

RHODES UNIVERSITY
EDUCATION DEPARTMENT

Where Leaders Learn

TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE DEVELOPMENT:
INVESTIGATING SECONDARY SCHOOL TEACHERS' INTEGRATION AND USE OF
TECHNOLOGY DURING EMERGENCY REMOTE TEACHING IN ENDOLA
EDUCATION CIRCUIT

By

MS. JOHANNA MUNYANYO

g11m0014

**A thesis submitted in fulfillment of the requirements for the Masters of Education in the
Faculty of Education at the Rhodes University**

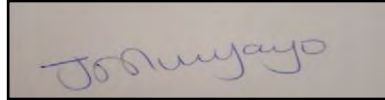
SUPERVISOR: Dr Clement Simuja

AUGUST 2023

DECLARATION

I, *Johanna Munyanyo*, declare that the contents of this thesis represent my own unaided work and that the thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Rhodes University.

Signed:



Date: 27 AUGUST 2023

ABSTRACT

The Covid-19 pandemic has created the largest disruption of education systems in human history. The closure of schools and other learning spaces has impacted billions of learners worldwide. The mitigative measures and many new standard operating procedures have brought restrictions and many challenges. The face-to-face traditional teaching method lost its value, and teaching shifted to distance through the integration of technologies. The integration of technologies necessitated the emergency remote teaching process, as it is one of the distance teaching modes that can make teaching possible even for less technologically privileged nations. Literature has shown that the integration and usage of technology during teaching support the development of technological pedagogical and content knowledge (TPACK) of teachers. This study, therefore, sought to investigate how the integration and use of technology during the emergency remote teaching of Covid-19 developed the secondary school teachers' technological pedagogical and content knowledge. The study is underpinned by an interpretive paradigm, and a qualitative case study approach was employed. It was conducted in seven secondary schools in the Endola education circuit, Ohangwena region, with the purposeful participation of twenty-six secondary school teachers. Data was collected using semi-structured questionnaires and semi-structured interviews. The study was informed by Vygotsky's (1978) sociocultural theory together with the TPACK framework of Thompson and Mishra (2007) as both theoretical and analytical frameworks. The study's results showed that teachers made use of existing technological resources to sustain their teaching efforts during ERT. They encountered various challenges, including a lack of technological expertise (knowledge) among both teachers and learners. The shift to virtual instruction during ERT supported teachers in developing proficient technological pedagogical content knowledge. This research concludes that schools possess the necessary technological infrastructure to enable teachers to incorporate technology into their teaching methods. Furthermore, it highlights that teachers generally hold favourable attitudes toward integrating technology into their instruction. Nevertheless, it recommends that there is a need for improving both in-service and pre-service teachers' training and support for effectively teaching in online and blended learning environments.

Key words: Integration and use of technology, emergency remote teaching, and technological pedagogical and content knowledge (TPACK).

ACKNOWLEDGEMENTS

My sincere thanksgiving goes to:

I am deeply grateful to the Almighty God for His unceasing Grace and the gift of life and wellbeing. I extend my heartfelt appreciation to my Mom **Tuhafeni Absalom** for her courage and for always telling me to work harder in whatever I do. Her unwavering love and support mean the world to me. To my sibling, **Iyaloo Munyanyo** for always being there with the kids and making them feel the motherly love in my absence. To my husband **Trofimus Shilamba**, I am thankful for your affection, care, and understanding over these past years. To the beautiful kids who had never given me a reason to quit my studies, **Tonateni, Tuhafeni, Trofimus**, and **Twapewomagano**, you are the reason why I have to work so hard. To my niece **Lellie Leonard**, for working tirelessly in the household chores, thank you for making sure dinner was served in my absence. To my very critical friend, **Secilia Silvanus**, for lifting up my hands every time I felt it wasn't going to work. Your presence has been a source of comfort and strength, and I hold your contributions in high regard.

I extend my gratitude to my supervisor **Dr. Clement Simuja**, your consistent encouragement during challenging periods, along with your patience and expert guidance, have been invaluable. Your willingness to share your extensive knowledge has enriched my journey. I am particularly thankful for your guidance during moments of uncertainty, your insightful advice, and the motivating pep talks that kept me going, all the financial assistance, and all the exposures you dropped at my disposal.

A special thanks goes to all the secondary school teachers in Endola education circuit who bravely took part in this research study. Your participation was pivotal, and without your involvement, the study would not have been possible.

I also want to extend my acknowledgment to all the spicing groups, from the proofreading team to the editing and structure organizing team. Your constructive feedback and comments were of immense importance, and I greatly appreciate your contribution to refining my work.

DEDICATION

This thesis is dedicated to my beloved late father,

Onesmus Munyanyo

Your death has left an irreplaceable void but I am forever grateful for your well-lived life. You were such an education-loving man, and I still shed tears as you didn't witness any of our graduations. The unconditional love, unfaltering support, and constant encouragement you provided during your lifetime will sustain me for the rest of my life.

LIST OF ACRONYMS AND MEANINGS

ACRONYMS	MEANING
CK	: Content Knowledge
COVID	: Coronavirus Disease
DSF	: Digital Skills Foundation
ERT	: Emergency Remote Teaching
FGI	: Focus Group Interviewer
ICT	: Information Communication Technology
MoE	: Ministry of Education
MoEAC	: Ministry of Education Arts and Culture
NAMCOL	: Namibian College of Open Learning
PCK	: Pedagogical Content Knowledge
PK	: Pedagogical Knowledge
QP	: Questionnaire Participant
RQ	: Research Questions
SFH	: School-From-Home
SOP	: Standard Operating Procedures
SS	: Secondary School
SSI	: Semi-structured interviewers
TCK	: Technological Content Knowledge
TK	: Technological Knowledge
TPACK	: Technological Pedagogical Content Knowledge
TPK	: Technological Pedagogical Knowledge
WHO	: World Health Organisation

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Chapter One: Introduction

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1.1 Introduction to the study

The outbreak of the Covid-19 pandemic across the world has profoundly changed almost all aspects of life, including education (Dhawan, 2020). The difficulty of preventing the outbreak from spreading more widely has made world leaders and the World Health Organization (WHO) develop super-strict rules that can help stop the spread of the COVID-19 virus (Aliyyah et al., 2020). The World Health Organization advised all countries to follow health and safety protocols to prevent the spread of Covid-19. A ‘Lockdown’ was one of the mitigating measures to stop the spread of the disease among the nations, and it forced most educational institutions, including schools to close. Schools in 191 countries were closed, affecting at least 1.5 billion university students and hundreds of millions of school teachers and learners (Mustafa, 2020; Rehman, Zhang & Iqbal, 2021). Since then, millions of students in Africa and around the globe could not attend face-to-face classes (Paschal & Mkulu, 2020); as a result, in most developing countries, traditional classroom learning and teaching were reviewed and transitioned to virtual classrooms (Khlaif et al., 2021).

The international educational organizations mindful of this transition called on academic institutions, including basic education schools, worldwide to implement alternative methods of teaching and learning using technology and other distance learning techniques in the wake of the closures of schools to make sure the continuation of education happens (Ali, 2020; Williamson & Potter, 2020). Teachers had to come up with a variety of mitigating measures to make sure teaching and learning continued. One measure is the development of various teaching practices referred to

as emergency remote teaching (Green et al., 2020). Emergency remote teaching (ERT) is defined as a temporary shift of instructional delivery to an alternate mode due to crisis circumstances (Hodges et al., 2020). Emergency remote teaching can ensure teachers continue teaching through multiple avenues, and it also involves total remote teaching solutions for instruction and education that could be delivered in face-to-face or blended mode (Bhamani et al., 2020).

A report from the World Bank (2020) states that several countries had implemented emergency remote learning systems as physical schools were closed due to the outbreak of the Covid -19 pandemic. For instance, in early February 2020, China implemented an online learning system by holding simultaneous online learning exercises to ensure that learning for learners was not interrupted. In Bulgaria, the Ministry of Education and Science launched an e-learning management system. Similar, to Finland, due to school closure, instruction and guidance for students have been implemented through distance learning, digital technology learning environments, and independent learning. And lastly, in Indonesia, distance-learning or online technologies have provided solutions for schools that are starting to implement the School-From Home (SFH). The application of technologies in education increases the accessibility to learning resources such as emergency remote learning and many other programs to meet the need for distance learning (Hodges et al., 2020). Some of the technologies applied to meet educational needs are Zoom, WhatsApp, Skype, YouTube, and Google Classroom (Wiyono et al., 2020). The sudden change in education during Covid-19 has driven teachers to use different tools and platforms that they were not prepared to use or trained on (Khalif et al.,2021). Teachers faced the challenges of using new technological devices and the urgency to integrate the technologies into teaching and learning (Oliveira et al., 2021). Similarly, Niemi and Kousa (2020) added that some teachers did not know how to use technology and interact with students efficiently.

Although there has been a wide use of technologies during emergency remote teaching, it is evident that most teachers lack the technological knowledge to integrate technology into pedagogies and content (Yang & Chen, 2021). Moreover, Koehler and Mishra (2009) suggested that teachers' technological pedagogical content knowledge is a foundational knowledge base teachers must acquire; the interplay of these components across various contexts influences the extent and quality of educational technology integration. Teachers' understanding of technological pedagogical and

content knowledge can provide a coherent structure that allows teachers to understand better sound technology integration (Harris, Mishra & Koehler, 2009). Teachers with sound technological integration make practical decisions regarding academic content or what they will teach, pedagogical methods of how they will teach, and how they will assess the lesson outcomes (Carrillo & Flores, 2020). Sound technological pedagogical content knowledge is a crucial concept in education that emphasizes the integration of technology, pedagogy, and content knowledge to enhance teaching and learning experiences (Demirok & Baglama, 2018). This knowledge helps teachers to integrate technology seamlessly into their teaching practices (Anderson, & Putman, 2020); it goes beyond simply using technology for its own sake and focuses on how technology can enhance the understanding of content and improve pedagogical methods (Falloon, 2020). Teachers with strong technological pedagogical content knowledge can select appropriate technological tools and strategies that align with their content objectives and teaching methods (Mouza et al., 2017; Santos, & Castro, 2021).

Similarly, teachers with a grasp of technological pedagogical content knowledge can use technology to create engaging and interactive learning experiences, and they can adapt their teaching methods to suit different learning styles and levels of students, fostering more inclusive and effective classroom management (Heitink et al., 2017; Fuad et al., 2020). Teachers with such knowledge understand how to use technology to create interactive lessons, simulations, multimedia presentations, and other engaging content that can make learning more exciting and relevant to learners' lives. They are also capable of tailoring instructions to individual learners' needs, facilitating and guiding the collaborative activities effectively because they are adaptive and open to learning new technologies and teaching methods, especially through continuous professional development that would make them stay up to-date with educational trends and tools (Kupchyk, & Litvinchuk, 2021; Haleem et al., 2022).

Though there is a need for strong technological pedagogical content knowledge among teachers, there are some hindrances. Lack of good technological pedagogical content knowledge among teachers in developing countries posed significant challenges during the emergency transition to remote teaching (Nimavat et al., 2021; Shrestha et al., 2022). According to, tThere are technological challenges teachers experience, such as a lack of technological infrastructure that

made it difficult to engage learners. Some teachers were without the necessary pedagogical knowledge and thus struggled to create meaningful online learning experiences (Joshi et al., 2021). Overall, many teachers in developing countries lack access to training, professional development, and supportive resources to help them affect teaching during emergency remote teaching (Bozkurt et al., 2020).

1.2 Background of the study

Emergency remote teaching has become a worldwide phenomenon due to COVID-19, resulting in a temporary shift to online teaching (Hodges et al., 2020). These exceptional circumstances have brought the use of technology in education to the attention of a broader public. Moreover, the change from face-to-face to emergency remote teaching forced teachers and learners to urgently adopt and adapt to teaching and learning through the Internet and other digital tools. Most schools in developing countries adopted different technologies that could offer convenient teaching and learning.

In Namibia, initiatives such as “Rationalization of the Basic Curriculum,” whereby the rationalized syllabus was drafted up to 70% of the original curriculum, were implemented (MoE, Circular 6/2020). Standards Operating Procedures (SOP) were also implemented whereby schools are authorized to opt between a “Phased-in approach,” “Platooning,” “Time-based cohorts” and “Distributed groups” (MoE, Circular 7/2020). The promotion requirements for grades 1 to 9 were also revisited (MoE, Circular 8/2020), and the “Resilience Plan” was developed with strategies to support the implementation of the curriculum. With the limited resources available and in partnership with stakeholders, the ministry accelerated the expansion of information and communication technology (ICT) infrastructure in schools as well as the capacity building and motivation of teachers and learners to use ICT and blended modes of learning (MoE, Circular 2/2021). In the same vein, there is a self-administered program that the ministry initiated for teachers in 2020 and 2021 called the Digital Skills Foundation (DSF). Teachers were offered online information technology skills and trained in how to use 21st-century methodologies. To respond positively, teachers carried out teaching activities to make sure education was continued. Teachers used blended forms of learning, whereby they established WhatsApp groups for various subjects.

Platforms such as the KOPANO virtual platform and Namibia college of open learning (NAMCol) Notes Master are utilized.

It is also important to note that teachers in Namibia have been integrating different technologies before the COVID-19 pandemic. The integration of technology in education has ascended the education agenda with the release of various policies and guidelines on integrating and using technology in the Namibian education system. For instance, the ICT education policy for Namibian schools was developed to outline the integration and use of technology for education and respond to the education challenges of the 21st century. Despite Namibia's government implementing an ICT education policy in 2006, most teachers lack technological knowledge and integrating technology into the pedagogies and content makes it much more difficult (Johnson et al., 2016; Erstad & Voogt, 2018; Tanak, 2020).

Even though many technologies were adopted and adapted in basic education during the emergency remote teaching, the disparity in access to technologies and the Internet is a real threat to continuing teaching and learning at such a time of unprecedented education disruption (Bozkurt et al., 2020). The available educational systems in most African countries have insufficient technology-support infrastructures such as electricity, telecommunications computers, and technically-savvy users (Chen & Kidd, 2007; Kshetri, 2013), and Namibia is not an exception. The teaching shift from face-to-face to distance has affected the teachers and learners differently.

Consequently, most teachers are unfamiliar with integrating technology to teach lessons, irrespective of their teaching experience (Ottenbreit-Leftwich et al., 2018; Ketelhut et al., 2020; Wang et al., 2021). Thus, the remote emergence of teaching in Namibia requires teachers not only to learn to use the new technologies merely but also to acquire the technological pedagogical content knowledge as a concomitant facet of the overarching teacher knowledge base (Kim, 2018). This contemporary teaching context, which is technology-oriented in ways that might never have been envisioned a few years ago, is, thus, very different from the earlier understandings of teacher knowledge which emphasized mastery of content and pedagogy as the knowledge domains that embodied an expert teacher. It is, therefore, against this background that this study intends to

investigate the development of technological pedagogical and content knowledge (or not developed) in teachers as they used and integrated technologies during the emergency remote teaching of Covid-19.

1.3 Statement of the problem

The coronavirus outbreak (Covid-19) has brought many changes across several industry sectors, including Namibia's education sector. One of these changes is that the physical classroom has begun to lose its value as a place of teaching and learning (González-Calvo et al., 2022; Khanna & Kareem, 2021; Varea & González-Calvo, 2021). As in many nations worldwide, Namibian education was shifted to distance education, ensuring teaching and learning continues, and emergency remote teaching was introduced. Technology integration in teaching became mainstream because teaching was conducted online and offline (Valentino et al., 2021; Ashraf et al., 2021); teachers invented different innovations in terms of technology to help learners thrive learning crisis (Hartshorne et al., 2020). Even though technology is believed to be an essential component of remote teaching (Pamuk, 2012; Koehler et al., 2013; Kebritchi et al., 2017), there are still concerns that most teachers do not possess the technological knowledge to use and integrate technology in pedagogies and content in their classrooms. It is also observed by Kim (2020) that most teachers in developing countries such as Namibia lack technological pedagogical content knowledge to integrate technology to offer the emergency remote teaching during the covid 19 pandemic and meet teaching needs. Thus, the emergence of remote teaching in Namibia schools has inevitably added another layer of complexity to the teaching process (Henriksen et al., 2019; Taghizadeh & Hasani Yourdshahi, 2020; Wang et al., 2021).

As a grade 8 and 9 science teacher in Endola Education Circuit in Namibia, I observed that during the pandemic period, teaching with technology created an arduous and complex task for most teachers, given the multiple sources of knowledge that needed to be contextualized and negotiated. This complexity of teaching with technology brought to the forefront a new type of teacher knowledge that would encompass the understanding of technology, pedagogy, and content. Thus, my interest is to investigate the development of teachers' technological pedagogical and content knowledge after integrating and using technology during emergency remote teaching. To achieve the purpose of this study, the following questions were taken into consideration; (a) how do

secondary school teachers integrate and use technology during the emergency remote teaching of the covid-19 pandemic in Endola education circuit, and (b) How do integration and usage of technologies during emergency remote teaching in the Endola education circuit support secondary school teachers' technological pedagogical and content knowledge development? There is a shortage of empirical research on whether secondary school teachers in Namibia develop technological pedagogical content knowledge during the remote emergency teaching period. The few studies available in Namibia on remote teaching focus on; challenges experienced by students studying through Open and Distance Learning (Ilonga et al., 2020); E-learning challenges faced by students during COVID-19 (Kaisara & Bwalya, 2021); English teacher readiness to conduct online teaching during the COVID -19 lockdown (Boer et al., 2021); Characterization of Online Learners (Shihomeka, 2021). These studies have not shed light on how emergency remote teaching in Namibia contributes (or not) to secondary school teachers' technological pedagogical and content knowledge development. Hence, this study seeks to bring new knowledge about how the emergency of remote teaching in Endola Education Circuit in Namibia offered secondary school teachers the opportunity or not to develop technological pedagogical and content knowledge.

1.4 Purpose and significance of the study

The study intends to investigate the development of technological pedagogical content knowledge among secondary school teachers as they were integrating and using different technologies during the emergency remote teaching of Covid-19. The activities in the study aimed to inspire the selected secondary school teachers to share their experiences of utilizing technologies during the remote teaching period. The selected teachers who participated in this study are anticipated to understand the relationship between their technological knowledge competencies and how it was related to their pedagogies and content presentation during emergency remote education.

The findings of this study will therefore benefit other teachers because it aimed to investigate how teachers used and integrated technologies for emergency remote teaching, which is a new direction of education in the Namibian context. The pedagogical strategies and technological tools that are implemented during the integration and use of technologies for teaching during the emergency of remote teaching, in particular Endola Education circuit schools where resources are limited, are valuable to inform the current and developing knowledge base in this area of research.

Understanding the experiences of the selected teachers in this study may assist in filling some of the gaps in knowledge that relate specifically to how secondary school teachers develop technological pedagogical content knowledge in Namibia. Additionally, contributing to the knowledge base in this area of research, understanding the value and support that technological pedagogical content knowledge offers to secondary school teachers will allow the study to make a significant contribution to the current debate in Namibia on the use of technologies in Education. Technological pedagogical content knowledge development shows great promise in helping teachers improve teaching and learning when knowledge is used to inform the processes and practices of integrating technology into the classroom (Guerra et al., 2017; Ahmed et al., 2019). Therefore, it is assumed that findings from this study will contribute to understanding the links between constructs of technological pedagogical content knowledge and integration and use of technology in secondary school teaching. The findings of this study might further offer literature for future researchers who might use a broader sample, incorporating different geographical and socio-economic locations (Ndlovu, 2015; Snyder, 2019). Moreover, the findings might also inform policymakers to formulate policies to provide continued in-service professional development whenever possible, for example, by providing technological training that relates to pedagogies and content presentations.

1.5 Research goals

(a) Research objectives

The primary purpose of this study was to investigate the technological pedagogical and content knowledge development of secondary teachers through integration and use of technology during emergency remote teaching in the Endola education circuit during the breakout of the covid-19 pandemic. The research work aimed to:

- To investigate how secondary school teachers integrate and use technology during the emergency remote teaching of the covid-19 pandemic in Endola education circuit.
- To explore how integration and use of technologies during emergency remote teaching support TPACK development.

(b) Research questions

To achieve the purpose of this study, the following questions were taken into consideration:

1. How do secondary school teachers integrate and use technology during the emergency remote teaching of the covid-19 pandemic in Endola education circuit?
2. How do integration and usage of technologies during emergency remote teaching in the Endola education circuit support secondary school teachers' technological pedagogical and content knowledge development?

1.6 Definition of terms

For clarification purposes, the researcher chose to offer a brief explanation of the following key terminology used in the research purpose, objectives and main question and sub-questions. Below is the list of definitions.

Technology: refers to the collection of techniques, methods, processes, and tools used to create, modify, and utilize various goods and services in order to solve problems, enhance efficiency, and achieve specific goals.

Technology integration: refers to the incorporation of technology tools, resources, and strategies into various aspects of teaching, learning, and daily activities to enhance and improve the overall experience and outcomes. In the context of education, technology integration involves the deliberate use of technological tools and resources to support and enhance learning. This can encompass a wide range of activities, such as using computers, tablets, interactive whiteboards, and educational software.

Emergency remote teaching: refers to the temporary shift from in-person instruction to remote or online teaching in response to sudden and unexpected circumstances that prevent traditional face-to-face classes from taking place. These circumstances could include natural disasters, public health emergencies, political unrest, or any other situation that forces educational institutions to quickly adapt to a remote teaching model.

Technological pedagogical content knowledge: is a theoretical framework that describes the knowledge and skills that teachers need to effectively integrate technology into their teaching

practices. TPACK emphasizes that effective technology integration is not just about using the latest gadgets, but about understanding how technology can enhance teaching and learning in a way that aligns with the subject matter and pedagogical goals.

Covid-19: COVID-19, short for "Coronavirus Disease 2019," is a highly contagious respiratory illness caused by a novel coronavirus called SARS-CoV-2. It was first identified in December 2019 in Wuhan, China, and quickly spread globally, leading to a pandemic that has had significant impacts on public health, economies, and daily life worldwide.

Secondary school teachers: Secondary school teachers are teachers who work with students in the secondary education level, which typically encompasses grades 8 to grade 12 in Namibian context.

Information communication technology (gies): refers to the use of various digital tools, technologies, and resources to enhance and support the teaching and learning process. It encompasses a wide range of hardware, software, internet-based tools, and digital content that are utilized to facilitate educational activities, improve communication, and provide access to information.

Socio cultural theory: is a psychological and educational framework that emphasizes the importance of social and cultural factors in the development of human cognition and learning.

TPACK constructs/domains: the types of knowledge that a teacher needs to possess in order to integrate technology effectively.

1.7 Thesis outline and organization

This thesis is organized into six comprehensive chapters that collectively delve into the intricate facets of development technological pedagogical content knowledge among secondary school teachers during the emergency remote teaching of covid-19 pandemic. Each chapter offers distinct perspective and contributes uniquely to the thesis.

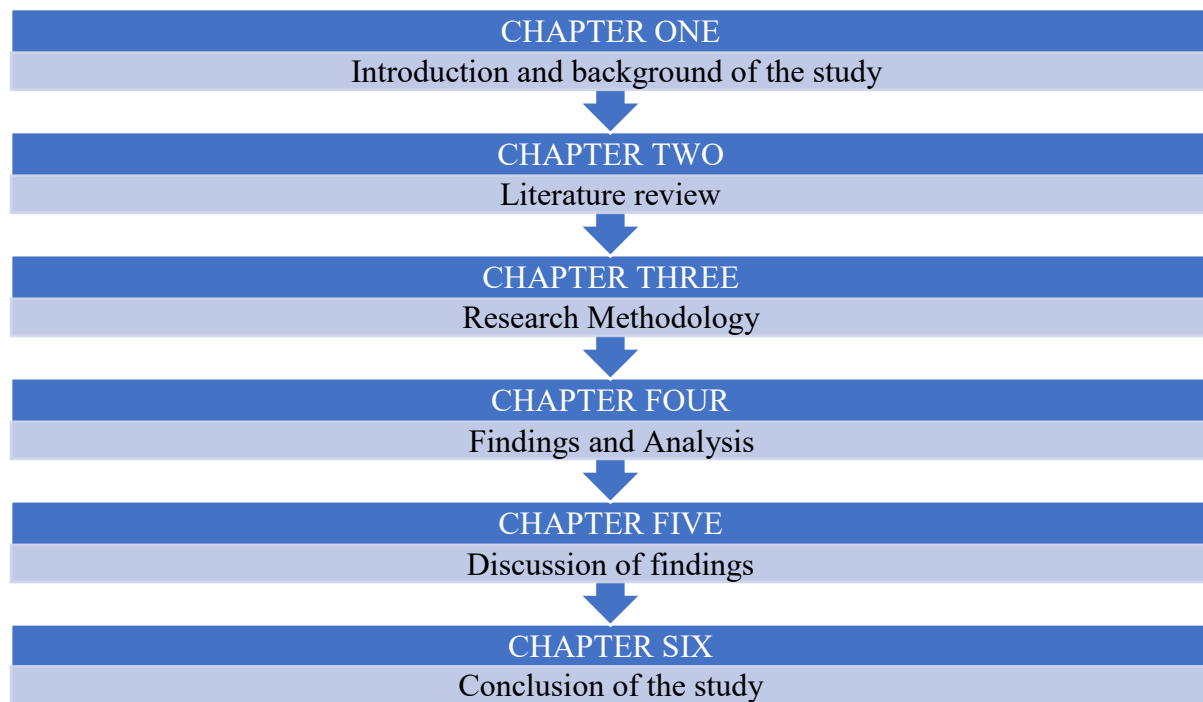


Figure 1.1: The structure of the study

The following is a brief outline of the contents covered in each chapter.

