows a detailed Botswana Covid-19 zonal map where the data sample came from (all the education regions and sub regions in the country).

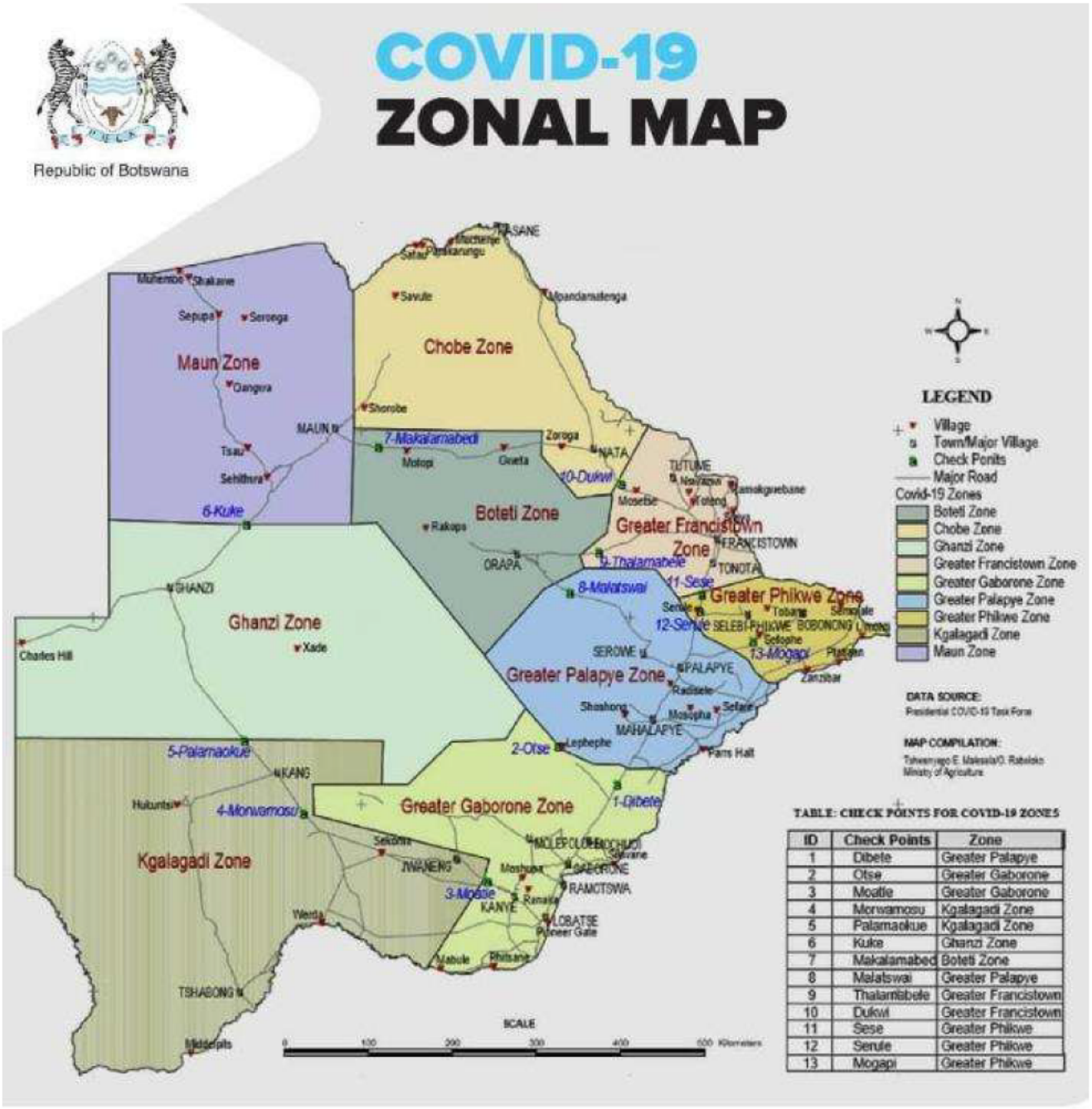


Figure 4.1: Botswana Covid-19 zonal map (Source: Government of Botswana, 2021)

In the context of this study, data was collected in two different phases. Quantitative data was collected in phase 1 through the distribution of the questionnaires, while phase two – qualitative

data was collected after all the questionnaires were handed back to the researcher. Qualitative data focused on focus group interviews conducted both virtually and physically. This was done to cater for the sample which did not mind being interviewed online through Microsoft teams. Tongco (2007) emphasised that the mixed methods approach sampling is best used when samples are chosen conveniently or purposely. Tongco (2007), however, maintained that to retain the reliability of the data, the subject must be competent to participate in the study. All the data sample used in the study were qualified Botswana in-service teachers who have a qualification ranging from a certificate to a master's degree in education and are registered with the teaching service management. They were competent enough to participate in the study. The sample method was chosen because it enabled the researcher an opportunity to seek data which was responding to the research questions (Dilshad & Latif, 2013).

4.5.3 Size of sample

As already mentioned above, a convenience sample method was used when choosing the sample for the study because it is easy to contact or reach the targeted population. The method is extremely speedy, easy, readily available and cost effective, making it attractive to most researchers (Henry, 1990). The total sample for the study was 350, and was derived from a population size of 2110 using the formula in Figure 4.2 as shown below:

$$SS = \frac{X^2\ NP\ (1-P)}{d^2(N-1) + X^2\ P\ (1-P)}$$

Figure 4.2: Formula to derive the size of the sample. Source: Krejcie and Morgan (1970).

Where:

SS = sample size of a finite population size,

X = z-value for confidence level of 95% which is known to be 1.96. At 95% confidence level with degree of freedom 1, the chi-square value (X^2) is 3.841

N = Population size (2110),

P = Population proportion (expressed as decimal) (assumed to be 0.5 (50%)

d = Degree of accuracy (5%), expressed as a proportion (.05); It is a margin of error.

Table 4.1 outlines the participants' groupings when collecting data for both phases from a sample of 350.

Table 4.1: Participants of the study

Category of the sample population	Focus group interviews (qualitative data)	Number of questionnaires distributed (quantitative data)
Total	Six groups of five people each (total of 30)	350

4.6 Data collection instruments

Data was collected using a mixed methods approach to critically analyze the use and technology adoption in teaching by in-service teachers in Botswana schools during the Covid-19 pandemic. The study adopted the UTAUT - 3 and TPACK theoretical frameworks.

4.6.1 Questionnaire

A quantitative questionnaire distributed to the sample size of 350 was used to collect data for the study. The questionnaire data helped to address the following research questions: (1) What are the perceptions of in-service science teachers towards the use of ICT tools in teaching and learning in a Covid-19 environment? (2) What are perceived as barriers for integrating ICTs into the virtual classroom in a Covid-19 environment and what strategies can be used to overcome these? (3) How do the teachers' knowledge domains of the TPACK and UTAUT-3 framework correlate with each other and the perceived use of technology? Data was collected using the questionnaire method because the restrictions imposed due to the Covid-19 virus were eased in Botswana compared to other countries. The study examined the impact of teachers' knowledge on the evaluation of those components and by incorporating TPACK. The study attempted to investigate the association of teachers' knowledge and the major components in UTAUT-3, and the actual use of technology in teaching.

In designing a good questionnaire, the following was considered: the number of scale points and ranking used; the type of questions for the purpose of data collection and whether the questions are open or close ended. Open-ended questions present to the respondent a blank space in which he/she must fill the desired response, while closed-ended questions in which the researcher present a list of predefined questions for the participant to choose (Krosnick et al., 2005). In this study, qualitative questionnaires used had closed-ended questions only. Open-ended questions were catered for in the interview guide.

4.6.2 Focus group interview discussions

The focus group interview discussions were the second phase of data collection. As shown in Table 5.1, a total of 30 (six groups of five) participants from a sample of 350 were used in the focus group interview discussions. There were two virtual and four physical focus groups interviews discussions conducted respectively. The questions below from the interview guide were used to collect data for the interviews: (1) Describe how the technology training that you received (both formal through Professional Development/Workshops/Trainings and informal through other means) has translated to use of technology in your classroom during the Covid-19 pandemic. Please share an example of something from your own classroom (2) What did you feel is the most frustrating aspect of using technology for your lessons during the Covid-19 pandemic? (3) Recalling a technology training that you participated in, please describe the context of the training and how it "Did" or "Did not" enhance technology use in the classroom environment (either formal through Professional Development or informal through other means) during the Covid-19 environment? (4) In which ways do you think ICT integration in teaching and learning can be improved in regard to: (a) access of student and teachers to computers and other ICT (b) teacher ICT skills and training (c) ICT usage in teaching in specific subjects during Covid-19 pandemic and (5) Describe any importance computers have had in your in-class teaching (how you teach, what you teach) during the Covid-19 pandemic.

Focus group interviews and discussions are a replacement to interviewing only a single party, but rather intended for a group of individuals (the selected sample) with a common interest where the researcher or the research assistant acts as guide or facilitator during the process (Blandford, 2013). The researcher used closed-ended questions when collecting quantitative data and was

aware of the limitations. Open-ended questions were catered for in the interview guide. Lijadi and Schalkwyk (2015) concluded that focus group discussions can be best used to support in situations where quantitative tools are hard to reach. In addition, Dilshad and Latif (2013) ascertain that it is difficult to get every participant on time for the intended focus group discussion. Dilshad and Latif (2013) concur that vocal participants pose a disadvantage to others even though they may not always agree on the issues and cases presented more especially if the facilitator or the interview conductor is not experienced. Taking into consideration the above, in this study, all participants were given time and chance to participate even when they came late.

4.6.3 Document analysis

Document analysis also formed part of the quantitative data for the study. It is defined as a procedure for reviewing and evaluating documents either paper based or electronic (Corbin & Strauss, 2008). It involves analysing documents which are interpreted by the researcher to give a true reflection and proper meaning to the topic (Bowen, 2009). A rubric with a score or a grade can also be used (O'Leary, 2014). In this study, a rubric of the academic results of pre - Covid - 19 and during the pandemic was used to compare the results of the learners before and during the Covid - 19 pandemic. Document analysis has many advantages in that it is an effective and efficient method of data collection. It is also easy to manage the documents. Documents are also reliable (Bowen, 2009).

4.7 Data collection procedure

First, ethical clearance to conduct the study was sought from the University of KwaZulu-Natal Research Committee. Upon approval, the permission to conduct the study in Botswana's schools

was also sought from the Ministry of education in the department of science, research, and technology. Quantitative data was collected using a quantitative questionnaire, while qualitative data was collected using focus group interviews. An explanation of why data collection was presented to the data subjects and the importance of the significance of the study (Appendix 1: Consent form to participate in the research) was made available to all the data subjects. The two data sets collected were presented separately to make the analysis easier to critically analyse the use and integration of ICT in teaching in Botswana secondary schools by in-service teachers. Table 4.2 details the data collected per research question and the type of tool used to collect data.

Table 4.2: Data collection instruments and participants

Research Questions	**Data collection instruments**	**Participants**
What are the perceptions of in-service science teachers towards the use of ICT tools in teaching and learning in a Covid-19 environment?	Questionnaire	In-service teachers
What are perceived as barriers for integrating ICTs into the virtual classroom in a Covid-19 environment and what strategies can be used to overcome these?	Questionnaire/ interview	In-service teachers
Does the use of ICT by teachers influence learners' academic	Looking at past results of the same learners before the Covid-19 pandemic and their results during	Document analysis (learners' results)

performance during the Covid-19 environment?	the Covid-19 pandemic since they now use technology that they did not use previously.	
How do teachers' knowledge domains of the TPACK and UTAUT-3 framework correlate with each other and the perceived use of technology?	Questionnaire	In-service teachers

4.8 Reliability and validity of data

The research tool must ensure face validity by measuring what it is supposed to measure. Literature search and review has been done extensively so that all valid and important points were covered and not left out in the study. Internal consistency was computed in the questionnaire items to ensure that it is same construct reliably. A reliability coefficient of 0.70 or higher is considered adequate (Barclay, Higgins & Thompson, 1995), so was the case in this study. Trustworthiness, transferability and auditability were all considered to deal with issues of rigour. Readers were assured of reliability of the study using prolonged data collection; and verification of theories – where the findings of the study were compared to the results of previous studies. The content validity of the research instrument was confirmed by ensuring that the items in the data collection instruments were related to the concepts of using ICT in education and were in line with the purpose of the research and its objectives. The reliability of the research instrument was established through the test and retest process, with Cronbach's Alpha being .856, which is above the .70 level of acceptability as stated by Cortina (1993).

4.9 Ethical considerations

This study began after obtaining ethical approval from the Humanities and Social Sciences Research Ethics Committee of the University of KwaZulu-Natal. Participation in the study was voluntary, and consent forms and information leaflets were provided to the participants before completing the questionnaires. Research ethics describe various actions carried out by the researcher in each study. Ethical rules in a study, according to Cresswell (2014), contain two main areas, namely: research requirements, and individual protection requirements. Also, participant protection, which consists of confidentiality, consent, information, and utilisation requirements, remains vital throughout the study. During this study, after obtaining a research permit from the Botswana Ministry of Tertiary Education, a copy of the research permit request was sent to the principals of the selected schools four weeks before the actual data collection date. Written on the research permit was an application to collect data from the different sampled participants around Botswana schools. Before the instruments were presented to the participants, the significance of the study was clearly communicated to each participant. Participants of the study were informed that the study was to be used for academic purposes only, and the data would be treated with the highest degree of confidentiality. Participants were informed that all data quotes obtained in the study were anonymous, and not directed towards any information that would reveal their identity. Extra time was given to each participant for clarifications about the phenomenon under study before the interview could start.

A progress report, which included short descriptions of investigations and findings, was submitted to the relevant institution at intervals specified in the research permit. A preliminary report was submitted to the Ministry which issued the research permit. The final report was

submitted to the Ministry of education and skills development which issued the research permit, the National Archives, the University of Botswana Research and Development Office, the Botswana National Library Services (one copy each), and to the affiliating body in Botswana (two copies) within two months after the completion of the final report.

