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**Integration of Educational Technology Resources in the Teaching of
Grade 10-12 Life Sciences**

by

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**This dissertation is submitted in partial fulfilment of the academic
requirement for the degree of Master of Education in the Curriculum Studies
Discipline**

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Date Submitted: 07 January 2025

DECLARATION

I, Zothani Minenhle Thela, declare that:

- a) The research reported in this thesis, except where otherwise indicated, is my original work.
- b) This thesis has not been submitted for any degree or examination at any other university.
- c) This thesis does not contain other person's data, pictures, graphs or other information unless specifically acknowledged as being sourced from other persons.
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 - e) Their words have been re-written but the general information attributed to them has been referenced;
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Researcher



Date: 07 January 2025

Ms Z.M Thela

As a candidate's supervisor, I hereby approve the submission of the dissertation for examination.

Supervisor

Date: 08 January 2025

Dr L.H Sokhulu

DEDICATION

This study is dedicated to everyone who has contributed to the person that I am today, but a special dedication to my Mother, *uNyambose, uDingiswayo, uHlangalezwe, Inkonyane yeNkosi*. I have seen you do the impossible, *uyibambe ishisa mfazi*. I also dedicate this work to my late father, Mtima and my late grandpa Dingiswayo, although I wish they could have lived to witness this moment, but I know they are proud of me where they are. I will always love you. *Khululeka Mtima*, mom did a phenomenal job raising me.

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“For with God nothing shall be impossible” Luke 1:37

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ABSTRACT

The use of Educational Technology resources has brought numerous benefits in the education system such as enhancing the teaching and learning process. Furthermore, integrating educational technology resources fosters inclusive education and offers an engaged learning environment where learners acquire the 21st century skills relevant in this digital age. This study explored the integration of Educational Technology resources in the teaching of grade 10-12 Life Sciences. The study was carried out in four different high schools in the urban, rural and township of Eshowe town. This qualitative case study adopted the interpretive paradigm, involving four teachers purposively and conveniently selected. The study used reflective activities, one-on-one semi-structured interviews and observations to generate data. The generated data was analysed using thematic analysis. The emerging themes formed the main findings of the study. In addition, Connectivism was employed as a philosophical lens to guide this study.

The findings of the study indicated that participants integrated similar hardware and software resources to teach Life Sciences. These included textbooks, overhead projectors, anatomical models, charts, laptops, videos and WhatsApp. The findings further reveal that participants were integrating these successfully in conjunction with the whole-class strategy but for different personal reasons. For instance, while some participants were using textbooks for assessing, others used them for visuals, and while other teachers were using OHPs to display notes some used them to display videos or pictures. Based on the study findings, it is recommended that teachers be equipped with more knowledge of other software and hardware resources such as YouTube, and apparatus. In addition, the study also recommends that teachers draw from the curriculum policies to integrate relevant educational technologies as formally prescribed.

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LIST OF ABBREVIATIONS

(C2005) Curriculum 2005

(CAPS) Curriculum and Assessment Policy Statement

(EdTech) Educational Technology

(HW) Hardware

(ICS) Interim Core Syllabus

(OBE) Outcome-Based Education

(RNCS) Revised National Curriculum Statement

(SW) Software

CHAPTER 1

THE SYNOPSIS, CONTEXT, AND OBJECTIVES

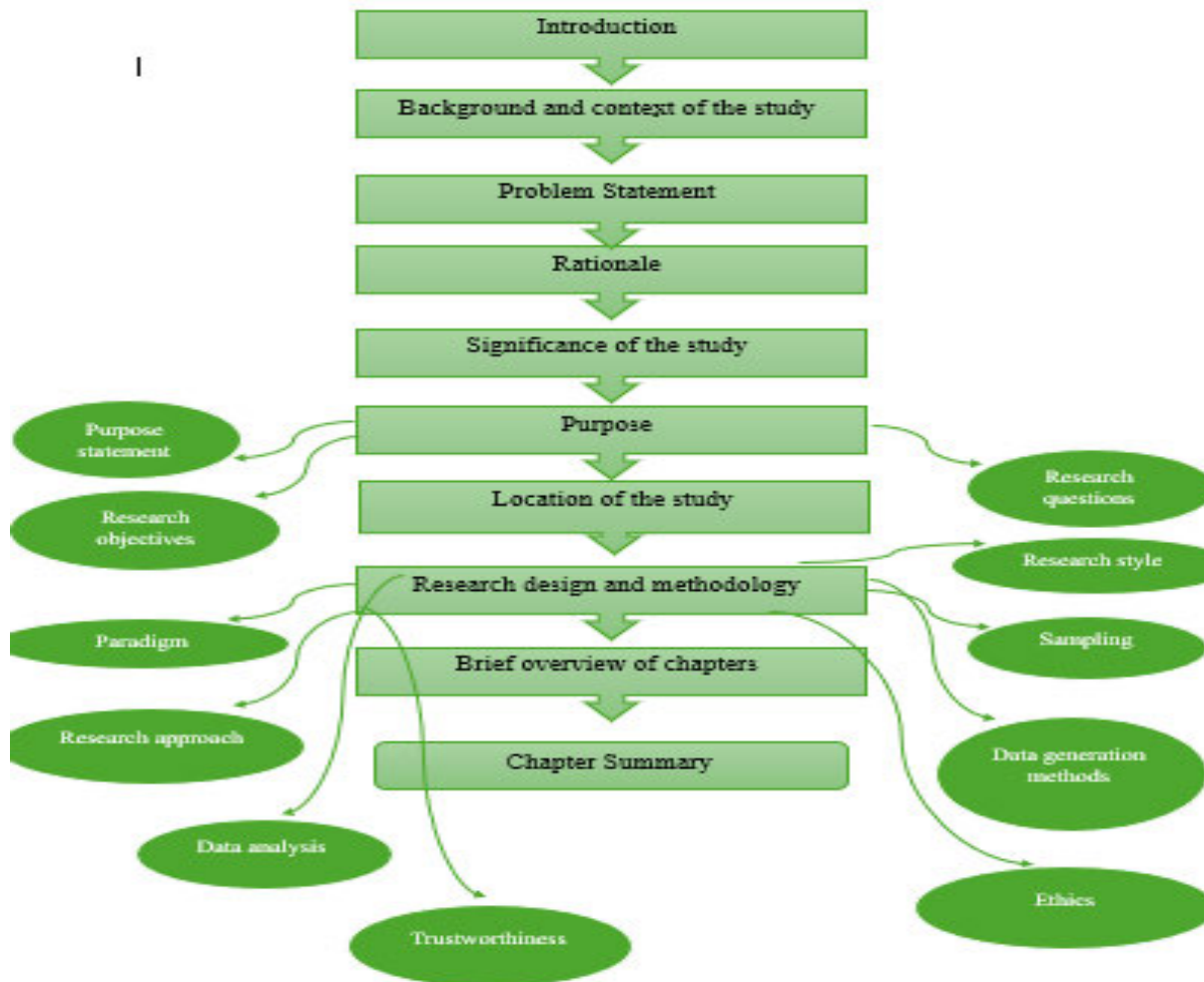


Figure 1.1: A flow chart showing the structure of chapter 1

1.1 Introduction

This chapter discusses the synopsis of the study to provide a brief insight into how the study was conducted. The chapter begins by laying out the background and context of the study. It then highlights the problem statement, and discusses the rationale and the significance of the study. The location in which the study was conducted is provided. The chapter further explains the purpose of the study and lists the research questions and objectives that guided the study. A brief description of the methods employed to conduct the study is also discussed. Additionally, the chapter briefly discusses the ethical principles addressed by the study and concludes with a brief overview of the chapters.

1.2 Background and context of the study

According to Shah (2022), as we live in the 21st era, the digital age, everything has changed, even including how we live, work and think. Technology has emerged as a significant force of change that has exposed children to the world of social media and the internet to such an extent that they cannot imagine their lives without it (Graham et al., 2020; Ogegbo & Aina, 2020). In addition to changing people's lives, the introduction of technology also made some schools abandon pencil and paper and chalk and chalkboard and created an academic environment that allows for better understanding of content (Boruah, 2022). Furthermore, Ogegbo and Aina (2020) state that technology is so important in schools because it promotes inclusive education and enables learners to obtain information that would be impossible to obtain manually. This means that the introduction of technology has improved the quality of education.

Chandra et al. (2024) also state that the use of technology in the educational system is vital because it allows learners to obtain and employ the 21st century skills required in the digital age. For instance, learners who are exposed to technology will be more prepared for a workplace where technology is used extensively. This means that the use of technology in schools also prepares learners for the future and the outside world. It is in this light that conducted a study on the integration of Educational Technology resources in schools. The aim was to understand if teachers are using technology in schools to reap the benefits mentioned in the foregoing statements. However, regardless of the advantages that technology brings in education only a small number of South African teachers are effectively integrating technology in their classroom (Graham et al., 2020). Such that for the past years, South Africa, has been making efforts to create classrooms that are paperless (Munje & Jita, 2020).

1.3 Problem statement

In a world that is led by the new development of technology, schools in developing countries seem to be facing a lot of challenges, particularly in the integration of Educational Technology (EdTech) resources into the curriculum. Despite EdTech showing great impact on the education system, especially in developed countries, in developing countries, mostly African countries, EdTech resources have been introduced in the education systems but the integration is facing many challenges (Barakabitze et al., 2019; Rana & Rana, 2020; Salam et al., 2018). Studies by Moshtari and Safarpour (2023) and Salam et al. (2018) assert that both developed and developing countries are making efforts to invest in EdTech resources but paces seem to differ, the pace is faster in developed countries while developing countries are lagging due to challenges of the absence of clear EdTech policies, the digital divide and financial constraints.

Furthermore, countries in Sub-Saharan Africa suffer from a lack of EdTech infrastructure, a lack of teachers with appropriate knowledge and skills of EdTech integration, and a lack of both hardware and software, which limit these countries from effectively integrating EdTech resources (Barakabitze et al., 2019; Kukulska-Hulme et al., 2023). For instance, South Africa as one of the Sub-Saharan countries faces challenges of poor internet connections, electricity outages (load-shedding), technological illiteracy in teachers, and little to zero access to EdTech equipment in public schools, all of which prevent the successful integration of EdTech (Mahlo & Waghid, 2022). In developed countries like Hong Kong and Singapore, the implementation of EdTech is much further advanced, because they have useful technology infrastructure in place and qualified teachers with relevant EdTech skills (Hermawan et al., 2018). This suggests that teachers from developing countries like South Africa are struggling with integrating EdTech resources due to the different circumstances they face as compared to the ones in developed countries. As such, it is evident from literature that teachers from developing countries still need more understanding of different EdTech levels of integration.

1.4 Rationale of the study

The study explored the integration of educational technology resources in the teaching of Grade 10-12 Life Sciences. I chose to conduct this study due to my experience as a learner and a student teacher. In the years that I was a learner, I noticed that my teachers integrated EdTech resources into the curriculum differently, no uniformity. Some teachers were so technologically illiterate that they struggled to use the available EdTech resources prescribed by school policies. As a result,

they resorted to using EdTech resources recommended by other teachers and those they learned about in teacher development workshops. Teachers, including myself, often choose to combine prescribed resources with those we have acquired through teacher development workshops due to our passion for the subjects. This indicates that the integration of EdTech is influenced by varying contexts. Different circumstances lead to diverse approaches in incorporating EdTech. As a result, I saw the need to conduct this study with the main purpose of exploring teachers' integration of EdTech resources specifically in the teaching of Life Sciences in Grades 10-12.

Khoza (2021) notes that there are three levels of integrating EdTech, namely formal or school settings (vertical), non-formal or semi-school (horizontal), and informal or non-school (diagonal). Vertical integration is when teachers integrate EdTech resources in the classroom following a prescribed policy and how they integrate EdTech is championed by policies, and teachers' knowledge and skills (Dlamini & Mbatha, 2018; Raja & Nagasubramani, 2018). This suggests that, at the vertical level teachers integrate EdTech as prescribed and declared in the policies, while guided by their qualifications to drive the integration of EdTech resources. At the horizontal level, teachers' use of EdTech resources is informed by the ideas or opinions of others, gathered by engaging and interacting with other teachers during professional development programmes and relying on other tech-savvy colleagues (Barton & Dexter, 2020; Ibda et al., 2023). This suggests that EdTech resources used in horizontal integration are ones learned about through socialisation with other teachers, but that teachers are not limited to only these levels of EdTech integration. Diagonal integration of EdTech is when teachers use EdTech resources flexibly, allowing them to work at their own pace with a personalised curriculum (Shand & Farrelly, 2018).

1.5 Significance of the study

This study, therefore, aimed at improving as well as expanding teachers' knowledge on what integration of EdTech is, how EdTech resources can be integrated even in not-so-friendly environments, and why it is so important to integrate EdTech in teaching, especially of Life Sciences in Grade 10-12. The results might be helpful in changing teachers' understanding of technology integration and inform curriculum developers and subject advisors of the circumstances preventing teachers from integrating technology effectively in their subjects. Moreover, it might urge and influence the departmental officials to establish training programmes and workshops that could assist with equipping teachers with the necessary skills and knowledge

as well as providing schools with the necessary resources needed to integrate technology. Furthermore, the study might serve to make learners and all other interested parties aware of the importance of integrating technology into the learning process. Finally, the study might be beneficial to scholars by adding to the existing literature available on the integration of EdTech in the science curriculum.

1.6 Purpose, objectives, and research questions of the study

1.6.1 Purpose statement

This study aimed to explore the integration of educational technology resources in the teaching of grade 10-12 Life Sciences.

1.6.2 Research objectives

- a) To explore teachers' integration of educational technology resources in the teaching of grade 10-12 Life Sciences.
- b) To understand how teachers integrate educational technology resources in the teaching of grade 10-12 Life Sciences.
- c) To understand why teachers integrate educational technology resources the way they do in the teaching of grade 10-12 Life Sciences.

1.6.3 Research questions

- a) What educational technology resources are teachers integrating in the teaching of grade 10-12 Life Sciences?
- b) How do teachers integrate educational technology resources in the teaching of grade 10-12 Life Sciences?
- c) Why are teachers integrating educational technology resources in the teaching of grade 10-12 Life Sciences the way that they do?

1.7 Location of the study

This study was conducted in four high schools in the Eshowe circuit in King Cetshwayo district, KwaZulu Natal, South Africa. From all the high schools in the Eshowe circuit, the researcher chose to conduct this study in four high schools with different socio-economic statuses and varying educational technology resources. These four high schools offer Life Sciences as a subject in the Further Education and Training phase. One of these schools is from the urban area and is well-resourced, having outstanding facilities, the latest interactive educational technologies in the

classroom, and excellent sports facilities. Another school is from the township King Dinizulu, and is a school well-resourced, and semi-developed in terms of infrastructure. Two rural schools were also visited, both of which are in the deep rural areas on the outskirts of Eshowe and under-resourced. These rural schools are located in underdeveloped communities, where there is water scarcity. Most members of these communities have a high level of illiteracy.