- Chapter 1: In this opening chapter, the groundwork is laid for the entire thesis. It provides the introduction, background, and significance of the study. The significance and relevance of the study are also elucidated, along with the research objectives and questions. A succinct overview of the subsequent chapters is provided, offering readers a roadmap to navigate through the content where necessary.
- Chapter 2: Introduces the main concepts and definitions connected with this study, including the theoretical frameworks. In this chapter, a comprehensive review of existing literature is undertaken. A synthesis of prior research and scholarly works related to emergency remote teaching and development of TPACK through the technology is presented, highlighting both the gaps in knowledge and the areas of consensus. This synthesis sets the stage for the original contribution of this thesis.
- Chapter 3: It presents methodological approaches of the study. This chapter delineates the methodology employed in this research. The research design, data collection methods, and

analytical techniques are detailed, substantiating the rigor and reliability of the study's findings. By transparently articulating the methodological choices, this chapter bolsters the credibility of the thesis.

- Chapter 4: It provides the results of this study which are presented in line with the research questions and objectives. This penultimate chapter unveils the empirical findings of the research. Data collected through meticulous procedures are analyzed, and patterns, trends, and correlations are unearthed. The insights gleaned from this analysis lay the foundation for the subsequent discussions and conclusions.
- Chapter 5: It sets out the discussion which presents a critical interpretation of the results, literature-backed results analysis, and the explanation of the significance of results. Building upon the preceding chapters, the findings are comprehensively discussed, connecting them to the theoretical framework and the broader context. This chapter also addresses the research questions and objectives.
- Chapter 6: It provides the conclusions based on the answers to the research questions, limitations, and recommendations for future studies. Synthesizes the key findings and their implications. Revisits the research objectives and questions, addressing how they were answered. Suggests potential avenues for further research and exploration.

Chapter Two: Literature Review

2.1	• Introduction
2.2	• Technology integration
2.3	• Emergency remote teaching
2.4	• Technological pedagogical content knowledge
2.5	• Theoretical frameworks
2.6	• Summary of the chapter

2.1 Introduction

The previous chapter provided the introduction of the study, the background of the study, the problem statement, the purpose and significance of the study, and the overview of the study. As this study sought to investigate the development of technological pedagogical content knowledge among secondary school teachers when integrating technology during the ERT of the Covid-19 pandemic, this chapter examined the existing literature relevant to the study. Literature refers to a collection of published information such as books, scholarly articles, academic journals, reports, and other sources that are related to the trends and gaps in a particular area of the research topic (Vom Brocke et al., 2015). A literature review is the writing process of summarizing, synthesizing, and/or critiquing the literature found as a result of a literature search (Galvan & Galvan, 2017). Further definition is elucidated by Xiao and Watson (2019) that a literature review is a systematic and comprehensive analysis of literature relevant to the research area and that analysis should direct the research questions and objectives of the study.

The purpose of the literature review in this study was to gain an understanding of the existing research and debates relevant to the integration of technology into teaching. Conducting a literature review in this study, the researcher-built knowledge of the study as Rahi (2017) resonates that through literature review, researchers learn more about the important study concepts, research methods, and experimental techniques used in the area of the study. Moreover, a literature review enabled the researcher to identify the gaps in the area of the study and be in the best position to fill those gaps to contribute to the development of knowledge in their field of research. On the other hand, a literature review in this thesis will help the readers understand knowledge gaps in the

existing research, as Snyder (2019) highlighted that a literature review identifies the topic's area that has not been researched in detail. This chapter is a compilation of recent and relevant literature reviewed about the integration of technology into teaching and learning with a special emphasis on emergency remote teaching. The literature in this study was sourced from a diverse range of academic journals, authoritative books, reputable conference proceedings, government reports, newspaper articles and relevant research articles, all carefully selected to provide a comprehensive and up-to-date foundation for the research topic. It is discussed thematically in relation to the following aspects: a general understanding of the integration of technology; uses and integration of technology into teaching and learning; benefits and challenges of integration of technology; emergency remote teaching; integration of technology during the ERT of Covid-19; development of teachers' technological pedagogical content knowledge.

The chapter is structured as follows: Section 2.2., presents the definition of the concept of technology integration including the uses and integration of technology, and the challenges of technology integration into teaching and learning. Section 2.3., presents the definition the emergency remote teaching, and the literature on the integration of technology during the emergency remote teaching of covid-19 pandemic. Section 2.4., presents the literature on the technological pedagogical content knowledge that includes the development of TPACK constructs in teachers. Section 2.5., presents the literature about the theoretical frameworks that are TPACK framework with all its constructs and sociocultural theory with socio-interaction and mediation of learning. Lastly, this chapter presents the concluding remarks.

2.2. Definition of 'Technology Integration'

There are different views on the definition of technology integration. Technology integration is defined in terms of the kinds of low-level and high-level usage of computers by both teachers and learners. Low-level usage involves activities such as learners performing internet searches, while high-level use includes activities such as learners performing multimedia presentations, collecting, and interpreting data for learning projects (Pittman & Gaines, 2015; Hsu 2016; Gilakjani 2017). Further, technology integration is defined as how teachers incorporate technology to do familiar tasks more productively and how the utilization can reshape tasks such as; the utilization of technology tools in general content areas in education in order to allow learners to use computer

and technology skills to learn and problem-solving (Mormah, & Bassey, 2021). Technology integration is the application of technology to improve the educational environment (Okumuş et., al ,2016; McCulloch, et., al, 2018). Technology integration for some teachers might mean utilization of the most recently developed technologies such as tablets and wearable devices, implementation of a one-to-one laptop initiative, and development of daily lessons integrating interactive whiteboard, or even the launch of online instructional programs that may substitute the use of the traditional textbooks. To other teachers, it may mean creating a PowerPoint to demonstrate an understanding of a concept or learners' access to technologies in a computer laboratory. Still, other teachers may recognize technology integration as using overhead projects, chalkboards or dry-erase boards, or textbooks with papers and pencils (Kim et al., 2019). Finally, technology integration as defined by Gilakjani (2017) is how teachers apply technology to develop learners' thinking skills. Technology integration in this study means the strategic or intentional incorporation and use of technologies in an educational environment to support teaching and learning.

2.2.1 The uses and integration of technology into teaching and learning

Technology integration has become essential for teaching today (Kim, et., al, 2013). Technology integration is the process of determining the tools and methods for implementing these tools to address pedagogical situations and problems (Ertmer, et., al, 2015). According to a study by Rodinadze and Zarbazoia (2012), using technology, teachers can increase literacy and understanding in any subject. Their study findings revealed that using audio and video components in lessons motivates more learners to participate in class, raise their understanding, and able to check their progress through the internet.

Different researchers have demonstrated how integrating technology into teaching and learning is very important. As suggested by Hunter (2015) integrating of technology should consider three elements that are content, pedagogy, and technology, not in isolation but in complex, vibrant operational relationships that define teaching practice. In regard to some schools in developing countries, poverty and issues related to the availability of substantial financial resources can hinder access to a wide range of technology (Hsu, 2016). Thus, Agyei & Voogt (2015) indicated that to increase teachers' hands-on experiences, skills, and competencies in the use of technologies in

teaching, related courses, and training should be made readily available to prepare them to use technologies in their classrooms. Technical support, adequate time, and professional development programs should be extended to teachers to increase their self-confidence and competency in the use of technologies in teaching (*ibid*). On the same note, digital devices and supporting equipment, such as computers, tablets, smartphones, etc., can afford opportunities to enhance the learning experiences and convey concepts and ideas that would otherwise be difficult to express (Mulenga, & Marbán, 2020; Naidoo, 2020). The integration of technology goes beyond the utilization of a digital device but rather is a part of the instructional process and must be deliberate in how and why it is being used. Placing technology devices in the classroom or installing a computer lab only provides increased access for learners. Technology integration must also consider infrastructure and network capabilities to ensure adequate operation as well as capacitate teachers to implement effective classroom and pedagogical use. It is also insufficient to provide learners and teachers with digital devices without technical support and to explore what can be done with these technologies and how they can enhance the teaching and learning processes (Chun et al., 2016).

In the study conducted by Ratheeswari's (2018) the findings revealed that the use of ICT in education, technologies were found to play salient roles in educational institutions, and technologies were also recognized as catalysts for learning change. The study further concluded that the technology used in the classroom offered learners opportunities to learn and develop the required 21st-century skills. It is within this view that Gilakjani (2017) suggests that technology improves teaching and learning as it transforms teachers' roles into facilitators of pedagogical environments. Technologies help teachers to present their teaching attractively at any level of educational programs. Most technologies exemplified by the internet and interactive multimedia are an important focus for future education and must be effectively integrated into formal teaching and learning. Though technology is believed to enhance and provide learners with the opportunities to demonstrate creative ideas in an innovative format that is otherwise unobtainable in the standard classroom setting (Matuk et al., 2015); the teachers' knowledge and perceptions of the technology integration plays an important role in influence the way they integrate technologies in their classrooms (Ifinedo et al., 2020).

2.2.2 Challenges of technology integration in teaching and learning

The rise of digital technologies and the expectation of their successful integration into the classroom provides many teachers with a substantial challenge (König et al., 2020). Barriers such as the improper operation of computers, maintenance problems associated with outdated software, inadequate technical support, lack of time to learn the operation of technology and lack of access to technology are some of the experiences that hinder teachers from effectively integrating technology into teaching (Raja & Nagasubramani, 2018; Ghavifekr & Rosdy, 2015).

The study done by Ruggiero and Mong (2015) revealed that technology in the classroom makes learning more accessible and engaging but must be strengthened efficiently to meet instructional goals. Standard technologies, such as books, chalk, and blackboard, as well as more advanced technologies, such as the internet and digital video, require specific technological knowledge and skills to be implemented well in the classrooms (Mishra & Koehler, 2006). It is also noted by Mohebi and Meda (2021) that where the teacher leads, the implementation of technology is the key to creating a classroom that integrates technology into the curriculum to enhance learners' experiences and better prepare them for the future. In order to integrate technology successfully in classes, both teachers and learners should adopt new roles and use technologies in suitable ways. Teachers should be prepared with technological skills to integrate technologies into the content and pedagogies (Gilakjani, 2017). Despite the benefits that the integration of technology brings to the classrooms, there are challenges found in other studies. In the study conducted by Ertmer et al., (1999) findings revealed the factors influencing technology integration in Mathematics instruction, pointed out some internal and external barriers to technology integration. Internal barriers involve teachers' attitudes and beliefs while external barriers include the availability of computers, level of administrative support, and professional development opportunities involving technology. Other factors affecting technology integration in the classroom are poor infrastructure, inadequate technology, lack of sufficient technological tools, effective professional development, low teacher self-efficacy, and teacher perceptions (Harrell & Bynum, 2018).

2.3 The Emergency Remote Teaching

The risk-mitigating measures taken by governments to curb the spread of the coronavirus have led millions of students to stay at home, inconveniencing not only parents and guardians but also teachers. Such a compulsory inconvenience has prompted educational innovations to introduce education over a distance. The gradual outbreak of Covid-19 posed a major challenge to the educational landscape as educational institutions, both primary and secondary and tertiary were forced to close down and look for alternative teaching and learning approaches, thus emergency remote teaching was introduced (Liquori & Winkler, 2020). Emergency remote teaching is defined as a direct transposition from face-to-face to distant learning without pedagogical concerns (Bozkurt & Sharma, 2020). It is a period lived in times of crisis in which the main concern is to maintain contact between schools and learners (Hodges et al., 2020). Emergency remote teaching offers teachers an opportunity to develop other forms of learning which would enable learners to continue learning even when they may lack access to high-speed broadband internet required to fully implement online learning (Bozkurt et al, 2020). Emergency remote teaching mainly focuses on the education groups in settings where the educational physical infrastructure is severely affected, such as the impacts of natural disasters (hurricanes and earthquakes) or armed conflicts such as war (Oliveira et al., 2021). The Covid-19 pandemic crisis, on the other hand, has not affected the physical infrastructure of educational institutions but has caused an unexpected worldwide disruption of traditional teaching and learning methods migration. There is a distinction between the normal everyday type of effective online instruction and that which is done in a hurry with bare minimum resources and scant time, which is referred to as emergency remote teaching (ERT). The primary objective of ERT is to provide temporary access to instruction and instruction support in a manner that is quick to set up and is reliably available during an emergency or crisis (Hodges et al., 2020).

There have been arguments by experts that the teaching modality offered as a result of the transition to digital teaching and learning caused by Covid-19 cannot be labeled as ‘online’ learning, and thus a new concept has emerged to define the situation ‘emergency remote teaching’ (Hodges et al, 2020; Milman, 2020; Rapanta et al., 2020; Uopeople, 2020). The scholars posited the main difference between online and emergency remote teaching. The difference lies in that online teaching results from a very careful instructional design and planning, requiring an investment in

a whole ecosystem of learners' supports that takes time to build, whereas emergency remote emerges as a response to a crisis and entails or temporary shift of instructional delivery mode that involves the use of fully remote solutions for instruction that would otherwise be delivered using face-to-face, blended or hybrid courses. They further highlighted that emergency remote teaching assumes that teaching will return to the original format once the crisis ends. On the contrary, Mohammed (2020) noted that using a curriculum designed for face-to-face learning in emergency remote teaching can be a major challenge for teachers. In his study, he reported that many teachers who participated pointed out that they were using PowerPoint presentations, E-books, and online materials instead of school textbooks to share knowledge with their learners.

2.4 The integration of technology during the emergency remote teaching of Covid-19

The global Covid-19 pandemic necessitated shifts away from face-to-face (Iglesias et al., 2021; Sharma et al., 2021). To sustain education during the pandemic in most countries, teaching and learning practices were forced to move to an online environment (Nerantzi, 2020; Aliyyah et al., 2020). The system demands the use of technological tools such as videoconferencing and learning management systems typically reliant on the Internet but also accomplished in some places through the delivery of physical materials such as books and paper packets (Azlan et al., 2020). Since the pandemic in 2020 required teachers to instantly revise their daily teaching practices by endeavoring to apply technological novelty to achieve pedagogical goals, the unexpected pedagogical transformation was smoother for some teachers than others. This shift pushed the educational systems to jump into technology-mediated teaching and learning conditions. The study conducted by Adov and Maeots (2021) on 'What can we learn about science teachers' technology use during the Covid-19 pandemic' revealed that the higher teachers' perceived willingness to use technology, the easier it was for them to overcome potential obstacles and cope with the unexpected distance learning. The study further revealed the main obstacles, such as; lack of slow internet connections, lack of digital skills among students, and teachers' beliefs about technology use for teaching. The study also highlights the importance of understanding and considering the variability in the possible obstacles that emerge in using technology in education for teachers with different levels of experience.

There are many examples of countries responding to school closure in a time of crisis. However, Shraim and Khalif (2020) noted that school closures caused many families to spend a lot of money to provide their children with educational resources and enrichment activities as well as private lessons to fill the learning gaps, an act that has caused inequity in education for poorer families in particular. Researchers, however, reported that education continued despite the above-mentioned issues. For example, Copperbelt University in Zambia installed the Moodle platform in August 2020 on its e-learning platform for the main purpose of administering end-of-academic-year examinations scheduled for September 2020. It was noted that most students and lecturers were not familiar with using the Moodle LMS hence intense training was conducted in a three-day space for the staff.

The study by Arlinwibowo et al., (2020) that aimed to understand the response of schools related to the Covid-19 emergency policy and preparation of learning conducted by teachers in Indonesia revealed some very interesting findings. The study found that schools quickly adhered to government policies to implement distance learning. However, follow-up at each school varied greatly. Each school interprets the government circular and adapts it to suit the contextual educational situation. It was noted in the study most teachers modified the existing learning curriculum by considering local conditions and learners' learning needs. Modifications to the learning curriculum were very different because the learners' needs and the materials' character were very versatile. The most difficult challenge was designing learning media and making fair assessment plans. The teachers' lack of technical skills was an obstacle in designing digital content and planning the assessment.

Another study done by Khalif et al. (2021), on the teachers' responses to school closure in developing countries, teacher participants responded that they faced some critical issues. For example, the ambiguity of the guidelines to use to transform to online learning, lack of technological pedagogical knowledge, lack of technological content knowledge, and learners, implementation of equity and access to the lessons in an online environment, and the teaching environments. Teacher participants from developing countries also reported different challenges that emerged due to the transformation to online teaching and learning, such as; lack of online teaching infrastructures, lack of technical support, the inexperience of teachers including unequal

learning outcomes caused by teachers' varied experiences, lack of instructional skills in distance education, the information gap and the complexity of the social environment.

The major challenge of implementing ERT is the lack of direct interaction and communication between the teachers and learners (Varea & González-Calvo, 2021). Teachers and learners needed to adapt quickly to the radically different teaching and learning environments while coping with the social and psychological effects of the crisis (Rapanta et al., 2020). A study conducted by Abel and Alvarez (2020) titled 'Phenomenon of learning at a distance through emergency remote teaching amidst the pandemic crisis', revealed four themes as main challenges faced during the crisis: poor to no internet access, financial constraints, lack of technological devices, and affective or emotional support. The study done by Rahiem (2020) on the technological barriers and challenges in the use of ICT during the COVID-19 emergency remote learning reported that the use of appropriate and relevant pedagogy for emergency remote instruction depended on the expertise and exposure to information and communication technology by both teachers and learners. Not all schools have the human and physical resources to transit entirely to emergency remote teaching (Watermeyer et al., 2021). In many developing countries, economically challenged children cannot afford to acquire and access technology devices and internet services.

Findings from the study done by Chuah and Mohamad (2020) on emergency remote teaching scenarios, struggles, and soundboxes, a case study on Malaysian teachers. The study suggests a necessary step to identify and determine how teachers articulate their perspective as remote educators during emergency remote teaching. Through a survey, a group of trained graduate teachers was recruited as participants to investigate strategies and struggles encountered during ERT. This study's findings showed that teachers were equipped with pedagogical knowledge in integrating technology. They were also unable to fully utilize what they learned in their teacher training program during ERT due to a lack of administrative support from the school and poor infrastructure accessibility. In their study, Chuah and Mohamad (2020) suggested a need for future studies to investigate the synergy between parents, schools, and teachers in working cohesively to ensure effective learning at home and in school, especially during the ERT.

The study by Mugroho, Haghegh, and Triana (2021) on exploring the teachers' insights and suggestions to overcome the challenges of the ERT amidst the global pandemic. The findings from the 26 participants through self-reflection and semi-structured interviews revealed that teachers encountered challenges such as unfamiliarity with digital platforms, inability to provide quick feedback and lack of student motivation and engagement. Mugroho et al. (2021) suggested that joining professional development programs, creating representative lesson plans, and designing interactive online classroom activities could become alternative solutions.

2.5 Theoretical Frameworks

The theoretical framework is the 'blueprint' for the study that serves as the guide on which to build and support a study (Osanloo & Grant, 2016; Yamauchi et al., 2017). defined A theoretical framework as a structure that guides research relying on a formal theory constructed by using an established, coherent explanation of certain phenomena and relationships (Osanloo & Grant, 2016). The objective of this study was to investigate the development of technological pedagogical and content knowledge of teachers through the integration and use of technology during the emergency remote teaching of the Covid-19 pandemic. Therefore, the TPACK framework (Mishra and Koehler, 2006) and the Socio-Cultural theory (Vygotsky, 1978) are the informing theoretical frameworks of this study. The TPACK framework allows teachers to examine and reflect on their practice and how technology is integrated into the classroom, it, however, does not optimize teaching and learning through social and cultural interactions using technologies (Purwati, 2022; Kearney et al., 2020; Chen & Xu, 2022). The TPACK framework has also received criticism for not being practically useful, particularly, the technology knowledge domains have been criticized for being vague (Cox & Graham, 2009; Graham, 2011). Vygotsky (1978) believed that meaningful learning is strengthened through social interactions with artifacts (materials) from their culture. Sociocultural theory is, therefore, used in this study to investigate whether the integration and use of technology mediate learning[teaching] during the emergency remote teaching period. Within this theory, the researcher used two concepts of sociocultural theory; *mediation of learning* and *social interactions*.

However, with the increasing ubiquity of technology in teaching and the expectations that teachers will include technology in their instruction, Koehler and Mishra's (2009) technological pedagogical and content knowledge model (TPACK) is discussed and used as a model that places

the knowledge and pedagogical uses of instructional technology in content-specific settings. The Vygotskys' (1979) social constructivism theory assumes that very complex and dynamic learning is a result of social and cultural interactions. In the traditional paradigm, social and cultural interactions are implemented using face-to-face communication with peers and people from different target cultures. This situation becomes very problematic when learners' learning environment does not support the conditions mentioned above. However, in the era of technology, teachers can use technology to facilitate learners to interact and engage in different cultural situations to optimize learning. Technology promotes its benefits to connect, interact, engage communications, and make meanings in a wide range of authentic learning situations and diverse cultural backgrounds (Kukulska-Hulme et al., 2017). It is, therefore, against these criticisms that this study found the aforementioned theories worth combining in order to exploratory investigate teachers' development of TPACK through the integration and use of technology during the emergency remote teaching of the Covid-19 pandemic in the Endola education circuit.

2.5.1 Technological Pedagogical and Content Knowledge Framework

Technological pedagogical and content knowledge (TPACK) was introduced to the educational research field as a theoretical framework for understanding teacher knowledge required for effective technology integration (Mishra & Koehler, 2006). It builds on Shulman's construct of pedagogical content knowledge (PCK) to include technology knowledge as situated within the content and pedagogical knowledge. The TPACK framework is a requirement for designing, implementing, and evaluating curriculum and instruction with technology (Taopan et al., 2020)., resonates that the TPACK framework helps explain the types of knowledge most needed to make technology integration successful in the classroom (Hilton, 2016). In the era of technology, teachers can facilitate their learners to interact and engage in different cultural situations to optimize their learning.

Technological pedagogical content knowledge is the basis of good teaching with technology and requires understanding the representation of concepts using technologies (De Rossi & Trevisan, 2018; Makawawa et al., 2021). There is no single technology solution that applies to teaching and all teachers. Effective teaching requires developing a nuanced understanding of the complex

relationships between technology, content, and pedagogy and using this understanding to develop appropriate, context-specific strategies and representations (Koehler et al., (2013). As technological pedagogical content knowledge is regarded as the basis for teaching with technology, it requires understanding pedagogical techniques that use technologies constructively to strengthen previous knowledge and develop new knowledge (Graham, 2011; Malik et al., 2019). Understanding technological pedagogical content knowledge among teachers can provide a coherent structure that allows them a better understanding of sound technology integration. Teachers with sound technology integration make effective decisions regarding learning content, teaching goals, and pedagogical methods and assess the lesson outcomes (Henriksen et al., 2016).

Mishra and Koehler (2006) adjusted the TPACK to demonstrate the framework within the subject context, as indicated in *Figure 1* below.