4.10 Data analysis

The responses from the questionnaires were grouped per type of questions. The data was entered in a spread sheet template and later exported into an SPSS design template and then analysed using the Statistical Package for Social Sciences (SPSS). The data from SPSS included inferential statistics looking for correlations to answer the research questions. The data from focus group interviews were descriptive. Daily interpretative analysis was used to analyse the interview data, that is, every day after conducting interviews, it was essential for a selected research assistant to review the notes and write a report that summarised and interpreted the information obtained. Qualitative data was subjected to a thematic analysis to come up with assertions that helped answer the related questions. The interview, as defined by Lund (2012), is a verbal interchange, where one person elicits information from another person through series of questions prepared by the interviewer, which was the case in this study.

Krippendorff (2013) argued that where the phenomena of interest to analysts are social in nature or when text and images are involved, quantitative measurement have serious shortcomings that only competent human can overcome. Qualitative analysis demands a high level of creativity to categorise meaningful data to address the research problem from large data sources (Cresswell, 2014). In this study, data was analysed using SPSS. For the sake of familiarity and precision of

the data, the transcripts were checked for easy inductive analysis. The interview was used as the primary foundation for data collection, participants' comments were analysed and similar responses were grouped together to avoid data duplication and minimise similarities. Data was analysed using descriptive statistics (mean, median, mode, standard deviation, frequencies and percentages) and multivariate analysis (correlations and regression analysis). For correlations, the study sought to see if there were any correlations between the knowledge domains (TPACK) and UTAUT.

TPACK was used in order to determine the different knowledge domains of the participants. On the other hand, UTAUT was used to see which constructs are strong indicators of technology adoption of participants. Now, when we combine the two, we want to see if there is any relationship between the domain knowledge that participants have and their tendency to adopt technology (UTAUT - 3) etc.

4.11 Limitations of the study

Botswana is economically challenged, and there are no sufficient ICT resources in schools. ICT resources which have been supplied are out-dated since most of them were legacy systems. Teachers were technophobic and were afraid the use of ICTs in their delivery of the curriculum. This hindered successful data collection in this study since majority of them thought they will be subjected to using technology tools after during or after data collection. Some participants did not pay much attention to detail when responding to the questionnaire and this delayed the analysis of the results. The Finance and Education Ministries have had their budgets cut and now mainly focused on paying salaries and not procuring new ICT tools and resources. After

completion of their studies, some teachers are posted to the most remote areas, where there is no access to adequate ICT resources and services. This made it difficult for them to use ICT services during the Covid-19 pandemic. During this time, some potential participants fell ill and some passed. This affected the data collection.

Conclusion

This chapter presented the research methodology. The research was conducted using 350 in-service teachers in Botswana. A mixed method research approach was used to collect data. The chapter further described data collection methods, instruments, sampling procedures, reliability and validity of data and data analysis procedures. The next chapter presents quantitative data.

CHAPTER 5: QUANTITATIVE DATA ANALYSIS

5.1 Introduction

Chapter four discussed the methodology used in the collection of data. Data collection was obtained using questionnaire and interviews. Quantitative data was analyzed using descriptive statistics (mean, median, mode, standard deviation, frequencies, and percentages) and multivariate analysis (correlations and regression analysis), while qualitative data was analyzed and presented descriptively using verbatim statements.

5.2 Data collected

The quantitative data collected is presented in this section. Table 5.1 shows a combination of all the participants involved in data collection from the questionnaires and focus group interviews.

Table 5.1 Participants of the study

Sample Details	**Quantitative (questionnaire)**		**Qualitative (focus group interviews)**	
Population	**Distributed**	**Returned**	**Proposed**	**Conducted**
Secondary school teachers	350	349	Six groups of 5 (30)	Six groups of 5 (30)
Total	350	349 (99.7%)	30	30 (100%)

Table 5.1 shows that a total of 350 participants were sampled from the total population to participate in the study. It showcases an overview of the questionnaires that were distributed, and the focus group interviews conducted in the study. Out of the total of 350 questionnaires

distributed, 349 were returned (a return rate of 99.7%). Only one questionnaire was not used in the study because it was not fully completed and there appeared to have been some negligence from the respondent when filling in the responses. The qualitative questionnaires return rate of 99.7% was used in the analysis stage. It is shown in Table 5.1 that out of the proposed six groups of five (30 participants), all the intended focus group interviews were conducted achieving a response rate of 100%. However, it was anticipated that only 80% would respond because the participants were stretched in different education district across the country and there was a fear that some would withdraw from the study. Fortunately, this was not the case.

A return rate approximating 60% is considered good and of high quality, while that of 50% is considered suitable for analysis (Morton et al., 2012). This study, therefore, has a return rate of more than 60%, and this means its results are worth reporting and are of good quality. Dillman (2007) noted that a return rate is influenced and motivated by humans' behaviour on what they expect to elicit from the study and how it will benefit the entire population. Section 5.3.1 presents the demographic details of the participants in this study.

5.3 Socio demographic

The socio demographics for this study in section A of the questionnaire is presented in this section. This section has the following aspects: gender, age, teaching subject, training received, mobile technology device, and educational qualification. All respondents completed their socio demographic data.

5.3.1: Demographic details of the participants

The following section presents the demographics (gender, age groups, teaching subjects and educational qualifications) of the respondents.

Table 5.2: Gender of the respondents

Gender		Frequency	Percentage
	Female	188	54%
	Male	161	46%
	Total	349	100.0 %

The findings in table 5.2 reveal that they were more female teachers than males who responded to the study. This is attributed to the fact that the teaching fraternity in Botswana is dominated by females than males. However, this is discussed in chapter seven.

Table 5.3: Age groups of the respondents

Age		Frequency	Percentage
1	18-25	41	12%
2	26-36	131	36%
3	37-51	119	34%
4	52+	57	16%
	Total	349	100%
Missing	NA	1	.3%

The findings in table 5.3 revealed that out of 349 respondents, 348 answered the questions and one was missing. The majority of the respondents came from the youth aged range of between 26-36 and majority of the teachers are 51 years and younger.

Table 5.4 presents the teaching subject of all the participants who responded to the study.

Table 5.4: Teaching subject

Teaching subject		Frequency	Percentage
Valid	Mathematics	85	24%
	Sciences	100	29%
	Computer studies	50	14%
	Humanities	67	19%
	Practicals	47	14%
	Total	349	100%

The findings revealed that majority of the respondents teach sciences, followed by mathematics and that both computer studies and the practical subjects recorded the lowest percentage.

Educational qualifications of the respondents are shown in table 5.5 below.

Table 5.5: Educational qualifications

Education Level	Frequency	Percentage
PhD	0	0%
Masters	70	20%
Degree	103	30%
Diploma	110	31%
Certificate	66	19%
Total	349	100%

The results showed that majority of the respondents were diploma holders and the least respondent's qualification recorded was the certificate. There was a balance with respect to educational qualifications because the difference recorded was 1, while there was not a single teacher who held a Doctor of Philosophy qualification.

The participants were asked if they have received training in any computer course in their career. The results are shown in table 5.6.

Table 5.6: Computer training

Computer training course		*Frequency*	*Percentage*
Valid	*Yes*	*192*	*55%*
	No	*157*	*45%*
	Total	*349*	*100%*

The results show that most of the respondents received computer training, or their studies included computer training.

Participants were asked if they own any mobile technology device, and the results are presented in figure 5.1.

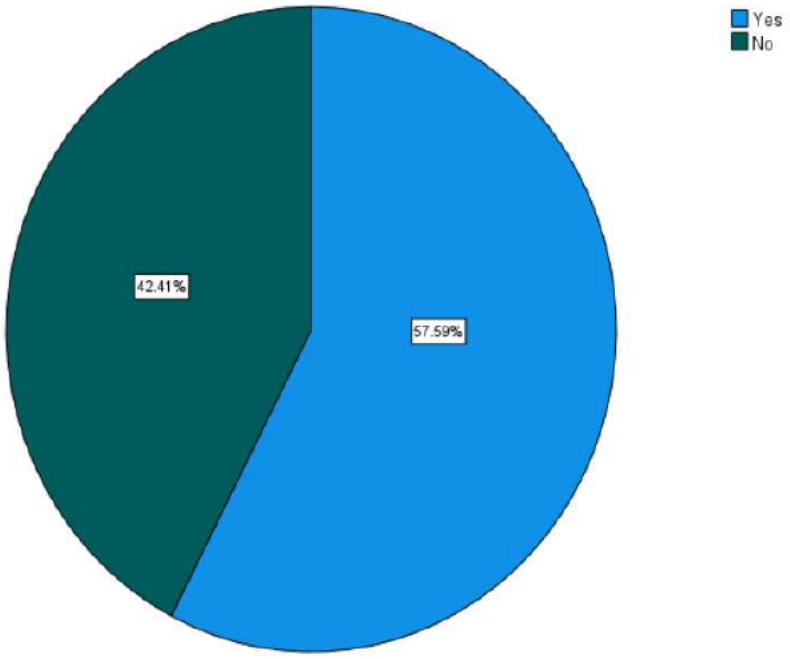


Figure 5.1: Responses to owning a mobile technology device.

Figure 5.1 shows that majority of the respondents at least owned a mobile technology device.

Participants were asked to indicate if they have received computer training in their career. A cross tabulation of gender by computer training was also done to see if there was any significant difference between their responses and the results are presented in table 5.7.

Table 5.7: Cross tabulation of gender by computer training.

			Male	**Female**	**TOTAL**
What is your gender?	Mathematics	Count	40	45	85
		% within teaching subject	47.1%	52.9%	100.0%
	Sciences	Count	62	38	100
		% within teaching subject	62.0%	38.0%	100.0%
	Computer studies	Count	31	19	50
		% within teaching subject	62%	38%	100%
	Humanities	Count	29	38	67
		% within teaching subject	43.3%	56.7%	100%
	Practical's	Count	30	17	47
		% within teaching subject	63.8%	36.2%	100%
TOTAL		Count	192	157	349
		% within teaching subject	55%	45%	100.0%

Table 5.7.1: Chi-square test on cross tabulation of gender by computer training.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.333a	4	.035
Likelihood Ratio	10.359	4	.035
Linear-by-Linear Association	.296	1	.587
N of Valid Cases	349		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 21.14.

The cross tabulation above reveals that many respondents (192 (55%)) mentioned that they have received training in any computer course compared to 157 (45%), who said they did not receive it. The test of significance value is 0.032, which is less than the p-value of 0.05. Therefore, this means significantly more males received computer training in sciences, computer studies and practical's than females.

Table 5.8 presents the results of the participants after they were asked to indicate where they mainly accessed the internet during the Covid - 19 pandemic. A cross tabulation of gender by internet access was also done to see if there was any significant difference between their responses.

Table 5.8: Cross tabulation gender by internet access.

			At school	Via Mobile Phone	At home	Internet cafe	TOTAL
What is your gender?	Male	Count	27	47	26	34	134
		%with what is your gender	20.1%	35.1%	19.4%	25.4%	100.0%
	Female	Count	39	46	35	39	159
		%with what is your gender	24.5%	28.9%	22.0%	24.5%	100.0%
TOTAL		Count	66	93	61	73	293
		%with what is your gender	22.5%	31.7%	20.8%	24.9%	100.0%

Table 5.8.1: Chi –square test on cross tabulation by gender on internet access.

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.742a	3	.628
Likelihood Ratio	1.745	3	.627
Linear-by-Linear Association	.072	1	.788
N of Valid Cases	293		
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 27.90.			

The cross tabulation above reveals that most respondents accessed the internet on their mobile phones than any other place during the Covid-19 pandemic. Home access to internet recorded the lowest response. The asymptotic test of significance value is 0.628, which is higher than the p-value of 0.05. Therefore, this means that there was no significant difference in response between the two genders when asked where they mainly accessed the internet from.

Table 5.9 presents a across tabulation of gender on how many hours per week participants spent on ICT tools use in teaching and learning related tasks during the Covid-19 era. A cross tabulation was done to see if there was any significant difference between their responses.

Table 5.9: Cross tabulation on gender and on how many hours per week spent on ICT tools use in teaching and learning related tasks during the Covid-19 pandemic.

			Less than an hour	1 < 5 hours	5 – 8 hours	More than 8 hours	TOTAL
What is your gender?	Male	Count	27	45	43	31	146
		%with what is your gender	18.5%	30.8%	29.5%	21.3%	100.0%
	Female	Count	37	50	35	46	168
		%with what is your gender	22.0%	29.8%	20.8%	27.4	100.0%
TOTAL		Count	64	95	78	77	314
		%with what is your gender	22.5%	31.7%	25.7%	24.6%	100.0%

Table 5.9.1: Chi –Square test on cross tabulation of gender and on how many hours per week on ICT tools use in teaching and learning related tasks during the Covid-19 pandemic.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.922a	4	.295
Likelihood Ratio	4.938	4	.294
Linear-by-Linear Association	.012	1	.912
N of Valid Cases	314		

a. 2 cells (20.0%) have expected count less than 5. The minimum expected count is 1.39.

The cross tabulation above reveals that 314 respondents responded to the question while 14 did not. Out of the responses recorded, majority (31.7%) spent between 1 to 5 hours on ICT tools use in teaching and learning related tasks during the Covid-19 pandemic. The asymptotic test of significance value is 0.295, which is higher than the p-value of 0.05. Therefore, this means that

there was no significant difference in response between the two genders when asked how many hours they spent using ICT tools for teaching and learning.

The following section presents results on the level of ICT competency by the participants. The participants were asked to rate their level of ability from very poor to very good for each of the computer operations as the results show in tables 5.10 using Mean and Standard Deviation.