1.8 Research design and methodology

1.8.1 Research paradigm

This study was underpinned by an interpretive research paradigm to get a better understanding of how teachers integrate EdTech resources to teach Life Sciences in grades 10-12. An interpretive research paradigm is defined by Kivunja and Kuyini (2017) as an approach that provides an insightful and in-depth understanding of the phenomenon, it makes an effort to get to the roots of the subjects being studied to understand and interpret what the subject means. As such, an interpretive paradigm in this study assisted in getting a description of the integration of EdTech resources when teachers teach Life Sciences at a greater and more insightful depth since different views were obtained from different teachers. Furthermore, an interpretivist paradigm holds two views, an ontological view and an epistemological one (Alharahsheh & Pius, 2020).

The ontological perspective is subjective and built based on socially constructing meanings while the epistemological perspective is constructed on knowing how we come to know what we believe we know, such as the approaches that bring us to know what we believe we know (Al-Ababneh, 2020; Alharahsheh & Pius, 2020). As such, this paradigm was used to get subjective understandings and interpretations of teachers on the integration of Edtech resources when they teach grade 10-12 Life Sciences.

1.8.2 Research approach

According to Aspers and Corte (2019a) the qualitative research approach is understood as a process of studying or exploring the nature of a phenomenon to provide a deeper insight into it to understand and explain why or how a phenomenon is the way it is to provide insights and explanations of real-life problems and experiences. Therefore, using this method was befitting for this study because it allowed me to better understand the integration of EdTech resources when teachers teach Life Sciences in Grades 10-12 in a more detailed way since the qualitative approach allows researchers to collect more data and information (Mwita, 2022). Moreover, using this

approach I was able to gather and interpret non-numerical data on the integration of EdTech resources in the teaching of Grade 10-12 Life Sciences by means of methods which are exploratory in nature, such as semi-structured interviews and observation.

1.8.3 Research style

According to Abutabenjeh and Jaradat (2018) a research style is a strategy used to obtain required data to answer research questions; it is a framework of the methods and techniques to be applied to generate and analyse data to answer the research questions. The research style that was adopted by this study was case study design. Case study is one of the most accepted and used means of research methods in qualitative research to generate an in-depth understanding of a phenomenon (Coombs, 2022). An exploratory case study is concerned with exploring a specific topic to the point where a detailed and complete understanding is reached, but with no single outcome (Patnaik & Pandey, 2019). As such, in using an exploratory case study I worked with multiple participants from different schools with different situations. Therefore, no single outcome was obtained, but I was able to gain in-depth knowledge on how teachers integrate EdTech resources when they teach Life Sciences in Grades 10-12. The use of a case study was useful as I was flexible enough to collect multiple kinds of information, which allowed me to provide detailed descriptions on the integration of EdTech resources in the teaching of Grade 10-12 Life Sciences.

1.8.4 Sampling

Sampling is defined by Mweshi and Sakyi (2020) as a process of selecting an appropriate sample of participants from an individual or large group of population to use them to generate rich information on the phenomenon being studied. This study adopted purposive sampling supported by convenience sampling to select the most accessible participants to explore the integration of EdTech resources in the teaching of Life Sciences in Grades 10-12. According to Campbell et al. (2020), purposive sampling refers to a non-probability sampling technique in which members to participate in a study are deliberately selected because they possess certain qualities. In adopting purposive sampling in my study, the selection criterion was based on experience. I decided to select four Life Sciences teachers with an experience of five years and above in teaching Life Science. Secondly, I chose teachers who taught Life Sciences in public schools from three different contexts, namely urban, rural, and township. I then used convenience sampling, which is defined as the technique of selecting samples or a pool of participants who are conveniently close to hand, available or easily reachable, or most accessible (Etikan et al., 2016). In adopting convenience

sampling I decided to select four teachers within my proximity in Eshowe circuit. The recruitment of participants was done face-to-face, and high schools around Eshowe town that offer Life Sciences were physically visited.

1.8.5 Methods of data generation

According to Goldkuhl (2019), data generation is the process of gathering and measuring rich and meaningful information to answer stated research questions. This study employed three data generation methods: reflective activity, unstructured observations, and one-on-one semi-structured interviews.

- **Reflective activity**

According to Cohen et al. (2011) , reflective activities mean a written series of questions that address the phenomenon in which participants reflect on their experiences and then provide authentic data, and the researcher's subjective views do not hold precedence over the views of participants. In this study, teachers reflected using a series of open-ended questions that I designed and distributed to teachers as an activity to reveal their understanding of the integration of EdTech resources when teaching Life Sciences in Grades 10-12. For completion of the reflective activity, a reasonable time of three weeks was granted to all participants to complete the questions. As some participants might have been reluctant to divulge written information honestly, I prepared one-on-one semi-structured interviews for further clarity.

- **One-on-one semi-structured interviews**

According to Ruslin et al. (2022), semi-structured interviews are defined as a data generation method used in qualitative research that focuses on asking participants a set of open-ended questions to gain an in-depth understanding of their voices on a preplanned topic but neither the order nor the phrasing of the questions is specified. Al Balushi (2016) states that semi-structured interviews are the best of both worlds because they combine both structured and unstructured interviews in which some of the questions asked to participants may be predefined while others may not. This method (one-on-one semi-structured interview) was used to generate rich and detailed data as well as allowing me to acquire specific information to compare with open-ended reflective activity. This method was suitable for this study because I was able to obtain rich and

detailed data and was flexible enough to ask probing questions. Upon completion of these interviews, observation then followed.

- **Unstructured observation**

According to Jibril (2018) , observation is a qualitative data generation method that researchers use to gather descriptive analysis data without asking questions but by going to the site and observing people or participants and what takes place there. Sosa-Moreno et al. (2022) state that observation can be structured or unstructured. This study employed unstructured observation; I physically went to the chosen schools to witness first-hand how Life Sciences teachers integrate EdTech resources when teaching Life Sciences in Grades 10-12. According to Sosa-Moreno et al. (2022) , unstructured observation is conducted in an open and free manner in the sense that there are no pre-determined variables or objectives. The observations were appropriate for this study as I was able to personally observe everything and was thus able to provide detailed and meaningful data.

1.8.6 Data analysis

According to Alem (2020) , data analysis refers to the process that comes after empirical data has been successfully generated using different appropriate methods. Therefore, this study employed thematic analysis. Thematic analysis is the process of identifying patterns within qualitative data to see and make sense of collective meanings (Guest et al., 2012; Peel, 2020). Therefore, this study used themes identified in the generated data to categorise Life Sciences Teachers' responses accompanied by quotes from their responses.

1.8.7 Trustworthiness

Trustworthiness refers to the accuracy of the research design in qualitative research, the credibility of the researcher, the believability of the findings, and the applicability of the research method, interpretation, and methods used to ensure the quality of a study (Rose & Johnson, 2020). Credibility, transferability, dependability, and confirmability are the relevant terms for determining and strengthening the trustworthiness of a research (Kyngäs et al., 2020).I then paid more attention to these four elements: credibility, transferability, dependability, and conformability. According to Hussin et al. (2020), credibility is concerned with the reality of the research findings, that is looking at whether the original data from participants have been correctly presented and interpreted. To ensure credibility in this study triangulation was employed, where different methods to generate

data were used such as taking notes and making recordings during the interview process. Dependability is concerned with the reliability of the study; this is where we look at whether the study can be replicated by other researchers and whether the findings would still show consistency or if the same results would be obtained if the same phenomenon were to be explored again (Khalid & Alkhudhir, 2019). To ensure dependability in this study, research questions were clearly stated and a clear explanation of the methodology used, and the presentation and analysis of data were provided.

According to Kasirye (2021), confirmability is concerned with confirming that data and interpretations are not subjective to the researcher but demonstrate neutrality in the interpretation of findings by the researcher. To ensure confirmability in this study transparency of the research process was ensured by provision of the details of the process of data collection, data analysis, and interpretation of the data as well as clear citations. According to Nyirenda et al. (2020), transferability is concerned with the generalisability of findings, that is looking at whether the results of qualitative research may be applicable or transferred to other contexts or settings. In this study, transferability was ensured by providing a detailed description of the research procedures: a clear explanation of the research methodology; an explanation of the research approach; a summary of the data generation and data analysis processes; and a detailed conclusion drawn from the findings of the study.

1.8.8 Ethical considerations

A study by Bhandari (2021) defines ethical considerations as a set of principles that guide research designs and practices and a code of conduct for researchers to follow when collecting data from participants. Arifin (2018) states that consent must be obtained from participants, meaning that participants must be fully informed of the aim and objectives of the study as well as understand that their participation is voluntary. Furthermore, the study must ensure not inflict or cause harm to others through means of confidentiality and anonymity (Pundak et al., 2021). Moreover, the study has to be beneficial, meaning that findings should benefit the community and contribute to the educational community (Bifarin & Stonehouse, 2022). In this study efforts were made to accommodate ethical requirements by ensuring that consent was obtained from participants, and to avoid any harm to participants, any information that was provided by them was kept between the researcher, the participants, and the University, and that the personal identities (names) of

participants were hidden as pseudonyms. Moreover, before involving participants, I first applied for the gatekeepers' letter from the Department of Education and thereafter applied for and obtained ethical clearance from the University of KwaZulu-Natal research office.

1.9 Brief overview of chapters of the study

This study is presented in six chapters. The **first chapter** introduces the study context. It lays out the background of the study. It outlines the problem statement, what motivated me to undertake this study as well as the significance of the study. It also outlines the location in which the study took place, the purpose of the study, the research objectives that underpinned the study, and the research questions that guided the study. The methodology was also briefly touched on in this chapter and is fully elaborated on in chapter three.

The **second chapter** reviews the existing relevant literature to provide the background to the integration of EdTech resources. The phenomenon (integration) of the three categories of EdTech and the three levels of integrating EdTech resources are discussed. Furthermore, the chapter outlines the curriculum of Life Sciences in the South African context and the teaching of Life sciences in a technology-enhanced environment and concludes by discussing the digital divide.

The **third chapter** discusses the theoretical framework, which is Connectivism, that was adopted to guide the study using the eight principles of that theory. The chapter begins by discussing the background of Connectivism and identifies its founders. Subsequently, the chapter unpacks each of the eight principles in relation to the current study.

The **fourth chapter** discusses the methodology used for this research. It provides deep descriptions and full discussion of the paradigm, research approach, sampling, data collection methods, and data analysis methods used for this study. The chapter concludes with a discussion of the trustworthiness of the findings, and ethical considerations.

The **fifth chapter** presents and discusses the findings of the research. It presents the results obtained from all the participants in the form of reflective activities, semi-structured interviews, and observations.

The **sixth chapter**, the final section wraps up the study. This chapter discusses the conclusions based on the findings of the study and recommendations. The results were examined using the themes that emerged from the framework.

1.10 Chapter summary

In this chapter, the problem statement, significance of the study, and reasons for conducting the study were discussed. The chapter highlighted what the study hoped to achieve by the end and the impact it will hopefully have in the education sector. Furthermore, the chapter discussed the purpose of the study and the research questions that guided the study. This was followed by a brief outline of the methodology used and the code of ethics followed. In addition, the chapter outlined what each chapter of this study contains.

CHAPTER 2

REVIEW OF LITERATURE

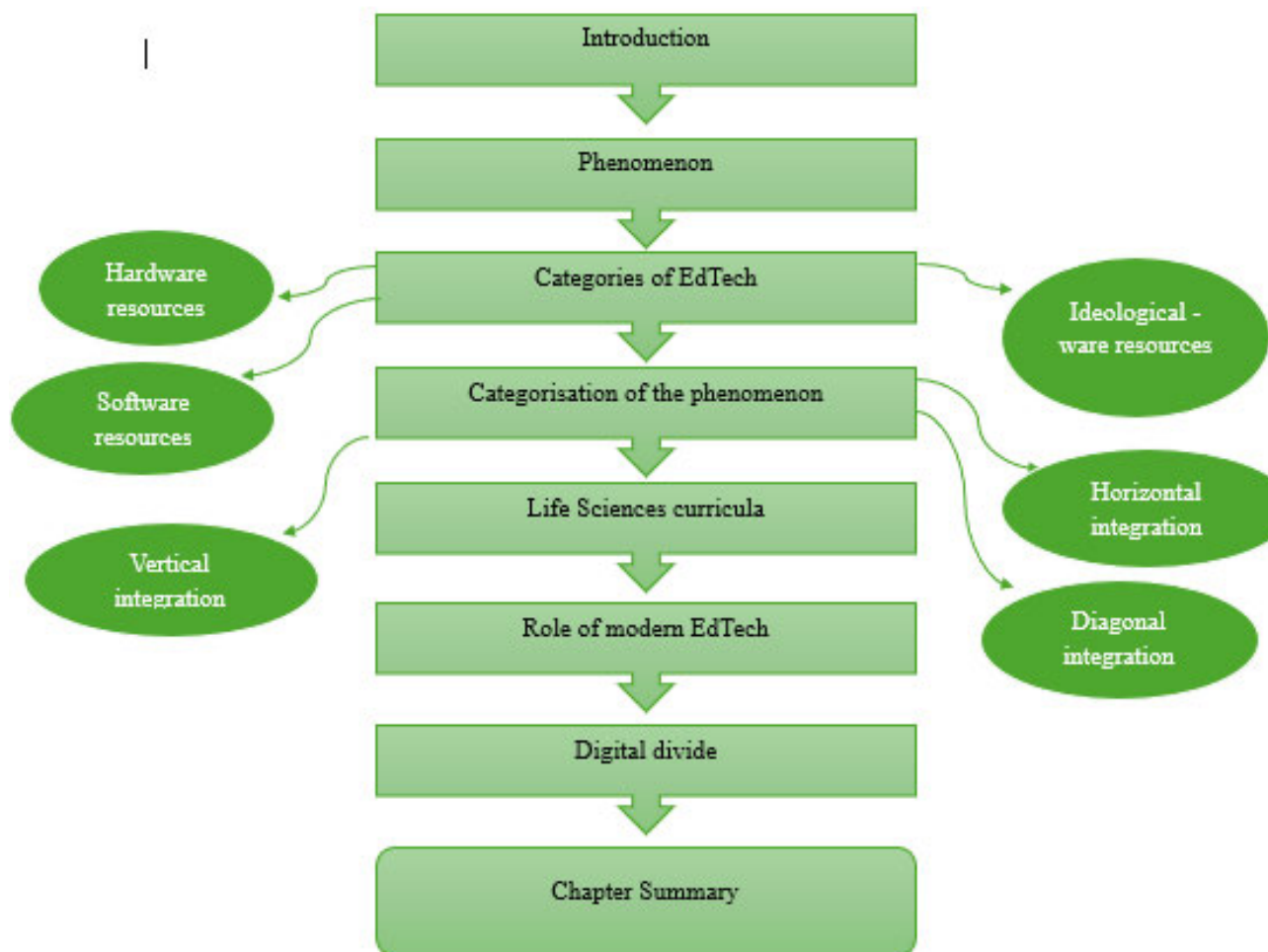


Figure 2.1: A flow chart describing the structure of chapter 2

2.1 Introduction

This chapter provides a literature review based on the integration of EdTech resources. According to Rowe (2014), a literature review is defined as a collection of existing work that is written and classified on a particular topic by researchers. This chapter defines the research phenomenon

according to three levels of integration, vertical, horizontal, and diagonal, as informed by literature. The chapter explores and tracks the three categories of EdTech resources. The chapter also reviews the different curricula that have been used in Life Sciences in the South African context, and further discusses the benefits of EdTech resources in teaching Life Sciences and the challenges that teachers encounter when using EdTech resources to teach Life Sciences.