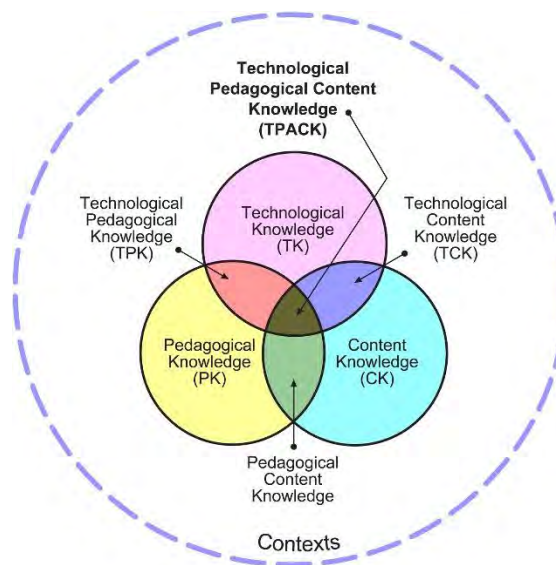


Figure 2.1: shows the picture of the TPACK framework as adopted from tpack.org

The combination of the knowledge domain, as illustrated in Figure 2.1 brought about what is known as constructs of the TPACK framework, and all seven constructs were found to be relevant to this study. The description of each construct is discussed below.

a) Content knowledge (CK): is the knowledge about the subject matter to be taught (Koehler & Mishra, 2009). The knowledge that the teacher should have about the subject including concepts,

theories, ideas, etc. This component was used in this study to aid in revealing whether teachers know what they are teaching (subject matter) in relation to integrating relevant technologies.

b) Pedagogical knowledge (PK): is the knowledge about the processes and practices or methods of teaching and learning (Koehler, Mishra & Cain, 2013). The in-depth understanding of the teaching process and methods that the teachers must have. This component was necessary for this study because for secondary teachers to integrate technology successfully during emergency remote teaching, they needed to know how best their learners learn and what teaching strategies they need to meet their learning needs.

c) Technological knowledge (TK): the knowledge and ability to use various technologies, technological tools, and associated resources (Falloon, 2020). This is the knowledge that teachers have about thinking methods and cooperation with technology, practical tools, and teaching resources that can continuously adapt to changes in information technology. This component was essential for this study because, for the effective integration of technology, teachers must possess skills and knowledge of different technologies used in teaching and learning.

d) Pedagogical content knowledge (PCK): is the knowledge of pedagogy that is applicable to the teaching of specific content (Archambault & Barnett, 2010; Carlson et al., 2019); when a teacher is able to find multiple ways to explain the topics and adjust and value the syllabus or teaching content based on the student's prior knowledge (Aksit et al., 2018). This knowledge covers teaching, learning, courses, assessment, and reporting. Since teachers were urged to teach during the emergency remote teaching period of Covid-19, this component was needed for this study because teachers need to understand the best practices for teaching specific content to their specific learners.

e) Technological content knowledge (TCK): is the knowledge of understanding the manner in which technology and content influence and constrain one another (Mishra & Koehler, 2008, March). Teachers must have a deep understanding of how specific technologies can be applied to change the topic, understand which specific technology is most suitable for solving the topic of their field, and how the content determines or even changes the technology. This component helped

the study to investigate whether the secondary teachers in the Endola circuit understood specific technologies best suit for presenting and design content -learning in their domains and how the content dictated or even perhaps changed the technology or vice versa.

f) Technological pedagogical knowledge (TPK): is the knowledge of how teaching and learning can change when particular technologies are used in particular ways (Koehler, Mishra & Cain, 2013). Teachers' knowledge of how various technologies can be used in teaching and understanding that using technology may change the way an individual teaches. This was the most significant construct in this study because general pedagogical knowledge has been highlighted as an important ingredient for high-quality teaching. This construct captures the subject-independent knowledge teachers need as a foundation to effectively use technology in their teaching. As it stresses the relationship between general pedagogical knowledge i.e., the specialized knowledge of teachers for creating effective teaching and learning environments for all learners independent of subject matter (Guerriero, 2017), and general technological knowledge i.e., a basic understanding of technology use, skills required to operate particular technologies and the ability to learn and adapt to new technologies.

The approaches to how teachers acquire an operational understanding of complex relationships among content, pedagogy, technology, and context are of interest in this study. Teachers' digital competence involves their proficiency in using technology professionally, with good pedagogic-didactic judgment and awareness of its implications for learning strategies. From this perspective, technologies are considered a way to support pedagogical knowledge and methods. However, most of the widely used technology is not designed to operate in educational contexts, and many popular software programs are not primarily intended for educational purposes but for business purposes (Krumsvik, 2008). In the same way, most web-based services are primarily designed for entertainment, communication, and social networking (Koehler et al., 2013). This is an indication that teachers need specific knowledge to develop methods, strategies, and applications of the technology which are suitable in a teaching and learning context (Kivunja, 2013; Krumsvik, 2008; Mishra & Koehler, 2006). Typical approaches to technology-related professional development are based on assumptions that it may be enough to expose teachers to particular educational technologies and possible curriculum-based uses of the tools and resources (Ryan & Bagley, 2015; Koomson et al., 2022). Approaches that train teachers to acquire technology skills are insufficient

since learning about technology is different from learning what to do with technology instruction. Teaching technology skills in isolation does little to help teachers develop knowledge about how to use technology to teach and present content more effectively (Kafyulilo et al., 2016). Studies show that although teachers may have technological knowledge, it does not automatically mean they are capable of integrating technology into teaching practice (So & Kim, 2009; Tatto, 2013).

To help teachers develop and use technologies in ways that attend to the particular demands of different subject matter domains, Harris & Hofer (2006) suggested an important first step is creating awareness of the range of possible learning activity types within a particular content area, matching them to multiple ways that both digital and non-digital technologies can be used to support each type of learning activities. After determining the content and process goals for a particular lesson, teachers can select from among the full range of activity types in that particular content area, combining the types selected in ways congruent with learners' standards-based, differentiated learning needs and preferences.

2.5.2 Sociocultural Theory

The sociocultural theory explains how individual mental functioning is related to the cultural, institutional, and historical context (Eun, 2019); hence, the focus of the sociocultural perspective is on the roles that participation in social interactions and culturally organized activities play in influencing psychological development (Palmer et al., 2015; Polly et al., 2017). This theory describes learning as a social process based on understanding human intelligence in a society or culture (Pea, 2018). Vygotsky (1978) believed meaningful learning is strengthened through social interactions with artefacts (materials) from their culture. The sociocultural theory was therefore adopted in this study to exploratory investigate teachers' integration and use of technology-mediated learning[teaching] during the emergence of the remote teaching period in the Endola circuit. Within this theory, the author (researcher) adopted used two elements of sociocultural theory; *social interactions* and *mediation of learning* conjunctively.

a) Social interaction

Social interaction plays a critical role in the process of cognitive development, especially in the development of higher-order thinking skills (Polly et al., 2017; Baguma et al., 2019). Social activities between a teacher and a learner lay a foundation for how and what the child will think and do in other situations (Driscoll, 2000). Similarly, Vygotsky (1978) believed that learning is an active process rather than a natural or passive one. He added that people are engaged in their own learning and discovery, but their development happens in the context of social interaction as opposed to independently or in isolation. On the other hand, Vygotsky's theory stipulates that the development of the child's higher mental processes depends on the presence of mediating agents in the child's interaction with the environment (Kudumo, 2020).

b) Mediation of learning

Mediation as defined by Vygotsky (1978), refers to the link between teachers and learners that directly affects learners' understanding of knowledge and skills in learning a certain content. Mediation involves social mediation tools and/or artefacts that can mediate learning (*ibid*). In terms of technological learning environments, it is necessary to emphasize that the tools that mediate new knowledge can be represented in the form of various technologies such as the Internet, Learning Management Systems, and social media (DeSchryver & Yadav, 2015; Guichon, & Cohen, 2016). The theory acknowledges the dynamic nature of the interplay between teachers, learners, and tasks and provides a view of learning as arising from interactions with others. Socio-cultural theory assumes that learning arises *in interaction* but not *through interaction*. Learners first succeed in performing a new task with the help of a knowledgeable person and then internalize this task so that they can perform it on their own. In this way, social interaction is advocated to mediate learning (Ellis, 2000). As for this study, the technological tools used by the teachers (participants) were referred to as mediation tools and artefacts that enabled the teaching, and, social interaction in this study offered a lens analyzing how teaching was mediated through different technological tools (digital and non-digital) during emergency remote teaching in the covid-19 pandemic.

The intersection point of the above discussed theories is that sociocultural theory views technology as a tool that can mediate social interactions and cognitive development. When teachers apply TPACK, they consider how technology can be integrated into teaching and learning to enhance pedagogy (teaching

methods) and support the understanding of content. The sociocultural perspective helps teachers understand how the use of technology can facilitate social interaction and collaborative learning. Therefore, the TPACK framework and sociocultural theory can interact by emphasizing the role of technology in mediating social interactions, supporting collaborative learning, and creating culturally and socially rich learning environments. Combining these frameworks in this study helped the researcher to understand how secondary school teachers designed effective and contextually relevant culturally sensitive technology-enhanced teaching and learning experiences during the emergency remote teaching of the Covid-19 pandemic.

2.6 Summary of the chapter

This chapter launches into an expansive review of the literature pertinent to the field of study, closely analyzing works previously conducted by multiple scholars. This collection encompasses diverse research drawn from a multitude of both theoretical and analytical standpoints. The preliminary focus revolves around mainstream opinions concerning the integration of technology into teaching and learning settings, providing the context for further exploration. Understanding the incorporation of technology in these settings becomes particularly critical during periods such as the Emergency Remote Teaching (ERT), brought about by the unprecedented situation of the COVID-19 pandemic. This unusual context allowed for an examination of the challenges that stem from the integration of technology into teaching and learning during emergency periods.

Furthermore, the literature explores the evolution of Technological Pedagogical and Content Knowledge (TPACK) among educators, a development which has been catalyzed by the increased reliance on technology in educational practices. Forming the solid groundwork for this study, the chapter also elaborates on the two theoretical frameworks of learning, TPACK and Sociocultural theory, providing the readers with the necessary backdrop for this research. The following Chapter, Chapter 3, presents the methodology of the study that is used to unpack all the data about the development of TPACK after emergency remote teaching.

Chapter Three: Methodology

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3.2	• Study designs
3.3	• The researchers' position
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3.10	• Summary of the chapter

3.1 Introduction

In the previous chapter, the researcher examined the research thesis, papers, and articles that addressed the integration of technology in teaching. There is also an examination of the concept of emergency remote teaching and technological pedagogical content knowledge as knowledge that enhances the integration of technology into teaching and learning. Both the previous chapters also discussed models and frameworks (theories) of good teaching in relation to technology integration into teaching. In this chapter, the researcher elaborated on the methodological approaches employed to obtain the findings, how they were analyzed, the validity, trustworthiness, and ethical considerations.

Research methodology is the specific procedures or techniques used to identify, select, process, and analyze information about a topic (Abutabenjeh & Jaradat, 2018; Opoku et al., 2016); research methodology provides a mind that allows the researcher to find out how best to address research questions (Rutberg & Bouikidis, 2018). Therefore, this chapter delineates the research methodology employed to address the research questions:

1. How do secondary school teachers integrate and use technology during the emergency remote teaching of the covid-19 pandemic in Endola education circuit?

2. How do integration and usage of technologies during emergency remote teaching in the Endola education circuit support secondary school teachers' technological pedagogical and content knowledge development?

The study, therefore, was focused on the development of technological pedagogical content knowledge through the integration and use of technology during the emergency remote teaching of covid-19 pandemic. The researcher investigated the development of technological pedagogical content knowledge among secondary school teachers and the opportunities and challenges the participant secondary school teachers encountered during ERT.

This chapter is organized into distinct sections as outlined below: Section 3.1 introduces the chapter's structure and layout. In Section 3.2, the study designs are expounded, encompassing the research paradigm, approach, and the utilization of a case study. Researchers' perspectives are detailed in Section 3.3. The research site, sampling techniques, and participant information are presented in Section 3.4. Sections 3.5 and 3.6 elaborate on the data collection methods employed: questionnaires, interviews, and focus group interviews. The data analysis methodology is described in Section 3.7, while Section 3.8 delves into aspects of validity, reliability, and trustworthiness. Ethical considerations are addressed in Section 3.9, followed by the concluding remarks in the last section, 3.10.

3.2 Research Study Design

3.2.1 Research paradigm

A research paradigm is a way of looking at or research phenomena, a world view, or a view of what counts as an accepted or correct scientific way of working (McGregor & Murnane, 2010; Ryan, 2018). This study was underpinned by an interpretive paradigm, as the researcher's purpose is to describe and interpret the world's phenomena to share meaning with others (Antwi & Hamza, 2015; Kivunja & Kuyini, 2017). The paradigm is appropriate for this study to provide an understanding of the research problem since the study will seek participants' views concerning meanings and experiences on the use and integration of technology during emergency remote

teaching as well as the development of technological pedagogical and content knowledge. By adopting this paradigm, the study aims to delve into participants' perspectives, capturing intricate nuances related to the meanings and experiences associated with the utilization and seamless integration of technology within the realm of emergency remote teaching. Additionally, this paradigmatic approach will enable an insightful investigation into the dynamic evolution of technological pedagogical and content knowledge, shedding light on its development amidst the unprecedented challenges posed by emergency remote teaching scenarios. Through the lens of this paradigm, the study endeavours to unravel a rich tapestry of insights, contributing not only to the academic discourse but also to the practical enhancement of educational practices in times of crisis.

3.2.2 Research approach

Concepts such as social interaction, mediation, integration, and development are difficult to quantify. As a result, the researcher opted to use a qualitative approach to this study. By collecting data in real-world settings under common everyday conditions, the researcher has chosen a naturalistic qualitative methodology (Sherman et al., 2016). Naturalistic qualitative research is described as an approach to research that aims to understand and describe human behaviour and experiences in their natural setting without any intervention or manipulation by the researcher (MacDonald, 2012; Antwi & Hamza, 2015). In this type of research, the focus is on exploring the perspectives, beliefs, attitudes, and experiences of participants, and the researcher tries to capture the richness and complexity of their worldviews through open-ended interviews, observations, and document analysis (*ibid*). The goal of naturalistic qualitative research is not to test a specific hypothesis or theory but rather to generate new insights and understandings about the social phenomenon being studied (Thorne, 2000); researcher aims to immerse themselves in the context being studied and to understand the meaning and significance of events and interactions from the participants' perspectives (Krauss, 2005). For this study, the naturalistic qualitative tradition of the case study was used to explore if the integration of different technologies during the emergency remote teaching of Covid-19 pandemic provided opportunities for secondary school teachers to develop the technological pedagogical content knowledge for effective use and integration of technologies into their teaching their various subject areas.

3.2.3 The use of a case study in this investigation

In this study, the researcher investigated a contemporary phenomenon in depth within its real-world context. The phenomenon and context boundaries are not clear. It is situated in a context where there are more variables at play than simple data points. Therefore, multiple sources of evidence are needed (Altheide & Johnson, 2011; Mason, 2006). The study is also framed around the concept of existing theoretical propositions to guide analysis. According to A case study involves an in-depth examination of a particular phenomenon, event, or individual. It also involves collecting and analyzing data from a variety of sources, such as interviews, documents, and observations, to understand the complexity of the situation and gain insights into its unique characteristics (Flyvbjerg, 2011). A case study is therefore suitable for most empirical inquiries to pursue this study subject phenomena were integration and use of technology to continue teaching during the emergency remote teaching that influenced the experiences, opportunities, challenges, and development of TPACK thereof. The bounded context of technology integration in teaching and learning during the ERT was part of the larger context. The case in this study is secondary school teachers who integrated technology to continue teaching during the emergency remote teaching of Covid-19 pandemic.

3.2.4 Research design

The research design of this study constitutes a qualitative approach that involves the purposeful use or description, explanation, and interpretation of collected data (Moser & Korstjens, 2018; Fisher & Bloomfield, 2019). Thus, this study adopts the case study method. A case study as a process in which a researcher explores a program, an event, an activity, a process, or one or more individuals in depth (Hancock et al., (2021). A case study is appropriate for the study since the researcher has examined teachers' technological, pedagogical, and content knowledge development in natural settings, which is emergency remote teaching. The case in this study is secondary school teachers. And the unit of analysis is the integration of technology, emergency remote teaching, and technological pedagogical content knowledge.

3.3 The researchers' position

The position of the researcher is vital in qualitative research because their personal experiences and insights are an important part of the inquiry and critical understanding (Palaganas et al., 2017). The position of a researcher requires attention in research as it can negatively affect how data is collected and interpreted (Berger, 2015). When the researcher entered the field, collecting data, interpreting the data, and sharing the findings, as a researcher, I attempted to capture the voices and understand the interests of the participants as a group and as individuals. Therefore, it is very important to have a good understanding of my position in this study. At the time of this study, the researcher was the Head of the department for the secondary level phase and has also taken part in emergency remote teaching during the COVID-19 pandemic 2020-2021. For this study, the researcher and the participants are all secondary school teachers in the Endola education circuit. This position was likely to influence how the participants interacted with the researcher during the research process. As a teacher-researcher, I was aware of uneven power relations between me and the participants.

First, I acknowledge that my position as a teacher in the Endola Education circuit was a potential risk to the study. To counteract these power dynamics, I established rapport and trust with these teachers by explaining that I was doing this research with them rather than on them, as reiterated by Ngcoza and Southwood (2015). Furthermore, I acknowledged the role of culture in this research. My cultural background is the same as that of most participants. I acknowledged that I was dealing with participants' beliefs and lived experiences from the same culture as mine. As a result, I needed to set aside all my prior cultural beliefs and research assumptions and learn from the participants. Similarly, I also respected my participants' ages, languages, nationalities, customs, races, colours, genders, and marital statuses throughout the study. I have also integrated and used different technologies and different software applications. Although my position in this study was not as a participant researcher, it was important to acknowledge how my experiences in emergency remote teaching and my position influenced the development of questionnaires and adaptation of interview questions. My positionality also influenced the inferences drawn when interpreting the data.

3.4 Sampling procedures

3.4.1 Research site

The study was conducted in the Endola Education circuit, Ohangwena region, Namibia. Although many education circuit schools in Namibia were fit to participate in this study, convenience sampling was used based on the proximity and easy access to the researcher (Etikan et al., 2016). The participants are drawn from a population of secondary school teachers in the Endola Education circuit. The assumption in this study was that secondary schools have had varying experiences of integrating educational technologies in their teaching during emergency remote teaching during Covid-19 pandemic. The Endola education circuit finds its location within the picturesque landscapes of the Ohangwena region, nestled in the northern expanse of Namibia. This serene setting, however, comes with its unique challenges due to the predominantly rural nature of the area. Schools in this circuit are strategically placed at considerable distances from each other, creating a logistical hurdle for easy accessibility. The geographical terrain presents an additional layer of complexity, as certain schools are situated amidst dense bushes and unforgiving stretches of heavy sand. These natural barriers render them less accessible and pose challenges for researchers. In light of these circumstances, the research efforts were concentrated on a carefully selected subset of the schools.

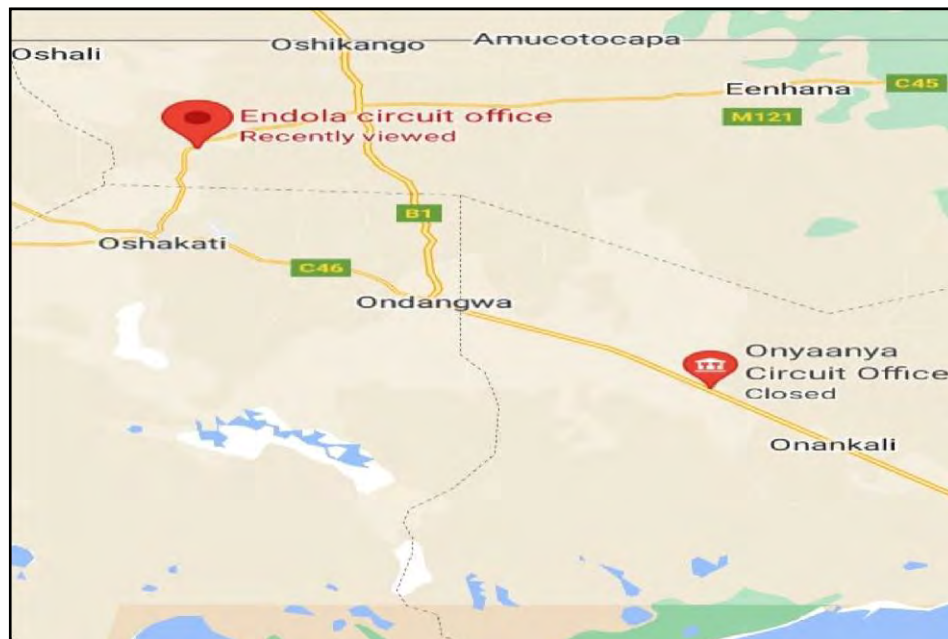


Figure 3.1: Shows the location of Endola circuit office

3.4.2 Research samples

From the broader spectrum, seven secondary schools were chosen as the focal points, allowing for a more comprehensive understanding. This deliberate sampling strategy led to the participation of twenty-six individuals, forming the core of the research study and contributing valuable insights despite the geographical constraints. The participants were selected using a purposive sampling technique. Purposive sampling is judgmental sampling and a non-probability technique that involves the conscious selection by the researcher of certain people to include in a study (Mishra & Alok, 2022). Participants are selected because they have particular characteristics that are of interest to the researcher (Moser & Korstjens, 2018). This approach enabled the researcher to carefully select participants who possessed distinct traits, which in turn enhanced their potential to make valuable contributions towards addressing the research inquiries comprehensively. As a result of these criteria, the participants were deliberately chosen based on the following aspects:

- They represented secondary schools within the Endola education circuit, thus ensuring a targeted and relevant sample.
- They had actively engaged in teaching amidst the challenges posed by the emergency remote teaching necessitated by the Covid-19 pandemic, bringing firsthand experiences to the study.
- Their enthusiastic willingness to take part in the research was underpinned by their prior consent approval, underscoring their commitment and eagerness to share their insights.

This deliberate selection process not only enriched the study's depth and scope but also established a robust foundation for meaningful exploration and analysis.

3.4.3 Research participants

It was expected that 36 secondary school teachers would participate in the questionnaires and interviews. A total of 36 self-administered questionnaires were distributed to seven secondary schools. Twenty-six questionnaires were recovered, and below is the table illustrating the administration process of the questionnaires.

Names of schools	Number of questionnaire s given	Number of questionnaire s recovered	Number of questionnaire s completed	Number of questionnaire s not completed	Number of questionnaire s unanswered
SS1	8	0	-	-	-
SS2	7	7	7	0	0
SS3	4	4	4	0	0
SS4	2	2	2	0	0
SS5	3	3	3	0	0
SS6	2	2	0	0	2
SS7	10	10	10	0	0

Table 3.1: Shows the distribution process of the questionnaires

The provided data depicts the distribution of thirty-six questionnaires across various schools. Among these, twenty-six questionnaires were returned fully completed. Notably, eight questionnaires from Secondary School One (SS1) remained unreturned despite multiple recovery attempts by the researcher. Additionally, two questionnaires from Secondary School Two (SS2) were retrieved but were left unanswered, with no attempt made. None of the returned questionnaires were found to be incomplete. Within the questionnaires, participants were given the option to express their interest in engaging in individual interviews and focus group discussions. Regrettably, only a mere three participants signaled their willingness to partake. Consequently, a subset of three secondary school educators took part in interviews and shared their reflections on the post-covid-19 scenario.

3.5 Data collection procedures

Data collection in a case study is a recursive, interactive process in which engaging in one strategy incorporates or may lead to subsequent sources of data. Further stated that there is no proscriptive method of data collection for case studies (Meriam, 1998). Thus, a unique context integration of technology necessitated undertaking an adaptive approach that relies on the utilization of a variety

of data sources in combination. A benefit of using a qualitative approach affords the personal experiences of the participants, along with the contextual settings in which a phenomenon occurs, to converge (Hanson et al., 2011; Alase, 2017). In this study, convergence, or triangulation of findings, occurred from multiple data-collecting sources that were used to increase confirmation and credibility (Abdalla et al., 2018). Prior to the study, a cover letter informing consent was given to each participant in advance, clearly outlining the intentions of the study. Additionally, the informed consent clearly disclosed protocols and procedures for the security of data, anonymity, and opt-out procedures. There were no monetary gains or otherwise offered for participation in the study. Although the experiences may have helped in the participants' professional development, they were afforded opportunities to reflect upon their practice that they would not have received had they opted out of the study. The researcher-initiated data collection in October 2022 and completed data collection in May 2023. Collected data in hard copies (questionnaires and documents analyzed) were stored in a private room at home. Audio recordings were professionally transcribed manually and secured safely upon transcription; the researcher decided to keep this for the next six months.

3.6 Data collection tools

The data is generated through carefully selected instruments to adequately address the research questions. Qualitative research is characterized in this study by the following data collection methods: interviews, semi-questionnaires, and document analysis (Coe et al., 2017; Ahuja et al., 2019). For this research study, the researcher used questionnaires, semi-structured interviews, and focus group interviews.

3.6.1 Semi-structured questionnaire

Semi-structured questionnaires are data collection tools comprising open-ended and closed questions to gather data from the respondents (Dalati & Marx Gómez, 2018; McIntosh & Morse, 2015). In opting to use the semi-structured questionnaire in this study, the researcher is also aware of its shortcomings, which included the possibility of some participants not completing and returning the questionnaires (Harrison et al., 2017). I observed that some participants find it bothersome to complete questionnaires as this needs their valuable time. Furthermore, if the questionnaire is too long, some respondents may hurriedly respond and may thus not finish responding to all the questions (Dalati & Marx Gómez, 2018). In an effort to

alleviate potential participant overwhelm, the researcher took a deliberate approach when designing the questions. This strategic design aimed to ensure that participants wouldn't feel inundated while providing their responses (Phillips, 2021).