Table 5.10: Teachers' level of ICT competencies

	Operating with Microsoft Office	**Networking/ communicating with others. e.g. twitter and Facebook**	**File management e.g., opening, renaming, or saving a file**	**Information browsing and downloading i.e., searching the internet for information**	**Email communication**	**Attaching files to emails**	**Use of presentation software e.g., PowerPoint**	**Technology management**
Mean	3.35	3.48	3.51	3.64	3.12	3.46	3.18	2.95
Standard deviation	1.376	1.258	1.313	1.258	1.335	1.248	1.231	1.207

The result in table 5.10 shows that in terms of teachers' level of ICT competency, teachers are intermediate in email communication, use of presentation software and operating with Microsoft Office. However, they consider themselves more competent in attaching files to email and networking/ communicating with others. In general, the results revealed that teachers are more competent in social media activity as well as information browsing & downloading and file management. Teachers have shown to be less competent in technology management.

The descriptive statistics of the UTAUT -3 constructs showing the mean, standard error of Mean, Standard deviation, minimum and maximum values are shown in table 5.11 below.

Table 5.11: Descriptive statistics of the UTAUT – 3 constructs

	Performance Expectancy	Effort Expectancy	Social influence	Facilitating conditions	Behavioral intentions	Hedonic motivation	Price Value	Habit
N	331	345	343	348	343	346	342	346
Mean	3.1544	3.4197	3.3994	3.1111	3.5236	3.5081	3.4322	2.9555
Std. Error of Mean	.03245	.04734	.03969	.03453	.04387	.04024	.03949	.03632
Std. Deviation	.59038	.87926	.73501	.64415	.81240	.74848	.73026	.67552
Minimum	1.00	1.60	1.20	1.00	1.00	1.00	1.40	1.20
Maximum	4.30	5.00	5.20	4.67	5.00	4.80	4.80	4.80

The results of the descriptive statistics for the UTAUT - 3 show that the mean for performance expectancy, effort expectancy, social influence, facilitating conditions, behavioural intentions, hedonic motivation and price value were between 3.111 or greater. This signifies that the majority of the respondents agreed with the statements that related to these constructs. Habit had the lowest mean score of 2.95, which signifies that the respondents were indifferent, i.e., the distribution of those in agreement and those in disagreement were almost equal. The lowest recorded standard error of the mean was .03245 for performance expectancy and the highest was .04734 for effort expectation. The values for the standard error of the mean were low and therefore signify that there is less discrepancy in the respondents' responses.

The descriptive statistics of the TPACK constructs showing the mean, standard error of Mean, Standard deviation, minimum and maximum values are shown in table 5.12 below.

Table 5.12: Descriptive statistics of the TPACK constructs

	Technology knowledge	Content knowledge	Pedagogical knowledge	Pedagogical content knowledge	Technical content knowledge	Technical pedagogical knowledge	Technical pedagogical content knowledge
N	334	343	347	345	347	342	345
Mean	3.3992	3.6799	3.5179	3.7020	3.5354	3.5576	3.5014
Std. Error of Mean	.03670	.04904	.04481	.04493	.04370	.04957	.04517
Std. Deviation	.67077	.90820	.83481	.83445	.81403	.91672	.83904
Minimum	1.33	1.20	1.29	1.40	1.60	1.00	1.00
Maximum	5.00	5.00	11.29	4.80	5.00	11.57	5.00

The results of the descriptive statistics for the TPACK constructs show that the mean for technology knowledge, content knowledge pedagogical knowledge, pedagogical content knowledge, technological content knowledge, technological pedagogical knowledge, and technological pedagogical content knowledge ranges between 3.399 and 3.702. This signifies that the majority of the respondents agreed with the statements per construct. The values for the standard error of the mean signify that there is less discrepancy in the respondents' responses.

Table 5.13 presents the result which shows if there were any correlations between the participants knowledge domains of TPACK and UTAUT – 3 constructs.

Table 5.13: Correlations of TPACK and UTAUT- 3 constructs

		Technological knowledge	Content knowledge	Pedagogical knowledge	Pedagogical content knowledge	Technological content knowledge	Technological pedagogical knowledge	Technological pedagogical and content knowledge
Performance Expectancy	Pearson Correlation	.225**	.473**	.346**	.453**	.451**	.444**	.495**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000
	N	319	325	329	327	329	325	327
Effort Expectancy	Pearson Correlation	.188**	.413**	.345**	.417**	.437**	.421**	.371**
	Sig. (2-tailed)	.001	.000	.000	.000	.000	.000	.000
	N	331	339	343	341	343	339	341
Social Influence	Pearson Correlation	.218**	.416**	.323**	.388**	.351**	.348**	.482**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000
	N	328	337	341	339	341	336	339
Facilitating Conditions	Pearson Correlation	-.016	.040	.017	.008	.156**	.040	.239**
	Sig. (2-tailed)	.769	.464	.749	.882	.004	.458	.000

	N	333	342	346	344	346	341	344
Behavioural Intentions	Pearson Correlation	.198**	.468**	.363**	.426**	.408**	.383**	.472**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000
	N	329	337	341	339	341	336	339
Hedonic Motivation	Pearson Correlation	.105	.449**	.273**	.336**	.381**	.360**	.489**
	Sig. (2-tailed)	.056	.000	.000	.000	.000	.000	.000
	N	332	340	344	342	345	339	342
Price Value	Pearson Correlation	.131*	.351**	.276**	.367**	.349**	.318**	.455**
	Sig. (2-tailed)	.017	.000	.000	.000	.000	.000	.000
	N	328	336	340	338	340	336	338
Habit	Pearson Correlation	-.002	-.177**	-.218**	-.245**	-.188**	-.226**	-.056
	Sig. (2-tailed)	.971	.001	.000	.000	.000	.000	.298
	N	331	340	344	343	344	340	342

The results in table 5.13 revealed that performance expectancy, effort expectancy, social influence, behavioural intentions and price value had a correlation, although weak to medium, with all the TPACK constructs. Facilitating conditions had a correlation, also weak to medium, with only two TPACK constructs, namely, technological pedagogical content knowledge and technological content knowledge. The results also showed that hedonic motivation and habitat had a correlation with all the TPACK constructs except the technological knowledge variable of TPACK.

The following section discusses the actual use of technology on several tasks. The respondents were asked how often they used ICTs to carry out their teaching and learning roles during the Covid- 19 pandemic and table 5.14 presents the results.

Table 5.14: Percentage scores on actual use of ICTs tasks in teaching and learning roles.

	Percentage scores				
Task	Never	Rarely	Sometimes	Often	Always
Searching/ browsing for information for lesson notes	7.7	16	22.9	22.1	30.1
Preparing work schemes	9.7	16.3	17.8	24.9	31.2
Preparing work records	9.5	17.5	17.8	26.4	28.7
Preparing lesson plans	6.6	35.8	16.3	22.9	18.3
Keeping learners' records	6.9	18.9	19.2	23.8	31.2
Using digitized lesson notes for example on an IPAD or notebook	7.7	20.6	21.5	24.6	25.5
Preparing class assignments and exercises	7.4	16	20.1	28.7	27.5
Analyzing examination results	7.4	22.9	23.2	25.2	21.2

Presenting lessons using projectors inside the classroom	7.4	17.8	22.6	26.6	25.5
Presenting lessons using projectors in computer laboratory	8.3	14.3	24.1	29.8	23.5

The results show that 56.2% of the respondents always used ICTs in preparing class assignments and exercises, followed by 55.1%, who used them on preparing work schemes and work records. The results also show that 52.1% used ICTs to prepare lesson plans, and this followed by 46.1% who used them to analyse examination results. Only 6.6% were recorded to have never used ICTs in preparing lesson plans.

The participants were asked to rate how much of a challenge the ICT related challenges were from not a challenge, slightly a challenge, a minor challenge, a challenge, and a major challenge respectively. The results are shown in table 5.15 showing the percentage scores per ICT related challenge.

Table 5.15: ICT related challenges.

ICT Related challenges	**Percentage scores**				
	Not a challenge at all	Slightly a challenge	A minor challenge	A challenge	A major challenge
Insufficient number of computers	15.2	15.2	17.2	26.6	25.2
Inadequate lack of skills on ICTs	9.5	18.9	16	22.9	32.7
Not enough copies of software for specific subjects	8.6	16.6	21.2	22.9	30.1
Lack of interest in teachers on the use of ICT in teaching and learning	13.8	21.5	18.6	19.5	26.4
Insufficient teacher time	17.2	24.1	18.3	19.8	20.3
Lack of adequate technical assistance	13.5	30.9	16.3	20.1	18.1
Slow speed of the internet	9.5	17.8	18.3	23.8	30.4
Lack of administrative assistance	12	21.2	16.9	21.5	27.9
Lack of adequate computer lab	7.2	17.8	16.3	23.5	35
Lack of proper policy and strategy on ICT usage in schools by the Ministry	15.8	19.8	19.5	22.3	22.3
Technophobia (fear to use ICT in teaching)	9.2	14.9	14.3	24.6	36.1
Computer virus attacks	15.5	25.2	16.6	21.8	20.6

The results show that 60.7% had technophobia (fear of using ICT in teaching). This was followed by 58.5%, who reported lack of adequate computer labs, while 51.8% stated the insufficient numbers of computers as a challenge. The results also revealed that 47.2% reported lack of technical assistance as a minor challenge, followed by 41.8% who also mentioned computer virus attacks as a minor challenge.

The participants were asked to indicate their level of agreement or disagreement using a five-point Likert scale from strongly disagrees to strongly agree on each of the constructs presented in table 5.16 on their perceptions on the use of technology in teaching and learning.

Table 5.16: Perceptions on the use of technology in teaching and learning.

Construct	Percentage scores				
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Using the technology in my job enabled me to accomplish tasks more quickly during Covid-19 pandemic.	9.2	17.2	20.3	20.9	31.8
Using technology would improve my job performance.	10.6	11.7	16.3	24.9	35.5
Using technology would enhance my effectiveness on the job.	8.3	11.7	14.3	33	33.2
Using technology would make it easier to do my job.	7.4	14.3	22.3	25.5	29.5
Using technology improves the quality of the work I do.	9.5	15.5	19.8	27.2	27.2
Using technology increases my productivity.	7.4	18.6	21.5	30.7	20.9
If I use technology…					
I will spend less time on routine job tasks.	7.7	16	20.1	27.2	27.5
I will increase the quality of output of my job.	7.4	17.2	22.6	22.6	27.5
I will increase the quantity of output for the same amount of effort.	7.7	19.8	26.6	23.6	21.8
My co-workers will perceive me as competent.	10.3	16	18.9	31.8	22.1

The results show that 66.2% agreed that using technology would enhance effectiveness on their job. This was followed by 60.4%, who also agreed that using technology would improve their work performance, while 54.4% stated that technology use would improve the quality of the work they do. The results also reveal that 27.5% disagreed that if they use technology, it will

increase the quality of output for the same amount of effort. Only 26% disagreed that if they use technology in their teaching, it will improve their productivity.

Overall academic results for learners were used to determine any impact after using ICT during 2020 and 2021. Results were taken for a class (X1) from a public school and compared to results taken from a class (Z1) in a private school. Combinations of the results were also taken to analyze overall impact. The following tables (table 5.17 and 5.18) presents descriptive statistics showing mean, standard error of mean and standard deviation for the results of class X1 from the year 2019 to 2021 while table 5.18 presents the overall class results comparison for the years 2019 to 2021. These results were collected before the outbreak of Covid – 19 in 2019 and during the Covid – 19 period in 2020 and 2021 respectively. This was to compare the results of learners to see and check if there was any academic improvement before or during the pandemic where teachers were forced to use ICTs in teaching. Class X1 represents government schools while class Z1 was from the private schools.

Table 5.17: Class X1 and Z1 descriptive statistics for the years 2019, 2020 and 2021

Class	**2019**			**2020**			**2021**		
	Mean	Standard error of mean	Std. deviation	Mean	Standard error of mean	Std. deviation	Mean	Standard error of mean	Std. deviation
X1	45.98	3.00	12.40	41.51	3.99	16.48	47.04	3.00	12.39
Z1	62.51	2.82	13.53	47.23	2.77	13.31	47.45	2.97	14.37

Table 5.17 shows that class Z1 performed better than class X1 in 2019 before the pandemic with a mean comparison of 62.51 to 45.98 respectively. Overall, there seems to be a drop in results when comparing the means of the year before Covid (2019) to the Covid years (2020 and 2021). However, when comparing the results for 2020 and 2021, there was a slight improvement of results for both classes with the means increasing from 41.51 % to 47.04% and 47.23% to 47.45% for class X1 and Z1 respectively.

Table 5.18: Overall class (X1 & Z1) results comparison for the years 2019 to 2021

2019		**2020**		**2021**	
Mean	Std. deviation	Mean	Std. deviation	Mean	Std. deviation
54.24	12.96	44.37	14.89	47.24	13.38

The results show that there was a decline in overall results performance during the year 2020 from 2019 and a slight improvement in 2021 with a mean increase of 2.87. The decline in results in 2020 could be attributed to the fact that teachers and learners were still becoming familiar with a new mode of delivery. The slight increase in results from 2020 to 2021 could be attributed to the fact that teachers and learners were now more comfortable with the new mode of delivery, after having a year's experience. These findings will be further discussed in chapter seven.

The following section reports an overall performance of the Botswana general certificate of secondary education (BGCSE) and the Botswana junior certificate education (JCE) results from 2019 to 2021. This helps to see how the national results looked like before and during the Covid

-19 pandemic. The Grades A*, A, B, C and D are the grades which enables one to proceed for further education at tertiary institutions.

Table 5.19: BGCSE number of grades awarded at key grades A, C, E and G.

Year		A or better	C or better	E or better	G or better	Total grades awarded
2021	Number of grades awarded	6595	70254	173543	224255	231721
	% of grades awarded	2.85	30.32	74.89	96.78	
2020	Number of grades awarded	6345	68508	169528	217820	226813
	% of grades awarded	2.80	30.20	74.74	96.04	
2019	Number of grades awarded	5497	63284	161159	210197	218094
	% of grades awarded	2.52	29.02	73.89	96.38	

Source: Botswana Examinations Council (2021).