2.2 Phenomenon (integration)

A study by Gullede (2006) defines integration as the process of combining two or more applications to work together. Cui et al. (2021) further define integration as a process of putting together two or more different systems to form a common task. This suggests that integration is making two units work together to produce something effective. In the education sector integration can be paired up with EdTech resources. Woodbridge (2003) describes EdTech integration as a teaching and learning strategy that can be used to improve educational practices. Studies by Gunu and Babacan (2018) and Shelly et al. (2005) add that EdTech integration is more than just using a strategy, method, or technology, it is combining technological tools both tangible and intangible to enhance teaching and learning. This concurs with studies by Consoli et al. (2023) and Redmann and Kotrlik (2004) that define the integration of EdTech as the employment of different technological resources or means to transform, support, and enhance teaching and learning practices.

Integration of EdTech resources may also be defined as effectively applying or using EdTech (electronic or mechanical tools, equipment, or devices) in the classroom to assist students in accomplishing desired learning objectives or goals (Davies, 2011; Davies & West, 2014; Tondeur et al., 2009). Rathore and Sonawat (2015, p. 3) assert that EdTech integration refers to “learners having access to a variety of tools that match the task at hand and provide them the opportunity to build a deeper understanding of content”. Moreover, integration is defined as the use of technological resources in the teaching environment, but using those resources efficiently (Gunu & Babacan, 2018). Abdu (2018) defines EdTech as the purposeful manipulation of any kind of only modern technology in pedagogy.

The integration of EdTech is also about the use of technological tools and practices in the classroom to meet the curriculum needs and assessment outcomes (Morrison, 2019; Wachira & Keengwe, 2011). EdTech integration is defined as teachers using and adopting technology

components such as mobile technology, tablets and computers (hardware), and software applications during the classroom teaching and learning process (Backfisch et al., 2021; Pattman, 2019; Safar & AlKhezzi, 2013).

Similarly, Akcil et al. (2021) and Consoli et al. (2023) describe the integration of EdTech as the process of bringing in and effectively using educational technological tools in the educational environment to contribute to the teaching and learning process by enhancing and transforming it. However, Tondeur et al. (2009) posit that the integration of EdTech is a process involving many diverse factors and changes frequently as new EdTech resources are developed and introduced from time to time.

2.3 The three categories of Educational Technology

This section begins by defining Educational Technology, and thereafter, categorises the concept into three. According to Percival and Ellington (1988) Educational Technology is the application of both Technology in Education (hardware and software resources) and Technology of Education (ideological-ware resources). Furthermore, according to Lazar (2015, p. 1) EdTech refers to the “systematic and organized process of applying modern technology to improve the quality of education”. In an earlier study, Khoza (2012) suggested that EdTech is any digital resource that communicates or helps channel teaching and learning. EdTech can also be defined as physical technological tools, technologies, techniques, and resources that can be used effectively to improve and support learning experiences as well as present instruction to the learners (Ahmadigol, 2016; Huang, 2019; Luppicipini, 2005). Therefore, it can be argued that EdTech refers to a wide range of tools and resources used in educational settings to support, facilitate, and enhance teaching and learning as well as improve student outcomes.

EdTech resources differ in two ways. There are traditional and modern EdTech resources. Traditional technology refers to methods and tools that are manual or with limited automation (Ansary, 2022). Traditional technology is also inclusive of non-digital educational material such as textbooks, models, images, charts, maps, objects and boards (Krylova et al., 2021; Liu & Long, 2014). Modern technology is defined as advanced and automation tools, electronics and computer-based systems and examples include smartboards, tablets, computers (Berkeshchuk. et al., 2020; Ghory & Ghafory, 2021). Studies by Percival and Ellington (1988); Khoza (2012) and Khoza and

Mpungose (2022) argue that EdTech resources are also divided into three categories, and that is hardware (HW) and software (SW) as well as ideological-ware.

2.3.1 Hardware Resources

Hardware (HW) resources are also called Technology in Education (Percival & Ellington, 1988; Warner et al., 2018). Hardware resources are defined as resources that are audio-visual aid materials that are tangible and can be seen and touched such as computers, laptops, charts, models, tape recorders, and projectors which are used for educational instruction and to facilitate the teaching and learning process (Amory, 2010; Johnson et al., 2016; Khoza, 2012; Khoza, 2016a; Sudarsana et al., 2019). In addition, Khoza (2016b) and Khoza and Fomunyam (2020) argue that some hardware resources utilise products of software resources to run and display information or for their functionality.

2.3.2 Software Resources

Software (SW) resources on the other hand are described as resources that can be seen but are intangible and the productivity and usefulness of them is dependent on hardware resources. and are used with hardware or that display information on a hardware resource (Amory, 2010; Khoza & Mpungose, 2022; Mpungose, 2020). This means that both software resources and hardware resources are used in conjunction and software resources highly depend on hardware resources for their functionality. As much as software resources are dependent on hardware resources to function both these resources also depend on ideological-ware as users of them need to understand how they work (Khoza & Fomunyam, 2020). Therefore, this suggests that users of both hardware and software resources are driven by ideological ware.

2.3.3 Ideological-ware Resources

Ideological-ware also known as Technology of Education (Percival & Ellington, 1988). Ideological ware is understood as a resource used in the process of teaching and learning that we can neither see nor touch such as teaching and learning strategies, theories, and ideas that help with the integration of EdTech (Amory, 2010; Khoza, 2015). In addition to this, Khoza (2018) and Hlynka and Jacobsen (2009) describe these resources (ideological ware) as resources used to facilitate teaching and learning by using and managing technological resources of hardware and software. Concurring with this is a study by Khoza and Mpungose (2022, p. 7) stating that ideological ware is “mind processes and systems motivating academics and students to use

hardware and software resources”. This suggests that ideological ware drives the use of hardware and software resources, and their successful use is dependent on ideological-ware therefore making ideological-ware important in the teaching and learning process. Studies by Zuma and Mthembu (2023) and Makumane and Ngcobo (2020) argue that ideological-ware resources are of the essence as they assist with deciding the relevant hardware and software resources to use during teaching and learning. As such, without them teaching and learning cannot take place even if both hardware and software resources are available. The literature revealed that there are different ways of integrating EdTech resources, as discussed below.

2.4 The categorisation of the phenomenon

2.4.1 Vertical integration of EdTech in the teaching of Life Sciences

According to Khoza (2021), vertical integration refers to the use of EdTech resources as prescribed by the curriculum to address the needs of the subject content. Further to this, Khoza (2021) mentions that teachers draw from their qualifications to use EdTech resources. Moreover, teachers follow or adhere to certain rules (policies and manuals) put in place when they integrate EdTech resources vertically (Hussan Sahib & Stapa, 2021; Khoza, 2021; Khumalo et al., 2023). Khoza and Mpungose (2022) state that these rules are stipulated in writing in various sources which teachers must find before they teach. This indicates that the use of EdTech resources to teach Life Sciences vertically is by professionally qualified teachers who follow policies as their roadmap to integrating EdTech successfully. As such, vertical integration is linked with the performance curriculum.

2.4.1.1 Performance-based curriculum

According to Hoadley and Jansen (2013) and Bernstein (2006) a performance-based curriculum is a type of curriculum that is strongly defined and controlled by the teacher, i.e. is teacher-centred. In support of this is a study by Muller and Hoadley (2019b) which further describes the performance-based curriculum as “chalk and talk” from teachers and they play a dominant role in the lessons. This is the type of curriculum currently used in South Africa since the adoption of Curriculum and Assessment Policy Statement in 2012 (Muller & Hoadley, 2019a). As Life Sciences is a subject under CAPS, the teaching of it follows a performance-based curriculum.

In addition, Roy (2019) states that the teacher and books are the only sources of information in performance-based curriculum and learning is passive because learners are simply expected to

listen and receive instructions that the teacher orally delivers. In a performance-based curriculum learners are therefore limited from learning things on their own and are expected to feed from what the teacher communicates.

Hoadley and Jansen (2013) note that in a performance curriculum learning takes place in specific learning places such as the classroom, lab, or training workshop. Moreover, Xu and Shi (2018) state that a performance curriculum is vertically organised and is very specific on what to be taught and learned. The latter study further states that even the order to be followed is specified, meaning teachers carry out learning activities, goals, and plans that are in accordance with the principle of teaching theory. As such, when teachers integrate EdTech resources in performance-based curriculum, they use teaching methods of repeating and memorising information, mainly from textbooks (Kumari et al., 2024; Labros et al., 2013). Therefore, there is a link between performance curriculum and vertical integration because they possess similar elements.

2.4.1.2 Face-to-face environment with use of hardware resources

When teachers integrate EdTech resources on a vertical level they prefer to use a face-to-face environment where the use of Edtech resources for teaching and learning can be in a specific learning place such as the classroom, hall, laboratory, or any allocated venue (Sankar & Sankar, 2010; Wang et al., 2019). In other words, when teachers integrate EdTech resources on a vertical level they prefer or rather opt for a live and physical interaction with the learners. For example, in Life Sciences the physical interaction happens in a classroom or a laboratory.

A face-to-face learning environment is an approach where both the teacher and learners are in a physical setting and are both actively involved in the teaching and learning activities and the majority of delivery of content happens there (Addis, 2009; Leo et al., 2021; Norman & Zoncita, 2020; Singh et al., 2021). In the face-to-face environment teachers integrate EdTech resources using instructional methods such as collaborative learning and, most commonly, direct instruction (Dhurumraj & Broadhurst, 2023; Sun et al., 2022). In this platform of learning as much both the teacher and learners are involved however, teachers dominate and learners have little involvement (Paul & Jefferson, 2019; Salimi & Ghonoodi, 2011). For science subjects, laboratories play a vital role for activities that require practical experiments. Without them, the teaching and learning of this subject cannot be effective (Shahzadi et al., 2023). Similarly, Shana and Abulibdeh (2020) state that laboratories are essential as they involve activities that allow learners to learn with

understanding while also engaging in a process of constructing knowledge by doing science. Hofstein (2017) also asserts that science laboratories are so important because they help learners gain a better understanding of the nature of science and gives them the opportunity to observe chemical systems discussed in writing in textbooks and in class. In the subject of Life Sciences the curriculum stipulates the laboratory experiments teachers and learners must conduct and the EdTech resources they should use (Gudyanga, 2020). However, notwithstanding the benefits mentioned in the latter, South African schools face the challenges of having inadequacy of Science laboratories (Ejidike & Oyelana, 2015; Penn & Ramnarain, 2019).

During vertical integration, teachers take control of the classroom environment. They initiate almost all the activities being guided and rely on resources such as textbooks and school policies (CAPS and others), and for content delivery they mostly rely on hardware resources such as exercise books, chalkboards, computers, and charts (Wang et al., 2019; Wang, 2022; Xu & Shi, 2018). Adu and Mtsi (2024) note that textbooks and workbooks are the two most important EdTech resources in Life Sciences. As stipulated by the CAPS document, textbooks are a must for every learner to have. Adu and Mtsi (2024) further state that in Life Sciences teachers also use HW resources such microscopes to examine cells and chemicals and glassware to perform experiments, and among other HW resources that teachers use, they also integrate models and charts for visual purposes. Again, CAPS stipulates that the Life Sciences classroom or laboratory must be equipped with charts or posters. This therefore suggests that with vertical integration of EdTech resources, Life Sciences teachers rely more on traditional resources as well as hardware resources.

Life Sciences is a subject that relies heavily on visualisation for teachers to make sense of information beyond the level of learners' experience and senses (Jenkinson, 2018). For example, in a study conducted by Karakoyun and Yapici (2018) in Turkey, teachers used slow animation (slowmation) techniques to allow learners to explain Science concepts easily. Slowmation is a technique that involves taking photos of hand-made materials and using those pictures to create an animation (Gürbüz et al., 2022; Paige et al., 2016; Stuppy et al., 2024). Similarly, a study conducted in Nigeria by Ibe and Abamuche (2019) observed how audio-visual materials in the form of videos help teachers maintain and sustain learners' interest. The latter study further notes that teachers use resources like models and charts to allow the learners to understand certain topics

in their real-life context. This provides an understanding of how Life Sciences teachers use EdTech resources that allow learners to experience topics in a more original form than abstract.

Teachers during vertical integration prepare lessons, design the teaching process and prepare teaching materials to be used. Learners have no say; they agree to whatever resources the teacher has decided or prepared to use at that specific time (Wang et al., 2019; Wang, 2022). This therefore means that in vertical integration teachers play a huge role. They dominate the classroom to the extent that they even influence the selection of EdTech resources to be used in face-to-face lessons. As teachers rule the classroom, they then assume the role of being an instructor.

2.4.1.3 Teachers as instructors

An instructor is a teacher that dominates the classroom, provides direct instructions and learning, and teaches learners in a manner that is conducive to sitting and listening (Keiler, 2018; Tularam, 2018). Furthermore, Wang (2019) posits that an instructor is a teacher with dominant power in the classroom, who initiates and is considered the only source of knowledge and leads and controls the teaching and learning activities, material, content, and pace of learning. Studies by Muller and Hoadley (2019b) and Serroukh and Serroukh (2022) state that vertical integration requires the teacher to use EdTech resources to dominate the lessons and have more control while the learner's position is a passive reactive role. This concurs with Zuma et al. (2022) who assert that vertical integration promotes passive learners. During vertical integration, teachers are the dominant force in the classroom and take control of all the teaching and learning activities, leaving the learners with less control of their learning and having to accept everything as it comes.

Although it is the teacher who is in control of the classroom environment, vertical integration is content-driven as the actions of teachers are informed and influenced by the reading of different sources such as study programmes and the curriculum (Makumane & Khoza, 2020; Solak & Cakır, 2014). This means that although teachers take dominance of teaching and learning when they integrate EdTech resources to teach Life Sciences on a vertical level, they draw guidance from stipulated rules. Makumane and Khoza (2020) further state that teachers refer to different sources with the end goal of achieving learning objectives to address the needs of the subject content. The latter study further adds that when teachers integrate EdTech resources on a vertical level, they bear in mind the objectives that need to be achieved at the end, thus how they select EdTech resources will always be influenced by the objectives.

2.4.1.4 Objectives and Prescribed content

Objectives are defined as short-term goals to be achieved by learners at the end of the lesson (Khoza & Biyela, 2020; Khoza & Mpungose, 2022). Furthermore, learning objectives are descriptions that clearly outline what the teacher intends to teach and what learners must be able to do after completing a certain educational activity (Chatterjee & Corral, 2017; Makumane & Khoza, 2020). Additionally, learning objectives are described as concise and specific statements that describe what the teacher intends to cover and what knowledge or skills learners should know or be able to do at the end of the lessons that they could not do before, and they are usually achieved within a relatively short time frame (Kennedy, 2006; Sewagegn, 2020). Umugiraneza et al. (2018) states that objectives are included in the lesson planning when teachers prepare and select the EdTech resources they intend to use in the delivery of content.