To further enhance the questionnaire's clarity and relevance, a piloting phase was initiated, engaging two teachers from one of the participating schools. This valuable input was instrumental in pinpointing and addressing any vague elements (Cook et al., 2020). During the piloting process, a significant revelation surfaced: a particular section of the questionnaire proved excessively lengthy, and upon closer inspection, its content appeared to heavily favour one specific research question. This observation highlighted the need for a more balanced distribution of content across the research questions to provide a comprehensive perspective. The pilot study played a very important role in the initial stages of this study research, serving as a critical foundation upon which the researcher built subsequent investigations. Its primary objectives were to confirm the reliability and validity of the research instruments, ensuring that the data collected are dependable and accurately represent the phenomena investigated in this study.

The distribution of the questionnaires was directed toward thirty-six (36) carefully selected teachers hailing from seven public secondary schools within the Endola education circuit (Appendix C). Regrettably, out of the distributed questionnaires, only 26 were returned completed two were unanswered and eight questionnaires were not returned (cross reference Table 3.1, section 3.4.3). Notably, as the researcher disseminated the questionnaires, engaging interactions with participants led to the emergence of several intriguing points. One particularly resonant issue raised by participants was the perceived gap in communication between researchers and participants. Participants noted that researchers often predominantly interacted with gatekeepers, overlooking direct engagement with the individuals central to the research. In light of this, participants suggested a valuable adjustment: the provision of research theses upon completion, offering them access to the comprehensive outcomes of the study. This input reflects a desire for enhanced transparency and recognition of their contributions to the research process.

3.6.2 Semi-structured interviews

Denzin and Lincoln (2021:126) state that “we interview to find out what we do not and cannot know otherwise”. For this reason, this study used semi-structured interviews due to their merit to

permit the researcher to best outline the research boundaries and allow for the identification of emerging themes that directly relate to the research aims. This study examined secondary school teachers' technological, pedagogical and content knowledge. Hence, semi-structured interviews are the most effective method to gather data on personal perspectives, beliefs, and experiences that are impossible to gather using methods such as direct observation (Aspers & Corte, 2021). To ensure alignment of the interview protocols with the study's theoretical frameworks, the interview questions were formulated from the dimensions of the TPACK tenets to access and understand the selected three secondary school teachers' technological pedagogical and content knowledge development. An interview guide was used to direct the flow of questions (Appendix F). All interviews were voice recorded and transcribed to allow member-checking and respondent validation. These are all in an attempt to ensure the validity and trustworthiness of data. The data collected from semi-structured interviews were used to answer all research questions. Even though the participants indicated initially that they were willing to continue to this session, there were so many delays in meeting the appointments of the interview sessions that brought the delays in the research plans as indicated in the research proposal.

3.6.3 Focus group interviews

A focus group is a group of people that a researcher brings together to explore ideas and experiences about a research topic (Wilkinson, 2015). Focus group interviews aim to gather high-quality data in a social context (Guest et al., 2017; Dilshad & Latif, 2013), and it assists in understanding a specific problem from the perspective of the participants of the research (Mahajan et al., 2020). The reason for involving focus groups in this study was to create a space that could offer participants the opportunity to share their views and learn about experiences encountered by others on the integration and uses of technology during the emergency remote teaching of the Covid-19 pandemic and, how the integration of technology offered them opportunities to develop a good technological pedagogical and content knowledge. In this study, the researcher employed this data-gathering technique (Appendix F) to conduct one focus group interview session with semi-structured reflective recall questions to help gather relevant information from nine teachers from secondary schools. As a researcher, my role in the focus group interviews was to initiate interview questions that all participants would answer and tape-record the responses. The participants were requested to consent to recording the focus group interviews. The participants

were informed that there were no wrong or right answers. Each one should be free to give his/her own point of view. This gave the chance that the teachers would recall through the discussion and remember what they did not include in the questionnaires and individual interview sessions. Data that emerged from the focus group interviews assisted in responding to all research questions.

In contradictory remarks, a general focus group discussion is supposed to have a minimum of six participants (Moser & Korstjens, 2018), it was unfortunate that the number of interested participants was only three secondary school teachers. Similarly, there was tension in terms of scheduling the participants. It took the researcher about a month to manage meeting the participants to one schedule, which really delayed the research process.

3.7 Data analysis

Data analysis is the most crucial part of any research (Wickham, 2016). Data analysis is a process whereby researchers reduce data to a story and interpret it to derive. It summarizes collected data and involves the interpretation of data gathered through analytical and logical reasoning to determine patterns, relationships, or trends (Hair et al., 2019). Data collection and analysis in qualitative studies are interactive processes, as well as recursive and dynamic (Yazan, 2015; Merriam & Tisdell, 2015). Data should be simultaneously analyzed while it is being collected, allowing the process to become more intensive over time and even more so once all data is collected. For this study, the researcher attempted to derive meaning from the data using techniques that complement the case study. As data was generated, the researcher read and re-read the data sources, particularly the questionnaires and interview transcripts, as these provided the most detailed descriptions, as emphasized by Demetriou et al. (2017). From there, the researcher was possible to develop initial codes. The researcher employed three steps that made it more accessible; *line-by-line*, *paragraphs*, and *whole documents*. Line-by-line coding forces the researcher to verify and saturate categories, minimizing missing an important category (Chong & Yeo, 2015), and ensures relevance by generating codes with emergent fit to the substantive area under the study, as emphasized by Holton (2007).

The data collected using questionnaires and interviews were analyzed inductively, allowing themes and categories to emerge from the raw data. Data analysis is categorized into different stages:

editing, coding, and creating an electronic data file. The data is checked in terms of correctness, consistency, and legibility. After it had been edited, it was coded, and symbols were assigned to raw data (Zikmund et al. 2013; Elliott 2018). This study analyzed the data collected from the questionnaires quantitatively using descriptive statistics. Descriptive statistics transforms or summarizes a set of data into either a visual overview, such as a table or graph or into a single or a few numbers that summarize the data (Bertram & Christiansen, 2014). The researcher used the two concepts of sociocultural theory: mediation tool and social interactions (Vygotsky, 1978) and components of TPACK that include the sense of technology on it, as adapted from Mishra and Koehler (2006) to serve as a lens for analyzing specific knowledge elements of technological pedagogical and content knowledge developed (or not) by the secondary school teachers during the emergency remote teaching in Endola circuit. The focus of the analysis was on the teachers' technological pedagogical and content knowledge development during emergency remote teaching. Finally, the researcher used different colour highlighters to group the data, then moved from coding to categories, sub-themes, and themes and coded the data, that is the process of choosing labels and assigning them to different parts (Engler et al., 2021).

3.8 Validity, reliability, and Trustworthiness

Trustworthiness in case study research as the consistency and repeatability of the research procedures used in the study. In this study, the intention of taking care of trustworthiness was to maximize validity. Validity is the degree to which the results are truthful, while reliability is the consistency or repeatability of test results (Mohajan, 2017). Validity is defined as the degree to which a research study accurately measures or reflects the concept or phenomenon it should investigate (Cypress, 2017). In other words, research validity refers to the extent to which the research findings are trustworthy, credible, and meaningful (Rose & Johnson, 2020; Connelly, 2016). To achieve this, the researcher focused on credibility, transferability, authenticity, and substantive validation (Hays & McKibben, 2021). The strategies to ensure trustworthiness in qualitative case study research (Baxter and Jack, 2008). In the context of this study, after exiting the field, interview transcripts and coded papers were made available to all participants to ensure accuracy, seek clarification and pinpoint instances of researcher bias.

Triangulation of the data collection tools is used to ensure validity in the analysis of the data collected for this study. Triangulation of the data was used to determine consistency and differences within findings (Lawlor et al., 2016). Triangulation is a method used to increase the trustworthiness, how believable the study is, and the extent to which a study accurately reflects the investigated concept. Through the use of constant comparison, and having the luxury to return to the data on multiple occasions, the researcher is also able to double-check the coding process (Noble & Heale, 2019); which is another way that the researcher ensures integrity in the interpretation. The data was also compared to the theoretical framework for the convergence of the data to provide a greater contextual understanding of the development of TPACK, experiences, challenges, opportunities, and integration of technology into teaching.

3.9 Ethical considerations

When conducting research, it is important to consider ethical principles and guidelines to ensure that the rights and well-being of participants are protected. The well-being of the research participants should be a researcher's primary priority whenever research is conducted (Mack *et al.*, 2005). Before commencing the research, ethical clearance was obtained (See Appendix A) from Rhodes University, which gave the researcher the go-ahead to get permission from the Directorate of Education Ohangwena region (See Appendix B), and thereafter get permission from the Inspectorate of Education Endola circuit (See Appendix C). Verbal permission was also obtained from the principals of the secondary schools that participated in the study. Teacher participants consequently signed consent letters prior to their participation in the study. For this research study, major ethical considerations were taken into account consequently as follows. For the informed consent, participants were provided with clear and understandable information about the purpose of the research, the procedures involved, and any potential risks and benefits. They were given the opportunity to ask questions and provide voluntary consent before participating. Participants' identities were kept confidential, and their personal information was not shared without their explicit permission. All data collected was stored securely and only accessible to the researcher. The research did not involve any physical or psychological harm to participants. Any potential risks were carefully considered and minimized through appropriate measures, such as debriefing and offering support if needed. The selection of participants was made without any bias or discrimination. The research was conducted in a manner that respected cultural, social, and

personal differences among participants. Participants were given the freedom to withdraw from the study at any time without consequences. They were also given the opportunity to participate in the research on their own terms and were not coerced into participating.

Overall, the ethical considerations taken in this research aimed to ensure that participants' rights and welfare were protected and that the research was conducted in a responsible and ethical manner. Confidentiality and anonymity are of the utmost importance in research (Marshall et al., 2022). All research data was therefore anonymized through a coding system that will be used for the publication of the thesis. Participants were also discouraged from using or stating any information that may lead to exposure, e.g., mention of names, schools, or people.

3.10 Summary of the chapter

In this study, the researcher sought to investigate the development of technological pedagogical content knowledge among secondary school teachers when they integrated technology into their teaching during the emergency remote teaching of the Covid-19 pandemic. This study examined the influence of technology integration in the development of TPACK. Participants were secondary school teachers who were teaching the secondary level phase during the lockdown of the Covid-19 pandemic. Participants completed questionnaires as well as underwent semi-structured interviews and focus group interviews, which focused on different aspects of TPACK. Other data collected came from documents analyzed that are teachers' personal reflections.

Furthermore, the reasoning behind the purposely selected thirty-six (36) participants from a population of the education circuit secondary school teachers was discussed. A process of data collection and analysis was provided, which highlighted how codes were generated and themes discovered. These themes form the basis of the empirical findings, which will be discussed in Chapter 4. The steps taken to ensure trustworthiness were outlined by stressing the importance of methodological triangulation and member checks. The researcher's position as a complete insider was stated, and the steps taken to counter subjectivity and bias were verification and reliability checks. In conclusion, ethical considerations were discussed by indicating how ethical clearance was obtained and the participants' well-being, confidentiality, and anonymity were ensured. Subsequent of this chapter is Chapter 4 which is the presentation of the data gathered through the

data gathering techniques as discussed in this chapter. The data is presented according to the research questions.

Chapter Four: Empirical research findings and Analysis

4.1	• Introduction
4.2	• Teachers' perceptions towards TPACK
4.3	• Technology used during ERT
4.4	• Uses of technology during ERT
4.5	• Challenges experienced during ERT
4.6	• Assessment of TPACK
4.7	• TPACK development from ERT
4.8	• Summary of the chapter

4.1 Introduction

This section follows the preceding chapter, which is excavated into the study's methodology. The prior chapter extensively covered the study's research design, data collection, data analysis, and ethical considerations. In the present chapter, the focus shifts to the outcomes derived from a multifaceted study aimed at fostering the development of technological, pedagogical, and content knowledge among secondary school teachers. This endeavour specifically targets the incorporation of technology during the emergency remote teaching necessitated by the COVID-19 pandemic. The investigation was undertaken to provide the researcher with an avenue to examine the development of technological, pedagogical, and content knowledge among secondary school teachers who participated in the study. Information regarding teachers' perceptions of technology integration, their technological backgrounds, and the development of their technological, pedagogical, and content knowledge was gathered using methodologies such as semi-structured questionnaires, focus group interviews, and semi-structured interviews.

The data presented in this chapter was gathered in two different phases, as discussed below:

- Phase One

In the initial phase of the study, the researcher diligently gathered essential data by means of carefully designed questionnaires. This pivotal step in the research process involved crafting comprehensive surveys that were tailored to extract specific insights. For further details regarding

this data collection approach, please refer to the section for an in-depth exploration of the methodologies employed.

- Phase Two

In the subsequent stage of this research project, the investigator, having thoroughly examined the collected questionnaires, proceeded to carry out a series of comprehensive research interviews. These interviews encompassed both one-on-one sessions and focus group discussions. This multifaceted approach allowed for a more in-depth exploration of the research questions, fostering a holistic understanding of the underlying nuances and perspectives.

In this chapter, a structured approach is employed, dividing it into distinct sections. The initial section, Section 4.1, serves as the chapter's introduction. It encompasses a review of the preceding chapter, outlines the phases under which the study was executed, the research questions and the participant's background. Subsequent sections, numbered 4.2 through 4.7, present various facets: teachers' perspectives on the integration of technology, the technological tools utilized during Emergency Remote Teaching (ERT), teachers' strategies for employing technology throughout ERT, the encountered challenges during this period, an evaluation of Technological Pedagogical Content Knowledge (TPACK) constructs, and the development of TPACK competence. The last section, Section 4.8, draws the chapter to a close, offering concluding insights.

Participants' background and information

Total number of participants	Gender		Age group range	Field of expertise	Teaching experiences (Years range)
	Female	Male		Mathematics and sciences	
	17	9		Languages	
26			24 – 49		5 – 22

Table 4.1: shows the participants' background profiles

Research questions:

During the unexpected and sudden change in instructional practices driven by the Covid-19 pandemic, teaching and learning practices switched from face-to-face to online and blended teaching instructions. The following research questions were designed to drive this study, and the findings are presented respectively:

RQ1: How did secondary school teachers integrate and use technology during the ERT of the Covid-19 pandemic?

RQ2: How do secondary school teachers' integration and usage of technology during ERT support TPACK development?

To answer research question 1, this chapter presents findings about the experiences of secondary school teachers TPACK, the type of facilities that were available at schools before ERT, the technological devices teachers used during ERT, and the technological tools that facilitate teaching and learning during ERT. A description of how teaching and communication were conducted between teachers and learners is also discussed, followed by how technology supported (facilitated or not), and technological challenges experienced during ERT. To answer research question 2, findings about the assessment of different TPACK constructs are presented, and lastly, the TPACK developed by secondary school teachers on the use of technology during ERT.

The total number of secondary school teachers who participated in the study was 26 teachers, and to protect their privacy and adhere to ethical protocols, participants were labelled by the numbers and type of research methods of their participation. All participants' quotes are presented exactly as transcribed, i.e., even if there are language issues, such as grammar, codeswitching, and repetition of words in their responses, it is kept as it is so that the responses would not lose their meaning and for sense-making and meaning, codeswitched words are indicated in the brackets after every codeswitch.

RQ1: How did secondary school teachers integrate and use technology during the ERT of the Covid-19 pandemic?

All participants who responded to the questionnaires reported that they experienced the shift from traditional face-to-face teaching instructions to ERT for the first of their teaching. Despite the challenges of limited resources, they have tried and managed to use the limited available technology tools and means that they have been using before the pandemic so that they can continue with education (teaching and learning) as requested by the Ministry of Education through different directives. Following is the presentation of findings from semi-structured questionnaires administered by 26 secondary school teachers in the Endola education circuit on the technology used during the ERT of covid-19 pandemic.

4.2 Secondary school teachers' perceptions towards' technology integration in teaching

To answer the main question about how secondary school teachers integrate and use technology during ERT, participants were asked questionnaires and interviews about the advantages and disadvantages of integrating and using technology in teaching and learning. All participants could identify the advantages and disadvantages of integrating technology into teaching. This builds a thesis that teachers have both positive and negative perceptions of technology integration. A large number of participants ($n=18$) showed negative perceptions, while a few numbers of participants ($n=8$) from the questionnaire responses responded positively. During the semi-structured interview, participants could explain how technology is important and how it facilitates teaching and learning.

According to participants, technology helps them to teach effectively only if teachers are also good at it. Technology improves learners' participation because some tools raise the curiosity of learners towards the lesson content. It also gives teachers more opportunities to use different resources. Teachers are no longer bound to the hard textbooks and common knowledge carried from their training and their communities. Technology is also time-saving because instead of going to the library to search for books, teachers can only search on different search engines and get more information in a short time. As participant FGI1 stressed during the group discussion *"let me say it was a challenge to teach during the time of COVID-19, but I must thank the existence of technology, to be specifically the existence of social media"*. During the individual interview sessions, participants interviewed explained how technology was found useful. SSI1 narrated that:

"In fact, there are several factors that encourage teachers to use technology in their teaching. Aaa... I can say, it makes learning easier and more fun to the learners. It saves time when you are using either a laptop

or a computer or a smartphone. It saves time and resources rather than traditional ways of teaching whereby you have to prepare some hard copies, to duplicate, you have to look for some books, sooo with technology you get (all this) as quick as possible, so it saves time and resources.

Other participants from individual interview sessions added that technology has many advantages to both teachers and learners, such as that technology creates a more engaged environment. It incorporates different learning styles, as some children learn well through the integration of technology, it also improves collaboration as teachers and learners will be helping each other when they are using technological tools. And lastly, technology in the classroom provides teachers with more sources to support learners. SSI1 narrated that

“ So, another thing aaa... when aaa, when you integrate technology during teaching and learning, it stimulates learners’ interest in a certain subject aaa...it facilitates learners’ activeness in group work and strengthens learners’ collaboration. (With technology) activities are more presentable and they are having less (fewer) errors, learners’ access more wide variety of information through internet compared to just teachers’ notes and textbooks.”

Most participants felt that technology only helped those schools and individuals that have equitable technological facilities and the schools that have learners who have technology skills. Participants also indicated that the type of technologies they used to facilitate teaching and learning were chosen because of familiarity and availability. SSI2 stated that:

“It is important to think about learners’ interests when it comes to learning and technology is all about removing limitations and building connections. I used different tools because they are more familiar to learners and parents. For example, radios, TVs, and laptops. Most of the learners and parents are familiar with them.”

QP8 from the questionnaire responses also noted that technology only benefits learners who came from backgrounds of exposure to the uses of the internet. Participants also indicated that technology in teaching can develop creativity among teachers and enhance critical thinking in both teachers and learners. For instance, SSI1 stated that:

“the learners learn at their own time, where, anywhere they are, even outside the classroom, learning is just taking place. So, again it creates creativity and critical thinking among learners because they visualize things in their real life. So, it is like they are

learning, thinking in real life then just theory because they can see videos, they can see pictures, and so forth from the internet.”

From the individual interview sessions, some participants also indicated positive notes that technology facilitates teaching and learning. According to SSI2:

“Many digital tools equip learners with freedom to explore their own ideas. Activities are created according to the topic or theme of the day. Activities for the languages are created according to the skills. When I want to give an activity in listening and responding, I will use/give audio and learners will listen to it and will be answering. In other areas of my subjects, I used computers to google the pictures and make the questions and this made explanations clearer to the learners.”

This is similar to what participants from the focus group discussion have said, for instance, FGI3 said:

“Some concepts in science, they are sort of difficult to explain, but if you search on the internet, you will be able to see or to get, like to get pictures and videos that you can give to your learners for them to understand. So, issues of visualization, where learners will be able to see”.

SSI1 discussed the importance of technology in teaching: nowadays there are what is called team markings, technology makes marking easier, and recording marks on a computer is very safe and fast compared to a pen and paper. The use of technology has improved teaching by using different applications, such as YouTube, instead of traditional ways of teaching. It keeps students (learners) more engaged and, most important, saving information for learners’ results about their tests and examinations to keep them in the computer is safer compared to the ordinal files that have been used years back (SSI1, 2023). FGI1 narrated from the focus group discussion that *“For example, if I do not have resources, what do I do? Technology is there. There are a few computers at school. We go to the computer lab, we go on YouTube, we watch the videos of the experiments... Not only in doing experiments, but also in researching to expand their knowledge and understanding of various subjects. So really technology is really helping a lot.”*

Findings in this section show that secondary school teachers possessed both positive and negative perceptions toward the integration of technology into teaching and learning, as noted by Önalın,

& Gökçe, (2020) in their study *exploring Turkish EFL teachers' perceptions of the factors affecting technology integration*, that teachers know well about commonly-used software programs, they have positive attitudes toward using technology in their teaching, they have a high level of self-confidence in integrating technology into their teaching.

4.3 Technology used during ERT

4.3.1 Facilities available at schools

In an attempt to find out the type of facilities available at schools, participants who responded to questionnaires were asked to indicate the type of facilities they had before the pandemic. Findings from semi-structured questionnaires show that schools have been in possession of different technological facilities before the COVID-19 pandemic. Some teacher participants indicated that there are technology facilities available at their schools and have been using them for teaching and learning even before the covid-19 pandemic. Facilities such as laptops and internet access have been in use for teaching purposes before the pandemic. Figure 4.1 below shows the summaries of the type of facilities available in participants' schools.

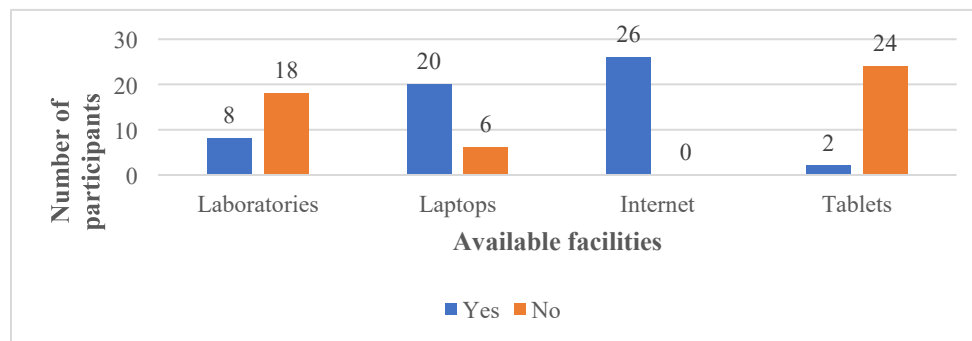


Figure 4.1: Facilities available at schools prior covid-19 pandemic

A number of questionnaire participants ($n=8$) indicated that they have computer laboratories, while a large group of participants ($n=18$) indicated that there are no computer laboratories at their schools (Fig. 4.1). The majority of participants ($n=20$) showed that they own or access computers and/or laptops for teaching and learning purposes. All participants ($n=26$) had access to internet connections at schools, and only a very small number of participants ($n=2$) had tablets for teaching and learning purposes.

4.3.2 Technological devices used during the lockdown of covid-19 pandemic

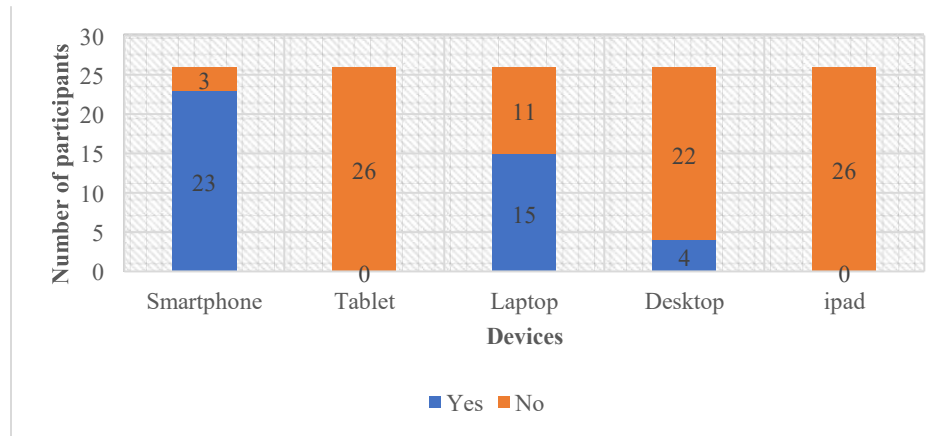


Figure 4.2: shows the technological devices used during the Covid-19 pandemic

On the semi-structured questionnaires, technological devices presented to the participants were listed as smartphones, laptops, desktop computers, tablets, and iPads. According to the findings in Fig. 4.2 above, a large number of participants ($n=23$) indicated that smartphones were the common devices they used for interacting with learners. Laptops were used by many participants ($n=15$) for creating materials and sharing resources with the learners. Only a few participants ($n=4$) indicated that they were using desktops for creating materials. There were no participants ($n=0$) who used an iPad or a tablet for teaching and learning during the ERT, as it was suggested on the semi-structured questionnaires.