The results shows that the there was an improvement in the results, G, E, C and A or better from 2019 (before Covid – 19) and between 2020 and 2021 respectively when there was use of ICTs in teaching and learning during the pandemic.

Table 5.19.1: BGCSE Number of Grades which are C or better

Year	2019	2020	2021
Total grades awarded	218094	226318	231721
Number of grades C or better	63284	68508	70254
% of grades C or better	29.02	30.20	30.32

Source: Botswana Examinations Council (2021).

The results show that in 2019, the percentage of grades C or better awarded increased from 2019 to 2021 with an increase of 1.18% between 2019 and 2020, while there was an increase of 0.12% between the years 2020 and 2021. This is also attributed to the fact that during Covid – 19 teachers were now used to the use of ICTs in their curriculum delivery. This is discussed further in chapter seven.

Table 5.19.2: BGCSE number of grades which are A or better.

Year	**2019**	**2020**	**2021**
Total grades awarded	218094	226813	231721
Number of grades A or better	5497	6345	6595
% of grades A or better	2.52	2.80	2.85

Source: Botswana Examinations Council (2021).

Table 5.19.2 shows that the total grades awarded which are A or better increased from 2019 to 2020 and 2021 during ICT use in teaching and learning.

Table 5.19.3: BGCSE Grades Awarded to Candidates in Government and Government Aided Schools and Private Candidates (including those from private schools), all syllabi.

Grades awarded	**Grade A***		**Grade A**		**Grade B**		**Grade C**		**Grade D**		**Grade E**		**Grade F**		**Grade G**		
	No.	Cum %	No.	Cum %	No.	Cum %	No.	Cum %	No.	Cum %	No.	Cum %	No.	Cum %	No.	Cum %	No
2021 190066	1496	0.79	4191	2.99	17690	12.30	37675	32.12	46870	56.78	36807	76.15	23696	88.61	16724	97.41	491
2021 41655	267	0.64	591	2.06	2173	7.28	6114	21.95	11023	48.42	8621	69.11	5890	83.25	4306	93.59	267

Source: Botswana Examinations Council (2021).

The results in Table 5.19.3 for the BGCSE awarded to candidates and government, government aided and private schools in all syllabi show the cumulative percent of 0.79% for grade A in 2021 for government and government aided schools and a slight decrease with a cumulative percentage of 0.64% for the private schools. There were more grade F in government schools than private schools respectively in 2021.

Table 5.19.4: National JCE summary of overall grades from 2019 to 2021.

	2019			2020			2021		
Grade	Count	%	Cum	Count	%	Cum	Count	%	Cum
Merit	3	0.01	0.01	11	0.03	0.03	13	0.03	0.03
A	484	1.18	1.19	485	1.11	1.14	543	1.17	1.20
B	4205	10.24	11.43	4187	9.54	10.68	4176	9.03	10.23
C	9833	23.95	35.38	9865	22.48	33.16	10322	22.33	32.56
D	14181	34.55	69.93	14924	34.01	67.17	15367	33.24	65.80
E	6088	14.83	84.76	5947	13.55	80.72	6112	13.22	79.02
U	5920	14.42	99.18	6626	15.10	95.82	6744	14.59	93.61
X	334	0.81	100.00	1838	4.19	100.00	2955	6.39	100.00
Total	**41048**			**43883**			**46232**		

Source: Botswana Examinations Council (2021).

NB: X means failure to meet the grading requirements to be awarded a qualification, while U denotes a failure for one to meet the minimum requirements at grade E.

The results show that the cumulative pass rate (grade E or better) stood at 79.02% in 2021 to that of 80.72% in 2020, which showed a slight decline in percentage, while a credit pass rate (grade C or better) is 32.56% compared to 33.16% in 2020 respectively, which has also scored a decline in percentile.

5.4 Conclusion

This chapter reported the findings of the quantitative data collected using a quantitative questionnaire. The discussion of these results follows in chapter seven.

Chapter 6: QUALITATIVE DATA ANALYSIS

6.1 Introduction

This chapter presents an analysis of the qualitative data obtained through the focus group interviews. Its aim is to analyze the qualitative data obtained from thirty (30) secondary school teachers who were interviewed in groups of six. They all responded to the interview questions which formed part of the qualitative data collection process. A description of the sampling method used is also presented. The interview data was transcribed, and similar responses were grouped together to make the analysis easier to understand.

6.2 Sampling procedure

All the respondents who were chosen to participate in the study were invited to participate in the focus group interviews. Those who showed interest were asked to provide their available time slots and contact details. About 56 responded positively, but only thirty, which formed six groups of five, were chosen to respond to the interview questions. According to Creswell (2013), interviews enrich the understanding of the qualitative data. In this study, it was done to help in the critical analysis of technology use among secondary school teachers during the Covid19 pandemic.

6.3 Data collection

Data was collected using focus group interviews, made up of six participants per group. The researcher sat down with all the groups and explained the purpose of the study. The interview questions were read to the participants before the interview process could start. This was done to ensure that all were aware of the type of questions to be asked. The focus group interviews lasted

between 20 and 30 minutes each. The researcher conducted and recorded the interviews with the help of the research assistant. All the recorded interviews were later transferred into a Microsoft word document and the data was analyzed manually to ensure that that nothing was left behind as with the use of some software (Cresswell, 2003). All Covid-19 protocols were followed to avoid infections. Appendix B contains interview guide questions.

6.4 Data analysis

6.4.1 Identified themes

The Microsoft word data was searched for any reoccurring opinions, and if there was, a number was placed next to the theme. A theme was identified to be significant or fit to be theme if the word or an opinion occurred more than once. All the phrases representing opinions were searched upon and after identification they were coded as themes. All the themes identified were easy to define and explain. Table 6.1 presents the themes which emerged from the focus group interviews.

Table 6.1: Identified themes from the focus group interviews.

Themes
Professional development
Collaboration
Lack of internet availability
Lack of technology gargets/devices
Poor network reception
Technology use and support
Technological pedagogical instruction
Social media
ICT skills training
Online learning
Teaching resources

The themes identified in Table 6.1 relate to the use of technology or technology adoption in teaching and learning during the Covid-19 pandemic. These themes are classified under the categories presented in Table 6.2.

Table 6.2: Categories of themes.

Themes	Categories
Lack of internet availability Lack of technology gargets devices Unequipped computer labs Poor network reception Lack of sufficient resources	Barriers for ICT integration in teaching and learning
Professional development Technology use and support Technological pedagogical instruction Social media	Influence factors
ICT skills training Online learning Teaching resources Collaboration	Perceived useful

6.4.2 Barriers for ICT integration in teaching and learning

Five themes make up this category: lack of internet connectivity, lack of technology gargets/ devices, unequipped computer labs, poor network reception and lack of sufficient resources. To identify these barriers, the following question was asked to the focus group participants:

What do you feel is the most frustrating aspect of using technology for your lessons during the Covid-19 pandemic?

6.4.2.1 Lack of internet availability

According to the participants, there is acute lack of internet connectivity, due to lower bandwidths which slower data transmission. This consumes all the time needed to dispatch important learning information to the learners. There are also higher data charges which make it difficult for schools to subscribe to higher bandwidths. The following responses validate the above views.

In our schools, there are lower internet speeds. Teachers don't really use internet in their teaching and learning and that for one to purchase data bundles, it is so expensive that we end up not subscribing for such. [Participant 2]

Internet connection in our school is very slow and disappointing. There is only one area to access the internet, which is the computer labs which are always busy with computer lessons from morning to afternoon. [Participant 22]

Most teachers do not use internet in their teaching and learning. This makes it difficult for support to be channeled towards high internet bandwidth. This was raised by one of the participants:

Teachers mostly rely on textbooks. They do not use the internet to do research unless it's for personal use only. For example, in my subject, there is a textbook we use which covers all the topic areas in the curriculum. There is no need to use the internet for that very same reason and, again, it [internet] is not available. [Participant 3]

Teachers are not using the internet because it is not available. If internet is made available, it will benefit teaching and learning because we will have access to more learning materials. [Participant 12]

There is no support from senior management during budget allocations every year. This makes the budget to be depleted without inclusion of internet purchases, thus lack of internet availability. [Participant 7]

6.4.2.2 Lack of technology gargets/devices

The participants reported lack of technology gadgets/devices and any technology devices which could be used in teaching and learning. There are also fears that even though some are made available in the school premises, most teachers are not equipped on their proper use and dissemination in teaching and learning. This was expressed by some participants:

We do not have enough technologies at our workplaces which we can effectively use during teaching. Majority of us mainly depend on our personal technology device (smart phones) when the need to use technology arises. This is also a distraction because sometimes our smartphones rings during classroom contacts and disturbs the whole learning process. [Participant 14]

Most classes need to be equipped with technology devices to use in teaching and learning. Whilst there, teachers and learners must be sensitized on the adoption and use of these technologies for efficient use and disposal. [Participant 1]

If teachers and learners do not have access to technology gadgets/devices 100% of the time, it is impossible to integrate and adopt technology into teaching and learning. [Participant 8]

Lessons can be interesting if we had technologies at our disposal and with proper training on its use. [Participant 12]

Some participants were satisfied with the technology devices in their schools. These are/were mostly from private schools:

We have enough internet availability and technology devices for use in teaching and learning in our school. [Participant 23]

In our school, every learner is equipped with technology devices with support from the parents or guardian. Every learner undergoes training on the use of technology in teaching and learning before they could proceed with other classes. [Participant 43]

There is a general requirement in our school that every teacher must undergo technology training. This capacitates the facilitators with skills needed to integrate technology in teaching and learning. Management also supports technology integration in teaching and learning by conducting workshops every quarter in a year. [Participant 19]

The situation is, however, different in government aided schools, as indicated by some participants:

It depends on the type of management, whether they were trained on technology use or not. If they had training in technology use in teaching and learning or have interest in technology use, they then allocate budgets towards the purchase of technology gadgets/devices to be used in schools. [Participant 14]

There are some tablets which were donated to schools for use by the learners. These tablets are kept at the computer labs under strict supervision of the computer department personnel. Learners do not have access to these gadgets and the software's are old fashioned in that they cannot be updated. All is left for the school to attend to. [Participant 25]

6.4.2.3 Unequipped computer labs

Majority of the respondents/participants reported that unequipped computer labs without appropriate resources and up-to-date software packages hinder the successful implementation and integration of ICTs This is evident on the following assertions:

Our computer laboratories are not equipped with up-to-date technology and Softwares. There are very old computers, some still running with windows 2003 and Microsoft office package 2003. This makes one to not have the zeal to use the computer labs. [Participant 30]

The computers in our laboratories are very slow and sometimes non-responsive. Learners are not allowed to bring devices or gadgets to school. This makes us lose morale to use these computers. [Participant 6]

In our schools, there are old projectors which are often blurry and not visible. Sometimes, these do not work with current updated technologies. [Participant 18]

If the technologies we have in our computer laboratories are up-to-date, lessons could be more interesting and fashionable. There would be no need for learners to be present in class all the time. [Participant 10]

The situation was different in one of the schools:

We have two computer labs in our school. The government built-one was refurbished with new computers and appropriate technology for teaching and learning. Software is up-to-date and new software's were installed in all the machines. We have another smart computer laboratory. These were donations from the local mine in our locality. This has made technology integration in teaching and learning very easy. [Participant 3]

6.4.2.4 Poor network reception

Most participants responded as follows regarding poor network reception:

We use our personal devices to access the internet. We are in a remote area where network comes and goes. Sometimes you can't even have a connection to access the internet. The network in our area is very poor. [Participant 17]

There is a service provider which has placed their radios (internet receivers) in our area so that we can't connect to the network. Sometimes during and after windy storms and heavy rainfalls, we can't access the network and because the service provider stays very far in the cities, we have to wait for them for days until the situation normalizes. [Participant 15]

The network reception in our area is very poor. It is even difficult to make just a simple call to a learner when they are not present in school. [Participant 11]

Poor network reception makes it very difficult for one to connect to the internet and train learners online. [Participant 24]

The government needs to make sure that we are living on the 4th industrial revolution and by making technology and services available to all citizens. This will enable us to curb issues where lessons have to halt during the pandemics. [Participant 30]

Bad/poor network reception makes us to just stare at the technologies that we have at our disposal and not use them for the intended benefits, e.g., during the Covid-19 pandemic, it was very difficult to connect and communicate with our learners due to poor networks from all the three service providers: Mascom, Orange and BeMobile. We need an improvement on these services. [Participant 1]

6.4.2.5 Lack of sufficient resources

The most raised worries by the participants were lack of sufficient resources in school's premises and teachers' houses:

All classes, including laboratories, should be equipped with sufficient up-to-date technology resources required for teaching and learning. [Participant 8]

All learners should be equipped with at least one mobile technology device to use for learning. For example, a laptop or tablet per. With proper training on technology use, this will yield positive results as we will be able to teach 24/7 with no time limit, and the learners will have access to content materials all the time. [Participant 29]

If we don't have access to technology all the time, it will be impossible to integrate it into teaching and learning. [Participant 3]

There are no technology resources for use at my school. [Participant 5]

In most secondary schools, the internet connection is very poor, or you simply will not have access at all. [Participant 24]

In one of the schools, it was different:

We have tablets for use by both learners at out computer labs in my school. This was a donation from one of the churches in the localities. [Participant 16]

In our school, there is internet connection in both the computer laboratories and the administration area. The government has improved internet connectivity in our school. [Participant 27]

6.4.3 Influence factors

This category comprises four themes: professional development, technology use, technological pedagogical instruction, and social media. The participants responded when they were asked the following questions:

Describe how the technology training that you received (both formal through professional development/workshops/trainings and informal through other means) has translated to use of technology in your classroom during the Covid-19 pandemic. Please share experiences from your own classroom.