Objectives are therefore important as they help teachers plan accordingly and provide a layout of what content to be taught and how much of that content to teach and what resources to use (Mahajan & Singh, 2017). As teachers dominate the classroom, they teach prescribed content to meet the objectives, of which teachers are expected to have a qualification to know the content to be taught (Dhurumraj & Broadhurst, 2023). Prescribed content refers to information that teachers should teach the learners which learners are expected to learn and master in each subject (Campbell et al., 2014; Khoza & Mpungose, 2022; Kutub & Wijayanti, 2019). A study by Makumane and Khoza (2020) asserts that subject content is prescribed to drive the systems of vertical integration. This suggests that when teachers integrate EdTech resources vertically they are influenced by content. In other words, the choosing of EdTech resources to be used for a certain topic must align with that topic to be able to deliver the content to learners.

In Life Sciences content is divided into four strands: Life at molecular, cellular, and tissue levels, Life processes in plants and animals, Diversity, change and continuity, and environmental studies, and each of these strands has its prescribed EdTech resources to be integrated (CAPS, 2011a). To carefully evaluate whether or not the learners have acquired the prescribed content, summative assessment is considered the main evaluation method (Asamoah, 2019; Glushkova et al., 2021). Through summative assessments teachers also evaluate the effectiveness of the EdTech resources used to deliver content or enhance lessons.

2.4.1.5 Assessment of learning

According to Bacquet (2020), summative assessment refers to the formal evaluation of learners to determine how much knowledge the learners have absorbed and it is taken after learning has been concluded. The outcome of a summative assessment is graded, which indicates whether the learner has acquired an acceptable level of knowledge (Khaled & El Khatib, 2020). It is used at the end of a specific instructional period to evaluate how much learning learners have mastered, how much skill they have acquired, and academic achievement based on the curriculum objectives (Bozorova & Shaxnoza, 2023; Heryani et al., 2023). Mogboh and Okoye (2019) state that this assessment is used as a diagnostic tool to measure progress and functions to help specific students to then allow teachers to judge the effectiveness of the materials, curriculum, and instruction used to meet curriculum standards. They further state that feedback from this type of assessment is either used to promote a learner to the next grade, for certification or admission to higher levels of education.

As such, in vertical integration, teachers formally use traditional EdTech resources such as pen, paper, and pencil to assess learners to get a clear understanding of how much knowledge a learner has gained and this is usually done through different forms such as mid-term and year-end examinations, controlled tests, projects, standardised tests and portfolios (Bozorova & Shaxnoza, 2023; Guo & Yan, 2019; States et al., 2018). For example, in Life Sciences, learners write one formal test in each term, mid-year examinations, and year-end examinations which utilises EdTech resources such as pen, paper, books and pencil. For practical tasks and projects that they do in the first three terms they make use of different EdTech resources such as chemical equipment and apparatus, depending on the topic (CAPS, 2011a).

2.4.2 Horizontal integration of EdTech in the teaching of Life Sciences

Horizontal integration is referred to as the use of EdTech resources based on societal opinions. Teachers in horizontal integration use EdTech resources that are socially acceptable to conduct educational activities (Khoza, 2021; Makumane & Khoza, 2020). This suggests that societal opinions rather than policies are placed at the centre of the horizontal integration of EdTech resources. Therefore, horizontal integration is highly influenced by societal opinions. For this reason, horizontal integration is linked to competence curriculum.

2.4.2.1 Competency-based curriculum

A competency-based curriculum is a type of curriculum whereby teachers allow learners to construct knowledge and skills by themselves based on their experiences and everyday knowledge (Bernstein, 2006). Furthermore, the teacher allows the learners to draw from the community and what learners already know from societal and local activities and not transmitted from outside (Chunga, 2020; Hoadley & Jansen, 2013; Shkak & Hassan, 2020). A study by Hoadley and Jansen (2013) notes that a competence curriculum allows teaching and learning to take place anywhere, there is no specific place for learning. In addition, a study by Kabombwe and Mulenga (2019) asserts that the knowledge and skills that learners acquire are applicable in real-life contexts and address societal needs. Moreover, this type of curriculum does not necessarily use examinations but other methods to measure how much content learners have mastered (Amutabi, 2019). This suggests that a competence-based curriculum is based on learning that allows for the acquisition of knowledge and skills that learners will be able to apply in their everyday lives. Due to these elements that make up a competence-based curriculum, there is a link between a competence-based curriculum and horizontal integration because during, horizontal integration learners become active participants who control the direction of their learning, meaning they are put behind the steering wheel of their academic learning activities where they generate their content through reflecting on their experiences to achieve learning outcomes (Khoza & Mpungose, 2022; Misra & Mazelfi, 2021).

2.4.2.2 Facilitators

There is a link between horizontal integration and competence curriculum as studies by Dhawan (2020), Dhull and Arora (2019), and Niktinat (2021) show that the horizontal integration process is more learner-centred, because teachers do not just pour knowledge into learners' heads but learners have control over the use of Edtech resources for teaching and learning as they are allowed to construct and make sense of their learning and can determine, plan and direct their learning activities, including learning styles and content to be taught.

In other words, teachers become facilitators of learning rather than transmitters of knowledge where they facilitate the process of learners demonstrating the content they have generated to their peers through these different software technologies (Dhull & Arora, 2019; Niktinat, 2021; Zuma & Mthembu, 2023). When a teacher assumes the role of being a facilitator in the classroom they step down as instructors who control the learning activities and allow learners some space to be

creative and innovative (Sjølie et al., 2021) . A study by Vidoni et al. (2023) asserts that teachers as facilitators optimise the learning and educational experiences of learners by finding out what skills and content are needed to assist the learners grow themselves. Teachers facilitating Life Sciences teaching using EdTech resources guide learners in the learning process by pushing them to think deeply (Aktepe & Coskun, 2014; Saks et al., 2020). Importantly, as facilitators in Life Sciences, teachers are responsible for learners' use of EdTech resources, overcoming any deficiencies in the EdTech resources and ensuring that learners integrate them into the curriculum (Munna & Kalam, 2021). This implies that during horizontal integration teachers are guides of learning, they prioritise learners' knowledge and regard their own input as additional knowledge.

Learners expand their understanding of the content learnt in schools by exploring different EdTech resources ranging from digital libraries to watching television and looking at websites (Basar et al., 2021). This suggests that content in horizontal integration is not prescribed but rather learners use EdTech resources to accumulate or generate it from activities they engage in.

2.4.2.3 The use of software resources

The transmission, delivery, and sharing of the content or knowledge that the learners have generated happen through means of different platforms using software resources such as social media sites (WhatsApp, Facebook, and others), Learning Management System, Microsoft Teams, Video conferencing (Zoom, Skype) or any other software application that they are most comfortable with, aided by digital resources (computers, laptops, mobile phones, and others)(Adebo, 2018; Dung, 2020; Mpungose, 2020; Mukhtar et al., 2020). For example in a study conducted by Abualrob and Nazzal (2020) on using WhatsApp in teaching chemistry and Life Sciences, the authors found that teachers use social media sites such as WhatsApp for Science educational purposes by sharing activities and videos and sometimes learners use the platform to ask questions and to share. However, the study's findings also showed that sometimes this is unsuccessful as learners take this platform to be social and share jokes instead of using it for educational purposes. This is evidence that teachers make use of software resources, however, learners may not be keen to use these resources to engage in educational activities.

These types of software resources as well as digital resources can be used in no specific place as they can be used from anywhere and anytime in the world (Adebo, 2018). This therefore suggests

that horizontal integration takes place in a space that is not demarcated, meaning the distribution of learning and delivery of content happens anytime and anywhere through the incorporation of different EdTech resources. As such, this implies that the use of certain technological resources allows the freedom of learning to be not as limited to being inside the classroom. Due to the flexibility of the EdTech resources being used anywhere and anytime there is freedom for the teacher to be in a different location than that of a learner (Gilbert (2015).

2.4.2.4 The outcomes

In horizontal integration, teachers play their role of facilitating by giving learners the chance to demonstrate to their peers the content they have generated to reach the learning outcomes (Khoza & Mpungose, 2022). In horizontal integration teachers facilitate the process of learning where they provide support to learners as they construct knowledge through interacting with the activities given to them, and producing content that is then used to achieve learning outcomes (Khoza, 2023; Makumane et al., 2022). The knowledge that learners construct to produce content to achieve learning outcomes comes from their everyday knowledge (Khoza & Biyela, 2020; Zuma et al., 2022). Learning outcomes are what learners have actually acquired or achieved at the end of the lesson and not what was expected of them to acquire by the end of the lesson, and they focus on what the learner demonstrates effectively after learning skills (Akinrinola, 2021; Harden, 2002; Kennedy, 2006). Learning outcomes are thus statements of what learners know understand, and can do after learning has been completed (Harris and Clayton (2019). Learning outcomes are described as the observable knowledge and skills that students have obtained and demonstrate upon completion of a learning experience (Osueke et al., 2018); they are statements that describe what learners understand and can do upon completion of a learning process (Dias, 2020; Mpungose, 2021). A study by Khoza and Mpungose (2022) further posits that what learners have achieved at the end of the lesson is what matters the most more than what path they took to arrive at that outcome. This confirms that horizontal integration prioritises what learners can actually demonstrate at the end of an educational activity rather than what they should know. Moreover, Khoza and Mpungose (2022) also indicate that horizontal integration to establish how much knowledge learners have mastered is seen with the outcomes at the end of the learning period of which those outcomes are checked through peer assessment.

2.4.2.5 Peer assessing

Learning is facilitated by practice, feedback, assessment, and reflection, whereby learners are taught to reflect regularly on their learning progress and then evaluate themselves as well as use feedback to improve their learning (Cuyacot & Cuyacot, 2022). Through assessing the learners, teachers are then able to evaluate the effectiveness of the software resources as well. As part of this facilitation process, in horizontal integration, teachers use peer assessment where they allow and encourage learners to critique each other's work (Karthikeyan, 2021). Peer assessment refers to when learners reciprocally provide an analysis, grade, or score on a task undertaken or performed by peers and then give feedback to peers in written or oral comments (Loureiro & Gomes, 2023; Topping, 2021). Teachers use software resources such as Microsoft Teams and Zoom to facilitate the process of learners peer assessing themselves and then use Email and Moodle to allow the learners to track their performances on the assessments (Aina & Ogegbo, 2021; Loureiro & Gomes, 2023).

2.4.3 Diagonal integration of EdTech resources into the curriculum

A combination of both vertical and horizontal integration produces diagonal integration. Khumalo et al. (2023) maintain that diagonal integration combines the strength of both vertical and horizontal integration. According to Khoza (2021), diagonal integration refers to when teachers use EdTech resources driven by their identity (love, passion, self-esteem) to address their needs and to select and utilise EdTech resources depending on their situations. This concurs with Makumane et al. (2022) who state that diagonal integration refers to when teachers make use of EdTech resources according to their individual needs based on a specific situation. This suggests that when teachers integrate EdTech resources to teach Life Sciences on a diagonal level they do it the way they see fits the purpose or their needs.

2.4.3.1 Pragmatic curriculum

A pragmatic curriculum involves blending of subjects and activities where construction of knowledge is concerned with the developing of the learner as their needs and situation require of them (Sharma et al., 2018). Therefore, there is a link between diagonal integration and pragmatic curriculum because the focal point for both is nurturing natural interests.

2.4.3.2 Blended environment

Diagonal integration is linked with pragmatic curriculum because it combines both synchronous (face-to-face interaction/vertical integration) and asynchronous (online learning activities on learning management systems/ horizontal integration)(Anthony et al., 2022a; Kumar et al., 2021; Vallée et al., 2020). This therefore indicates that when teachers integrate EdTech resources to teach Life Sciences on a diagonal level they blend both environments, meaning they combine both face-to-face and online learning activities. Studies by Subramaniam and Muniandy (2019) and Anthony et al. (2022b) further state that the reason teachers use diagonal integration is because it helps them attain certain goals, which could be to enhance their teaching qualities or train learners to produce a skill. This means that the use of diagonal integration is always for a personal reason or purpose since it combines two different environments that are meaningful to individuals.

2.4.3.3 Flexible teachers

According to Usmani (2021), diagonal integration represents flexibility as teachers assume the role of being researchers more than passive teachers. Teachers as researchers subsume all other roles, such as being an assessor, instructor, facilitator, mediator, manager, and organiser (Khoza, 2020). Teachers assume the role of being researchers in order to customise the instructional design to meet their teaching needs, which involves carefully planning and choosing appropriate tools and preparing learning materials for the teaching and learning process (Khoza, 2021; Singh, 2021; Siraj & Maskari, 2019; Usmani, 2021). Teachers as researchers know how to address their needs, by finding out for themselves what works well in their context of teaching and learning process (Beveridge & Stevens, 2020a). Moreover, teachers as researchers locate and implement teaching strategies that address their identified issues and the learning needs of their students (Beveridge & Stevens, 2020b). Therefore, when Life Sciences teachers integrate EdTech resources they individually strategise in terms of the role to assume to meet their personal needs and use different theories. So, what EdTech resources to use and how to use those EdTech resources will always be dependent on which role a teacher has assumed at that particular time.

2.4.3.4 Ideological-ware

In diagonal integration, teachers use their different frameworks/theories (ideological-ware) to choose and use both hardware (vertical integration) and software (horizontal integration) resources in a particular way to meet their personal needs (Khoza & Fomunyam, 2021). This is in line with a study by Zuma et al. (2022, p. 1) stating that “ideological-ware resources are cognitive processes

that drive or manage human actions in using hardware and software resources to address human needs”. They further state that ideological-ware resources are vital in education. This suggests that the kind of EdTech resources teachers use at a diagonal level are always guided by certain ideas to achieve learning aims.

2.4.3.5 Teachers’ aims

According to Khoza (2021) diagonal integration balances vertical (policies) and horizontal (societal opinions). This implies that when teachers integrate EdTech resources on a diagonal level to teach Life Sciences they make use of both the vertical and horizontal directives as well as resources. In diagonal integration, teachers incorporate both vertical and horizontal directives with the mission of achieving learning aims. According to Alruwaili (2020), learning aims are general statements that describe the ultimate goal of what the teacher wants to achieve at the end of learning rather than statements of what learners will learn or do, and aim to provide a general direction for learning. In summary, on a diagonal level teachers integrate both hardware and software resources driven mostly by ideological-ware resources with the goal of achieving their needs as teachers rather than that of learners. To check if their purpose has been served, they resort to formative assessment.