Additionally, from the interview sessions, participants indicated the type of technologies they were using during the ERT. SSI1 stated that she has used a laptop and a smartphone for continuing the teaching and learning process. She narrated that

“during covid-19 as we all know that everybody else was isolated, learners, and schools were locked down, and the only way to interact with learners and to continue with the teaching and learning process was using a laptop through Zoom.

Other participants from interview sessions explained that laptops and cell phones are highly portable, easy to carry, and allow learners to use them wherever they find themselves; when it comes to laptops, they are also easy to connect and use less power and space, and those who have

access to cell phone only, were able to use their mobile data, once they cannot access the internet. For instance, SSI2 listed in the responses that the technological tools used during the ERT are laptops, cell phones, computers, photocopy machines, radios, and TVs, as she narrated:

“during covid-19 pandemic, I have used laptops, cell phones, ... and also computers, photocopy machines, radios, and TVs... I used laptops to type my learners’ activities, to email activities to the parents and we also used TVs whereby learners were watching lessons on TVs nationally”

Similarly, from the focus group discussion, participants indicated that they commonly used smartphones, because most of the students could get hold of a mobile phone, a smartphone, at home. FGI3 stated that *“why the mobile phone was commonly used. And we think that students, most of them, know how to operate the cell phone.”*

4.3.3 Technological means used to facilitate teaching during ERT

In the semi-structured questionnaires, participants were asked to indicate the type of applications and software they used during ERT. The Five scale ranging from ‘always’ to ‘not at all’ was presented for the participants to rate themselves. Table 3 shows the findings.

Technological means	Always	Often	Some times	Lesser extent	Not at all
Blackboard collaborate	<i>n=6</i>		<i>n=5</i>		<i>n=15</i>
Zoom	<i>n=1</i>	<i>n=1</i>			<i>n=24</i>
WhatsApp groups	<i>n=7</i>	<i>n=2</i>	<i>n=4</i>	<i>n=1</i>	<i>n=12</i>
Facebook groups			<i>n=3</i>	<i>n=1</i>	<i>n=22</i>
SMS	<i>n=2</i>	<i>n=4</i>	<i>n=6</i>	<i>n=2</i>	<i>n=13</i>
Radio	<i>n=3</i>	<i>n=1</i>	<i>n=6</i>	<i>n=2</i>	<i>n=13</i>
Telephone	<i>n=1</i>	<i>n=1</i>	<i>n=2</i>		<i>n=22</i>
Television programs			<i>n=3</i>		<i>n=23</i>
Telegram					<i>n=26</i>
Instagram				<i>n=2</i>	<i>n=24</i>
Email	<i>n=1</i>	<i>n=1</i>	<i>n=2</i>		<i>n=22</i>
Skype			<i>n=2</i>		<i>n=24</i>
Google Meet	<i>n=1</i>				<i>n=25</i>
Ms Team					<i>n=26</i>
Twitter			<i>n=1</i>		<i>n=25</i>

TikTok			<i>n=1</i>		<i>n=25</i>
WeChat					<i>n=26</i>

Table 4.2: shows technological applications and software used during ERT

Data from semi-structured questionnaires shows that all participants ($n=26$) were using some technological applications and software to continue teaching during ERT. According to the record in *Table 4.2*, none of the participants ($n=0$) used *Telegram*, *Ms Team*, and *WeChat* to continue education (teaching and learning) during the ERT. Applications and software such as Zoom, Facebook, Telephone calls, Television programs, Instagram, email, Skype, Google Meet, Twitter, and TikTok were barely used. A large number of participants, ranged from $n=22$ to $n=25$ responded to questionnaire questions indicating that either they did not use them [at all], or used them to a lesser extent. A quite good number of participants ($n=11$) from the questionnaire responses also indicated that they were always using blackboard collaborate. Radios and SMS were also commonly used, as many participants ($n=13$) indicated that they were always using both applications during the ERT. A large number of participants ($n=14$) responded to questionnaire questions indicating that they were always on WhatsApp. Even from the focus group discussions, participants indicated they could only WhatsApp to reach out to the learners, as FGI indicated here that “*but through WhatsApp, some of us managed to reach and communicate with our learners. Of course, you can only do that when you have access to a mobile phone.*”

In this section, the findings presented show that teachers have been using technology for teaching and learning prior to the pandemic. The commonly used technological tools were listed as computers, cell phones (smartphones), photocopy machines, radios and TV. This finding correlates with the findings of Béch  (2020) in the study about *Cameroonian responses to COVID-19 in the education sector*, as they found out that institutions and community members have been using technological materials ranging from paper-based materials to distance learning platforms, TV and radio communication tools.

4.4 How teachers used technologies to continue teaching during the ERT

Study participants were probed through semi-structured questionnaires and individual interviews on how they continued teaching during ERT. Findings from a large number of participants ($n=26$)

who responded to questionnaires and the interview sessions revealed how teachers were interacting with learners during the lockdowns of the Covid-19 pandemic. Findings show that they were interacting with learners through technologies, and following in this section on how teaching and learning were conducted through and using radios, cell phones (smartphones), printed materials, WhatsApp groups, and face-to-face instructions.

4.4.1 Lessons over Radios, TVs, and Smartphones

Participants from semi-structured questionnaires and individual interview sessions indicated that they were using both community radio and TV channels to interact with learners as a way of continuing teaching and learning. Radio programmes were used to give updates on matters arising at schools and also to present audio lessons for different grades. Local TV channels also served as a means of continuing teaching education because some teachers were presenting topics on TV. Respondents to the questionnaires noted that they used radio announcements for the parents to collect learners' work at school and also announced the due date of the learners' activities and other given readings. QP8, in response to the questionnaire questions, noted that *"through the school, we sent out a message via the radio for the parents to pick up handouts with activities for learners to work on."* Similarly, QP9 also noted that *"as a school, we make use of the local radios, to widely spread the information."* From the interview sessions, SSI2 narrated that *"...and we also used TVs whereby learners watched lessons on TVs nationally"*.

Additionally, secondary school teachers who responded to the semi-structured questionnaires indicated that they were also using text messages and sometimes phone calls as a way of reaching out to learners during the lockdown. QP3 noted that they used to communicate through SMS, radio, and phone calls. QP6 also reported that *"in my case, we communicated with parents' via SMS to come to collect the work for the learners at school"*. QP9 similarly reported that *"involving parents to assist learners with the school work, there was a strong communication between the school (teachers) and parents in case the school was to inform learners of the new information through the school we send text messages but the most effective way is making phone calls"*.

During the semi-structured interview SSI1 stated that *"...and my smart cell phone, for example on texting learners on what to do next or which topic to be presented tomorrow, for to communicate with them or with their parents about the school activities to be submitted or by contacting them"*

through SMS using a smart cell phone.” Focus group interview participants also stated that they used smartphones because they are affordable for both teachers and learners compared to other devices such as laptops and desktop computers. For instance, FGI2 indicated that *“for example, if I have to communicate to the learners via WhatsApp and we have to do the Zoom meeting or the Zoom classroom, it was a bit easier even for the students because they could afford smartphones”*

4.4.2 Printed learning materials

For teaching and learning purposes, secondary school teachers who participated in this study gave some insights on how they continued teaching and learning by using printed materials. From responses in the questionnaires, participants indicated that due to some reasons such as lack of suitable devices and internet connections, some learners could not be reached through technology thus, teachers decided to prepare hard copy materials so that parents could come collect from schools and take home to the learners. Participants emphasized that all the COVID-19 protocols were observed. Participants indicated that they printed worksheets, summarized notes, and question papers for the learners to do as they were at home. QP2 from the questionnaire responses noted that they printed worksheets and summaries/notes for learners which they can study, complete and answer at home. QP4 stated that most parents were the ones who were collecting the learners’ tasks from school. Many respondents shared similar responses that they printed hard materials and mostly, it was parents who came to collect them due to COVID-19 restrictions. QP11 noted that *“during the lockdown, I gave my learners printed notes to study and the activities to do.”* Similarly, QP7 indicated that *“mostly we print out activities and parents pick the from school...”* QP21 and QP22 respectively responded: *“I used to print and make copies of the activities...; we printed question papers, parents collect them and bring them back”*. To elaborate further, QP23 stated that they used to make handouts and give them to the learners on a weekly basis. Similarly, from the interview sessions, SSI2 stated that *“I also used computers and machines to create the learning materials that parents used to come and collect from school.”* Another participant from semi-structured interviews indicated the use of printed materials instead of sharing using technology due to some limitations and prohibitions experienced by either teachers or learners. SSI1 indicated that:

“Those who were only accessing cell phones and it was not easy for them to send via email, as you know some of our learners are not good in technology at least we allowed them to submit hard copies but the safety measures for covid-19 were applied such as sanitizing.”

Despite that, some respondents indicated how it was difficult to teach during the lockdown (ERT) because of the communication barriers. QP20 noted that as their school is in a remote area, it was very difficult to communicate with their learners because they are not exposed to technology, and resources are unavailable, *“we tried, by all means, to come up with activities and their parents would pick them from school.”* Similarly, QP24 also mentioned the issue of the parents coming to pick up learners’ work from school, *“...however we prepared some notes and activities that we use to give parents so they can administer to their children while at home”.*

4.4.3 The use of WhatsApp groups and other Apps

Findings collected from both semi-structured questionnaires and interviews illuminated that some secondary school teachers used WhatsApp groups and other Apps such as Zoom technology for teaching and learning purposes. Most of them indicated that creating WhatsApp groups for specific grades and subjects helped them a lot to reach out to many learners during the ERT. According to responses, the uses of WhatsApp groups were mostly to share notes, voice notes, videos, and general information. *“...but then we have to continue with our teaching, of which the only possible way for us was just through creating a WhatsApp group.”*, FGI3 narrated that there were also other platforms that you could use with the mobile phone, like Zoom, participants, however, indicated that many learners and some teachers didn’t know how to operate with zoom. Extracts from semi-structured questionnaires were recorded as;

QP5: “I have been using digital tools such as laptops and mobile phones to use software applications such as WhatsApp groups to communicate with my learners.”

QP18: “We created WhatsApp groups for everyone to communicate on the platform”.

QP14: “...by using different means of communications such as WhatsApp groups and others...”

Furthermore, some participants elaborated further on how they were using WhatsApp groups for teaching and learning. QP19 described that during the time of lockdown, they created WhatsApp groups where parents were also added. The purpose of WhatsApp groups was to share notes and clarify any

part of the work that would not be understandable by the learners by using voice notes. In the same manner, QP16 shared their experiences that it was very easy to communicate with the learners via WhatsApp groups. QP12 elaborated that they also created WhatsApp groups whereby people used to join using the link:

“...compiled notes and activities were always posted to the WhatsApp groups. Learners were then instructed to study the notes and answer the questions. Learners forward their answers to the teacher privately. The teacher has to go through the work of each learner and give feedback through the WhatsApp group.”

From the semi-structured questionnaires whereby participants were asked to give their views about how technology facilitated teaching and learning, QP19 noted that *“teachers used WhatsApp to engage learners in teaching and learning”*. And from the interview sessions, SSI3 narrated that *“I commonly used my cell phones to share the recorded lesson presentations on WhatsApp groups I have created for different grades. The recordings were helping learners to learn from their houses. The WhatsApp groups created helped me to be touch with learners and their parents when providing updates...”).*

In the same vein as the individual interview sessions, SSI2 expressed:

“I also used to send activities via WhatsApp whereby parents will download the activities for those learners who cannot make it to school. SSI1 also stated that “mostly I created a WhatsApp group with my learners, it was through a WhatsApp group where I can send videos or an audio or pictures presenting a topic for learners to watch, later I will chat with them by asking questions and responded as I said it earlier.”

According to SSI3:

“I commonly used my cell phone to share the recorded lesson presentations on WhatsApp groups that I have created for different grades. The recordings were helping learners to learn from their homes. The created WhatsApp groups helped me to be in touch with learners and their parents when providing updates or giving instructions on the activities that their parents come to collect from the school.”

However, on the contrary, QP17 experienced something different from others. According to this participant in their questionnaire response, not all the learners were able to be engaged through WhatsApp groups. *“I used to upload homework and videos explaining a particular topic and the learners commented accordingly, this was hard as only a few learners were having access to phones let alone data or wi-fi.”*

4.4.4 Face-to-face teaching instructions

Some participants indicated that using technology was not possible for them because of some challenges they experienced. Participants decided to teach learners at schools under the COVID-19 alternative protocols. One of the alternatives, according to COVID-19 guidelines, was to group people (learners) into small groups. Some teachers who participated in this study stated that they were left with no other option but to call learners at school in small groups. QP3 responded in the questionnaire that *“learners have been grouped into three groups named A, B, and C, each group used to come to school twice a week.”* Similarly, QP9 also shared the same issue that *“bigger classrooms, learners were divided into groups and they make shifts to attend lessons, e.g., groups of 15-20 learners in order to adhere to covid-19 protocols.”* QP7 noted that at some points, their learners have to come to school to do face-to-face teaching. And, QP10 noted the same remark that they could only teach when their learners come to school because the community they are teaching has no access to good technology facilities, and only a few parents have access to smartphones and the Internet. QP25 reported, *“teaching in secondary school is only possible and able when learners are taught through the face-to-face mode compared to online learning platforms”*.

The overall findings in this section show that for the teachers to interact with learners and parents, there have been the use of different technological applications such as WhatsApp, zoom, and Facebook pages. In the study of Shraim & Crompton (2020) about the use of technology to continue learning in Palestine, the same findings were drawn as they found out that participants identified that technologies such as mobile devices, social media and cloud computing would be useful for design and delivery of educational materials as well as raising safety awareness, and communication during the COVID-19 pandemic in Palestine.

4.5 Technological challenges experienced during ERT

Findings from semi-structured questionnaires and individual interviews illuminated some challenges that could not allow teaching and learning to take place during the lockdown. Teachers who participated in this study highlighted the main challenges that made teaching during ERT difficult or not possible at all. The main challenges identified are lack of technological knowledge, lack of devices, internet access, financial implications, and technology distractions.

The findings from both questionnaires and interviews revealed that some teachers do not know how to use technological devices for effective ERT teaching, on a similar note, some learners are also not oriented well on how to make use of technology, and thus, there were so many misunderstandings on the delivery of content between teachers and learners through using technology devices. Responses from the questionnaires indicate that both teachers and learners were prepared to engage in both teaching and learning through technologies. Some parents are also not acquainted with the technological knowledge to help learners, and not all of them were made to understand that they can play a role in making ERT a success. During the interview sessions, participants emphasized the lack of technological knowledge among teachers and learners as well as parents. According to SSI2:

“...main factor here is the lack of teachers’ confidence. This is one major factor that prevents teachers from using technology. Teachers who do not consider themselves as well skilled in using ICT, feel uncomfortable using technology in front of the learners, who perhaps know better than themselves. Also lack of teachers’ competencies to use technology is an obstacle.”

QP24 similarly remarked that *“as teachers, we were also technologically challenged without or with little knowledge to prepare activities during the time of need.”*

Similarly, a large number of participants ($n=18$) from the questionnaire responses felt otherwise that the use of technology during ERT did not facilitate teaching due to various reasons. The data illuminated that there are teachers who were also not well equipped for ERT to be fully implemented; for instance, QP21 stated that only a few teachers who are equipped with skills of using technology were able to continue teaching productively but those who are technological illiterate were struggling to proceed with teaching. Similarly, QP20 stressed that some people had

technical challenges thus education could not be successfully delivered, and it was a disadvantage to those who could not afford technological gadgets.

The data also indicated that some learners and teachers were technologically challenged for instance, QP2 responded that teachers still had to start over where they ended with the learners since it did not reflect some learners learned anything during the lockdown at home. QP4 quotes that:

“in most cases the education during the lockdown, more especially in rural areas was delayed and did not continue because many learners do not have access to technology and their parents either do not understand the use of technology or cannot afford to buy the appropriate devices to be used.”

QP12 has also observed the same issues as QP4 indicated that the use of technology is not accessible to all learners, whatever was taught through technology was still to be repeated with all learners when learners came back for face-to-face teaching mode because not all learners participated in ERT and it could not benefit all to continue with new contents. Some learners cannot learn because they are staying at places where they have no access to any form of technology, or they are staying with people with little skills in the usage of technology at their disposal.

Moreover, some participants in this study revealed further that the reasons why teachers lack technological knowledge are attributed to the lack of extra (in-service) training for technologies. FGI2 stated that:

“but now, even shifting to this teaching, online teaching, whereby the learners, it's now lockdown, during COVID lockdown, and you have to teach online. What was it? There was nothing happening there because we lacked training and people were not given any training.” SSI2 added that challenges are experienced due to a lack of training. She narrated that:

“Yes, most of teachers did not get training about using ICTs in teaching, especially those years, those teachers did not get training in computers. Some teachers cannot just do simple technological things, even create a WhatsApp group, and...” According to SSI1:

“... another factor that can inhibit is lack of ICT skills among teachers themselves and even among the learners. These are some factors that can inhibit teachers from using technology, lack of skills

so teachers need to be trained in how to use those technology and integrate them during their lesson presentations.”

She further explained that:

“I feel teachers need to be trained or they need to be themselves enrol at institutions that give computer classes. Because if you yourself are a teacher and you don’t know how to use the technologies like you don’t know how to send emails, you don’t know how to go on YouTube and download videos, then is obvious you are unable to present and integrate to the learners, even if you have facilities at your disposal” (SSI1,2023). Another participant, SSI3 revealed that: “...things like lack of training and support from our education officers and other officers in the ministry...” and “I feel I am more challenged in the area of handling technological tools. Sometimes I can have my videos and files from the internet on my mobile phone but I struggle to transfer them to the laptops. I need a training on that.”

Participants indicated that not all the teachers and learners had devices such as smartphones, laptops, radios, TVs or any other gadgets that could make ERT possible. Even though they created WhatsApp groups, there was only a small number of learners on WhatsApp groups, which were meant for all learners to participate in teaching and learning. QP25 noted that during the lockdown of covid-19 pandemic, teaching and learning were affected severely because there was no direct engagement from both sides, learners had no cell phones, laptops, or radios to interact with the teachers. Participants noted that learners without access to technologies could not receive the information that was being shared via technologies. They further added that only a few learners with access to technologies were available for teaching, resulting in few engagements from a few individuals. Parents found it an extra burden to buy smartphones specifically for learners. According to SSI1:

“Mostly in our case, or during covid-19 pandemic was a lack of facilities, many schools especially rural schools have no electricity and no internet connection. Many parents sometimes are reluctant and were not willing to buy smartphones and laptops to (for) the learners, and maybe this one is caused by disadvantages and the negative impact of social media among learners. Many parents were not willing even up to now, parents do not want to buy laptops or smartphones for their learners.”

Further data revealed that not all learners had smartphones to join WhatsApp groups that were commonly used, they were using other peoples' phones, which made it difficult for the information to reach them on time. QP14 shared that no teaching took place when learners were home for lockdowns because they didn't have other technologies for the learning process. QP26 similarly noted that *"this was more demoralized as only a few learners take place, e.g., if the learners in the class were 40 then only 10 can participate."*

Internet accessibility is also noted to hinder teaching and learning during ERT as some teachers and learners reside in rural areas and network and internet connections are problems. There was so much poor communication due to poor network coverage. Some responses shared that teaching and communication with learners were not easy because many stay in areas where the internet and mobile network connection is very poor, especially for smartphones. In the same vein, there were also some financial implications involved, some teachers could not afford to have Internet data or internet connections in order to be fully online. Learners, in the same vein, were not able to buy their own smartphones that could connect them at any time required. From the focus group discussion, FGI2 expressed that:

"poor facilities also play a role. They are not computer-less, they are not even up to standard. The server, the connection is not working. At times you will be told that the Wi-Fi is not paid or you don't know if the network is not working or it's low"

Participants responded in individual interview sessions narrated that:

"another challenge is that technology is very costly and expensive a teacher cannot really 100% rely on them. For example, internet connection is paid every month and not all the parents and not all the schools sometimes can afford to pay every month, the cost can also hinder the progress of using and integrating technologies every time you are presenting your lessons" (SSI1,2023).

According to SSI1:

"I have used a laptop sometimes for zoom presentation but unfortunately some learners were left out due to lack of internet connectivity in rural areas. And during this difficult time many libraries were also closed so, laptops and cell phones served as virtual libraries for many learners to complete their assignments and carry out their research." Additionally, according to QP13:

“it was not easy to us teachers to present a topic for the day and you end-up only having 2 to 3 learners for a whole day that had data or internet connections to participate and you end up repeating the same topic for 4 to 5 days which was time consuming. Most learners learn faster and easily when doing practical on their subjects so this was difficult to express.”

Findings also revealed some technology social distractions to the learners. According to SSI1, during the individual interview session, responded that the use of technology can be destructive to learners’ concentration and focus, for example, if they have their laptops, computers, or smartphones, there are so many things that can distract their concentration and divert their concentration out of the topic or the subject contents. SSI3 added that technology can distract my lessons sometimes when devices are not sufficient of sharing or using two devices in a class brings chaos to the lesson.

The overall findings in this section show that though teachers made efforts to continue teaching during the lockdowns, there were some technological challenges experienced. Issues such as lack of technological knowledge in both teachers and learners, lack of technological devices, things such as poor internet connections, accessibility to proper networks, financial implications to ensure the maintenance of technological devices and technology distractions. These findings were also revealed in earlier studies, for instance a study done by Henaku (2020) about *COVID-19 online learning experience of college students*, revealed that there are challenges experienced such as connectivity problems, Internet bundle availabilities, Challenges with Devices, and Overall perception of e-learning among educators. The findings further revealed that both social media and online learning platforms were used for teaching and learning by the Colleges of Education in Ghana. It was further elaborated that students experience internet connectivity problems, financial difficulty due to the high cost of internet data bundles, challenges with devices and disruption as a result of the need to assist in household production.

RQ2: How do secondary school teachers’ integration and usage of technology during ERT support TPACK development?

Data for this research question is drawn from a group of twenty-six secondary school teachers ($n=26$) by responding to semi-structured questionnaires. This sample of twenty-six teachers includes the subset of nine secondary school teachers who opted to continue through to individual interviews and focus group interviews. Another piece of data was generated from the post-pandemic reflections about the type of technological skills secondary school teachers gained after integrating and using technology during ERT of the Covid-19 pandemic. To answer the main question, findings about TPACK constructs assessment among the participants are presented, followed by a general understanding of how technology facilitates or hinders teaching in secondary schools, and lastly, findings about the TPACK developed by secondary school teachers during ERT are presented.

4.6 Assessment of TPACK Constructs

4.6.1 Technological knowledge (TK)

Secondary school teachers who participated in semi-structured questionnaires in this study were asked to rate their technological knowledge on a scale of Three-keys rating from agree to disagree. Table 4.3 and graph 4.3 respectively show the findings.

Technological knowledge	Agree %	Neutral %	Disagree %
I know how to solve my technical problems	58	23	19
I can learn technology easily	77	11	12
I keep up with necessary new technologies	69	8	23
I frequently play around the technology	73	12	15
I know about a lot of different technologies	69	19	12
I have the technical skills I need to use technology	69	16	15

Table 4.3: shows technological knowledge

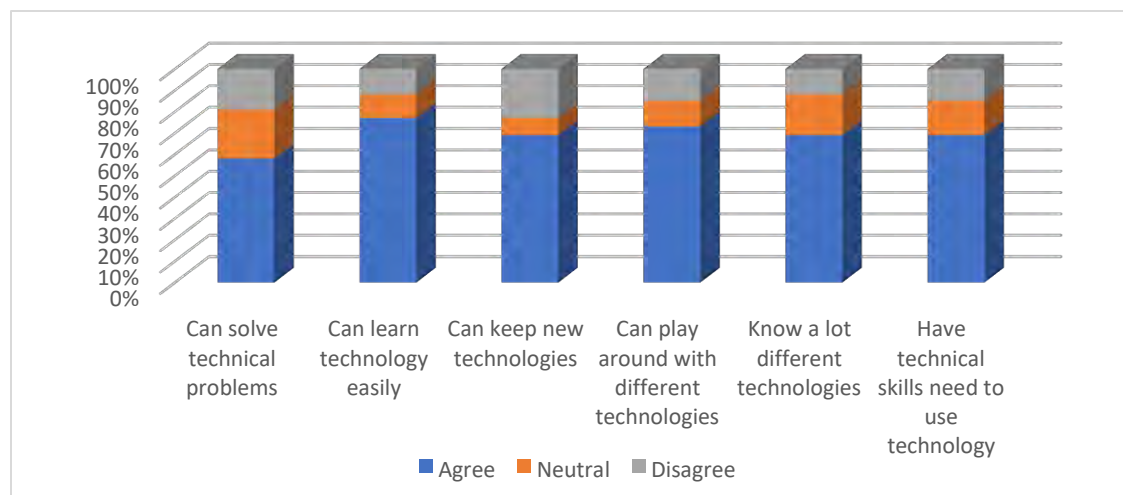


Figure 4.3: illustrates technological knowledge

Data shows that 77% of participants have strong capabilities of learning technology easily, while 73% can frequently play around with technology. 69% of participants strongly agreed that they can keep up with important new technologies, they know a lot of different technologies, and they have technical skills they need to use technology for their everyday purposes. All participants who participated in individual interviews were asked to define TK. SSI3 defined TK as the knowledge that involves how technological tools are used by the teacher to make meaning of the content. SSI1 defined TK as referring to the electronic devices or teaching tools that are used during the teaching and learning process, which can be computers, smartphones, projectors, and videotapes. SSI2 defined TK as a knowledge of the ability to use different technology, technological tools, and resources.