Recalling a technology training that you participated in please, describe the context of the training and how it "Did"or "Did not"enhance technology use in the classroom environment (either formal through professional development or informal through other means) during the Covid-19 environment.

In which ways do you think ICT integration in teaching and learning can be improved in regard to:

i. *Access of learners and teachers to computers and other ICT.*
ii. *Teachers' ICT skills and training.*
iii. *ICT usage in teaching in specific subjects during the Covid-19 pandemic.*

6.4.3.1 Professional development

Professional development was deemed to be the most influencing factor for one to effectively integrate technology into teaching and learning during classroom contacts and online/distance learning. Many responses supported that professional development is key and needed to capacitate teachers with the necessary skills to use technologies in their curriculum delivery. The responses follow below:

During my teaching at college, we were taught how to integrate appropriate technology into teaching and learning, so it is easy for me to use technology in my teaching. [Participant 18]

When schools were closed due to the Covid-19 pandemic, I was using short message service to communicate with my learners. This was all possible because our lecturer at college used to send us course contents update using the short message service. [Participant 30]

Teachers need to undergo professional development training and workshops on the use and integration of technology in teaching and learning. This will help them to effectively teach during tough times like Covid- 19 where there is no physical meeting between the teachers and learners. [Participant 14]

Technology keeps on evolving, so it is very important for teachers to acquire proper professional development so that they are at par with changing technology. [Participant 12]

Professional development is needed for every teacher teaching in the 21st century as this will help them better shape their lessons in an online environment. [Participant 3]

Teachers should be provided with appropriate training on the integration of technology in teaching and learning. This training is needed so that they know which proper tools to use for different learning subjects and when conducting practicals. [Participant 22]

6.4.3.2 Technology use and support

Participants reported that even though some technologies are available at their schools, they are either obsolete, old or not working at all. So, they need continuous technological support to use such technology during their lessons:

Most of the technologies we have are not working at all and some are obsolete. So, this technology devices/gargets need to be constantly monitored and updated so that we can effectively use them, at any time. [Participant 25]

The computers at my schools are slow to load the operating systems and programmes. It is frustrating to find computers non-responsive, yet one has planned for a lesson to take place using those computers. Technical support should be available at all times when one is to use technology in teaching and learning. [Participant 28]

In order to effectively integrate technology in teaching and learning, we need technical support at all times. This will make life easier and one to enjoy using technology in teaching and learning. [Participant 10]

6.4.3.3 Technological pedagogical instruction

Several responses stressed the need for proper training on technological pedagogical instruction so that learning does not shift to be something else, but hold contextual meaning and purpose:

The curriculum design and developers should include technology in the curriculums so that technology integration in teaching and learning should start at early stages. This will reduce fear and phobia to use technology in teaching and learning. [Participant 21]

Teachers need to take up a module before they graduate on how to use technology in teaching and learning. [Participant 20]

There is a need for continued professional development on technological pedagogical instruction so that every teacher/facilitator is fully informed on the integration of technology in teaching and learning. [Participant 4]

6.4.3.4 Social media

During Covid-19, I relied on the use of Facebook and WhatsApp to send course content materials and to communicate with the learners. [Participant 7]

Social media pages were used to communicate and give update on what is happening in schools and offer advice to learners and guide them where to get classroom content materials. For example, the Ministry of Education and Skills Development, in collaboration with the Botswana Open University, had packaged learner content materials for all grades and used social media on how to gain access to such content. [Participant 2]

It was easy to send course content materials during school closures using WhatsApp and Facebook messenger. I collected all the parents/guardians' numbers and used them to

communicate with the learners. This also helped because parents were also involved in the teaching and learning of their children. [Participant 1]

Social media made and still makes learning interactive because the leaners are so excited and exposed to the use of technology. [Participant 11]

Technology makes the learner to engage in personalized learning since they can revisit the materials any time of the day using any medium it was sent on. [Participant 26]

6.4.4 **Perceived useful**

This category includes four themes: ICT skills training, online learning, teaching resources, and collaboration.

6.4.4.1 ICT skills training

The participants reported that training in ICT skills is very useful in the integration of technology in teaching and learning. The following comments support the above sentiments:

Teachers need proper ICT skills for them to be able to integrate technology in teaching and learning. This will also reduce chances of fear/technophobic. [Participant 27]

Workshops should be conducted on equipping teachers with appropriate ICT skills to use when disseminating pedagogical instructions. [Participant 7]

With increasing ownership of hand-held devices, majority of teachers and learners have ICT skills which can be used in times of need derived from these handheld devices. This makes learning 24/7 with no time limit. [Participant 25]

Many ICT skills are available on educational sites online. So, it is very easy for one to learn online and implement in their curriculum delivery. [Participant 2]

6.4.4.2 Online learning

Some participants reported that online learning is very effective as materials and resources are always at the learner's disposal with no time limit. They reported that online learning has helped ease their work and reduce the transmission of Covid-19 virus. This is expressed in the comments below:

Online learning has made me and my learners to collaborate more. This was made possible because the learners were not shy to engage with me during lessons compared to physical classroom contacts where they feared asking questions. [Participant 25]

With online learning, learners were exposed to personalized learning and some learners really improved their performance. [Participant 5]

Online learning has helped fight the spread of the Covid- 19 since there was no physical contact which could have transmitted the disease. [Participant 12]

Technology has made my learners remember more concepts, especially educational videos which are always available to the learners at fingertips. [Participant 14]

I use online learning with my learners mostly during the weekend when they are not in school. I have created a WhatsApp group using the parents' contacts and learners engage more all the time. We even discuss topics ahead of class. I find it easier to use online learning as a substitute for physical contact. [Participant 13]

Some participants reported that with online learning, activities can be created using web 2.0 tools, especially Facebook and WhatsApp, which can motivate learners. The following comments support this view:

Learners are more involved when class activities are sent using web 2.0 tools and above, because they can collaborate on their own privately before they give their responses. Learners are already exposed to using these tools in their daily lives, so it is easier for them to get excited and enjoy using tools. [Participant 19]

Online learning is a good thing to be included in the curriculum from inception as this will make learners show interest from an early age to use technology. This will also make life easier for teachers when they integrate technology in teaching and learning. [Participant 14]

6.4.4.3 Teaching resources

Some participants claimed and reported that teaching resources should be made available online and teachers should be taught how to conduct an effective online class. This is expressed below:

Teaching resources should be adequate so that an online class should not differ from the normal physical lesson. [Participant 6]

Teachers should be taught how to design a good online lesson so that online classes do not eat [use] much of the time intended for learning in case a teacher is stuck. [Participant 8]

If teaching resources are made available for both the teacher and the learner, it will be easy to conduct an online class. This will make the learners more empowered and be at the center of their learning [Participant 24]

Adequate teaching resources can stimulate and promote interest in learning. The teacher will also be motivated to effectively conduct a successful lesson. [Participant 23]

6.4.4.6 Collaboration

According to the participants' responses, it was evident that online learning using web 2.0 tools and above support collaboration between the learners and teachers. Majority of the participants reported that their engagement with learners through online classes and web 2.0 tools made it possible for the learners to engage with them more on class discussions and increased lesson engagement. This is shown by the following comments:

Social media, especially WhatsApp and Facebook, are very important to the lives of everyone these days. This has translated to other sectors of the economy. Young people use social media to communicate and collaborate online. [Participant 17]

I believe that collaborative learning is very important because it fosters growth in skills and personal development. [Participant 16]

Teachers and learners can work better collaboratively using web 2.0 tools and above. Teachers can share learner materials using any medium and learners can engage and harness skills from the discussion topics. [Participant 24]

Web 2.0 tools provide unlimited collaboration opportunities. Synchronous of asynchronous communication can still be in place and one could respond to the thread any time of the day to engage the other party. [Participant 1]

Some participants used web 2.0 tools for communication purposes sending updates to their peers. i.e., during presentation of student marks and discussion of tests and examination papers:

We use web 2.0 tools to communicate in my school. It is easy for us, teachers, to discuss learners' marks, moderate tests and examinations. This has made life easier because we do not have to travel long distances to convene a meeting to discuss such. [Participant 23]

If we are given tasks at school, we discuss them using WhatsApp and a decision can be made after collaborative discussions to map the way forward. [Participant 6]

Some participants have shown displeasure in using web 2.0 tools and above. This is attributed to the following comments:

Some learners send explicit content to teachers by mistake or purposively to distract the lesson. [Participant 5]

I don't think majority of learners are ready for online learning because, in my class, they never comment, yet one can see that they are online. This frustrates a lot. [Participant 20]

I sometimes give learners work in groups. This makes it difficult for those who do not have access to technology devices to use because they can't participate in the discussion. This, therefore, means that they will be lagging behind with course content materials. [Participant 10]

Sometimes, it is difficult to access learners' work online if one did not undergo proper training and ICT skills and creating an online class. [Participant 24]

In many instances in my class, learners take a long time to respond and engage in an online lesson. This takes all the time to cover the important topics. [Participant 7]

It is difficult to manage an online collaboration class if everyone is typing instantly, there won't be any proper flow of facts. This makes some learners, especially slow learners, to lose content. [Participant 8]

6.5 Other findings

The researcher found that there are different types of teachers with regards to technology integration in teaching and learning; the resistant teacher, the technophobic teacher, the passionate teacher, the undecided teacher and the anxious one.

6.5.1 The resistant teacher

The resistant teacher is the one who lacks confidence to use technology in teaching and learning. This is the teacher who resists change in the way things are done. They believe that traditional teaching methods are more effective than technology integration in teaching and learning:

Moving away from traditional teaching methodologies to technology integration in teaching and learning will take most of the time to prepare and disseminate information. Technology disappoints all the time. [Participant 4]

I prefer using what I know than what I am less confident in. [Participant 5]

6.5.1 The technophobic teacher

Some teachers are not confident in using technology and do not know the appropriate tools to use:

If I use technology, I get scared that if something goes wrong then the whole lesson is doomed. [Participant 15]

I have never been trained on technology use in teaching and learning, so I prefer the traditional way of teaching. [Participant 8]

Technology is not user friendly. I get goose bumps on the tough of a computer and this makes me lose self-esteem in front of my learners. [Participant 3]

6.5.1 The passionate teacher

The passionate teacher is the one who has passion to do something: to try new things and not afraid to use technology:

I use technology every day and enjoy using it to explore new things. I communicate mostly using technology and I am confident that technology helps in making communication easier and faster. [Participant 11]

Using technology enables critical thinking skills. One can research and collaborate effectively because one has the answers online. [Participant 10]

These teachers are the ones who use technology even beyond classroom contacts, sending materials to their peers and learning all the time. Communication is always at their fingertips as they explore new possibilities and opportunities using technology.

6.5.1 The undecided teacher

The undecided teacher is the one who is not sure whether to use technology in their teaching or not. They know how to use technology, but cannot take advantage of it to bring about the desired benefits in the 21st century:

When I think of using technology in teaching, I think about the leaners who do not have access to technology devices/gadgets. This makes me lose hope on technology integration and wait for physical contacts. [Participant 23]

Sometimes, it takes time for one to receive responses online on time, so it is better to use traditional teaching methodologies. [Participant 12]

6.5.1 The anxious teacher

Teachers show anxiety over learner and online classroom management using technology.

Learners are often distracted by using technology in class. They bully others and send explicit content using technology. This disrupts classes and leads to failure. [Participant 30]

Some social media sites and web 2.0 tools distract the learners as they end up spending more time on it following contents/topics not for discussion during class. This increases their concentration span on things off class discussion. [Participant 18]

Majority of teachers perceive that managing an online class would be difficult as learners are easily carried away by distraction. The researcher recommends that teachers should not accept personal invites from learners, more especially using Facebook, as these might distort the student-teacher relationship and cause distractions in learning. Web 2.0 tools, which the teachers choose, should be used for educational purposes only.

6.6 Conclusion on technology implications

Teachers are no longer the epitome of knowledge. The phrase 'teacher no mistake' has been buried by the emergence of technology in teaching and learning. Learner content materials are available in every platform online. One needs to have a reasonable internet connection to be able to access the online resources and download content materials. This has made learning on the go, 24/7, with no time limit. Learning is now at the fingertips of those who have access to technology devices and internet. With the right materials and technology teaching resources, teaching is more fun than ever before. Teachers acquire new skills to implement in the teaching and learning online. There are digital libraries which have replaced physical libraries where people no longer travel long distances to fight for one book. Technology has digitised all the learning content materials.

6.7 Summary

This chapter has discussed the qualitative data obtained from the 30 respondents, who formed six groups of five in focus group interviews. Three categories emerged, and these are: barriers for ICT integration in teaching and learning, influence factors and perceived useful. These categories and their respective themes were presented, in detail, in this chapter showing comments, opinions, suggestions and attributes from the participants. In the next chapter, the discussion of the quantitative and qualitative data is presented.

CHAPTER 7: DISCUSSIONS OF THE RESULTS

7.1 INTRODUCTION

This chapter provides a discussion of the research findings obtained through both quantitative and qualitative methods. The conclusions drawn from the quantitative and qualitative results are presented as well. Chapter 8 provides the recommendations and conclusions of the study.

7.2 RESEARCH QUESTION 1: WHAT ARE THE PERCEPTIONS OF IN-SERVICE TEACHERS TOWARDS THE USE OF ICT TOOLS IN TEACHING AND LEARNING IN A COVID-19 ENVIRONMENT?

Perceptions of in-service secondary school teachers towards the use of ICT tools in teaching and learning during the Covid-19 environment are discussed in relation to the TPACK and UTAUT - 3 frameworks. Perceived ease of use, perceived usefulness, technology knowledge and technology pedagogy content knowledge are the main components that form part of the discussion to address this research question.

The perceptions revealed by the study are that most in-service science teachers mentioned that the training they have received included ICT integration in teaching the subject area as shown in Table 5.6. The respondents also noted that the training was relevant in terms of equipping them with skills on lesson planning, delivery and preparing using ICT tools. This is attributed to participant 18, who noted that:

During our training at college, we were taught how to integrate appropriate technology into teaching and learning, so it is easy to use technology in teaching.