2.4.3.6 Assessment for learning

In diagonal integration, teachers lean towards formative assessment to check the progress of learners (Aina & Ogegbo, 2021). According to Chng and Lund (2018, p. 2), formative assessment refers to “frequent, interactive assessments of student progress and understanding to identify learning needs and adjust teaching appropriately”. Karaman (2021) notes that this type of assessment is effective because it assists in providing feedback and instructional corrections to improve learning as well as motivate learning in the teaching and learning process; it can both determine and monitor the understanding and learning skills of students. In addition, formative assessments are used to understand the learning levels of learners and are also used to guide and enhance the learning process (El Hashash, 2022). As such, when teachers integrate EdTech resources using the diagonal approach they use formative assessment synchronously through presentations, clicker questions, and online discussions or asynchronously through quizzes to check the progress of a lesson learnt (Aina & Ogegbo, 2021; Dhawan, 2020). Thus, teachers then integrate different EdTech resources such laptops and different software programmes to access

asynchronous activities. For example, in Life Sciences, teachers may formatively assess learners through observations, class discussions, practical demonstrations where teachers use different Life Sciences models, or even informal classroom interactions (CAPS, 2011a).

2.5 Life Sciences curriculum in South Africa

2.5.1 Different curricula implemented in Life Sciences

According to Le Grange (2008) the introduction of Biology in the South African curriculum was due to the influence of overseas countries. Le Grange (2008) noted that Biology as a school subject existed in the Cape Province then was later introduced in the Transvaal Province in 1935. De Villiers (2011) states that different curriculums have been used in South Africa for Life Sciences in the Further Education and Training phase. The first curriculum for Life Sciences was the apartheid curriculum which directed teaching until 1995. When the democratic government gained power in 1994 an Interim Core Syllabus (ICS) document was established as a curriculum that would cleanse the apartheid syllabus (Bertram, 2020) (Bertram, 2020; De Villiers, 2011). As the word 'interim' implies, the Interim Core Syllabus was temporary while they were still planning for a more extensive curriculum (Bertram, 2020). This therefore suggests that South Africa got its freedom to review its curriculum after they got political independence from the colonisers.

After the country decided it was ready to produce a unified curriculum, there was the birth of Outcome-Based Education (OBE), Curriculum 2005 (C2005) implemented in 1998 (Mogashoa, 2013). C2005 is described as the first major post-apartheid curriculum that was outcome-based and liberated the nation from education that is racist (Bantwini, 2010; Maluleka & Ledwaba, 2023; Ramnarain & Fortus, 2013). Due to flaws in the implementation of the C2005, there was a call to revise C2005 and was referred to as the Revised National Curriculum Statement (RNCS) which was adopted in 2000 and introduced between 2002 and 2006 for all grades (Chisholm, 2005).

As the National Curriculum Statement was implemented for the Further Education and Training phase in 2006, the subject Life Sciences replaced the subject known as Biology in Grades 10-12 (Ramnarain & Padayachee, 2015). This curriculum was introduced to make the school curriculum more understandable in South African classrooms by teachers as they are the ones who live the realities of the classroom. However, RNCS suffered the same fate as C2005 with regard to implementation challenges, and that resulted in a fourth curriculum reform attempt which saw the

adoption of the current Curriculum and Assessment Policy Statement (CAPS) in 2011 (Maluleka & Ledwaba, 2023; Ramatlapana & Makonye, 2012).

2.5.2 Introduction of CAPS

The Curriculum and Assessment Policy Statement, better known as (CAPS), was introduced in 2011 but implemented in schools in 2012 by the Department of Basic Education, replacing the OBE (Charamba & Zano, 2018). Charamba and Zano (2018) assert that CAPS is not a new curriculum but an amendment to the NCS. This therefore suggests that although CAPS was introduced it still follows the same process and procedure as the NCS with a few adjustments. This is supported by Letshwene and du Plessis (2021) who state that the introduction of CAPS was to strengthen the NCS and to specify what should be taught and which topics should be covered. Therefore, this means that three different curricula have been used for Life Sciences. For Life Sciences in CAPS, according to CAPS (2011b) there are four components of content knowledge, which are referred to as strands, namely:

1. Life at the Molecular, Cellular and Tissue Level
2. Life Processes in Plants and Animals
3. Environmental Studies
4. Diversity, Change, and Continuity

2.5.3 Compulsory EdTech Resources recommended by CAPS for Life Sciences

The Life Sciences Curriculum and Assessment Policy Statement (CAPS) document emphasises the need for every learner to have a textbook and it is evident in the document that all the topics in Life Sciences require a textbook (CAPS, 2011b). This suggests that a textbook on Life Sciences is an important EdTech resource. In addition to the textbook hardware resources such as charts, test tubes, Bunsen burners, thermometers, microscopes and microscope slides, different models, Televisions, DVDs should be made available in all Life Sciences classroom or laboratory (CAPS, 2011b). Moreover, the teaching of Life Sciences requires teachers to make use of software resources such as the internet. This therefore suggests that the teaching of Life Sciences in South Africa as per the guide of the curriculum focuses more on hardware resources than software resources. This implies that they vertically integrate EdTech resources.

2.6 The role of modern EdTech resources in Life Sciences

According to Farhana and Chowdhury (2019) Life Sciences is a complex subject to teach and learn. It contains unfamiliar, complex, and abstract concepts, meaning that some sections and topics require and rely on visual methods and practical activities to make clear connections and transitions between certain concepts, so teachers must employ EdTech resources (Sayan & Mertoglu, 2020) . As such, to enhance learners' understanding of certain topics and concepts teachers employ EdTech resources such as digital simulations and virtual laboratories as it gives them an easier approach to exploring the different concepts of Life Sciences (Doyan et al., 2021). The use of EdTech resources mentioned above in Life Sciences is argued to make learning interactive and allows learners to explore scientific concepts and conduct experiments within a virtual space (Haleem et al., 2022).

For example, in a molecular topic, when learners have no access to laboratory experience and activities, they face difficulties in studying Life Sciences (Byukusenge et al., 2022). Virtual laboratories then come into play to fill that gap of not having physical laboratories. They provide flexibility as learners can repeat experiments (Yilmaz, 2023) . Findings of a study by Byukusenge et al. (2022) argue that Life Sciences cannot be meaningful to learners without practical experience in school laboratories because Life Sciences like any other Science subject requires laboratory exercises as a part of the practical skills acquisition process. The latter study further states that with no access to laboratory activities learners may face difficulties in the learning of Life Sciences. This suggests how vital laboratories are in Life Sciences. The integration of EdTech resources makes it possible for learners to access laboratories albeit that they are virtual. Not only does the integration of EdTech resources give access to virtual laboratories they are less costly compared to physical laboratories in terms of space and maintenance (Byukusenge et al., 2022; Fisher et al., 2012).

The use of EdTech resources such as 3-D models has also been argued to have a great influence in Life Sciences as teachers can highlight and better explain how certain structural aspects work and function not only verbally but by visual representation to sharpen learners understanding of concepts (Yilmaz, 2023) . However, Gudyanga and Jita (2019) state that this is a cause of concern in some areas of South Africa, as there is a lack of models in some high schools. Life Sciences is a subject that is also concerned with teaching living organisms and life processes (nature), but

some organisms are only found in remote areas and are difficult to access by every learner, but with technology teachers can bring that nature into classrooms (Makuru & Jita, 2022). This means that using EdTech resources teachers can bring to class what is beyond their physical means.

2.6.1. Different EdTech resources integrated in Life Sciences curriculum

Mahambehllala (2019) asserts that to make the teaching of Life Sciences more effective teachers can use of a wide range of EdTech resources. According to Ndlovu (2021) these EdTech resources include whiteboards and computers which can be useful in teaching topics such as cell division. EdTech resources such as computers and tablets are integrated in Life Sciences to visualise objects to learners that are deemed difficult to view. These include human anatomy, human and animal cells as well as the reproductive system through PowerPoint slides or videos that teachers download (Aina, 2013; Kingori, 2016). Dhindsa and Emran (2006) further state that a computer is also used in conjunction with the whiteboard and a projector, and they work together simultaneously to display the information taught.

Wang (2017) adds that computers are also used to present the information visually through well-prepared pictures, three-dimensional models and animations. Further to this, Badarne (2019) avers that also in Life Sciences animations, models and simulations are amongst other EdTech resources used. In a traditional classroom, Life Sciences lessons are taught using EdTech resources such as a chalkboard and whiteboards on which the teacher and learners directly write on them (Dhindsa & Emran, 2006). Dhindsa and Emran (2006) further share that teachers also use EdTech resources like CDs and ROMS to explain topics such as chemical plants, populations, and food chains. Thus, it is evident that teachers integrated different hardware and software resources to teach Life Sciences.

2.6.2 Reasons behind Life Sciences teachers integrating EdTech resources

According to Van Rooy (2012) and Aina (2012) integrating EdTech resources into the teaching of Life sciences opens up new possibilities, and one of the reasons why teachers integrate EdTech resources is because it introduces teachers to methods that are beyond the traditional, such as chalk and talk. Van Rooy (2012) and Farhana and Chowdhury (2019) further add that teachers use EdTech resources because they help learners better understand the emerging knowledge and processes of Life Sciences that are deemed too complicated to teach. This concurs with Badarne

(2019) who asserts that visual illustrations are used by Life Sciences teachers to clarify ideas and abstract concepts because visuals are easy to remember. Badarne (2019) further adds that teachers make use of illustrations because it allows both the teacher and learners to share ideas and knowledge based on what they can see. Furthermore, Musau (2020) and Belay et al. (2020) state that many science teachers integrate EdTech resources because they enhance the classroom practice, making the lessons more interesting and understandable. Therefore, this demonstrates that teachers use EdTech resources fueled by different reasons to enhance their teaching and visualisation of content.

2.7 Digital divide as a barrier affecting the integration of EdTech resources

Despite the above-mentioned benefits of using EdTech resources in education, there are disparities in access to these resources, and their adoption in schools has faced a number of challenges (Chomunorwa & Mugobo, 2023; Mirzajani et al., 2016). The disparity that the latter studies are referring to is the digital divide (Faloye & Ajayi, 2022). The term digital divide refers to the unequal or imbalanced access to EdTech, or the gap separating individuals that have access to and can effectively use EdTech resources from those who do not (Goncalves et al., 2018; Ndoya & Asongu, 2024). There are differences in the use of EdTech resources and the availability of infrastructure across South African schools (Adeleke, 2021; Woldegiorgis, 2022). These differences are caused by the fact that some schools, particularly in the underdeveloped townships, and some rural schools are strongly affected by the issues of access to EdTech resources due to insufficient infrastructure and no electricity and internet or network connectivity (Chisango et al., 2020; Hart, 2023). This suggests that the infrastructure of a school has a strong influence in the sustainable use of mobile technology, so much so that without proper infrastructure, the integration of EdTech resources will be a challenge.

In rural communities, internet connectivity and access to a stable connection are scarce, and in some community areas are not available at all (Myende & Ndlovu, 2020). Such issues are problematic because it means that learners from rural areas are left in a disadvantaged position, where using EdTech resources will always be a foreign thing to them. Due to the latter mentioned issue of not having the power that is necessary for the functionality of digital transformation and other technological devices, these schools have no choice but to stick with traditional teaching and learning models as the only form of instruction (Chomunorwa & Mugobo, 2023). This means that

due to the challenges that some of the rural schools' face, they are deprived of modern EdTech resources, and are thus far from reaping the benefits that come with EdTech.

2.8 Chapter summary

This chapter started with a detailed discussion of the notion of integration. It then defined three distinct categories of EdTech and explored the three levels of integrating EdTech resources. Additionally, the chapter examined Life Sciences curricula and discussed the role of EdTech resources in education. It also addressed the digital divide as a barrier to the effective integration of these resources. The following chapter delves into the theoretical underpinning of the study.

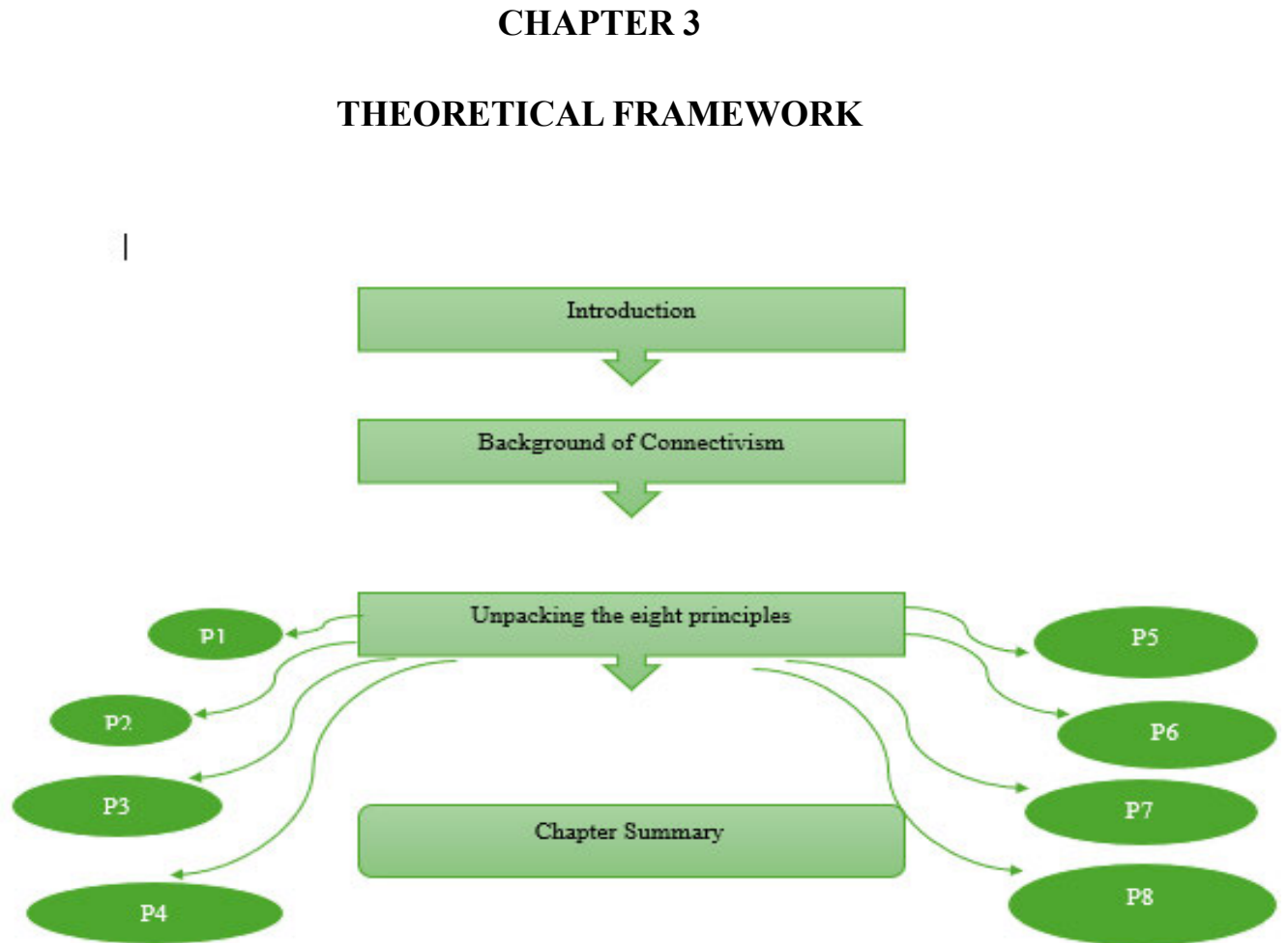


Figure 3.1: A flow chart presenting the structure of chapter 3

3.1 Introduction

This chapter discusses Connectivism which is the theoretical framework that was adopted by the study. According to Grant and Osanloo (2014) a theoretical framework is a roadmap or guide that

researchers use to construct and support their research. In qualitative research, the theoretical framework is useful for providing direction to the researcher in selecting the appropriate research design, methodology, and data analysis techniques (Grant & Osanloo, 2014; Kivunja, 2018). In other words, without the theoretical framework, the study would not have a clear structure or precise direction for discussing the research findings (Imenda, 2014). The chapter begins by providing the background of the theoretical framework, then goes on to list the eight adopted theoretical framework principles. The chapter then delves into each of the eight principles. The chapter concludes by outlining how the Connectivism theory applies to this study.