4.6.2 Content knowledge (CK)

Participants were asked to rate their content knowledge, as it can affect the way they can use and integrate technology in their teaching. The data in graph 4.4 shows that 96% of participants have sufficient knowledge about their subject contents. 4% disagreed about their sufficiency in content knowledge.

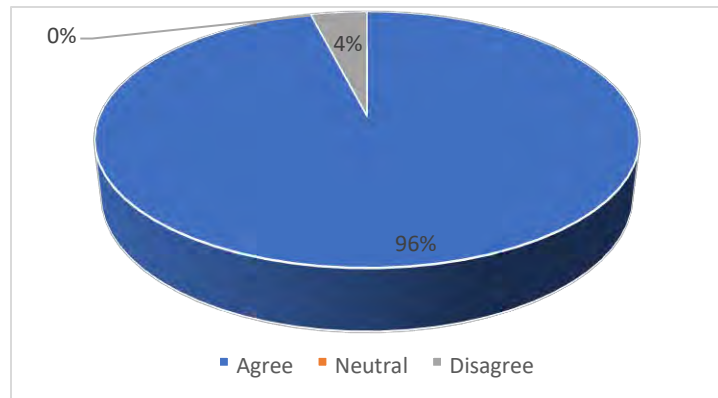


Figure 4.4 shows the content knowledge of participants

4.6.3 Pedagogical Knowledge (PK)

In the questionnaires, participants were also asked to indicate their pedagogical knowledge as it is one of the issues that can affect their integration of technology. Findings are illustrated in Table 4.4 and Figure 4.5.

Pedagogical knowledge	Agree %	Neutral %	Disagree %
I know how to assess student performance in a classroom.	96	0	4
I can adapt my teaching based on what students currently understand or do not understand (prior knowledge)	96	0	4
I can adapt my teaching style to different learners (different learning needs)	96	0	4
I can assess student learning in multiple ways	65	23	4
I can use a wide range of teaching approaches in a classroom setting	92	4	4
I know how to organize and maintain classroom management	92	0	8

Table 4.4 shows the rating pedagogical knowledge of participants

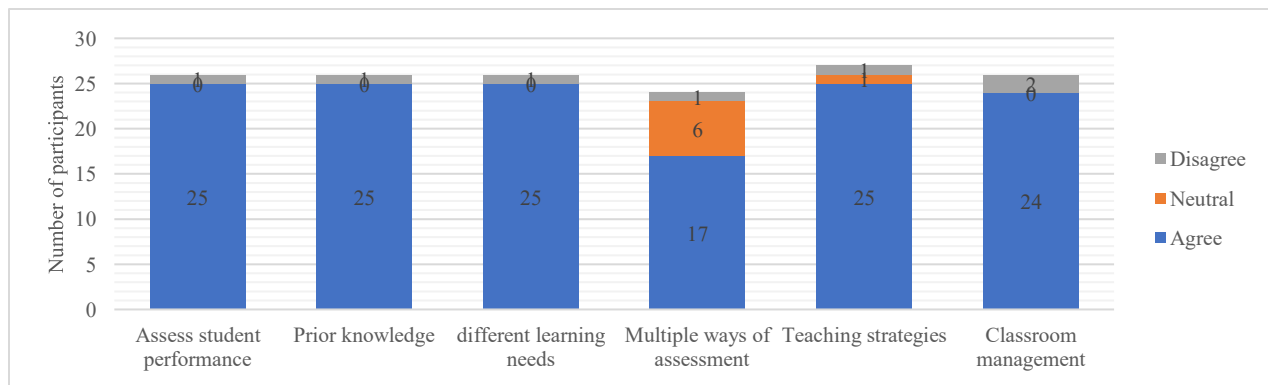


Figure 4.5: shows the pedagogical knowledge of participants

Table 4.3 and Fig. 4.5 respectively illustrate that 96% of the participants know how to assess student performance in a classroom, they can adapt their teaching based on what students currently understand or do not understand (prior knowledge), and they can adapt their teaching styles to different learners (different learning needs). Whereas 92% indicated that they can use a wide range of teaching approaches in a classroom setting and they know how to organize and maintain classroom management, of which 23% others are neutral about whether they can access student learning in multiple ways or not.

4.6.4 Pedagogical Content Knowledge (PCK)

In response to semi-structured questionnaires, 92% of participants indicated that they know about the technologies that they can use for teaching their subjects, and 8% don't know the technologies suitable for their subjects. Figure 4. 6. below shows the findings.

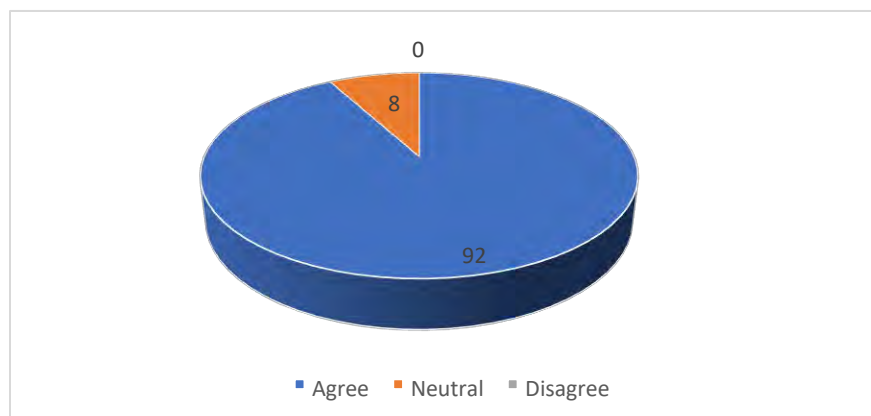


Figure 4.6 shows the pedagogical content knowledge of participants

4.6.5 Technological content knowledge (TCK)

Secondary school teachers who participated in the questionnaire were asked to indicate their level of technological content knowledge.

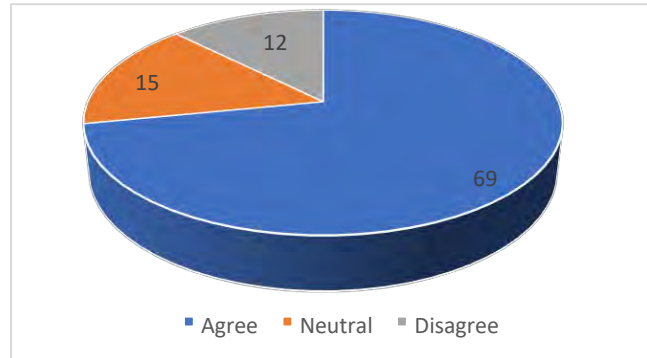


Figure 4.7: shows the technological content knowledge of the participants

Data shows that 69% of participants know the technologies they can use for understanding and doing their subjects, 12% don't know the technologies they can use in understanding their subjects and 15% are not sure of their level of technological content knowledge.

4.5.6 Technological pedagogical knowledge

To indicate the self-assessed level of their technological pedagogical knowledge, secondary school teachers who participated in this study were given questions related to Table 6 below.

Technological pedagogical knowledge	Agree %	Neutral %	Disagree %
I can choose technologies that enhance the teaching approaches for a lesson.	78	11	8
I can choose technologies that enhance students' learning for a lesson.	73	15	8
My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom.	46	38	12
I am thinking critically about how to use technology in my classroom.	65	19	12
I can adapt the use of the technologies I am learning about to different teaching activities.	78	11	8

I can select technologies to use in my classroom that enhance what I teach, how I teach, and what students learn.	78	11	8
I can use strategies that combine content, technologies, and teaching approaches that I learned about in my coursework in my classroom.	73	15	8
I can provide leadership in helping others to coordinate the use of the content, technologies, and teaching approaches at my school and circuit.	69	19	8
I can choose technologies that enhance the content of a lesson.	69	19	8

Table 4.5: showing the technological pedagogical knowledge of the participants

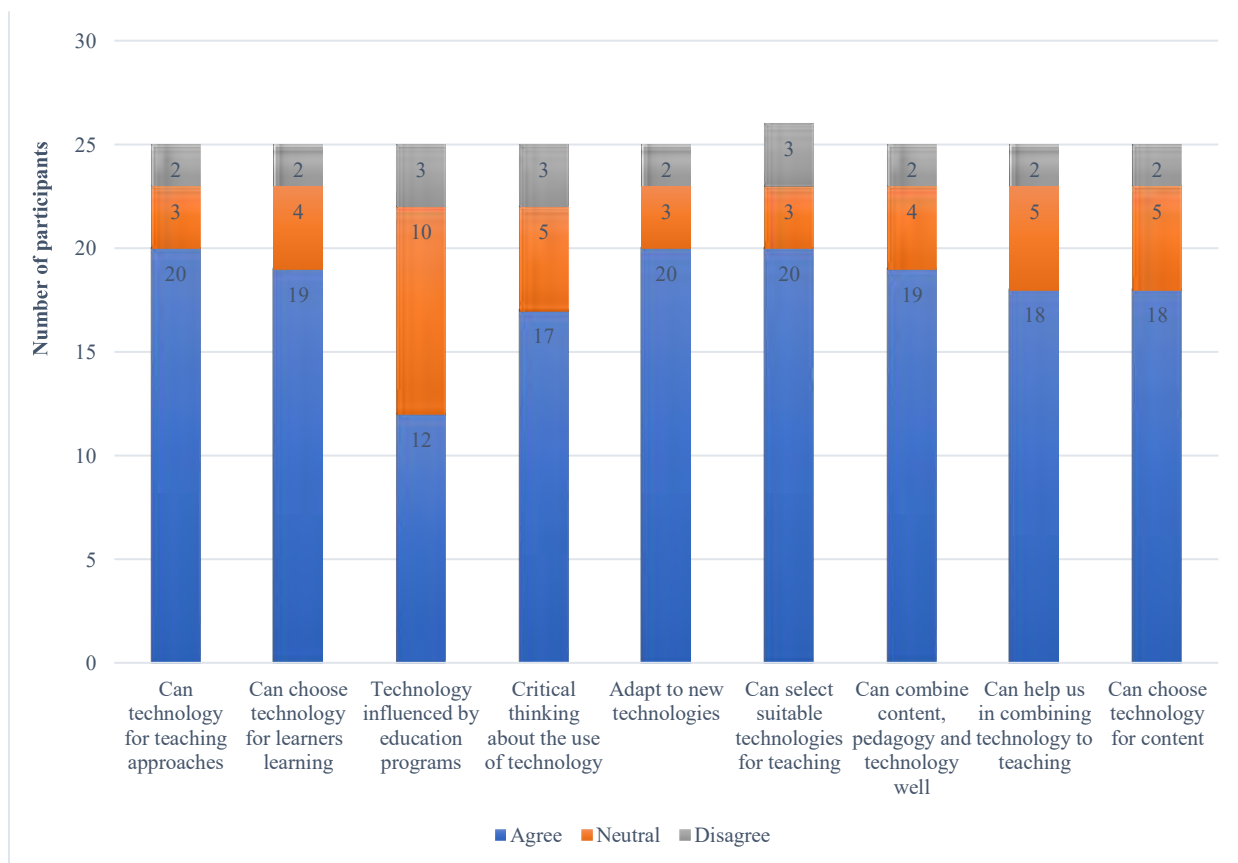


Figure 4.8 shows the technological pedagogical knowledge of the participants

Data in Table 4.5 and Figure 4.8, respectively show that 78% of the participants were able to choose technologies that enhance the teaching approaches for their lessons, they can adapt the use of the technologies they learn about to do different teaching activities, they can also select technologies to use in their classrooms that enhance what they teach, how they teach and what students learn.

Further, data shows that 73% of participants can choose technologies that enhance learners' learning for a lesson, and they can use strategies that combine content, technologies, and teaching approaches that they learned about in their coursework. 69% of participants indicated that they can provide leadership in helping others coordinate the use of the content, technologies, and teaching approaches at their school and circuit levels, and they can choose technologies that enhance the content of a lesson. Lastly, data shows that 65% of participants can think critically about how to use technologies in their classroom and 46% stressed that their teaching education programs have caused them to think deeply about how technology could influence the teaching approaches they use in their classrooms.

4.6.7 Technological pedagogical and content knowledge

Secondary school teachers who participated in this study were also asked to indicate their self-assessed technological pedagogical and content knowledge.

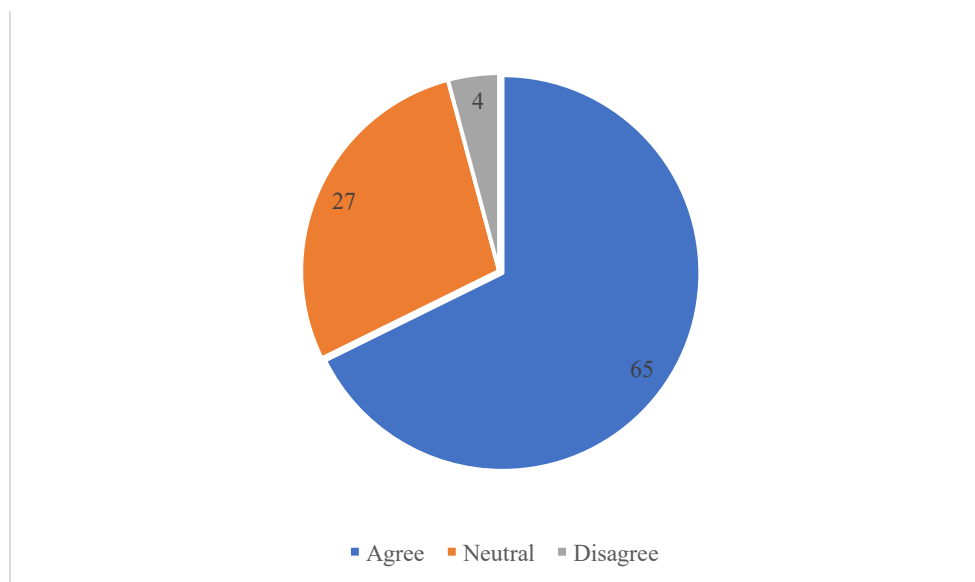


Figure 4.9: shows the technological pedagogical and content knowledge of participants

Figure 4.9 shows that only 65% of participants agreed that they can teach lessons appropriately by combining their subject's knowledge (content), technologies, and teaching approaches (pedagogies). 4% of participants disagreed, while 27% were uncertain about their technological, pedagogical and content knowledge levels.

The overall findings in this section have shown some interesting facts about the constructs of TPACK. The findings show that teachers have good knowledge of CK, PK, TK, TPK, and PCK, whereby all the rating is above 85%. But then in terms of other constructs that involve more technology integration, TCK, and TPCK teachers seemingly possess low levels of knowledge, as the rating is 69% and below. Findings of the same nature were earlier generated by the study done by Mensah, Poku, & Quashigah (2022) in the study titled “*Technology integration into the teaching and learning of geography in senior high schools in Ghana*” and findings have shown that teachers possessed a high level of content (CK) and pedagogical knowledge (PK) in Geography. The analysis, however, showed that teachers were not as confident as they were in content and pedagogy (PCK) compared to technological knowledge (TCK) and its subsequent integration into the teaching and learning of Geography. Similarly, in the study of Alqurashi, Gokbel & Carbonara (2017) about, “*Teachers’ knowledge in content, pedagogy and technology integration: A comparative analysis between teachers in Saudi Arabia and United States*” findings revealed that teachers in both the US and Saudi Arabia had a higher rating of their knowledge in content (CK) and pedagogy (PK) than technology knowledge (TK). Teachers in Saudi Arabia, however, had higher TK, TCK, TPK and TPCK than teachers in the US.

4.7 TPACK developed during ERT

In an attempt to probe the development of TPACK among secondary school teachers, many participants ($n=16$) from the set of questionnaires were positive that the use of technology during the ERT of COVID-19 helped them gain different skills related to technologies. Similarly, individual interview session findings revealed how secondary school teachers accepted that they had gained some skills they had not before they used technology during the lockdown of COVID-19. Additionally, the subset of secondary school teachers who participated in individual and focus group interviews were asked to write brief reflections about different skills they gained during ERT. The findings illuminated insights about some degrees of developed TPACK constructs. And for this study, all constructs revealed by data were recorded from the analysis. Following is the section on TPACK development from the ERT.

4.7.1 Technological knowledge (TK)

The qualitative findings of the study show that there is technological knowledge developed in some teachers as they indicated that the use of technology during ERT enhanced teachers' level of technological skills. To probe how this knowledge was developed, participants were asked to state the new skills they have learned about this knowledge. According to participants during the focus group discussion, they are able to type the lesson plans on the computer and print them out (FGI2, 2023). From the questionnaire responses, here are some extracts. QP3 stated that "*it enhanced my level of technological skills*", similarly, QP15 stated that "*... the knowledge was enhanced because of everyday technology usage*". In the same vein, QP24 also stated that "*...I practiced much of my typing the activities by using the computers*". Similarly, QP23 said, "*it really helped me, as I learned a lot on how to use laptop*". Furthermore, findings show that integration of technology allowed teachers to realize the importance of possessing technological knowledge, as they stated that it has to start with the environment where teachers are working. They noted that if both teachers and learners have sufficient skills in technology usage and have technology tools at their disposal, then teaching will be more fun and easier.

Findings in this section show that teachers gained some technological knowledge through integrating and using technology during ERT as they are now more able to use laptops, printers, and other skills regarding technologies for teaching and learning processes. The same findings were revealed from the study done by Istiningsih (2022) about "*Impact of ICT integration on the development of vocational high school teacher TPACK in the digital age*" revealed that teachers are capable of resolving issues that arise during online learning activities and providing learning assessment values that are appropriate for their learners' skills and learning performance. These findings suggested that schools must provide more effective and professionally targeted ICT support and training in order to improve teacher competence.

4.7.2 Technological content knowledge (TCK)

All participants have shown a better understanding of TCK. During the individual and focus group interviews, the participants were asked 'what informs their selections of particular technological tools that suit their subjects?', SSII narrated that "*...what informs my technology tool selection is*

the content that I am going to teach according to the syllabus. Also, the availability of the technology tool...” SSI2 adds that technology conforms to an understanding of considering its possibilities for a specific subject or classroom learning to recognize where it will assist teaching. On the contrary, SSI3 clarified that “... *and also sometimes I find myself in a situation whereby all the available technologies cannot really be useful for that content, so, that is why sometimes I end up not using technology for specific topics.*”

The findings further revealed the TCK gained by the teachers as they indicated that they were able to use the available technologies to prepare the subject matters, such as notes and worksheets for the learners. They also indicated that they are able to search online the lesson activities and download the pictures, as some learners learn well through visuals. Participants are now capable of searching and gathering relevant information needed by learners from the internet. They further indicated that the use of technology influenced them from being relaxed to being active as they had to search for more information and gather resources. QP2 stated that “... *to me as a teacher, it was not a challenge to compile notes for the learners as well as the worksheets the available technological devices/technologies available at school was one of the shortcomings.*” QP20 also stated that “*I have learned a variety of things through searching the internet and downloading activities that were suitable for the grades I was teaching.*” QP23 also stated that “...*technology brings reality into the classroom, some learners may not have seen certain things like wild animals but with the help of technology learners are able to see pictures and water videos and this makes it easy for them to learn faster.*”

From the individual interview sessions, secondary school participants stated that the use of technology during the lockdown helped them to plan their lessons well. SSI1 narrated as “*it helped me as a teacher to plan my lessons very well, because I can for example if the topic am going to present to learners are I need more clarity, I need more information, I just have to search through internet and I get a lot of information about the topic.*”

In this section, findings show that teacher gained TCK since they have indicated that after integrating technology during ERT they can now use available technologies to prepare subject matters. They are also able to relate technology to their content subjects. According to the study

done by Annamalai, Ab Rashid, Saed, Al-Smadi, & Yassin (2022) in the study titled “*A phenomenological study of educators’ experience after a year of the Covid-19 pandemic*”. Results revealed that after a year of teaching online, the potential of technology has been acknowledged by the teachers after some trials and constraints were addressed. The domains related to Technology Content Knowledge (TCK), Technology Pedagogical Knowledge (TPK), and TPACK were evident in the findings.

4.7.3 Technological pedagogical knowledge

Some of the teachers who participated in the study indicated that they were supported by the process of integrating technology during the ERT to develop TPK. To probe their development of TPK, they were asked to explain how they combine the content, pedagogy, and technological knowledge during their planning. Both SSI1 and SSI3 narrated the same process of choosing the content first, choosing the suitable pedagogy, and lastly, the suitable and available technological tool available. But on the contrary, SSI2 stated otherwise:

“... I have to choose the content, which I will teach to my learners, and then choose the variety of technological tools that are appropriate with the subject, and then choose the various teaching approaches that are appropriate for the lesson.”

Technology created a positive atmosphere in the classroom and enhances a good teaching environment. According to QP7 “*even though there was little contact with the learners, on the side of teachers it has benefited me most. I could share and receive study or teaching aids through technology*”. Another participant added that “*I was supported by technologies, I developed new knowledge on how to use technologies during my teaching and to prepare my lesson plan using technology*” (QP5). Another participant, QP9 also indicated that “*...I can search all relevant information that has connection with the topic I will teach for that day, as well as I can google for the vocabulary.*”

The observations in this section reveal that, following the utilization of technology during the COVID-19 pandemic for emergency remote teaching, teachers expressed their inclination to explore a variety of technological tools within their lessons. This exploration aims to identify the most effective approaches aligned with their teaching style and the learning requirements of their

students. Consequently, they have become well-versed in the latest technological advancements and trends, ensuring their adeptness in deploying technology when contextually suitable. These findings are consistent with the conclusions drawn in the research conducted by König, JägerBiela, & Glutsch (2020), titled "*Adapting to online teaching during COVID-19 school closure: teacher education and teacher competence effects among early career teachers in Germany.*" The study unveiled the significance of information and communication technologies (ICT) tools, especially in terms of digital teacher competence and opportunities for educators to enhance their digital proficiency. These factors played a pivotal role in enabling the successful transition to online teaching during the period of COVID-19-induced school closures.

4.7.4 Technological pedagogical content knowledge

Secondary school teachers who participated in this study confirmed that they developed some new skills in integrating technologies into their teaching. To probe this skill/knowledge, participants were asked to elaborate on how they understand the relationship between technology, pedagogy, and content. During the individual interview sessions and questionnaires, participants revealed good knowledge of technological pedagogical content knowledge. Participants noted that the relationship between the three types of skill/knowledge is that pedagogy is on content and technology depends on both content and pedagogy. SSI3 narrated that “...*technology is not a driving force; what it does is just to help us teachers deliver the content and also support the teaching method which the pedagogy one is using.*” Findings revealed that using technology during the lockdown (ERT) helped the participants to be able to search for useful information on the internet. Teachers also realized the importance of technology and the need to expose themselves to technology. QP6 stated that:

“at my own personal capacity, yes it helped me to develop good knowledge and be creative when teaching the learners, and, technology is a good weapon to be used in the third industrial revolution since most of things are moving to the new way of doing things technology is one of them that must be used in teaching and learning.”

To explain further in the interview another participant elaborated that:

“first, I get the learning content from the syllabus by means of learning objectives and basic competencies. From there, I have to consider the best practices in teaching as well as assessment processes. Finally, is when I can choose the suitable technology according to availability and usability. Aaa... and also sometimes I find myself in a situation whereby all the available technologies cannot really be useful for that content, so, that is why sometimes I end up not using technology for specific topics.”

From the findings in this section, it is evident that there is a TPACK developed by teachers. Aspects such as the selection of appropriate digital resources that enhance the learning experience and align with the subject contents and seeking out opportunities to enhance their technological knowledge and explore new tools and strategies. Similar findings are generated from earlier studies like the study done by Morris (2021) in *“Exploring the TPACK of Grade 9 mathematics teachers in the Western Cape of South Africa”* which has shown that teachers appear to be comfortable using technology themselves in their classrooms though they need guidance in learner-centred technology use. The evidence also shows that teachers appear to be more confident with the use of technology after the emergency remote teaching of the COVID-19 pandemic.