This is also supported in Figure 5.1, which showed that the majority of the participants (57%) own a mobile phone, which is, in turn, supported in Table 5.8, which shows that 32% access internet using their mobile phones. This shows that the computer training received by majority (55%) of participants played a critical role in the use of technology by teachers as shown in Table 5.7. They can do their work and access the internet through their mobile phones. It is also evident in Table 5.7 that 62% asserted that the computer training they received included ICT integration in teaching and learning. Only 45% said the computer training they received did not include ICT integration in teaching and learning. This supports the reasons why they did not or do not use ICT in their teaching and learning. This is the same as the study conducted by Kaleli-Yilmaz (2015) and Demir et. al (2011), who analysed the teachers views on the factors affecting their integration of ICTs in their teaching and learning. In these studies, mathematics teachers responded that neither one of them used ICT because they were not knowledgeable on its use. This is also similar to the study by So and Kim (2009), who cross examined the complexity of the pre-service teachers' technological pedagogical content knowledge and found that it was challenging for teachers to use the right tools fit for the calibre of learners they had.

In this study, on the level of ICT competency by teachers on the use of technology in teaching and learning, it is shown in table 5.10 that in terms of teachers' level of ICT competency, teachers are intermediate in email communication, use of presentation software and operating with Microsoft Office. However, they consider themselves more competent in attaching files to email and networking/ communicating with others. In general, the results revealed that teachers are more competent in social media activity as well as information browsing & downloading and file management. Teachers have shown to be less competent in technology management. These

results show that, indeed, over 53% of teachers were very competent in the use of ICT for their benefit. This is different from the study conducted by Agyei and Voogt (2011b), who concluded that pre- service teachers had low levels of ICT integration in their lessons. The current study is different in the sense that, the in-service teachers who responded to this study went for further studies sponsored by the government.

Professional development, technology use and support, technological pedagogical instruction, social media, ICT skills training and enough teaching resources have been attributed as important factors which enable teachers to use and effectively integrate ICTs in teaching and learning. The following responses from chapter six on the analysis of qualitative data support the above statement:

When schools were closed, due to the Covid-19 pandemic, I was using short message service to communicate with my learners. This was all possible because our lecturer at college used to send us course contents update using the short message service. [Participant 30]

Teachers need to undergo professional development training and workshops on the use and integration of technology in teaching and learning. This will help them effectively teach during tough times, such as during Covid-19 where there is no physical meeting between the teacher and learners. [Participant 14]

In order to effectively integrate technology in teaching and learning, we need technical support at all times to help in need. This will make life easier and to enjoy using technology in teaching and learning. [Participant 10]

The curriculum design and developers should include technology in the curriculum so that technology integration in teaching and learning should start at an early stage. This will reduce fear and boredom to use technology in teaching and learning. [Participant 21]

Teachers need to take up a module before they graduate on how to use technology in teaching and learning. [Participant 20]

Social media pages were used to communicate and give update on what is/was happening in schools and offer advice to learners and guide them where to get classroom content materials. For example, the Ministry of Education and Skills Development, in collaboration with the Botswana Open University, had packaged learner content materials for all grades and used social media on how to gain access to such content. [Participant 2]

Teachers need proper ICT skills for them to be able to integrate technology in teaching and learning. This will also reduce chances of fear/ technophobia. [Participant 27]

Workshops should be conducted on equipping teachers with appropriate ICT skills to use when disseminating pedagogical instructions. [Participant 7]

Teaching resources should be adequate so that an online class should not differ with the normal physical lesson. [Participant 6]

If teaching resources are made available for both the teacher and the learner, it will be easy to conduct an online class. This will make the learners more empowered and be at the centre of their learning [Participant 24]

These findings are similar to the views of a study by Gupta and Dharamveer (2017), which found that majority of the respondents agreed to strongly agree that ICTs and enough resources, coupled with relevant updated course content materials, helped them improve their teaching. In support of this, in other countries, investors in the education fraternity have helped the adoption and use of ICT in teaching and learning grow and consequently ICT was considered the catalyst to enhancing the quality and effectiveness of teaching (Jaffer, Ngambi & Czerniewicz, 2007). Buabeng-Andoh and Totimeh (2012) also support that ICT integration has brought remarkable changes and improvement in teaching and learning. Technology use and support is very important in teaching and learning as evidenced by the results of this study. This is supported by Albugarni and Ahmed (2015), who stressed that the successful implementation of ICT-based learning needs the presence of a technical support personnel so that both the teachers and learners can be supported on the use of ICT in teaching and learning. ICT resources should be always available to enable the process of teaching and learning. Lim and Khine (2006) supported Newhouse (2002) that without technical support, it would be difficult to integrate ICTs in the classroom.

Social media has helped send announcements and learner contents materials during the Covid-19 pandemic as attributed by participant two above. Even though there are mixed reactions on the use of social media in schools and its purported impact on learner academic performance, Irwin et al. (2012) argued that if properly used, social media can be an excellent tool to use in teaching and learning. They concluded, in their study, that learners were very receptive and attentive in incorporating it in their academic lives. This was supported by Aghaee (2010), who maintained that social medias provided a platform for collaboration skills between the teachers and the learners themselves. This was also found in this study as presented in the following comments from participants 1, 17, 16 and 24 respectively:

Web 2.0 tools provide unlimited collaboration opportunities. Synchronous of asynchronous communication can still be in place and one could respond to the thread any time of the day to engage the other party. [Participant 1]

Social media, especially WhatsApp and Facebook, are very important to the lives of everyone these days. This has translated to other sectors of the economy. Young people use social media to communicate and collaborate online. [Participant 17]

I believe that collaborative learning is very important because it fosters growth in skills and personal development. [Participant 16]

Teachers and learners can work better collaboratively using web 2.0 tools and above. Teachers can share learner materials using any medium and learners can engage and harness skills from the discussion topics. [Participant 24]

When responding to the actual use of ICT tasks in teaching and learning roles in Table 5.14, 56.2% said they always used ICTs in preparing class assignments and exercises, while 55.1% used them in preparing work schemes and work records. In the same Table, 41.6% said they used it for analysing examination results and a minority (6.6%) never used ICTs in the preparation of lesson plans. School culture and vision is very important. A school that has leadership that supports the use of ICT in teaching and learning is likely to do well when it comes to ICT integration in teaching and learning because their leadership supports its use (Fu, 2013). Therefore, for a successful actual use of ICT tasks in teaching and learning roles, the school management needs to create a conducive ICT learning environment and be supportive. Findings revealed that 66.2% agreed that using technology would enhance effectiveness on their job, while 60.4% agreed that using technology would improve their work performance. Finally, 54.4% agreed that technology would improve their quality of work (see Table 5.16).

Kamaruddin et al. (2017) revealed that ICT awareness is an important factor as successful integration in one's job will yield positive results if put to good use. Effective adoption and use of ICTs depend on the readiness of an individual. This is supported by Brun and Hinostroza (2014), who argued that teachers need to have covered ICT training and integration in teaching for them to successfully implement them in their teaching profession. On a similar note, Kamaruddin et al (2017) concluded that effective implementation of ICTs depends on the

readiness and professional training of the teacher. This view is supported by the following comment:

Teachers need to undergo professional development training and workshops on the use and integration of technology in teaching and learning. This will help them effectively teach during tough times, such as during Covid-19 where there is no physical meeting between the teacher and learners. [Participant 14]

This clearly shows that teachers strongly believe that professional development is a key factor in making sure that one grows and do well in their profession. This is supported by Mahdi and Al-Dera (2013), who concluded that teachers responded positively to professional development, and said that it was needed for successful implementation and integration of ICT in teaching and learning.

7.3 RESEARCH QUESTION 2: WHAT ARE PERCEIVED AS BARRIERS FOR INTEGRATING ICTS INTO THE VIRTUAL CLASSROOM IN A COVID-19 ENVIRONMENT AND WHAT STRATEGIES CAN BE USED TO OVERCOME THESE?

The results of this study have pointed out several factors which act as barriers to successful integration of ICT in teaching and learning. The literature review, discussed in chapter two, also discussed barriers found by other researchers. The finding revealed in Table 5.15 that 60.7% of the respondents showed that being technophobic is a barrier to integrate ICT in teaching. It further revealed the following as barriers: For instance, 58.5% reported lack of adequate

computer labs, 51.8% insufficient number of computers, while 47.2% reported lack of technical support as a challenge. Insufficient teacher time (40.1%), computer virus attacks (42.4%), limited copies of softwares for specific subjects (53%), low internet speed and bandwidth (54.2) were also some of the identified barriers. These results are supported in chapter six by the following comments:

In our schools, there are lower internet speeds. Teachers don't really use internet in their teaching and learning and for one to purchase data bundles, it is so expensive that we end up not subscribing for such. [Participant 2]

Internet connection in our school is very slow and disappointing. There is only one area to access internet, which is the computer labs which are always busy with computer lessons from morning to afternoon. [Participant 22]

Teachers are not using the internet because it is not available. If internet is made available, it will benefit teaching and learning because we will have access to more learning materials. [Participant 12]

We do not have enough technologies at our workplaces which we can effectively use during teaching. Majority of us mainly depend on our personal technology devices (smart phones) when we need to use technology. This is also a distraction because sometimes our smartphones ring during classroom contacts and disturb the whole learning process. [Participant 14]

If teachers and learners do not have access to technology gadgets/devices 100% of the time, it is impossible to integrate and adopt technology into teaching and learning. [Participant 8]

Our computer laboratories are not equipped with up-to-date technology and softwares. There are very old computers, some still running windows 2003 and Microsoft office package 2003. This makes one to not have the zeal to use the computer labs. [Participant 30]

In our schools, there are old projectors which are often blurry and not visible. Sometimes, they do not work with current updated technologies. [Participant 18]

The fourth industrial revolution perceives that everyone in the world should have internet access as the internet is deeply embedded in our everyday lives. With the internet, there will be a slow pace of developments in the economies of the developed and developing countries (Tran Dinh Tan, Polyakova & Shipilova, 2015). This is supported by Byun et al., (2009) and Jones (2002) when they concluded, in their studies, that the internet is used in a broad sphere and covers all sectors of the economy. Learners depend on the internet for the research and collaboration purposes. Findings from this study, in Table 5.6, also revealed that 55% of the respondents have received computer training and Figure 5.1 shows that 57.59% own a mobile technology device, while Table 5.8 indicates that 100% have access to internet whether at school, via a mobile phone, at home and at the internet café, however, these come with challenges such as slow internet speed. This shows that, indeed, internet access plays a pivotal role in everyday lives, including teaching, where teachers and learners are provided with quick access to documents, articles and related course content materials and resources for use (Ali, 2018).

The results of this study have also shown that there are barriers on the level of ICT competency by teachers, as shown in Table 5.10, the results show that in terms of teachers level of ICT competency, teachers are intermediate in email communication, use of presentation software and operating with Microsoft Office. However, they are more advanced in attaching files to email and networking/ communicating with others. In general, the results revealed that teachers are more competent in information browsing & downloading and file management. Teachers have shown to be less competent in technology management. This shows that lack of ICT competence and training hinder one to successfully integrate ICT in their teaching. Learners also need to be competent in the use of ICTs so that they can effectively use them in their learning. Zielezinski and Darling-Hammond (2016) show in their study that student's achievement improves with the use of technology. These barriers have been categorised into two, first order and second order barriers (Saxena, 2017). A study in the United States has shown that first order barriers have lowered and that the majority of the educators have failed to integrate technology tools in classroom teaching (Tondeur, et al., 2017). This shows that barriers need to be eliminated at all costs so that technology can benefit teaching and learning. It has also been shown that socio-cultural believes and surroundings, pedagogical considerations and attitudes of teachers influence how they perceive integrated technology in teaching (Grosser, 2017; Heath, 2017; Magana, 2016).

Research by Ross and Tsibolane (2017) found that attitudes affected technology integration of teachers in high schools in South Africa even though the participants thought of technology integration useful, their attitudes acted as a barrier.

There are some barriers revealed in this study (see chapter six) in relation to technological pedagogical instruction as expressed by participant 12:

The curriculum design and developers should include technology in the curriculum so that technology integration in teaching and learning should start at early stages. This will reduce fear and boredom to use technology in teaching and learning.

Curriculum designers should include technology use in the school's curriculum so that teachers can be taught on the right pedagogies and technologies to use in their teaching. This is supported by Taylor (2017), who noted, in his study, that when teachers are in colleges, they need to be trained on technology used in teaching and learning. This might help eliminate barriers associated with technological pedagogical content knowledge. Lack of ICT skills training is seen as another barrier to successful integration, as expressed in in chapter six by participant 27 below:

Teachers need proper ICT skills for them to be able to integrate technology in teaching and learning. This will also reduce chances of fear/technophobia.

Strategies to overcome barriers are reported in chapter eight under the recommendations.

7.4 RESEARCH QUESTION 3: DOES THE USE OF ICT BY TEACHERS INFLUENCE LEARNERS' ACADEMIC PERFORMANCE DURING THE COVID-19 ENVIRONMENT?

The finding of this study, which addressed this research question, was based on the results of the learners in 2019, 2020 and 2021 respectively. The results of 2019 were not affected by Covid-19, which thereafter led to the closure of schools in the 2020 and 2021. This left teachers and the learners with no choice, but to resort to online learning. The results in Table 5.17 shows that class Z1 performed better than class X1 in 2019 before the pandemic with a mean comparison of 62.51 to 45.98 respectively. Although, there was a decline in overall performance in 2020 for both classes, Class Z1 improved in results performance when comparing results for 2020 and 2021, with a mean improvement of 0.22 and X1 improved from 41.51 to 47.04 with a mean improvement of 5.53.