3.2 Background of connectivism

One theorist who describes Connectivism as a theory for the Digital Age is George Siemens, who developed it in 2005, along with Stephen Downes (Bell, 2009; Langridge, 2023; Şahin, 2012). The development of this theory was motivated by the shortcomings of Behaviourism, Constructivism, and Cognitivism, which did not adequately address learning that takes place through technology and outside of direct human interaction (Goldie, 2016), considering that technology has developed and made a huge shift in how we live, communicate, and learn (Dogan, 2014).

The theory of Connectivism emphasises the importance of socialisation and technology in the learning process, believing that knowledge is constructed beyond the level of individual human participation (Alam, 2023; Herlo, 2017; Şahin, 2012). Zambrano and Campuzano (2020) assert that the theory of Connectivism maintains that learning is more than the internal construction of knowledge; networking externally is also considered to be another form of learning. Thus, in a world where technology and the internet have a significant influence, Connectivism encourages learning using technological means like blogs, social media, and online networks (Banan et al., 2020). This theory focuses more on individual participation in that it asserts that a teacher's role is to assist learners create their own unique learning environments so that they connect to networks and become exposed to the flow of knowledge (Zambrano & Campuzano, 2020), meaning that, based on Connectivism, learning can occur by socialising with others using technology. In other words, the theorists, George Siemens believe and accept that technology is the major part and plays a very important role in the learning process.

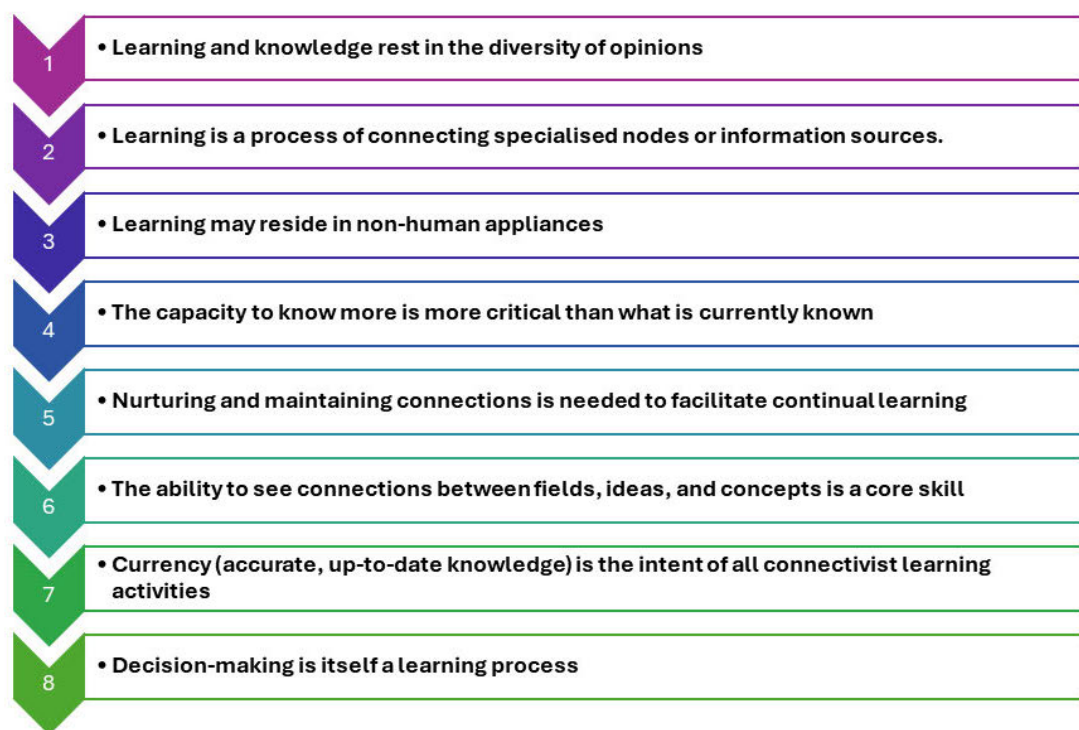
Connectivism is a theory that connects several networks through various learning communities to allow both synchronous and asynchronous learning. The aim is to provide individuals with access

to reliable information from millions of sources (Kathleen Dunaway, 2011; Kropf, 2013; Siemens, 2008). Asynchronous learning can occur at any time since it occurs even when the teacher and the learner are not online at the same time. It is frequently facilitated by media like discussion boards and email (Fadhilah et al., 2021). Asynchronous learning, for example, occurs in the Life sciences when the teacher uses WhatsApp to distribute content or even homework to learners, who may or may not be online. Conversely, synchronous learning occurs when the teacher and learners are online simultaneously and is frequently aided by media like Zoom Meeting and Google Meet (Baba et al., 2021; Hrastinski, 2008). Goldie (2016) states that a learning community can be described as a node, and nodes may also be organisations, libraries, websites, journals, databases or any other sources of information. This suggests that Connectivism is of the notion that learning happens through links between various communities.

According to Connectivism, learning begins when learners connect to and participate in a learning community, activating their prior knowledge (Goldie, 2016). Since Connectivism is focused on networking, knowledge is distributive rather than fixed, existing in the experiences and interaction between individuals connected by technology (Goldie, 2016). Because knowledge is distributed over networks and is open to different interpretations, it belongs to any individual (Goldie, 2016; Siemens, 2005). Siemens (2005) further states that because new information is continuously being received, learning from the Connectivism perspective is constantly altered.

Knowledge is altered when individuals access networks to exchange information and learn to expand their thinking horizons. The individuals then reflect on what they have learned, make adjustments, and re-establish contact with the community to share their newfound knowledge, and continue to learn new things (Khushk et al., 2023). Due to the frequent evolution of knowledge, the acquisition of knowledge is considered a continuous process (Khushk et al., 2023; Siemens, 2005). According to Siemens (2005) Connectivism as a theory is rooted in eight principles, as depicted in Figure 3.2 below.

Figure 3.2: Connectivism learning framework (Siemens & Downes, 2009)



3.3. Unpacking the eight principles of Connectivism

3.3.1. Learning and knowledge rest in the diversity of opinions

Connectivism embraces diversity by allowing every individual to contribute, which enables them to add perspectives and opinions on any given topic (Corbett & Spinello, 2020; Utecht & Keller, 2019). Technology can be used as a medium through which perspectives are shared (Boyras & Ocak, 2021). People can construct knowledge and learn from one another using technology to communicate views and understanding. In education, during the teaching of different subjects, teachers can utilise EdTech resources to help learners explore, reach and acquire information from other teachers and learners. For instance, Life Sciences teachers can use EdTech resources to share opinions and their understanding of Life Sciences using digital platforms. While sharing, they will also gain knowledge from the various teachers' perspectives shared. In this way, teachers create Life Sciences knowledge while also learning, which they pass on to their learners.

Connectivism maintains that there is no one right approach to understanding a concept or solving a problem. It emphasises the value of diverse perspectives in which knowledge is created and

exchanged (Dennis, 2020). As a result, this theory enables teachers to explore Life Sciences topics from different levels of understanding which they will then pass on to their learners. Moreover, it gives them the freedom to accept more than one solution to a problem. According to Connectivism, individuals do not have control but collaborate to synthesise information from a vast number of sources (Duke et al., 2013). This implies that teachers learn from the ideas and opinions shared and contributed, and that exposure to a range of perspectives will enhance their understanding of Life Sciences. This principle is based on the understanding that teaching Life sciences is a process that necessitates teachers to socialise and acquire different opinions of individuals and then make sense of those opinions. As such, this principle suggests that learning is not only acquired through formal schooling.

3.3.2 Learning is a process of connecting specialised nodes or information sources

Through sharing opinions as noted in principle 1, learning nodes are generated, which in turn create networks of information on a particular subject taught (Mpungose, 2023a). Kop and Hill (2008) assert that nodes and links are two terms that describe this theory in terms of how information is gained and connected in a network. Kop and Hill (2008) further describe nodes as a learning community that can be people in a network connecting or linking to one another to share resources or information. As such, according to Connectivism, learning is more about collaboration than it is about acquiring knowledge. To do this, learners must be able to make connections between ideas and experiences from a variety of sources using technology and social networks (Mampota et al., 2023; Shrivastava, 2018). Therefore, teachers should ensure that learners have access to and are provided with the appropriate EdTech resources so that they generate new content on Life Sciences. Teachers should not limit learners to them as the only source of information but give them the freedom to explore multiple sources of information from other teachers through means utilising EdTech resources for learning.

According to a study by Alam (2023) giving learners the freedom to establish connections is crucial since it exposes them to new knowledge, skills and ideas on Life Sciences content. Additionally, this aims to help teachers see that learning of Life Sciences is a process that calls for learners to gather information from various sources and then establish connections between the ideas they have learnt to make sense of Life Sciences content.

3.3.3 Learning may reside in non-human appliances

Connectivism acknowledges that learning can take place within technological systems and not restricted to human interaction, since knowledge can be preserved digitally in the form of social media posts, databases, or videos (Handabura, 2020). These appliances can be software-based, hardware-based or pedagogically based resources to communicate teaching and learning (Khoza, 2021). For instance, teachers can use hardware and software resources such as laptops, computers and the internet while teaching Life Sciences. This allows learners to access knowledge of Life Sciences from sources other than their teacher (Boyras & Ocak, 2021). Thus, Connectivism holds that knowledge is produced by learners themselves and that learning happens both within and outside of the classroom.

The reason why Connectivism believes that learning may reside outside of the classroom is because of the vast EdTech resources available that teachers and learners can use to add to their understanding of Life Sciences beyond the classroom context (Makina, 2016). As such, teachers themselves would not be able to carry all the knowledge that a learner needs to know in Life Sciences. However, they can use EdTech resources to expose learners to knowledge that they otherwise may not have been able to present to the learners. Therefore, Connectivism acknowledges the significance of forming networks that connect Life Sciences information seekers through EdTech resources. Thus, it can be argued that being in possession of and utilising non-human appliances can enhance the teaching of Life Sciences (Khoza, 2021).

3.3.4 The capacity to know more is more critical than what is currently known

Connectivism emphasises that expanding our knowledge and adapting to new situations is more valuable than what we already know because learning what we need for tomorrow is more important than what we already know today (Yin & Hanif, 2024). In other words, the need to keep learning is more vital than the knowledge that already exists, because new knowledge is introduced every day. Therefore, when teaching Life Sciences teachers should make use of various EdTech resources such as journals, and websites to accumulate more knowledge on Life Sciences and be able to expand learners' knowledge so that they gain more knowledge that will be useful in the future. This principle seeks to explore how the learning of Life Sciences is not stagnant because what is known today might be outdated tomorrow. Therefore, it seeks to make teachers understand that Life Sciences as a subject is forever changing or evolving. Therefore, to prevent having outdated information, this principle suggests that learning should be a daily activity.

3.3.5 Nurturing and maintaining connections is needed to facilitate continual learning

Since learning is a continuous process that is constantly changing, Connectivism believes that it is essential to maintain connections and networks. Actively interacting with others in networks and exchanging knowledge is essential to fostering and preserving connections (Ravenscroft, 2011). Therefore, by utilising EdTech resources such as the internet and WhatsApp, teachers would always maintain connections with their learners, thus keeping the teaching and learning of Life Sciences going. Additionally, this principle is linked with the fourth one, that since learning is continuous, for it to continue it needs to be strengthened by acquiring more and more knowledge and by maintaining connections.

3.3.6 The ability to see connections between fields, ideas, and concepts is a core skill

According to Makina (2016) Connectivism acknowledges learning digitally and encourages the ability to connect different pieces of information that individuals come to share. This ability to perceive connections between ideas allows individuals to generate new insights and advance their understanding of contents (Makina, 2016). As a result, for effective teaching and learning of Life Sciences, and for learners to be active participants in the learning process, teachers should allow learners to use EdTech resources during the teaching and learning process of Life Sciences. This will allow learners to make some connections on certain Life Sciences aspects on their own.

3.3.7 Currency (accurate, up-to-date knowledge) is the intention of all connectivist learning activities

Connectivism stresses the importance of learners accessing updated knowledge, hence, it is essential that knowledge is regularly evaluated and updated. New information is continuously supplied, and updated information becomes available (Mpungose, 2023b). As a result, educators must use EdTech resources to assist learners acquire current and accurate Life Sciences knowledge from a variety of sources. Teachers of the Life Sciences should equip their learners with the ability to verify the accuracy of information derived from a variety of sources. This principle focuses on understanding that Life Sciences knowledge should be relevant, meaning that current knowledge is more important than knowledge from the past.

3.3.8 Decision-making is itself a learning process

Connectivism identifies decision-making as a vital component because sifting through detailed and significant information and having the ability to make decisions based on comprehension is a fundamental skill. Connectivism theory thus promotes critical consumption of the knowledge we

come across once knowledge has been disseminated in the network community (Utecht & Keller, 2019). Therefore, it is vital for teachers in Life Sciences to employ EdTech resources to sift through information because what is useful, relevant and applicable knowledge today in Life Sciences may be obsolete tomorrow. This will assist teachers in deciding what to teach, when to teach it, and how and why to teach that particular knowledge to learners.

3.4 The relevance of connectivism theory in this study

The increasing use of technology as an educational tool requires teachers to adapt their teaching and learning methods (Peter & Ogunlade, 2024). Connectivism theory was appropriate for this study because it emphasises and supports the use of technology in teaching and learning. Thus, using Connectivism as the theoretical framework for this study was instrumental in examining how Life Sciences teachers integrate EdTech resources. By analysing the types of resources, they use and the reasons and methods behind their integration, the researcher was able to identify the gap between the three levels of EdTech resource integration. Connectivism theory is also useful in allowing researchers to discover the reason behind the way that teachers of Life Sciences integrate EdTech the way that they do, making it relevant for the study.

3.5 Chapter summary

In the first section of this chapter, the background of the theoretical framework of Connectivism was introduced. The chapter continued by outlining the eight principles of Connectivism and then unpacked in detail each principle, along with a connection to the use of EdTech resources in the teaching of Life Sciences. The chapter also discussed the applicability of Connectivism as a theoretical framework for this study.