4.8 Summary of the chapter

In this chapter, the researcher presented all the data findings as collected using three techniques: semi-structured questionnaires, individual interviews, and document analysis. Data is presented according to the research questions by means of text presentation, graphs, tables, and charts. To make meaning, in-text quotations are used where possible. After this chapter, there is a presentation of the findings, Chapter Five. The research will present the discussion of the findings against the existing data/findings by other researchers and in relation to the analytical and theoretical frameworks as discussed in chapter two.

Chapter 5: Discussions of Findings

5.1	• Introduction
5.2	• Summary of findings
5.3	• Discussion of findings
5.4	• Summary of the chapter

5.1 Introduction

The preceding chapter is the composition of the findings gathered to answer the main research questions. These main research questions were tackled through the utilization of a multifaceted data collection approach, encompassing the deployment of semi-structured questionnaires, conducting insightful semi-structured interviews, and fostering dynamic discussions within focus group sessions. The ensuing findings are systematically unveiled in alignment with the overarching research questions, each finding intricately woven into the study's objectives. The coherent presentation of these findings offers an illuminating insight that contributes to a comprehensive understanding of the research's objectives.

Consequently, the current chapter addresses the discussion of findings in the previous chapter. The findings, as presented earlier, are the data revealed in this study from the three main research strategies/methodologies, which are semi-structured questionnaires, interviews, and document analysis. This study created the environment for the participants to reveal the TPACK domains/constructs they have developed during the integration and usage of technology during the ERT of the covid-19 pandemic. These findings are discussed in alignment with the two main research questions and are also discussed against the existing related literature that includes the theoretical and analytical frameworks used to analyze the data. The two main questions that are answered are:

- RQ1: how did secondary school teachers integrate and use technology during ERT ofnCovid-19 pandemic?
- RQ2: how do secondary school teachers integrate and use technology during ERT to support TPACK development?

Firstly, the study found out about the technological background of the participants, how technology facilitated their teaching during ERT, assessed their technological pedagogical content knowledge, and probed the development of TPACK. A large number of 26 secondary school teachers participated by responding to semi-structured questionnaires. The aim was to give answers to both research questions. Secondly, the individual interviews of a subset of four teachers were conducted, followed by reflections of the same participants. Data descriptions of this study were mainly color-coded and originated themes were identified for analysis.

This chapter has been organized into four distinct sections. The first section, labelled 5.1, serves as the chapter's introduction, outlining its objectives and research questions. Moving forward to section 5.2, a summary of the discoveries is provided, while section 5.3 delves into a comprehensive discussion of these findings, further exploring the emerging themes. Finally, in section 5.4, the concluding remarks of the chapter are presented.

5.2 Summary of Findings

Research question 1: How did secondary school teachers integrate and use technology during the ERT of the covid-19 pandemic?

Overall findings indicated that schools have been in possession of different technological facilities before ERT. Teachers have been integrating and using technology before ERT, and the main facilities they have been using are desktop computers, laptops, and internet facilities such as fixed portable Wi-Fi devices. Then, during the ERT, teachers commonly use smartphones (cell phones) and laptops for teaching and learning processes. By extension, radios and televisions were also used as means of teaching and learning.

The findings address the way facilities stated above were used during the ERT. During the lockdown, teachers were using laptops and smartphones to create learning materials for learners, downloading materials from the internet, and sharing the materials with the learners as they were at home. Through internet connections, they created WhatsApp groups and Facebook pages and invites Zoom meeting sessions. As to how technology facilitated continued teaching and learning during ERT, teachers presented subject contents via Radio stations and TV channels, also by means

of sharing videos, voice notes, and emails of worksheets and study materials by using smartphones. There are also teachers who teach in areas where the internet and mobile network is accessible, for this reason, parents were motivated to come to collect printed materials (hard copies) from schools under a good observation of COVID-19 protocols such as sanitizing and keeping a distance. There are instances whereby using technology was not possible during ERT thus, some teachers opted to continue with face-to-face teaching instructions with a very small number of learners.

The study findings also illuminated different technological challenges experienced by secondary school teachers as they were integrating and using technology during ERT. The main challenges that could not allow ERT to be effective include lack of or limited technological knowledge among teachers and learners. Insufficient and lack of access to technologies for both teachers and learners and poor internet access and mobile network connections. Financial implications include parents not being able to buy technologies specifically for learners or paying for daily or monthly mobile internet data and social distractions that divert learners' attention towards entertainment from other non-educational websites.

Research question 2: How do secondary school teachers' integration and usage of technology during ERT support TPACK development?

The rich findings from the semi-structured questionnaires triangulated by interview created access for teachers' TPACK development to be revealed. In the first space, teachers' understanding of technology integration in teaching was probed, and data revealed a better understanding of technology integration among secondary school teachers. Participants could list the advantages and disadvantages of technology integration into teaching and learning, as they have indicated some contradictory remarks such that not all teachers could continue teaching and not learners could be able to use technologies to interact with teachers during the ERT.

Furthermore, the TPACK of teacher participants was assessed by rating their skills against TPACK constructs in the questionnaires and interviews. Data revealed that participants have strong capabilities and good technological skills (TK). They have good content (CK) and pedagogical knowledge (PK). Even though data shows good pedagogical content knowledge (PCK) among teachers, as well as better technological content knowledge (TCK), there is a large number of

participants who were neutral regarding their choice of assessment through technologies that are part of their (TCK). Participants indicated that they are uncertain about their technological pedagogical knowledge (TPK) and their technological pedagogical content knowledge (TPCK). The teacher participants in this study have revealed that they have gained new technological knowledge from the integration and use of technology during ERT. TPACK constructs such as TK, TCK, TPK, and TPCK were seamlessly extracted from interview discussions and reflective notes as they indicated their new ways of using technological tools, choosing suitable tools, and combining content, pedagogy, and technology skills.

5.3 Discussion of findings in relationship with related literature

The discussion of the findings in this study is presented according to the themes emerged from the raw data as analyzed using the theoretical and analytical frameworks driving this study. The discussion in this study is presented in alignment with the literature related to the field of technology in education specifically to teaching and learning and with the theoretical frameworks used to analyze the findings.

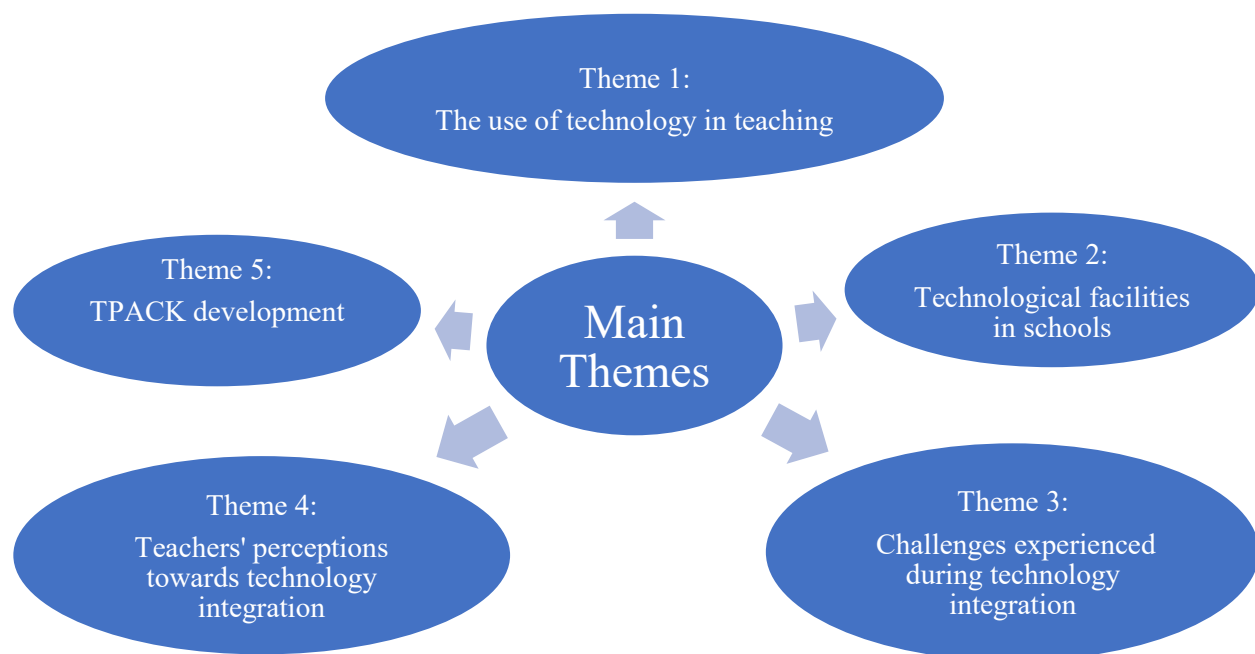


Figure 5.1: Themes emerged from the analysis

Therefore, the five themes that emerged as indicated in Fig. 5.1 are discussed in the following sections.

Theme 1: The use of technology in teaching and learning

The overall results as presented in Chapter Four Section 4.2 exhibited that the selected secondary school teachers hold positive perceptions and have good understanding towards the integration of technology. The literature states that the teacher's knowledge and perceptions of technology integration play an important role in influencing the way they integrate technologies in their classrooms (Ifinedo et al., 2020). Some teachers understand that integration of technology is only effective when teachers themselves are good in technology, this includes the familiarity and availability of technological materials. Meaningful learning is strengthened through social interactions with artefacts (materials) from one's own culture. Literature on learning further describes that people are engaged in their own learning and discovery, but their development happens in the context of social interaction as opposed to independently or in isolation (Vygotsky, 1978). For the purpose of results from this study, as teachers have been using different technological artefacts, mediation from Vygotsky would be related in a way that these different technological devices helped teachers to continue with teaching during ERT as they provided the link between teachers and learners that directly affects learners' understanding of knowledge and skills in learning a certain content (Vygotsky, 1978); as in terms of technological learning environments, it is necessary to emphasize that the tools that mediate new knowledge can be represented in the form of various technologies such as the Internet, LMS, and social media, (DeSchryver & Yadav, 2015; Guichon, & Cohen, 2016).

The teachers indicated that integration of technology can only benefit teachers and learners who possess good technological skills and knowledge. Teachers value the integration of technology specifically for administration in education, such as for team marking, recording marks, compiling reports and filing of learners' information. Generally, teachers understand that the integration of technology improves the participation of learners by raising the curiosity of learners. It gives teachers more opportunities to use a variety of resources, it creates a more engaged teaching and learning environment. It also allows collaboration among learners because it incorporates different learning styles. In relation to existing literature, research findings by Kim et al. (2013) on teachers' beliefs and technology integration revealed that technology integration has become essential for teaching today. Rodinadze and Zarbazoia (2012), stressed that using technology, teachers can increase literacy and understanding in their subjects. Their findings revealed that using audio and

video components in lessons motivates more learners to participate in class ,raise their understanding, and enables them to check their progress through the internet.

Similarly, in a study by Ratheeswari (2018) on the use of ICT in education, technologies were found as playing salient roles in educational institutions, and technologies were also recognized as catalysts for learning change. The study further concludes that the technology used in the classroom offered learners opportunities to learn and develop the required 21st-century skills. Within this view, Gilakjani (2017) suggest that technology improves teaching and learning as it transforms the teacher's role into a facilitators of pedagogical environments. Gilakjani adds that technologies help teachers to present their teaching attractively at any level of educational programs. Most technologies exemplified by the internet and interactive multimedia are an important focus for future education and must be effectively integrated into formal teaching and learning. However, technology is believed to enhance and provide learners with the opportunities to demonstrate creative ideas in an innovative format that is otherwise unobtainable in the standard classroom setting (Matuk et al., 2015).

Theme 2: Technological facilities for teaching and learning in schools

Overall findings show that many schools have technological facilities that can make it possible for technology integration into teaching during ERT. As the global Covid-19 pandemic necessitated shifts away from face-to-face (Iglesias et al., 2021; Sharma et al., 2021); to sustain education during the pandemic in most countries, teaching and learning practices were forced to move to an online environment (Nerantzi, 2020; Aliyyah et al., 2020). In Namibia, teachers indicated that whether ERT or not, they can integrate technology into their teaching process because of the availability of the necessary facilities in their schools. According to this study, facilities mainly found in Namibian schools are desktop computers, laptops, and PowerPoint projectors. Many schools are in possession of fixed and portable internet devices. Laptops and smartphones are devices commonly used by teachers for teaching and learning during ERT. Radio stations and TV channels can be used for lesson presentations during ERT. In line with these findings, literature reveals the system of teaching online through technology demands the use of technological tools such as videoconferencing and learning management systems typically reliant on the Internet but

also accomplished in some places through the delivery of physical materials such as books and paper packets (Azlan et al., 2020).

During ERT, laptops and smartphones were used to design and develop learning materials, download materials/resources from the internet, and share the materials with other teachers and learners. Through integrating technology, teachers created WhatsApp groups, Facebook pages, and Zoom meeting schedules. To present their lessons during ERT, teachers presented subject contents via Radio stations and TV channels by sharing video presentations, voice notes explanations and emails of worksheets and study materials. This shows teachers were integrating technology because, according to Ratheeswari (2018), technology integration is the application of technology to improve the educational environment. As Kim et al. (2019) elaborated that technology integration for some teachers might mean utilization of the most recently developed technologies such as tablets and wearable devices, implementation of a one-to-one laptop initiative, and development of daily lessons integrating interactive whiteboard, or even the launch of online instructional programs that may substitute the use of the traditional textbooks. To other teachers, it may mean creating a PowerPoint to demonstrate an understanding of a concept or learners' access to technologies in a computer laboratory. Still, other teachers may recognize technology integration as the use of overhead projects, chalkboards or dry-erase boards, or textbooks with papers and pencils. It is worth concluding that they were using technology during the ERT of the Covid-19 pandemic.

For the teachers who could not manage technology integration during ERT due to technological challenges and other factors, printed materials (hard copies) were distributed and some learners came to schools in a very small number of groups. Since the pandemic in 2020 required teachers to instantly revise their daily teaching practices by endeavouring to apply technological novelty to achieve pedagogical goals (Adov & Mäeots, 2021), the unexpected pedagogical transformation was smoother for some teachers than others. The study conducted by Adov and Macots (2021) on 'What can we learn about science teachers' technology use during the Covid-19 pandemic' revealed that the teachers' perceived willingness to use technology, the easier it was for them to overcome potential obstacles and cope with the unexpected distance learning. The study further revealed the main obstacles, such as lack of slow internet connections, lack of digital skills among

students, and teachers' beliefs about technology use for teaching. The study also highlights the importance of understanding and considering the variability in the possible obstacles that emerge in using technology in education for teachers with different levels of experience.

Theme 3: Challenges of integrating technology for teaching

In this study, the results presented in Chapter 4 Section 4.5 illuminated various technological challenges experienced by teachers during ERT. Literature from a study carried out by Chun, Kern & Smith (2016) supports the previous sections' results that the integration of technology goes beyond the utilization of a digital device but rather is a part of the instructional process and must be deliberate in how and why it is being used. They further stressed that placing technology devices in the classroom or installing a computer lab only increases learners' access. Technology integration must also consider infrastructure and network capabilities to ensure adequate operation as well as capacitate teachers to implement effective classroom and pedagogical use. It is also insufficient to provide learners and teachers with digital devices without technical support and to explore what can be done with these technologies and how they can enhance the teaching and learning processes.

The first challenge is the lack of technological knowledge. Some teachers do not know how to use devices. Some have limited skills in operating available devices for teaching and learning. Both teachers and learners were not by any means prepared to engage in teaching and learning through technology. Some parents are also not acquainted with the skills of operating technology devices; they are not made to understand their roles to play and support their children to make ERT a success. Literature supported the findings that the rise of digital technologies and the expectation of their successful integration into the classroom provides many teachers with a substantial challenge (König et al., 2020). Barriers such as the improper operation of computers, maintenance problems associated with outdated software, inadequate technical support, lack of time to learn the operation of technology and lack of access to technology are some of the experiences that hinder teachers from effectively integrating technology into teaching (Raja & Nagasubramani, 2018; Ghavifekr & Rosdy, 2015).

The study done by Ruggiero and Mong (2015) revealed that technology in the classroom makes learning more accessible and engaging but must be strengthened efficiently to meet instructional goals. Mishra and Koehler (2006) noted that both standard technologies, such as books, chalk, and blackboard, as well as more advanced technologies, such as the internet and digital video, require specific technological knowledge and skills to be implemented well in the classrooms. It is also noted by Mohebi and Meda (2021) that where the teacher leads, the implementation of technology is the key to creating a classroom that integrates technology into the curriculum to enhance learners' experiences and better prepare them for the future. In order to integrate technology successfully in classes, both teachers and learners should adopt new roles and use technologies in suitable ways. Thus, teachers should be prepared with technological skills to integrate technologies into the content and pedagogies (Gilakjani, 2017). Therefore, teachers need training on how to use and engage facilities for effective technology integration.

Secondly, there are not enough technology devices and resources to allow effective teaching during ERT. Not all teachers possess or have access to smartphones, laptops, and internet devices. All learners who have no access to radios, televisions, and other devices cannot receive information that has been shared via technology. Despite the benefits that the integration of technology brings to the classrooms, there are challenges found in other studies. Ertmer et al. (1999), in their study on factors influencing technology integration in Mathematics instruction, pointed out some internal and external barriers to technology integration. Internal barriers involve teachers' attitudes and beliefs external barriers include things such as the availability of computers, level of administrative support, and professional development opportunities involving technology. Other factors affecting technology integration in the classroom are poor infrastructure, inadequate technology, lack of sufficient technological tools, effective professional development, low teacher self-efficacy, and teacher perceptions (Harrell & Bynum, 2018). And those who had devices had problems with network and internet connections, including power availability. In their study, Khalif et al. (2021) on the 'teachers' responses to school closure in developing countries, teacher participants responded that they faced some critical issues. For example, the ambiguity of the guidelines to use to transform to online learning, lack of technological pedagogical knowledge, lack of technological content knowledge, and learners, implementation of equity and access to the lessons in an online environment, and the teaching environments.

Finally, one of the challenges is the financial implications Shraim and Khalif (2020) noted that school closures caused many families to spend a lot of money to provide their children with educational resources and enrichment activities as well as private lessons to fill the learning gaps, an act that has caused inequity in education for poorer families in particular. The study done by Rahiem (2020) on the technological barriers and challenges in the use of ICT during the COVID19 emergency remote learning reported that the use of appropriate and relevant pedagogy for emergency remote instruction depended on the expertise and exposure to information and communication technology by both teachers and learners. Not all schools have the human and physical resources to transition entirely to emergency remote teaching (Watermeyer et al., 2021).

In many developing countries, economically challenged children cannot afford to acquire and access technology devices and internet services. Social distractions such as playing games and watching non-educational videos also made ERT unsuccessful. The study was done by Mugroho et al. (2021) to explore the teachers' insights and suggestions to overcome the challenges of the ERT amidst the global pandemic. The findings from the 26 participants through semi-structured questionnaires and interviews revealed that teachers encountered challenges such as unfamiliarity with digital platforms, inability to provide quick feedback and lack of student motivation and engagement. In line with these findings, Mugroho et al. (2021) suggested that joining professional development programs, creating representative lesson plans, and designing interactive online classroom activities could become alternative solutions.

Theme 4: Teachers' understanding and perceptions towards TPACK

In this study, the results of the assessment of their self-reported TPACK by the teachers show the understanding of secondary schools' teachers' TPACK (See Chapter 4, section 4.6). The result of the teachers' TK shows that teachers developed strong capabilities of learning technology easily, whereby they were able to utilize different technologies in teaching. They also possess knowledge about different technologies and possess the technical skills they need to use these technologies. On the contrary, many teachers do not, however, lack the knowledge and skills to resolve technical problems and cannot keep up with new emerging technologies. The results showing teachers' CK indicate that teachers have sufficient knowledge about their subject contents. The results of PK show that teachers can adapt their teaching based on learners' prior knowledge and can adapt their

teaching styles to different learners' learning needs. They know how to assess learners' performance in a classroom setting and organization and maintain classroom management. Teachers are also neutral on whether they can assess learners' learning using technologies. Literature confirms that technological pedagogical content knowledge is the basis of good teaching with technology and requires understanding the representation of concepts using technologies (De Rossi & Trevisan, 2018; Makawawa et al., 2021). Koehler, Mishra & Cain (2013) elucidated that there is no single technology solution that applies to teaching and all teachers. Effective teaching requires developing a nuanced understanding of the complex relationships between technology, content, and pedagogy and using this understanding to develop appropriate, context-specific strategies and representations.

Furthermore, the results about PCK of teachers, indicates that teachers know about the technologies they can use for teaching their subjects. The results about TCK reveal that though teachers know the technologies they can use for presenting pedagogies in their subjects, many still do not know how to choose specific suitable technology present subject content. The results about teachers TPK revealed that teachers can choose technologies that enhance their teaching approaches, they can adapt the use of technology to do different teaching activities and they can select technologies that enhance or influence what they teach. Teachers can select technologies that enhance learners' learning and they can use strategies that combine content, technology and teaching approaches. The results about teachers' TPACK reveal that though teachers can teach lessons appropriately by combining their subject content, technology and teaching approaches, there are still uncertainties about the effectiveness of combining them. Some study findings related that technological pedagogical content knowledge is regarded as the basis for teaching with technology, it requires understanding pedagogical techniques that use technologies constructively to strengthen previous knowledge and develop new knowledge (Graham, 2011; Malik et al., 2019). And, understanding technological pedagogical content knowledge among teachers can provide a coherent structure that allows them a better understanding of sound technology integration. Teachers with sound technology integration make effective decisions regarding learning content, teaching goals, and pedagogical methods and assess the lesson outcomes (Henriksen et al., 2016).

Theme 5: Development of teachers' TPACK

The understanding of self-reported experience of how ERT aided teachers in acquiring an operational understanding of complex relationships among content, pedagogy, technology, and context was the interest of this study. The set of findings about the development of secondary school teachers' TPACK during ERT is presented in Chapter 4, section 4.5. In this section, it is discussed in relation to the literature from other studies and the literature about sociocultural theory and the TPACK frameworks.

According to the results of this study, teachers gained developed knowledges related to technology during ERT. The use of technology-enhanced teachers' ability to develop further technological knowledge (TK). Technology integration during ERT exposed teachers to the use of different technological tools and made teachers develop an interest in technology in teaching. The literature supports that teachers' digital competence involves their proficiency in using technology professionally, with good pedagogic-didactic judgment and awareness of its implications for learning strategies. From this perspective, technologies are considered a way to support pedagogical knowledge and methods (Krumsvik, 2008). Other studies reported that this is an indication that teachers need specific knowledge to develop methods, strategies, and applications of the technology which are suitable in a teaching and learning context (Kivunja, 2013; Krumsvik, 2008; Mishra & Koehler, 2006). Typical approaches to technology-related professional development are based on assumptions that it may be enough to expose teachers to particular educational technologies and possible curriculum-based uses of the tools and resources (Ryan & Bagley, 2015; Koomson et al., 2022). Teachers have gained the ability to use available technologies to prepare the subject matters (TCK). They gained confidence in using different websites. ERT influenced teachers to be active in searching for more information on internet teachers gained the capabilities of choosing suitable types of technologies suiting their content. According to the literature, to help teachers develop and use technologies in ways that attend to the particular demands of different subject matter domains. Harris & Hofer(2006) suggested an important first step is creating awareness of the range of possible learning activity types within a particular content area, matching them to multiple ways that both digital and nondigital technologies can be used to support each type of learning activity.

Furthermore, teachers gained knowledge in the capabilities of combining their subject contents with suitable teaching strategies (TPK). According to Mishra and Koehler (2008), teachers must have a deep understanding of how specific technologies can be applied to change the topic, understand which specific technology is most suitable for solving the topic of their field, and how the content determines or even changes the technology. As teachers gained capabilities of choosing suitable effective technology that suits strategies during their planning process, ERT exposed them to strict technology integration, and this helped teachers to recognise available technologies. Results show how teachers recognized the type of technologies that are related to the pedagogical approaches suitable for the subject content.

Similarly, teachers gained the ability to combine relevant content with relevant pedagogy together with relevant technology (TPCK) in a logical manner. According to Mishra and Koehler (2008) teachers' knowledge of how various technologies can be used in teaching and understanding that using technology may change the way an individual teaches. The relationship between general pedagogical knowledge i.e., the specialized knowledge of teachers for creating effective teaching and learning environments for all learners independent of subject matter and general technological knowledge i.e., a basic understanding of technology use, skills required to operate particular technologies and the ability to learn and adapt to new technologies (Guerriero, 2017). Mishra and Koehler (2008) concluded that teachers must have a deep understanding of how specific technologies can be applied to change the topic, understand which specific technology is most suitable for solving the topic of their field, and how the content determines or even changes the technology.