Class XI improved results as seen above. Class Z4 dropped from 62.51 in 2019 to 47.23 in 2020 and further improved by 0.23 to make an average mean of 47.23. This shows that in 2020, both teachers and learners were getting used to the use of technologies in teaching and learning, thus marking an improvement in academic performance. In 2021, the results improved, which shows that the learners were getting used to technology adoption and integration in teaching and learning. This shows that the use of technology in teaching and learning during the Covid-19 did influence learner academic performance in a positive way, although limited.

The results above are also supported by tables 5.19.1 to 5.19.4 respectively when both results for the respective years were combined to further explore influence and academic learner performance. This shows that learners' academic performance improved positively between 2020 and 2021when technology was now the center of teaching and learning. Technology use in teaching and learning is key to improve academic results as shown by the results above. This is evident in the national Botswana general certificate of secondary education (BGCSE) results for 2019, 2020 and 2021 in Table 5.19. It is shown that the national results for the grades A, C, E and G were 50.45% in 2019. It improved in 2020 to 50.94% and further to 51.21% in 2021. Table 5.19.1 shows that the number of grades C or better for 2019 was 29.02%, 30.20% in 2020 and 30.32% in 2021. This shows a positive improvement and indicates that technology use in teaching and learning did influence learner academic performance compared to the traditional methods of teaching.

It is further shown and supported in Table 5.19.2 that the BGCSE results for the number of grades A or better was 2.52% in 2019, 2.80% in 2020 and a further improvement to 2.85% in 2021. The national results from government and private schools were also compared to access how technology influenced teaching and learning during the Covid- 19. It is evident that government schools performed better than private schools during the Covid-19 pandemic. Table 5.19.3 shows the results for government and private schools' grades (all syllabi) for the 2021. It shows that for the grades A*, A, B, C, D, E, F, G, U, government schools performed better than private schools, with an average percentage of 51.91% to 47.37% that of private schools. This is supposedly so because there is a strong support on the use of technology by the government as compared to private schools and that private schools mostly focus on profit-making than the

government, which does it for the benefit of all. This is backed by the following qualitative comments from chapter six:

We have two computer labs in our school. The government built one was refurbished with new computers and appropriate technology for teaching and learning. Software is up-to-date and new softwares were installed in all the machines. We have another smart computer laboratory. This was donation from the local mine in our locality. This has made technology integration in teaching and learning very easy. [Participant 3]

We have tablets for use by both learners at out computer labs in my school. This was a donation from one of the churches in the localities. [Participant 16]

In our school, there is internet connection in both the computer laboratories and the administration area. The government has improved internet connectivity in our school. This will be done in other schools. [Participant 27]

The national Botswana junior certificate examination (JCE) results were also compared to see the differences in the results summary. Table 5.19.4 shows that for the results grades of Merit, A, B, C, D, E, U and X, the average percentages for JCE results for 2019, 2020 and 2021 was 12.5% respectively for all the years. It, however, shows that there was a decline in learner academic performance for the grade Merit, in 2020 (1.11%) from 2019 (1.18%) and an improvement in 2021 with a percentage increase of 0.06% from 2020. This shows that the Merit results improved between 2020 and 2021 when technology was adopted in teaching and learning.

The above results are supported by Charaya, Bana and Malhotra (2017) and Akinoso (2018), who concluded that ICT impacted positively in terms of academic achievement to those learners who used ICT in their teaching and learning. This is also the case in this study. Positive influence to learner academic improvement was also noted and seen to be similar to a study by Basri et al. (2018), who showed that learner academic performance improved their information and capabilities, which was attributed to GPA and character. Studies by Chenoby (2014), Rashid and Asghar (2016) and Habib and Shah (2017) showed that the use of ICTs by learners improves their academic performance. This quantifies and validates results in this study that the use of ICT in teaching and learning has a positive influence in teaching and learning. ICT tools are being used to modernize the education systems and new setting and strategies for achieving better academic performance results are being done so that no learner is left behind and that the intended academic targets are achieved (Ishaq et al., 2020). See chapter eight for strategies recommended to be used to overcome the challenges.

Table 5.13 shows that perceived ease of use strongly influenced positive attitudes of teaching to integrate technology in teaching during the Covid-19 environment. This move has also seen the learner's adopting ICT in the learning, and this has yielded positive results as shown above. Perceived ease of use is also seen to have influenced behavioral intention on the use of ICTs in teaching and learning since no one had a choice, but to resort to the use of technology integration in teaching and learning (Ishaq et al., 2020). The continuity on the use of ICTs in schools and the children growing up with ICTs has made teachers' use of ICTs in teaching and learning less of a concern than in the past.

7.5 RESEARCH QUESTION 4: HOW DO TEACHERS' KNOWLEDGE DOMAINS OF THE TPACK AND UTAUT-3 FRAMEWORK CORRELATE WITH EACH OTHER AND THE PERCEIVED USE OF TECHNOLOGY?

The findings of this study in this section were based on how teachers' knowledge domains of TPACK and constructs of UTAUT – 3 framework correlates with each other and the perceived use of technology.

The findings in Table 5.11 showed that all the UTAUT- 3 constructs were all above the mean 3.111. This means that the teachers were all aware of the UTAUT-3 constructs. The mean for all the TPACK constructs ranged between 3.3999 and 3.702 as shown in Table 5.12. This signifies that most of the participants agreed to the statements and were all aware of the knowledge domains of the TPACK constructs. Table 5.13 showed that there are correlations which existed between teachers' knowledge domains of UTAUT-3 and TPACK as follows: PE had positive correlations with CK, PK, PCK, TCK, TPK and TPCK. This means that performance expectancy had a positive relationship and influence on the teachers' use of technologies in teaching and learning during the Covid- 19 pandemic. They perceived they will do well in their job in relations to content knowledge, pedagogical knowledge, pedagogical content knowledge, technological content knowledge, technological pedagogical knowledge, and technological pedagogical content knowledge.

The results also show that perceived ease of use had a positive influence in the teachers' use and integration of technology in teaching and learning and has an influence in behavioural intention to use. It is shown in Table 5.16 that most of the respondents responded positively with an

average of 51.03% showing that perceived ease of use of technology had an influence on technology use. Majority perceived technology as easy to use, while 53.9% showed positive performance expectancy if they use technology. Moreover, 54.7% of the respondents agreed to strongly agree that if they use technology they will spend less time on routine job tasks, while 50.1% perceived that technology use will increase the quality of output on their job (see Table 5.16). It is evident as shown in the quantitative results that the respondents are competent in using technology in their teaching and learning (see quantitative results analysis in chapter 5). These findings were consistent with Buabeng-Andoh (2012), who found that teachers perceived computers as useful because they made their job easier. Only a handful showed that they were not ICT competent in using technology to carry out some of their tasks. This concurs with a study by Agyei and Voogt (2011b), who concluded and reported that low levels of ICT integration in teaching is a result of low levels of ICT competence and access to resources.

FC was significantly correlated with two constructs of TPACK, namely; TPCK and TCK. FC's role has never been hypothesised with BI (Venkatesh et al., 2003). However, only the UTAUT developers did hypothesise that FC is strongly correlated with the actual use. The findings of this study indicated that FC is significantly correlated with TPCK with a Pearson correlation 0.156 and TCK with a Pearson correlation of 0.239. This finding of this study in Table 5.13 indicated the following correlations between UTUAT-3 and TPACK constructs:

PE had correlations with CK, PK, PCK, TCK, TPK and TPCK, SI and BI had correlations with all the TPACK constructs (TK, CK, PK, PCK, TCK, TPK and TPCK).

This means that those teachers who were very positive about PE were also positive about CK, PK, PCK, TCK, TPK and TPCK and those positive about BI were positive with all the TPACK constructs. Only one UTAUT-3 construct, Habitat, did not have a correlation with all the TPACK constructs. Relationships between EE, SI and BI are consistent with the UTAUT-3 model and studies by Macharia (2011), McCombs (2011), and Williams (2015). The fact that PE had correlations with TPACK constructs plays a significant innovative role in environments (Ortega-Sánchez and Gómez- Trigueros, 2019). The quantitative findings show that TK has the greatest influence on intentions to use technology by teachers in their practice, followed by TPCK. These findings mean that teachers' confidence in technology knowledge and use is very important to developing confidence on the other TPACK constructs.

7.6: CONCLUSIONS

This chapter discussed the findings from both the quantitative and qualitative data collected from the respondents during the course of the study. Data was collected using a quantitative questionnaire and focus group interview discussions. It showed that teachers perceive technology use in teaching and learning as important because it helps improve their performance and enables them to do their job well and in time. It also showed that there are barriers which hinders successful adoption and use of technology in teaching and learning, this makes their curriculum delivery not to be as efficient and decreases learner academic performance. The discussion also showed that the use of ICT in teaching and learning during the Covid - 19 pandemic influenced learner academic performance and that some correlations exists between constructs of UTAUT and the teachers knowledge domains of TPACK. The findings from the focus group interviews were also discussed and they supported the quantitative results.

CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS

8.1 Introduction

The focus of this study was to critically analyze technology adoption in teaching by in-service teachers in Botswana during the Covid-19 pandemic.

To recap: The research objectives were as follows;

1. To examine teachers' perceptions towards the use of ICT tools in their teaching.
2. To critically analyze the impact of challenges in the adoption and use of ICT in enhancing teaching for in-service schoolteachers in Botswana.
3. To critically analyze the impact of the adoption of ICT on teaching and learning in Botswana schools.
4. To examine teachers' knowledge domains in terms of TPACK and investigate any correlations between TPACK and UTAUT – 3 frameworks.

In order to achieve the research objectives, the following research questions were used;

1. What are the perceptions of in-service teachers towards the use of ICT tools in teaching and learning in a Covid-19 environment?
2. What are perceived as barriers for integrating ICTs into the virtual classroom in a Covid-19 environment, and what strategies can be used to overcome these?
3. Does the use of ICT by teachers influence learners' academic performance during the Covid-19 environment?
4. How do the teachers' knowledge domains of the TPACK and UTAUT-3 framework correlate with each other and the perceived use of technology?

8.2 Conclusions

This study critically analyzed the adoption and use of ICTs by in service secondary school teachers during the Covid-19 pandemic. It has emerged from this study that there are barriers associated with technology use and integration into teaching. It became evident that the use of ICTs in teaching and learning did have a positive influence in learner academic results, although very limited. Positive correlations were found between teachers' knowledge domains of UTAUT-3 and TPACK constructs. This study has revealed that there are different technologies used in government and private schools and showed that government schools are doing well in terms of learners' academic performance when compared to private schools. The findings of this study also showed and affirmed that the Covid-19 pandemic significantly influenced the use of technology in teaching as it left no one with a choice. It also revealed that teachers had adequate knowledge on the constructs of TPACK and that the constructs of UTAUT-3 did correlate with different domains of knowledge found in the TPACK framework. These correlations can be used when considering new curriculum for teacher trainees as well as professional development programmes for existing teachers.

8.3: Recommendations

Based on the results of this study, the following recommendations were made:

1. The Ministry of Education and Skills Development should organise ICT training courses as part of the training for both primary and secondary schools so that teachers are taught how to effectively use and integrate technology in teaching and learning.

2. The curriculum developers should include technology use in teaching and learning (digital curriculum) when they develop school curriculum. This must be piloted to make sure that teachers have adopted, understood, and appreciate change.

3. Before graduating from colleges of education and universities, all teachers must enrol in an ICT course so that they are aware and knowledgeable to use technologies in their teaching.

4. The government of Botswana, through the Ministry of Education, should avail ICT resources for teaching and learning in all government schools so that access to these resources must be easy and available to all learners.

5. The school management should make sure that the utilisation of technology in teaching is done in an appropriate way by monitoring and evaluating how technology is integrated in teaching and learning and providing suggestions for better results so that the benefits intended are achieved.

6. The Ministry of Education, through the department of communication, information, and technology, must ensure that all the three network service providers in the country are available in all parts of the country, even in the remotest villages, so that there can be access to full network and internet resources for use by the citizens 24/7 with no time limit.

7. Regular professional development workshops should be conducted during schools' recess so that teachers are equipped with ICT special skills on technology integration in teaching.

8. All the schools level grades, from reception to form five, should have access to a technology device so that they can get used to technology use.

9. The Ministry of Education is requested to liaise with the Faculty of Education at the University of Botswana whenever there are changes to be made in the school curriculum. This

would make sure that experts from the faculty are engaged in teaching and learning development.

10. Proper communication channels should be used to communicate to stakeholders matters that concern education.

11. There should be partnerships between the Ministry of Education and other Education Ministries in the region and beyond to produce global competitive graduates.

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APPENDICES

Appendix 1: Research Permit

TELEPHONE: 3655400/3655483
TELEX: 2944 THUTO BD
FAX: 3914271

MINISTRY OF BASIC EDUCATION
PRIVATE BAG 005
GABORONE, BOTSWANA

REF: DPRS 7/1/5 XXXV (100) PAO-Research

7th December 2020

Rodnie K. Mafa
Po Box 1908
ABG Sebele
Gaborone

Dear Sir

RE: PERMIT TO CONDUCT A RESEARCH STUDY

This serves to grant you permission to conduct your study in the sampled areas in Botswana to address the following research objectives/questions /topic:

A Critical Analysis of Technology adoption in teaching during the Covid-19 pandemic by in-service teachers in Botswana.

It is of paramount importance to liaise with the Regional Directors, School Heads and Teachers from Institutions from which you are going to collect data from. We hope that you will conduct your study as stated in your proposal and that you will adhere to research ethics. Failure to comply with the above stated, will result in immediate termination of the research permit.

The validity of the permit is from **7th November 2020 to 6th November 2021. You are requested to submit a copy of your final report of the study as stated in the Research Guidelines (para 4.5 - 4.6, 2007) to the Ministry of Basic Education, Department of Educational Planning and Research Services, Botswana.**

Thank you.