CHAPTER 4

RESEARCH DESIGN AND METHODOLOGY

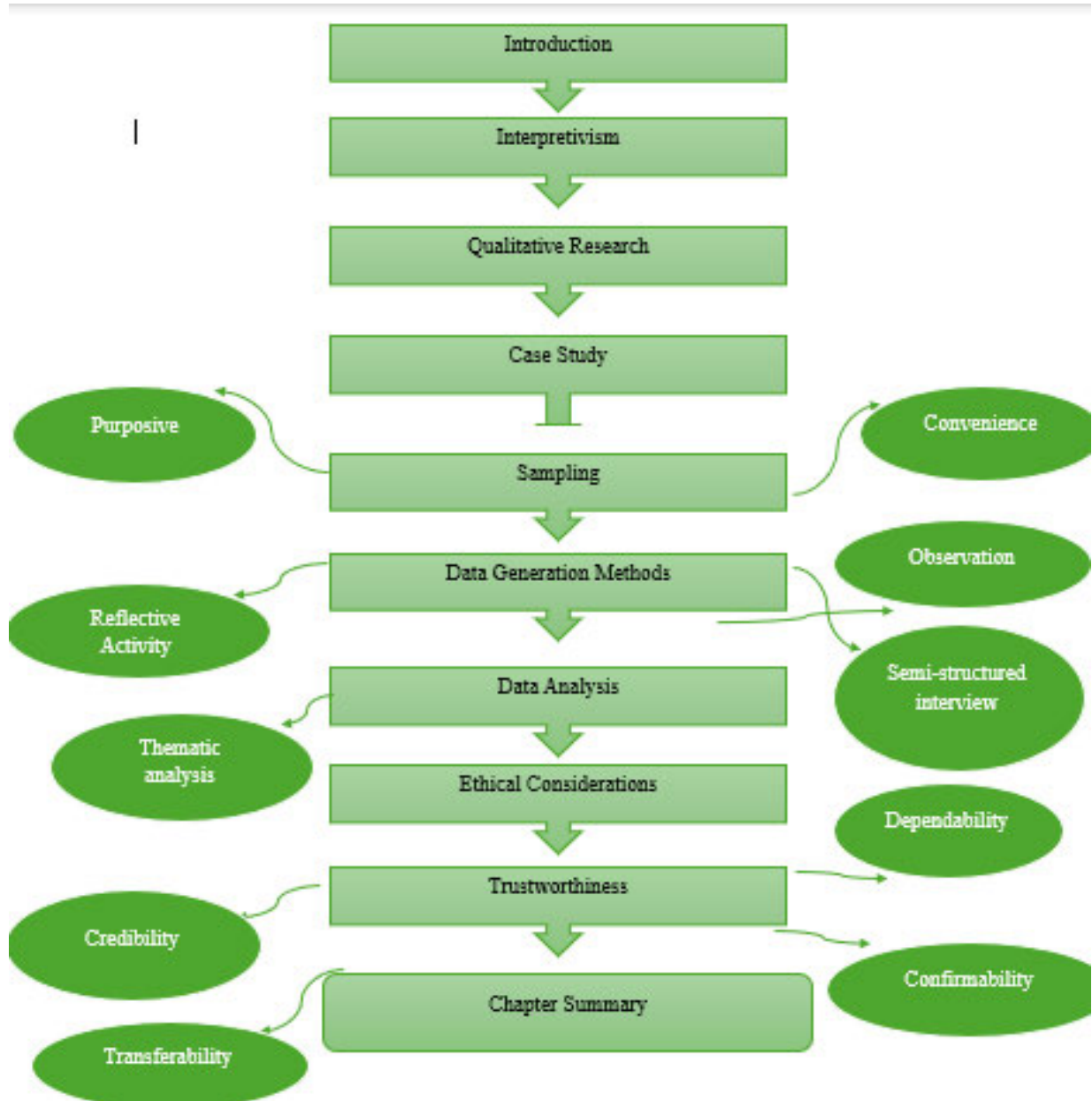


Figure 4.1: A flow chart showing the structure for chapter 4

4.1 Introduction

This chapter presents the procedures followed in designing the study and the methodology used to explore the integration of educational technology resources in the teaching of Grade 10-12 Life Sciences. Research methodology refers to the various approaches that the researcher can adopt to solve the research problem and address the research topic (Mishra & Alok, 2011; Patel & Patel, 2019). The methodological procedures discussed in this chapter are the interpretivism paradigm, the qualitative research approach, and case study as the research design. In addition, the chapter also discusses purposive and convenient sampling, which were the methods chosen for the study. Methods of generating data such as reflective activities, semi-structured interviews and observation are also outlined. The chapter also looks into the components of trustworthiness, namely credibility, dependability, transferability, and conformability. Methods of data analysis and ethical issues are also discussed.

4.2 Research paradigm: interpretivism

A paradigm is defined as a particular way of viewing the world, made up of the different perspectives, ideas and beliefs that shape how a researcher understands and interprets the world (Kivunja & Kuyini, 2017; Mackenzie & Knipe, 2006). Rehman and Alharthi (2016) similarly assert that a paradigm constitutes a set of beliefs that guides and shapes a researcher's understanding of the world, that is their views and interpretations of it. A paradigm is further defined by Khatri (2020), and Yong et al. (2021) as a set of principles that provides guidance for research and helps the researchers to structure their studies. This suggests that a paradigm is a method used by researchers to interpret the world to construct meaning to develop a better understanding of the topics researched. Yong et al. (2021) note that positivist, critical and interpretivist paradigms are the three primary research paradigms. This study adopted the interpretivist paradigm.

The interpretivist research paradigm seeks to provide an insightful and in-depth understanding of the phenomenon being explored. This in-depth insight is essential in understanding the subjects being studied in order to develop meaning and make relevant interpretations (Kivunja & Kuyini, 2017). Furthermore, the interpretivist paradigm emphasises understanding individuals and how they make sense of their reality and the world around them (Kivunja & Kuyini, 2017; McChesney & Aldridge, 2019). Interpretivism is about understanding the realities of the participants' complex world through exploring their lived experiences. Moreover, rather than making generalisations, an

interpretivist seeks to gain a deeper understanding of a phenomenon and its complexity (Pham, 2018b). As such, the information and knowledge obtained in this study on the integration of EdTech resources to teach Life Sciences is subjective to each teacher as it is based on each teacher's experience and understanding in teaching Life Sciences using EdTech resources.

Junjie and Yingxin (2022) emphasise that interpretive paradigm views are directly influenced by individual experiences. Interpretivists create their own understanding of the world based on their unique interpretations since they individually encounter the world differently. As such, using the interpretivist paradigm I was able to understand the integration of educational technology resources in the teaching of grade 10-12 Life Sciences from different teachers. Cohen et al. (2011) supported by Pham (2018) state that the weakness of an interpretive paradigm is that it is subjective and has a room for bias because the outcomes of the research are affected by the researcher's interpretation and beliefs. In this study, to address this weakness, data findings were described in details and the process of data analysis was thoroughly described outlining how the study conclusions were reached. The interpretivist paradigm possesses two relativist perspectives, ontological and epistemology (Alharahsheh & Pius, 2020). These are discussed below.

4.2.1 Ontology

The ontological view is that reality is not single and shared but has multiple interpretations and meanings to it and that the world we live in is only known through socially constructed meanings (Bayot et al., 2019; Ryan, 2018). Concurring with the above Mack (2010) states that in an interpretivist paradigm there are multiple perspectives on social reality because multiple people view social reality in different ways and interpret it differently. With regard to research, ontology is concerned with the researcher studying the existence of something in the real world and how it exists. Ontology deals with the assumptions made about the reality which the participant lives in (Ni'mah et al., 2024; Nyabuto & Wabwoba, 2024). Basically, ontology seeks to understand the fundamental beliefs and assumptions about everything that exists in the real world and how those things are making researchers unlock the way reality is understood (Manik et al., 2024; Sol & Heng, 2022).

Therefore, ontologically, this study used the interpretivist paradigm to explore different understandings and interpretations on the integration of Edtech resources when teaching Life Sciences. I accumulated different views on how teachers integrate EdTech resources when they

teach Life Sciences since I was working with different teachers who make sense of the truth differently, and therefore brought different and unique perspectives. The aim was to gain a deeper understanding from the different beliefs and assumptions of Life Sciences teachers on what EdTech resources they integrate and how they integrate those EdTech resources when teaching Life Sciences.

4.2.2 Epistemology

Conversely, Epistemology is defined as the study of what individuals know, how individuals know, and how knowledge is justified (Ekström & Westlund, 2019; Ghazali et al., 2021). It is defined as a theory of knowledge that believes that truth and knowledge are subjective because they are based on peoples' experiences and understanding of them (Mwita, 2022; Ryan, 2018). With regard to research, the epistemological perspective focuses on how researchers come to construct meanings, how researchers arrive at their conclusions, including the approaches that bring them to their conclusions (Al-Ababneh, 2020). As such, epistemologically, the study used the interpretive paradigm to generate knowledge through exploring and understanding the social world of Life Sciences teachers when they integrate EdTech resources in teaching and learning of Life Sciences.

Because of the greater number of details that can be generated to describe and understand the explored phenomenon, an interpretive paradigm has the advantage of allowing the researcher to study their phenomenon at a deeper level (Knotter, 2022; Pervin & Mokhtar, 2022). In other words, an interpretive paradigm allows a researcher to delve more into their phenomena. In this study, this paradigm was used to provide a more detailed description of the integration of EdTech resources when teaching Life Sciences and derive meaning from teachers' particular ways of EdTech integration.

4.3 Research approach: qualitative study

According to Taherdoost (2022) and Ganesha and Aithal (2022) a research approach is defined as a plan that a researcher uses and follows to generate, analyse and interpret data. There are three research approaches that are commonly used by researchers, namely, quantitative, qualitative and mixed methods (Bhawna & Gobind, 2015; Taherdoost, 2022). This study adopted a qualitative approach to come up with in-depth data about the integration of EdTech resources in the teaching of Life Sciences.

The qualitative research approach can be understood as a research that probes an individual's understanding and interpretation of a phenomenon (Creswell, 2014). Furthermore, qualitative research is also understood as a process of studying in detail the nature of a phenomenon in order to understand it (Gürbüz et al., 2022). In this way one is able to provide insights and explanations of real-life problems and experiences (Ugwu & Eze Val, 2023). Aspers and Corte (2019b) define the qualitative approach as a process of studying things in their natural settings as so to make sense of them. In this approach, researchers are able to interpret findings and develop meanings in order to improve understanding.

In addition, qualitative research is defined as less structured and emphasises words rather than numbers in the analysing of data (Gürbüz et al., 2022). It is concerned with discovering how human beings understand and experience the social world (Taherdoost, 2022; Walia, 2015). Mohajan (2018) states that qualitative research is exploratory and seeks to explain how a phenomenon is perceived and why it is perceived in that way. In other words, qualitative research is exploratory in nature and produces findings through textual data (Adedoyin, 2020). The qualitative approach was used in this study to achieve an insightful and in-depth understanding of how teachers integrate EdTech resources in the teaching of Life Sciences in Grades 10-12 through gathering and interpreting textual detailed data. The aim was to understand how Life Sciences teachers perceive the idea of integrating EdTech resources when they teach Life Sciences.

This approach was appropriate for this study since the purpose was to explore the integration of EdTech resources in the teaching of grade 10-12. This approach was used because the qualitative approach allows the researcher to understand their problem or phenomenon in a more detailed way since it allows researchers to generate more data and information on participants' opinions and experiences and describe them in detail (Mwita, 2022; Rahman, 2016).

As a result, I used a qualitative approach to socially construct all teachers' practices when teaching Life Sciences through studying their different levels of diagonal, horizontal and vertical integration. This led me to gain an in-depth understanding of how teachers integrate EdTech resources when teaching Life Sciences in Grade 10-12. Thus, through this study, teachers were able to reflect on the empowerment of their practices. A study by Mwita (2022) states that the limitation of this approach is that it is subjective and therefore the findings are not replicable and generalisable. However, in the study the aim was not to generalise but seek greater understanding

of participants integration of EdTech resources in their teaching. Therefore, readers can transfer findings in their relevant context.

4.4 Research style: case study

According to Boru (2018) research style is a framework of the methods to be applied to generate and analyse data to answer the research questions. Abutabenjeh and Jaradat (2018) define research style as a plan used to guide how the research should go about laying down how a study will move from the research questions to the outcomes. Therefore, this suggests that research style is a plan stipulating the methods to be used to generate and analyse needed data that will answer your research questions. This study adopted a case study as a style of research.

According to Starman (2013) and Karlsson (2016) a case study is a research strategy that describes and analyses a phenomenon in detail to develop an understanding about real-life situations. Heale and Twycross (2018) refer to a case study as a detailed study about people in which the researcher explores in-depth data. Case study is defined as one of the most accepted and used means of research method in qualitative research to generate an in-depth understanding of a phenomenon (Coombs, 2022; Sarah et al., 2011). Moreover, Choy (2014) asserts that the limitations of this style of research are that findings may only apply to similar cases as the one being studied.

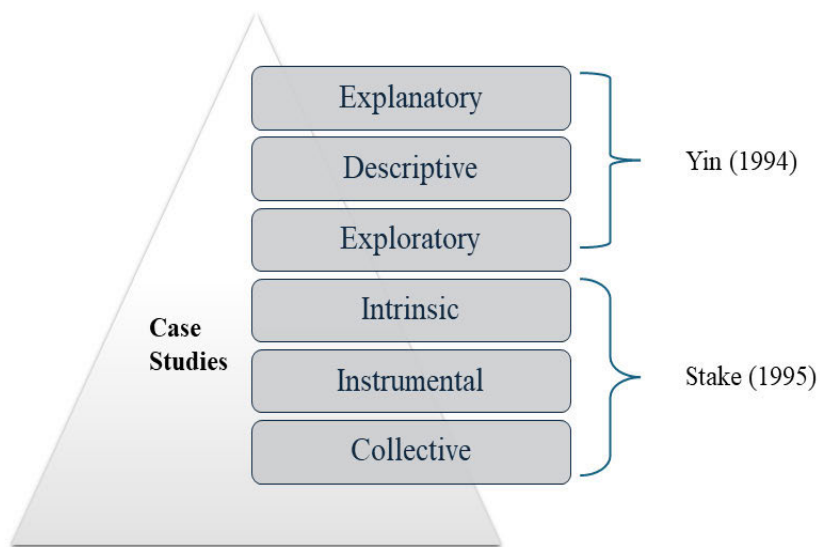


Figure 4.2: A diagram showing the types of case studies

4.4.1 Different types of case studies

There are different types of cases studies that can be employed by research studies. These include exploratory, intrinsic, descriptive, explanatory and instrumental. According to Peng and Shiyu (2019) and De Massis and Kotlar (2014) an explanatory case study is ideally used when the researcher seeks to explore casual links that are too complex to explain a particular phenomenon. This type of case study focuses on the why and how a certain thing is in a particular way. A descriptive case study is defined as a case study that serves the purpose of describing a phenomenon in a more detailed way or providing a full description of a phenomenon within its context (Peng & Shiyu, 2019). An intrinsic case study is one that is done to study a unique phenomenon which the study focuses on; the researcher must be able to define in as much detail as possible the uniqueness of the phenomenon as so to make it clear how it is different from all others (Salmi, 2010). Coombs (2022) asserts that an intrinsic case study is concerned with studying a new case; a unique situation is presented to gain an in-depth understanding of the new case and enable it to be distinguished from all other cases. The instrumental case study is concerned with exploring general areas to gain a broader understanding of the phenomenon rather than studying a particular or unique case (Kekeya, 2021; Salmi, 2010).