5.4 Summary of the chapter

The focus of this study was on teachers' comprehension of Technological Pedagogical Content Knowledge (TPACK) and the fresh abilities that aided the advancement of TPACK through Emergency Remote Teaching (ERT). The cumulative data underscored an enhanced level of ease and assurance among teachers when it came to leveraging and integrating technology to enrich the teaching and learning cycle. The teachers derived profound benefits from the exposure to and exploration of technology tools during the ERT period, which in turn facilitated their TPACK evolution.

Intriguingly, teachers have acknowledged their growth within the TPACK framework; however, they also highlighted certain areas where enhancements can still be made. There exist certain gaps which warrant further investigation and research within this context. These gaps could relate to specific areas of TPACK which are not being fully explored or are being overlooked within the ERT setting. Although this study has found significant improvements in teachers' TPACK comprehension and utilization during the ERT period, it's crucial to acknowledge that this process is ongoing. The evolution of TPACK calls for a consistent exploration and regular updating of digital strategies and methods. The next chapter focuses on discussing the conclusion of the study, and the implications and suggestions for future studies are listed. After the discussion in this chapter, following in the next chapter, Chapter Six is the presentation of the conclusion of the study, the implications, the limitations and suggestions for future research in the area of technology integration and emergency remote teaching TPACK development.

Chapter 6: Conclusions, Limitations, and Recommendations

6.1	• Introduction
6.2	• Overview of the study
6.3	• Conclusions of the study findings
6.4	• Recommendations for TPACK practices
6.5	• Recommendations for future studies
6.6	• Limitations of the study
6.7	• Summary of the chapter

6.1 Introduction

The previous chapter, Chapter 5 examined the outcomes as delineated in Chapter 4, encapsulating a comprehensive analysis of the research findings. This evaluative discourse aligns seamlessly with the overarching themes that have surfaced from the previous presentation chapter. The convergence of these themes serves to deepen the understanding and shed light on the intricacies of the study objectives inherent in the study's outcomes. Furthermore, the discussion engenders a heightened appreciation for the interconnectedness of these themes. As we traverse this synthesis of findings and themes, a more holistic appreciation of the study understanding emerges, underscored by the recognition that the themes themselves are not discrete entities but rather fluid concepts that interact in intricate ways. This intermingling of themes not only validates the significance of the initial research questions but also paves the way for a deeper exploration of potential avenues for future research studies.

The present section encompasses a comprehensive compilation, encompassing an overarching view of the study by incorporating the study's conclusive findings. Within these pages, there is a discussion of the research summary according to the research's main questions, an extensive exploration of the recommendations formulated for the augmentation of technological pedagogical content knowledge (TPACK) practices, and suggestions for potential future investigations. The structural organization of this chapter adheres to a meticulously designed layout, thoughtfully presented in the visual representation displayed graphically above the page.

6.2 Overview of the study

Chapter 1 outlined the primary purpose of this study, which was to investigate the technological pedagogical and content knowledge development of secondary teachers through integration and use of technology during emergency remote teaching in the Endola education circuit during the breakout of the COVID-19. Two objectives were identified to support the major purpose. Firstly, *to investigate how secondary school teachers integrate and use technology during the emergency remote teaching of the covid-19 pandemic in Endola education circuit.* And the second objective was *to explore how integration and use of technologies during emergency remote teaching support TPACK development.* To achieve the purpose of this study, the following questions were taken into consideration. (a) *How do secondary school teachers integrate and use technology during the emergency remote teaching of the covid-19 pandemic in Endola education circuit?* And (b) *How do integration and usage of technologies during emergency remote teaching in the Endola education circuit support secondary school teachers' technological pedagogical and content knowledge development?*

Chapter 2 introduced the main concepts and literature connected with this study. Relevant literature was reviewed on the understanding of teachers' integration of technology in teaching and learning. The literature about emergency remote teaching was also reviewed, such as how teachers integrate technology during ERT, the challenges experienced during ERT, and the development of TPACK through integrating technology. Finally, the sociocultural theory and TPACK framework were discussed in this chapter.

Chapter 3 discussed the research design and methodology used in the study. The study adopted an interpretive philosophy utilizing a mixed research approach. A case study design was used with a multi-method qualitative approach with three data collection techniques, namely: semi-structured questionnaire, and semi-structured interview. Purposive sampling was employed to select participants using pre-selected criteria. Thematic analysis through colour coding was used to collect data. The details of trustworthiness were ensured, and the researchers' position and ethical considerations are all discussed in this chapter.

Chapter 4 The study was conducted in a selected circuit whereby twenty-six secondary school teachers participated from seven schools. Data collected from the participants and analyzed through the lens of the TPACK framework and socio-cultural theory established the empirical findings, and conclusions were drawn from them. The findings are presented according to the research questions, and direct quotes were used to give the original meaning of the findings.

Chapter 5 sets out the discussion, which presents a critical interpretation of the results, literature backing up the results analysis, and the explanation of the significance of the results. There are five main themes that emerged out of the analysis, and the findings are discussed according to these themes against the relevant literature. Thereafter, Chapter 6 then discussed the conclusions, recommendations, and limitations of the study. These conclusions are presented below.

6.3 Conclusions of the study finding

The research questions formulated in Chapter 3, as initiated by the main research topic in Chapter 1, were answered by conducting a self-administered questionnaire, semi-structured interviews, and literature related to the research questions analyzed. All the data gathered aim to investigate the development of TPACK among secondary school teachers during the emergency remote teaching of the covid-19 pandemic that happened in 2020, 2021, and part of the 2022 academic year.

Generally, the results show positive perceptions that secondary school teachers have towards the integration of technology in teaching. Teachers hold good technological pedagogical content knowledge as they have the ability to identify the technology tools for teaching their subjects, how to use them in their subjects, and how to combine them with suitable pedagogical and technology. The detailed answers to the research questions, recommendations, limitations, and suggestions for further research of this study are discussed next in this section. The findings of this study are presented and discussed in chapter 4 and chapter 5, respectively. The emerging answers to each research question are therefore presented in this section.

RQ1: How did secondary school teachers integrate and use technology during the ERT of the Covid-19 pandemic?

Pursuant to this research question, the findings show that there are some Namibian schools in possession of different technological facilities that can allow teachers to integrate technology into teaching. Teachers were using all available facilities to continue teaching and learning during ERT. There are available technological facilities that teachers own personally to help them integrate technology from home, such as laptops and smartphones that are used for creating teaching materials such as video presentations, voice notes, and worksheets and sharing them with their learners. Teaching and learning during ERT were done via WhatsApp groups, Zoom meeting sessions, and lesson presentations on radio stations and TV channels. Even though many teachers are capable of integrating technology, there are challenges that hinder the process. Challenges include limited and/or lack of technological knowledge in teachers and learners, insufficient and lack of technologies for both teachers and learners, poor mobile network and internet connections, scarcity of electricity in rural areas, and financial implications on acquiring technologies. This finding was achieved through the collection of primary sources of data and eventually analyzed from both qualitative and quantitative approaches.

RQ2: How do secondary school teachers' integration and usage of technology during ERT support TPACK development?

Regarding this research question, overall findings from the triangulated data revealed the following answers. Teachers acknowledged their content and pedagogical knowledge for specific subjects that together produce good pedagogical content knowledge. Teachers gained strong capabilities and good technological skills from ERT, they gained good pedagogical content knowledge, as well as better technological content knowledge. There is a better understanding of teachers' ways of using technology tools, choosing suitable tools, and combining the content, pedagogy, and technology skills.

Teachers' experience from ERT provided them an opportunity to delve deeper into their subject matter, enhancing their content knowledge. This progress was not only witnessed in their understanding of the subjects but also in their ability to effectively deliver the knowledge

(pedagogical skills), contributing to their pedagogical content knowledge. Continuous engagement with ERT practices helped the teachers upgrade their technological skills by working with various advanced tools and teaching aids. An interesting turn of events was observed with the improvement in teachers' pedagogical content knowledge, which was reflected in their increased efficiency and effectiveness during ERT. The ability to present both content and pedagogical knowledge using technology is a new skill many teachers developed through the process. The pedagogical strategies of the teachers evolved with the enforcement of ERT, ensuring that they are supportive, flexible, and creative.

Technological content knowledge saw a visible elevation among these teachers as a result of the regular use of different technologies during ERT. The teachers' usage of technology tools was directed more towards achieving an optimal learning environment and less towards utilizing the maximum features of the tool. The choice of appropriate tools became increasingly intuitive for teachers, understanding the specific requirements for each lesson. There was observed a symbiotic relationship between the content, pedagogy, and technology, which helped in successful ERT implementation. The transition from traditional to virtual teaching forced teachers to reconsider their teaching methods and incorporate technology effectively. Thus, from these findings, it can be inferred that ERT helped to transform the teachers into more confident, effective, and technologically advanced educators.

6.4 Recommendations for TPACK Practices

The findings of this research work have revealed some evidence of a lack of technological knowledge as the basic knowledge required for technology integration in teaching. The relevance of this research work is to use the findings as the base to bridge the existing gap between the possession and integration/usage of technological knowledge. In this section, the key recommendation is suggested for Namibian schools and other developing countries. The following are the proposed recommendations.

- Some of the prominent issues regarding the poor development of TPACK in teachers is the lack or poor technological pedagogical training for teachers. This study recommends that there is a need for improving in-service and pre-service teachers' training and support for

learning how to identify, evaluate, and use technology to facilitate learning in any conditions being face-to-face or ERT (online and blended instructions).

- Various limiting factors to the development of TPACK of teachers around the availability and effective use of technological devices/tools. Increasing access to education technology and the internet to all teachers could provide opportunities for them to develop technology competencies.
- Continuous professional development programs at all levels such as school, circuit, regional, and national levels should aim to inculcate tangible measures towards the integration of technology in teaching at all phases of teaching.
- This study recommends that in addition to in-service training, teachers should be provided with subject-specific training. This training should include the use of technology pertinent to the instruction of specific subjects. Such training could increase their competency in integrating technology into their teaching strategies and thus enhance their Technological Pedagogical and Content Knowledge (TPACK).
- Teachers at a personal level, should be motivated to embrace the integration of emerging technologies apart from smartphones such as personal laptops, and internet devices at home, and engage in educational technology programs such as Digital Skills etc.

6.5 Recommendation for Future Studies

Several suggestions for upcoming research initiatives emerge from the findings of this study: Firstly, future studies should include more elements like the type of curriculum being taught, the school's surrounding environments, and attitudes of students and parents towards digital technologies. The selection process should be more efficient in incorporating these factors, for instance, by using simple random sampling. This can also help to pack more strength into the results by using a larger group of participants.

Secondly, the depth of the results can also be enhanced by viewing the connection between a teacher's technological, pedagogical, and content knowledge (TPACK) and how effectively they teach. This aim can be achieved by implementing more thorough, reliable ways of evaluating like observing teachers' methods in a classroom over some time, analyzing the teaching materials they use, and understanding student progress based on their value-added scores.

As an additional recommendation, it would be beneficial for future researchers to consider potential teacher training programs that could refine their TPACK skills. These recommendations not only enhance the validity of the study but also provide consequential insights for improving education practices.

6.6 Limitations of the study

The findings from this study present a limited view of the development of TPACK during ERT. Firstly, teachers reported they were using technological tools and apps, the findings include little undetailed explanations of how they were using them, and their effectiveness in integrating technology is yet to be studied. Secondly, findings revealed that teachers gained new skills related to technology integration in teaching, however, this study did not employ the observation sessions during their planning, teaching, and assessment processes to obtain on-spot data.

Additionally, the number of participants was small, which posed a challenge to the desired statistical analysis of the data. Some potential participants from the set of questionnaire sessions to the subset of interview sessions could not partake in the interviews because of the high triangulation of data. It is against these limitations that the researcher found a gap in good understanding of how TPACK is developed during the integration of technology during ERT. Therefore, further research studies are required to assess the level of TPACK developed among the teachers after the use and integration of technology during ERT of covid-19 pandemic.

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APPENDICES

APPENDIX A: RHODES CLEARANCE CERTIFICATE


RHODES UNIVERSITY
Where leaders learn

Rhodes University, Education Faculty
Research Ethics Committee
PO Box 94, Makhanda, 6140, South Africa
Tel: +27 (0) 46 603 8393
Fax: +27 (0) 46 603 8028
email: e.rosenberg@ru.ac.za
<https://www.ru.ac.za/researchgateway/ethics/>

28 September 2022
Dr Clement Simuja
Education Department
C.Simuja@ru.ac.za

Dear Dr Clement Simuja and Ms Johanna Munyanyo

Re: Technological Pedagogical Content Knowledge development: Investigating Secondary School teachers' integration and use of technology during emergency remote teaching in Endola Education Circuit

APPLICATION NUMBER: 2022-5911-7077

This letter confirms that your research ethics application has been reviewed and **APPROVED** by the Education Faculty Research Ethics Committee (EF-REC). Your permission letter(s) where applicable have been received and you are free to proceed with your study.

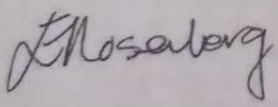
Approval is granted for 1 year. An annual progress report is required in order to renew approval for an additional period. You will receive an email notifying you when the progress report is due.

Should any substantive change(s) be made during the research process, that may have ethical implications, you should notify the Education Faculty REC Chair via email. This includes changes in investigators. The REC Chair will advise as to whether a new application is necessary.

Do keep this clearance letter secure and accessible throughout your study and after its completion. It will be needed when a thesis is examined and when publications are submitted to journals.

Please also submit a brief report to the REC Chair on the completion of the research. This can be done via email. The purpose of this report is to indicate whether the research was conducted successfully and whether any ethics-related matters arose that the committee should be aware of, in order to guide future studies.

Sincerely,



Prof Eureka Rosenberg
Chair: Education Faculty Research Ethics Committee

APPENDIX B: APPROVAL LETTER FROM OHANGWENA DIRECTORATE OF EDUCATION



REPUBLIC OF NAMIBIA
OHANGWENA REGIONAL COUNCIL
DIRECTORATE OF EDUCATION, ARTS AND CULTURE

Section: Office of the Director
Tel: (+264) 65 290200
Fax: (+264) 65 290224
Enquiries: Mirjam Nambehu
Our Ref: 12/3/10/1

Harelbeke Street, Greenwell Complex
Private Bag, 88005
Eenhana

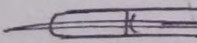
26 September 2022

To: Ms Munyanyo Johanna
Email: munyanyoj@yahoo.com
0812208498

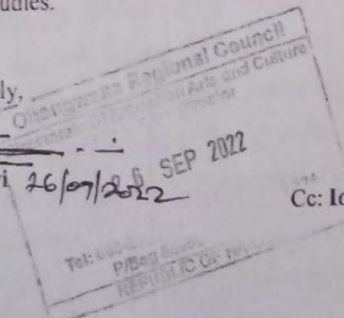
SUBJECT: PERMISSION TO CONDUCT RESEARCH AT SCHOOLS IN ENDOLA CIRCUIT.

1. Receipt of your letter on the above stated subject is hereby acknowledged.
2. The request has been evaluated and found to have merit.
3. Kindly take note that permission to collect data for research purpose at the selected schools in Endola Circuit has been granted under the following conditions and requests.
 - The information to be collected should only be used for the completion of your studies.
 - Kindly liaise with the concerned School Principals so that you make prior arrangements before the date of the data collection.
 - You should share the final report of your study with the directorate.
4. It is trusted that you will find this arrangement in order while wishing you all the best with your studies.

Yours Sincerely,


Isak Hamatwi
Director

Cc: IoE: Endola Circuit



APPENDIX C: PERMISSION LETTER FROM ENDOLA EDUCATION CIRCUIT



REPUBLIC OF NAMIBIA
OHANGWENA REGIONAL COUNCIL
DIRECTORATE OF EDUCATION, ARTS AND CULTURE

Section Inspectorate
Tel: (+264) 65 268810

ENDOLA CIRCUIT

P O Box 3668
Ongwediva
28th, September, 2022

Enquiries: Mr. Simon Vaeta
Email Address: vaetasimon@gmail.com
Our Ref: 12/2/9/1

To: Ms. Johanna
Email: munyanyoj@yahoo.com
0812208498

Dear Ms. Munyanyo,

SUBJECT: APPROVAL GRANTED TO CARRY OUT A RESEARCH STUDY AT SCHOOLS IN ENDOLA CIRCUIT, OHANGWENA REGION

1. Receipt of your letter on the above matter is hereby acknowledge.
2. The Endola Circuit Office of Education indeed supports and herewith grants approval to you to carry out the envisaged research on "using and integrating technologies during the "Lockdown" of the COVID-19 Pandemic.
3. Your case study is most welcomed as it will be done with a specific focus on the Secondary Teachers using and integrating ICT in teaching.

Additionally, this permission is given on condition that:

4. Schools activities are not disrupted during your research
5. The data collected should only be used for research purposes and for the completion of it.
6. You are kindly advised to make pre-arrangements with the school management before you embark on your research.
7. Sharing your study findings with the circuit office will be highly welcomed.
8. It is our firm believe that all ethical requirements will indeed be upheld and hope that you will find this arrangement in order and very fruitful.

Yours Sincerely, *Mr. Simon Vaeta*

28.09.2022

Mr. Simon Vaeta
Inspector of Education
Endola Circuit

OHANGWENA REGIONAL COUNCIL
DIRECTORATE OF EDUCATION, ARTS AND CULTURE
28-09-2022
P O BOX 3668 ONGWEDIVA
REPUBLIC OF NAMIBIA

APPENDIX D: CONSENT FORMS SAMPLE

- My identity in this study will be protected with the code of ethics stipulated by Rhodes University
- Having taken note of the above information, I freely and volunteer to take part in the research process and acknowledge that I have not been forced to do so.

Declaration

I, Nkululeko Tengen..... (full name and surname of participant) hereby confirm that I understand the contents of this letter and the nature of the research project. I consent to participate in the research project.

Signature of participant [Signature] Date. 18/10/22.....

Yours Sincerely

Johanna Munyanyo

[Signature]

(Master of Education - ICT Education)

APPENDIX E: QUESTIONNAIRE FORM SAMPLE

SEMI-STRUCTURED QUESTIONNAIRE

Introduction

This is a Master's Education research questionnaire designed to obtain your views and experiences about the integration and use of technologies during the emergency remote teaching “lockdown” of the Covid-19 pandemic in 2020-2021. Kindly be open and free as possible. Be assured that absolute confidentiality will be adhered to, and under no circumstances will your details be revealed to a third party. Please answer all questions to the best of your knowledge. Your responses will be kept entirely confidential. Thank you for your participation.

Instruction

Read each question carefully. Possible answers follow the questions. For each question you read, there are indications of the number of possible choices. Tick in the appropriate box(es) next to the answer of your choice. Kindly respond to **ALL QUESTIONS** to the best of your ability. Honesty is highly appreciated.

SECTION A: TECHNOLOGICAL BACKGROUND INFORMATION USAGE DURING THE "LOCKDOWN"

Respond by putting an (√) under the appropriate heading.

1. Are the following facilities available at the school you are teaching?

Available teaching and learning technologies	Yes	No
Computer Laboratory		
Computers/laptops for teachers' use		
Internet connectivity		
Tablets for teachers' use		

2. Which technological devices did you use during the lockdown of Covid-19 in 2020-2021?

Devices used	Yes	No
Smartphone		
Tablet		
Laptop		
Desktop		
iPad		

3. Which technological means did you use to present your content to the learners during the "Lockdown" of the Covid-19 pandemic?

Technologies	Always	Often	Sometimes	Lesser extent	Not at all
Blackboard collaborate					
Zoom					
WhatsApp groups					
Facebook groups					
SMS					
Radio					
Telephone					
Television programs					
Telegram					
Instagram					
Email					
Skype					
Google Meet					
Ms Team					
Twitter					
Tiktok					
WeChat					

4. Any brief description of how you have been teaching and communicating with learners during the "Lockdown" of the Covid-19 pandemic?

SECTION B: DEVELOPMENT OF TECHNOLOGICAL PEDAGOGICAL AND CONTENT KNOWLEDGE AFTER THE "LOCKDOWN" OF THE COVID-19 PANDEMIC

Technology is a broad concept that can mean a lot of different things. For this questionnaire, technology refers to digital technology/technologies. For educational purposes, we use digital tools such as tablets, computers, the internet, iPods, laptops, software programs, and data projectors. for educational purposes. *Please answer all the questions, and if you are uncertain of or neutral about your response, you may always select "Neither Agree nor Disagree".*

Technological knowledge	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
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I know how to solve my technical problems.					
I can learn technology easily.					
I keep up with necessary new technologies.					
I frequently play around the technology.					
I know about a lot of different technologies.					
I have the technical skills I need to use technology.					
Content knowledge	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I have sufficient knowledge about my subjects.					
Pedagogical knowledge	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I know how to assess student performance in a classroom.					
I can adapt my teaching based on what students currently understand or do not understand (prior knowledge).					
I can adapt my teaching style to different learners (different learning needs).					
I can assess student learning in multiple ways					
I can use a wide range of teaching strategies in a classroom setting.					
I know how to organize and maintain classroom management.					
Pedagogical content knowledge	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

I can select effective teaching approaches to guide student thinking and learning in my subjects.					
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	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Technological content knowledge					
I know about technologies that I can use for teaching and assessing my subjects.					
Technological Pedagogical knowledge	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I can choose technologies that enhance the teaching approaches for a lesson.					
I can choose technologies that enhance students' learning for a lesson.					
My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom.					
I am thinking critically about how to use technology in my classroom.					
I can adapt the use of the technologies I am learning about to different teaching activities.					
I can select technologies to use in my classroom that enhance what I teach, how I teach, and what students learn.					
I can use strategies that combine content, technologies, and teaching approaches that I learned about in my coursework in my classroom.					

I can provide leadership in helping others to coordinate the use of the content, technologies, and teaching approaches at my school and district.					
I can choose technologies that enhance the content of a lesson.					
Technological knowledge and content knowledge	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I can teach lessons that appropriately combine my subjects, technologies, and teaching approaches					

C. GENERAL INFORMATION ABOUT TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE OF SECONDARY SCHOOL TEACHERS

1. Based on the experiences of using technology to teach during the “lockdown”, what do you think was advantaging and disadvantaging the learners? Advantages Disadvantages
2. Do you feel that the use of technologies during the lockdown has allowed teaching to continue? Briefly explain.
Yes or No
Explanation
3. Do you think *using technologies during the lockdown* has helped/supported you to develop good knowledge in using technologies into your teaching process? What are your general views about *how technology usage influences teaching*?

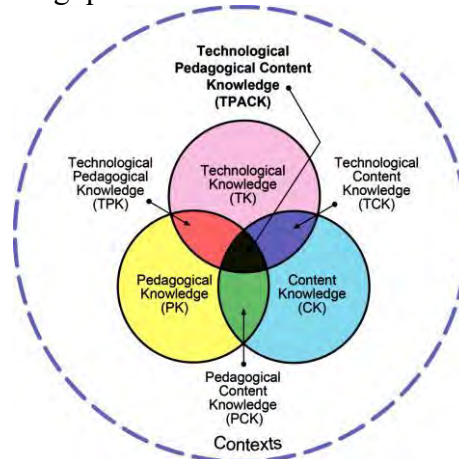
APPENDIX F: INTERVIEW GUIDE SAMPLE

Semi-structured Interviews and Focus Group Interviews

Interviews will be conducted after the questionnaires are back. It intends to collect data on how teachers taught by integrating technology during emergency remote teaching and how the integration and use of technology supported them in developing TPACK.

The Government of Namibia called for a “Lockdown”, and the ministry of education released circulars that teaching should continue; all educational institutions responded by teaching and integrating technologies at their disposal. It is against this background that I am conducting this interview with you.

1. What were your first experiences teaching with technology during the lockdown?
 - Tell me about how you’ve used technology in during lockdown to teach.
 - Tell me about assignments you have designed that require technology
2. How has your teaching with technology changed?
3. Has teaching with technology gotten easier or more difficult during the lockdown?
 - What are some challenges you have experiences teaching with technology?
 - What are some challenges you anticipate experiencing in the future using technology for teaching?
4. How would you describe your technology integration in your teaching during lockdown (ERT)?
 - How would you describe your experiences learning to use technology for teaching during Lockdown?
5. Please answer the following questions based on the TPACK diagram below.



- 5.1 Please place an ‘X’ on the diagram to identify where you believe your current TPACK resides with respect to your understanding of technology, pedagogy, and content knowledge for your teaching.
- 5.2 How would you describe your own TPACK based on where you marked X above?

- 5.3 According to your knowledge which factors, practices, or experiences (sources) from where do you draw your TPACK in your teaching during lockdown?
- 5.4 Have you had experiences teaching with technology that you would not repeat?