Yours faithfully

[redacted]

Onalenna Senwedi
For/Permanent Secretary

Appendix 2: Ethical clearance

09 February 2021

Mr Kgalemelo Rodnie Mafa (216076794)
School Of Education
Edgewood Campus

Dear Mr Mafa,

Protocol reference number: HSSREC/00002274/2021
Project title: A critical analysis of technology adoption in teaching by in-service teachers in Botswana during the Covid-19 pandemic
Degree: PhD

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 17 December 2020 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

This approval is valid until 09 February 2022.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

All research conducted during the COVID-19 period must adhere to the national and UKZN guidelines.

HSSREC is registered with the South African National Research Ethics Council (REC-040414-040).

Yours sincerely,

[redacted]

Professor Dipane Hlalele (Chair)

/dd

Appendix 3: Consent form to participate in the study

17 September 2020

Dear Participant,

INFORMED CONSENT LETTER

My name is Rodnie K. Mafa, a registered PhD student at the College of Humanities: Faculty of Education at the University of KwaZulu-Natal, Edgewood Campus, South Africa. I am carrying out a research study on the topic:

A critical analysis of technology adoption in teaching during the Covid-19 pandemic by in-service teachers in Botswana

The findings from the research will be useful for:

- Teachers and administrators in schools to use ICT tools in teaching and learning to enhance academic achievement or learning.
- The curriculum developers to effectively include ICT tools in school syllabuses, as this can help increase results performance.
- The Ministry of Education and Training, which legislates guidelines and policies for teaching and learning in the schools, who will be made aware of other teaching methods which will help in bringing about a significant improvement in academic enhancement.
- The teacher training institutions, which will be made aware of areas, in which they need to improve their pedagogy related to technology, to ensure that teachers integrate e-learning effectively in education.

To achieve all this, I would like you to be part of the informants who will be responding to the questions in this study with no intervention from anyone. Kindly note that attempts will be made as much as possible not to disrupt the day-to-day running of your daily business.

Please note that:

- Your privacy, anonymity, confidentiality and acknowledgement shall be upheld, your confidentiality is guaranteed as your inputs will not be attributed to you in person but reported only as a population member opinion.
- The questionnaire can be completed in just 20 - 30 minutes and total focus group interview time is approximately 20 minutes.
- Any information given by you cannot be used against you, and the collected data will be used for purposes of this research only.
- Data will be stored in secure storage and destroyed after 5 years.
- You have a choice to participate, not to participate or stop participating in the research. Please note that you will not be penalized for taking such a decision.
- Your involvement is purely for academic purposes, and there are no financial benefits involved.
- If you are willing to participate in this study by completing the questionnaire, please complete the declaration at the end of this page.

In the event of any problems or concerns/questions you may contact the researcher at the following contacts;

Researcher:
Mr Rodnie K. Mafa
Cell: +267 77573849
Email**:** mafavuke2004@gmail.com

Supervisor:
Prof. Govender W. Govender, PhD
Assoc. Professor – Discipline of Computer Science Education
University of KwaZulu-Natal
Durban, South Africa, Private Bag X03, Ashwood 3605
Tel: +27 031 2603428

Or the UKZN Humanities & Social Sciences Research Ethics Committee, contact details as follows:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban, 4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604557- Fax: 27 31 2604609

Email: HSSREC@ukzn.ac.za

Thank you for being part of this research.

DECLARATION

I…… (*Full name of participant*) hereby confirm that I understand the contents of this document and the nature of the research study, and I consent to participate in this research project. I understand that I am at liberty to withdraw from the project at any time, should I so desire.

…… ……

SIGNATURE OF PARTICIPANT DATE

Appendix 4 : Quantitative questionnaire

QUESTIONNAIRE FOR TEACHERS

Dear Educator

I would like you to be part of the informants and respond to the following questions with no intervention from anyone. Kindly note that your privacy, anonymity, confidentiality, and acknowledgement shall be upheld, your confidentiality is guaranteed as your inputs will not be attributed to you in person but reported only as a population member opinion. Any information given by you cannot be used against you, and the collected data will be used for purposes of this research only. You have a choice to participate, or not to participate or stop participating in the research. Please note that you will not be penalized for taking such a decision. Your cooperation is highly appreciated.

Section A: demographic information: Please select the ONE option that best applies to you.

1 Gender:

Male	Female

2 Age:

18-25	26-36	37-51	52+

3 Teaching Subject:

Mathematics	Sciences	Computer Studies	Humanities	Practical's

4 Have you received training in any computer course?

Yes	No

5 Do you own a mobile technology device?

Yes	No

6 Educational qualification:

PhD	Masters	Degree	Diploma	Certificate

Section B: ICT USE: Please tick the appropriate box

1 Did your training above include ICT integration in teaching your subject area?

Yes	No

2 How relevant do you rate the training in terms of equipping you with skills on lesson planning, lesson delivery and preparation using ICT tools?

Not relevant	Slightly relevant	Relevant	Very relevant

3 Where do you <u>mainly</u> access the internet during the covid-19 pandemic? (Select ONE option only)

At school	Via mobile phone	At home	Internet cafe

4 On average how many hours per week do you use ICT tools on teaching and learning related tasks during the covid-19 pandemic?

Less than an hour	1 - <5 hours	5 – 8 hours	More than 8 hours

5 Rate your level of ability (from very poor to very good) for each of the following computer operations?

Level of ICT Competency	Very poor	Poor	Average	Good	Very good
5.1 Operating with Microsoft office					
5.2 Networking/communicating with others. e.g. twitter and Facebook					
5.3 File management e.g. opening, renaming or saving a file					
5.4 Information browsing and downloading i.e. searching the internet for information					
5.5 Email communication					
5.6 Attaching files to email					
5.7 Use of presentation software e.g PowerPoint					
5.8 Technology management e.g. troubleshooting (fixing basic faults)					

ACTUAL USE

6 How often do you use ICT to carry out the following teaching and learning roles in your work as a teacher during the covid-19 pandemic?

Task	Never	Rarely	Sometimes	Often	Always
6.1 Searching/ browsing for information for lesson notes					
6.2 Preparing work schemes					
6.3 Preparing work records					
6.4 Preparing lesson plans					
6.5 Keeping learners' records					
6.6 Using digitized lesson notes for example on an IPAD or Notebook					
6.7 Preparing class assignments and exercises					
6.8 Analysing examination results					
6.9 Presenting lessons using projectors inside the classroom					
6.10 Presenting lessons using projectors in computer laboratory					

7 Rate how much of a challenge (from 1 = not a challenge at all to 5 = a major challenge) each of the following is during the covid-19 pandemic

ICT related Challenges	Not a challenge at all 1	2	3	4	A major challenge 5
7.1 Insufficient number of computers					
7.2 Inadequate lack of skills on ICTs					

7.3 Not enough copies of software for specific subjects					
7.4 Lack of interest in teachers on the use of ICT in teaching and learning					
7.5 Insufficient teacher time					
7.6 Lack of adequate technical assistance					
7.7 Slow speed of the internet					
7.8 Lack of administrative assistance					
7.9 Lack of adequate computer lab					
7.10 Lack of proper policy and strategy on ICT usage in schools by the Ministry					
7.11 Technophobia (fear to use ICT in teaching)					
7.12 Computer Virus attacks					

8 Indicate your level of agreement or disagreement with each of the following statements;

UTAUT - 3						
	Construct	Strongly ...	Disagree	Neutral	Agree	Strongly
Performance Expectancy						
1	Using the technology in my job enabled me to accomplish tasks more quickly during covid-19 pandemic.					
2	Using the technology would improve my job performance					
3	Using the technology would enhance my effectiveness on the job.					
4	Using the technology would make it easier to do my job.					

5	Using the technology improves the quality of the work I do.					
6	Using the technology increases my productivity					
7	**If I use the technology…**					
8	I will spend less time on routine job tasks.					
9	I will increase the quality of output of my job					
10	I will increase the quantity of output for the same amount of effort.					
11	My co-workers will perceive me as competent.					
	Effort expectance					
12	Learning to operate the technology would be easy for me.					
13	I find it easy to get the technology to do what I want it to do					
14	My interaction with the technology is clear and understandable					
15	I have no difficulty in choosing which is the right technology to use					
16	Working with the technology is so complicated; it is difficult to understand what is going on.					
	Social influence					
17	People who influence my behavior think that I should use the technology.					
18	I use the technology because of the proportion of co-workers who use the technology.					
19	The senior management of this school has been supportive in the use of the technology.					
20	People in my organization who use the technology have more prestige than those who do not					

21	My co-teachers encourage the integration of technology in my subject					

	Construct	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
	Facilitating conditions					
22	I have the right technology to integrate in my teaching					
23	I have the resources necessary to use the technology.					
24	I have the knowledge necessary to use the technology.					
25	There are people who can assist when technical things go wrong					
26	I have enough support choosing which technology to use					
27	Senior management at my institution makes sure that I have the necessary resources and tools for the smooth integration of ICT into my teaching.					
	Behavioral intention					
28	I am motivated to use ICTs in teaching and learning					
29	I intend to use ICTs apps in the future.					
30	I will use ICTs in my teaching even after the Covid-19 pandemic is over					
31	I plan to use/ continue to use ICTs in teaching and learning wherever possible					
32	I will use ICT in teaching wherever it is applicable					
	Hedonic Motivation					
33	I enjoy convening lessons using ICTs.					
34	I enjoy engaging with learners using ICTs.					
35	I enjoy using technology in teaching.					
36	I am eager to respond to the discussion groups online					
37	I enjoy using ICTs in marking.					

Price Value						
38	The benefits from using ICT in teaching far outweigh the cost of adopting it					
39	The cost of ICT for teaching is worth it given the benefits it gives to learning/teaching					
40	I will upgrade to new technology even if I were to bear the costs personally, given the benefits of using it.					
41	The benefits of using new applications with technology are worth the cost					
42	I would still use ICTs in teaching and learning, even if I incurred personal costs.					
Habit						
43	The use of ICT in teaching has become a habit for me					
44	I am addicted to using ICT to accomplish my work tasks					
45	Using technology comes naturally to me					
46	Using ICT for my job is something I do without thinking					
47	I am addicted to integrating technology in teaching and learning					

TPACK						
	Construct	Strongly ...	Disagree	Neutral	Agree	Strongly
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.					
4	I frequently play around the technology.					
5	I know about a lot of different technologies.					
6	I have the technical skills I need to use technology.					
CK (Content Knowledge)						

7	I have sufficient knowledge about my subject I teach.					
8	I have various ways and strategies of developing my understanding of my subject.					
9	I can use my subject content to understand new concepts.					
10	I have vast knowledge of facts, concepts, theories, and principles that should be taught in my subject.					
11	I have experience to relate what I teach in my subject to real life situations.					
PK (Pedagogical Knowledge)						
12	I know how to assess learner performance using technology during the covid-19 pandemic.					
13	I can adapt my teaching based-upon what learners currently understand or do not understand.					
14	I can adapt my teaching style to different learners.					
15	I can assess learner learning in multiple ways.					
16	I used a wide range of teaching approaches using technology during covid-19 pandemic.					
17	I am familiar with common learner understandings and misconceptions.					
18	I know how to organize and maintain teaching using technology during covid-19 pandemic.					
PCK (Pedagogical Content Knowledge)						
19	I can select effective teaching approaches to guide learner thinking and learning in my subject.					
20	I can make connections between my content area and other related subjects					
21	I can set relevant examination and test questions in my subject area					

22	I can distinguish between research on my subject area and other subjects					
23	I know what to teach in my subject area					

	Construct	Strongly ...	Disagree	Neutral	Agree	Strongly
	TCK (Technological Content Knowledge)					
24	I know about technologies that I can use for understanding and doing my subject.					
25	I know how to develop class activities and projects involving use of instructional technologies in my subject.					
26	I know how to use technologies achieve course objectives easily in my subject.					
27	I know which different technologies to use when I teach a particular content in my subject.					
28	I know the kinds of knowledge required for the successful integration of technology in teaching.					
	TPK (Technological Pedagogical Knowledge)					
29	I can choose technologies that enhance the teaching approaches for a lesson.					
30	I can choose technologies that enhance learners' learning for a lesson.					
31	I can choose technologies that enhance the content for a lesson.					
32	I am thinking critically about how to use technology in my lesson.					
33	I can adapt the use of the technologies that I learned about to different teaching activities.					

34	I can select technologies to use using technology that enhances what I teach, how I teach and what learners learn.					
35	I can use strategies that combine content, technologies, and teaching approaches.					
	TPCK (Technology Pedagogy and Content Knowledge)					
36	I can teach lessons that appropriately combine my subject content, technologies, and teaching approaches during covid-19 pandemic.					
37	I can choose technologies that enhance the content for a lesson.					
38	I can select technologies that enhance what I teach how I teach, and what learners learn during covid-19 pandemic.					
39	I can use appropriate technologies to deliver content of the subject I teach					
40	I can make interactions among content, pedagogy, and technology knowledge					

END OF THE QUESTIONAIRE

Thank you.

In the event of any problems or concerns/ questions you may contact the following contacts:
HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION
Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604557- Fax: 27 31 2604609
Email: HSSREC@ukzn.ac.za

Thank you.

Appendix 5: Focus group interview guide questions

1. Describe how the technology training that you received (both formal through Professional Development/Workshops/Trainings and informal through other means) has translated to use of technology in your classroom during the covid-19 pandemic. Please share an example of something from your own classroom.
2. What did you feel is the most frustrating aspect of using technology for your lessons during the covid-19 pandemic?
3. Recalling a technology training that you participated in please describe the context of the training and how it "Did" or "Did not" enhance technology use in the classroom environment (either formal through Professional Development or informal through other means) during the covid-19 environment.
4. In which ways do you think ICT integration in teaching and learning can be improved regarding.
    i. Access of student and teachers to computers and other ICT.
    ii. Teacher ICT skills and training
    iii. ICT usage in teaching in specific subjects during covid-19 pandemic.
5. Describe any importance computers have had in your in-class teaching (how you teach, what you teach) during the covid-19 pandemic.

Appendix 6: TURNITIN REPORT

turnitin

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