This study utilised the exploratory case study. An exploratory case study serves the purpose of studying a phenomenon by means of exploring, and discovering, with the case being studied having no single set of outcomes (Lucas et al., 2018; Yin, 2009). Furthermore, an exploratory case study involves conducting detailed research on a specific case to explore and generate new insights to gain a deeper and better understanding of the phenomenon being studied (Boru, 2018; Ragab & Arisha, 2018). This study saw it as appropriate to adopt an exploratory case study because it aimed to understand how different schools/teachers (Life Sciences teachers) integrate EdTech resources when they teach Life Sciences in Grade 10-12 to demonstrate and gain in-depth knowledge.

Exploratory case study was considered suitable to explore the integration of EdTech resources in the teaching of Life Sciences in grades 10-12 because it gives the researcher the freedom to provide long and detailed descriptions of their explored phenomenon (Choy, 2014). By using this style of research in my study I was able to explore and generate detailed data by capturing cases of Life Sciences teachers on the integration of EdTech resources in the teaching of Grades 10-12. In

addition, I gained a comprehensive understanding of teachers' integration of EdTech resources in their teaching.

4.5 Sampling

Sampling is described as the process of selecting people, sources, or a unit that is deemed appropriate and suitable to represent a wider population in a research project (Turner, 2020; Van Haute, 2021). The use of sampling in this study was relevant, to gather the data, I needed to interact and engage to respond to the research topic. This study adopted non-probability sampling. The figure below illustrates the different types of non-probability sampling.

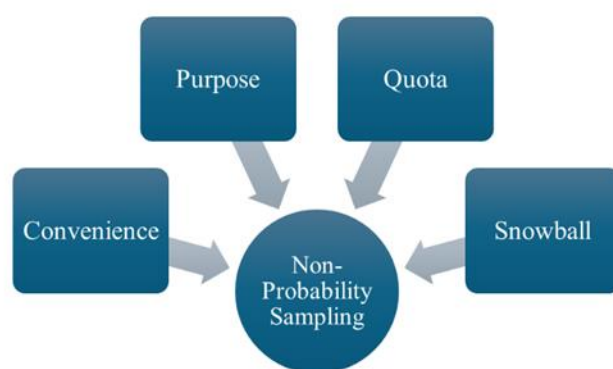


Figure 4.3: A diagram showing the different non-probability samplings.

Non-probability sampling is defined as a process where participants do not stand an equal chance of being selected or chosen (Adeoye, 2023; Baltes & Ralph, 2022; Deshpande & Girme, 2019). In other words, in non-probability sampling the chances of being selected for the sample are unknown (Kim, 2022; Vehovar et al., 2016). This means that participants are selected based on the researcher's subjective judgement and not randomly (Kim, 2022; Showkat & Parveen, 2017). This type of sampling has four primary methods: convenience, purposive, quota, and snowball (Adeoye, 2023; Baltes & Ralph, 2022; Makwana et al., 2023; Rahman, 2023). This study employed non-probability sampling, involving purposive in conjunction with convenience sampling, to select the four most accessible participants with the purpose of exploring the integration of EdTech resources in the teaching of Life Sciences in Grades 10-12.

4.5.1 Purposive sampling

Purposive sampling is when a researcher selects a specific group of participants with specific and unique qualities (Creswell, 2014). Purposive sampling further refers to the deliberate recruiting of individuals because they possess relevant characteristics needed in a study (Andrade, 2021; Campbell et al., 2020; Etikan et al., 2016). These studies further state that these individuals are deemed likely to provide appropriate and useful information. Etikan and Babatope (2019) define purposive sampling as a method that allows researchers to select participants for a study based purely on their knowledge, credibility and understanding that they will meet the objective of a study. Purposive sampling involves the researcher using their discretion to determine what needs to be obtained and then going out to find people who can and are willing to provide the information by virtue of knowledge or experience (Etikan et al., 2016; Joseph & Eleojo, 2019). In adopting purposive sampling in this study, I selected teachers who teach Life Sciences in three different school contexts - urban, rural and township. Additionally, teachers' qualifications and experience paved the way for different teachers to be chosen. I limited my selection to qualified Life Sciences teachers possessing a four-year degree and with teaching experience of 5 years and above. The four participants and their schools were given pseudonyms as shown in the table below.

Table 4.1: Profiles of the participants sampled

Participants	School	Qualification	Experience	Grade	School Context
Mr Shandu	Sydney Sec	Secondary Teacher's Diploma and ACE in Mathematics	23 years	12	Well-resourced school in an urban area
Ms Mbatha	Siyakhula High	BSc degree in Biochemistry and PGCE	8 years	11 and 12	Under-resourced school in a rural area

Mr Magwaza	Khuthala Sec	BSc in Environmental Sciences and PGCE	8 years	11 and 12	Under-resourced school in a rural area
Mr Ngidi	Ibutho High	Bachelor of Education, specialising in Psychology and Life Sciences	13 years	11 and 12	Well-resourced school in a township

4.5.2 Convenience sampling

According to Creswell (2014) convenience sampling is based on a researcher choosing a more manageable number of participants who are easily accessible to take part in a study. Furthermore, convenience sampling is based on accessibility, whereby participants are selected because they are easily reachable by the researcher (Golzar et al., 2022; Rahi, 2017). In support of the latter, Mishra and Alok (2022) and Farrokhi and Mahmoudi-Hamidabad (2012) define convenience sampling as a method that is concerned with samples being selected based on ease of access to the researcher, willingness to participate and availability at any given time. Therefore, convenience sampling was used in this study since I chose to work with a group of teachers who were easily accessible to me, whom I could meet up with conveniently without any difficulties. These were the teachers who resided in Eshowe, the same town where I also reside and planned to conduct my research. Additionally, this sampling method is easy and inexpensive (Shaheen & Pradhan, 2019). As such, the selected schools for this study are conveniently located near me, therefore reducing travelling expenses on my side. The limitation of convenient sampling is that the sample selected may not be representative of the population (Cohen et al., 2011). To address this limitation, I included teachers from different school contexts to increase diversity of the participants.

4.6 Data generation methods

Data generation refers to the process of creating, collecting and producing primary data through various research methods (Goldkuhl, 2019). This study used reflective activities, semi-structured

interviews, and unstructured observations to explore the integration of EdTech resources when teaching Life Sciences in grades 10-12.

4.6.1 Reflective activity

Reflective activity is the process of learning through experience and applying reflection to gain new insights of self (Cohen et al., 2011; Mollo & Falzon, 2004). Marcos et al. (2009) and Mortari (2015) describe reflective activity as the process of viewing one's work as a matter of self-examination to grow and gain a better understanding of oneself. This study took reflective activity as the initial method to generate data from teachers, with the aim that participants could share their experiences and answer a series of questions about the phenomenon being explored in the form of an open-ended questionnaire. Teachers were afforded an opportunity to reflect on their teaching experiences in the teaching of Life Sciences using EdTech resources. (Refer to annexure B for the reflective activity questionnaire schedule).

After the participant consented to being part of the study, I took the initiative to hand deliver copies of the questionnaires to each teacher in their respective schools. Teachers were required to respond in writing to a series of open-ended questions. Three weeks were allotted to them to answer the questions and all teachers responded to the reflective activity given to them. Following their completion, I went to their respective schools to collect the completed questionnaires and then I proceeded with the interviews. According to Mpungose (2015) the method is limited by the inability to verify participant honesty, as researchers cannot guarantee that reflections provided are genuine. To mitigate this limitation, I communicated expectations to participants and allocated sufficient time for them to thoughtfully respond to the questions.

4.6.2 One-on-one semi-structured interviews

Cohen et al. (2011) defines semi-structured interview as a conversation between a researcher and a participant that aims to elicit information on how the participant interprets and makes sense of their life experiences. Furthermore, a semi-structured interview is a qualitative data generation method that involves a verbal conversation between a researcher and a participant based on a set of questions. The researcher interacts with the participant with the aim of generating information on how participants make sense and meaning of their experiences and view the world in their lives (Ruslin et al., 2022). According to Jamshed (2014) and Elhami and Khoshnevisan (2022) semi-

structured interviews are interviews consisting of pre-determined open-ended questions that the participants are required to respond to freely. In addition to the above, the semi-structured interview format gives the researcher the freedom to add or even omit certain questions as well as the power to change the order, direction and wording of the questions (Alamri, 2019).

Semi-structured interviews were used in this study to allow participants to freely respond in detail to different questions asked. According to Ruslin et al. (2022, p. 4) “semi-structured interview is flexible, allowing new questions to be brought forward during the interview as a consequence of what the interviewees have said”. Thus, I went into the interviews with pre-planned questions in the form of an interview schedule. (Refer to Appendix C for the interview schedule). However, as I was interviewing the teachers and as they were answering questions on how they integrate EdTech resources to teach Life Sciences, there were probing questions to seek further clarity. Additionally, this method allowed teachers to answer questions freely without any limitations since they were free to use any language that they felt most comfortable with.

I considered it appropriate to use semi-structured interviews since they allowed me to probe deeper and not simply adhere to the interview guide. However, one of the drawbacks is that in this type of interview, inexperienced researchers may not be able to ask prompt questions, and when this happens, some relevant data might not be gathered (Monday, 2020). To address this limitation, I spoke less during the interview and allowed the participants to speak more. In the consent letter that was provided to teachers before beginning the data generation process, they all signed their consent to participate in all the methods of generating data that I was going to use including interviews. Teachers were also informed that the interviews were going to be recorded using a cellphone device. During the interviews between the participating teachers, I recorded and then at a later stage transcribed data from the recorded source. On average, the interviews ran for 45 minutes and were conducted after school in their respective schools. (Refer to annexure C for the one-on-one interview guide questions). Kakilla (2021) posits that the limitation of this method is a language barrier between the researcher and the participant. To address this limitation, in this study, I used a language that was understood by both myself as a researcher and the interviewee (participants).

4.6.3 Unstructured observation

Observation is when the researcher goes to the site of the study and observes what is happening (Bertram & Christiansen, 2014). Moreover, observation is a data generation method that involves the act of the researcher watching, paying attention or even directly experiencing the behaviour or events within their natural environments (Jibril, 2018; Katz-Buonincontro & Anderson, 2020). Furthermore, Moser and Korstjens (2018) state that when a researcher observes they must be physically present in the environment, take notes, record, interact and observe over an extended period of time.

Observation was the last data generation method used in this study. As the researcher, I physically visited the selected schools to observe how Life Sciences teachers integrate EdTech resources and which EdTech resources they use. Observations are classified into overt and covert and can either be structured or unstructured (Dewi, 2021; Sosa-Moreno et al., 2022; Stigen et al., 2023). A structured observation is controlled and planned whereas an unstructured observation is one in which the researcher acts as the observer and records all the participants' activities without any preset plan (Stausberg, 2011). A covert observation is one in which the participants are not aware who the observer is as it could be one of them and that they are being observed, whereas an overt observation involves participants being aware that they are being observed and who the observer is (Ekka, 2021). I opted for an unstructured overt observation since I had not planned anything ahead of time and the participants knew they were being observed. Each teacher was observed three times, for one hour per day. I went to observe on the days and times that I had agreed with the participants. There was an observation schedule set, which required notes to be taken as participants were being observed. (Refer to annexure F for the observation schedule).

The benefit of observation is that it allows the researcher to confirm whether what the participants say is really what they do, (Moriarty, 2011). Thus, I was able to compare what the teachers had said in their interviews with what happens in the classroom. Although observations have benefits, they also have downsides. Observations can be intrusive, making the participant uncomfortable and potentially changing the dynamic of the situation (Ellis, 2023). This may have meant that the teacher and learners may have been somewhat uneasy with my presence, but I did assure them that I was not there to cause any trouble, so they should please feel at ease around me. The limitation of this method is that the observer may be selective and distort data (Taherdoost, 2021). To address

this, I used an observation schedule guided by the study's objectives to take down notes during lesson observations.

4.7 Data analysis

According to Bhatia (2017) data analysis refers to the process that begins straight after the generation of the required data. Ibrahim (2015) describes this process as extracting useful information from the generated data and interpreting it to gain insights. Data analysis can also be described as cleansing data, breaking down large chunks into smaller ones or changing raw data gathered into simpler, meaningful and understandable data (Alem, 2020; Bhatia, 2017). This method was adopted to break down all the data obtained through the semi-structured interviews and reflective activities into manageable and sensible data. Alem (2020) notes that this method is used to reduce large data to discover useful information for interpretation. To this end, this research study employed thematic analysis.

Thematic analysis is a qualitative research method that involves organising and analysing a set of data by searching and identifying themes through carefully reading the transcribed data (Braun & Clark, 2012; Dawadi, 2021). To analyse data thematically, I began by taking the raw data obtained from the reflective activities, semi-structured interviews and observations and closely examined it, looking for patterns that came up repeatedly to identify common themes. I then derived the themes which were used to categorise Life Sciences' Teachers' responses into themes accompanied by quotes from their responses.

4.8 Ethical considerations

Bartneck et al. (2021) define ethics as principles, general judgements and norms as opposed to subjective judgements and values. In research, ethics refers to the principles, guidelines and norms that the research community have deemed are proper, fair and appropriate to guide the process of data collection and data analysis (Ederio et al., 2023). Ethics are also defined as procedures and methods for acting responsibly and in a trustworthy manner when conducting research (Ederio et al., 2023). Palaskar (2018) states that research ethics is concerned with the analysis of ethical problems that are brought up or arise during research. Bhandari (2021) asserts that ethical considerations are crucial since they ensure that a study is conducted in a manner that is responsible and ethical.

To ensure that this study met the research ethics requirements, I first applied for the gatekeepers' letter requesting permission in writing from the Department of Basic Education in Pietermaritzburg and it was granted (see Annexure E). Secondly, I sought permission and was granted from the selected school principals to conduct the research in their respective schools. Finally, I also applied for ethical clearance from the research office at the University of KwaZulu Natal's College of Humanities prior to involving the participants (see Annexure D). Ethical clearance was granted for one year. I then visited the teachers who teach Life Sciences in Grades 10-12 to ask them to participate in my study. Correia (2023) notes that in research ethical considerations include voluntary participation, informed consent, anonymity, confidentiality, and beneficence.

The first principle that the study addressed was autonomy. Informed consent is fundamental to research (Creswell & Creswell, 2018; Žydžiūnaitė, 2018). The autonomy of all the participants in the study was respected. Autonomy is the ability and freedom of an individual to make an informed and voluntary decision, free from outside interference, whether or not to take part in a research study (Motloba, 2018). Therefore, teachers were given the choice to decide whether to take part in the study or not without any pressure from me or anyone else. Once they had made a decision, they then communicated their decision with me. Traianou and Hammersley (2021) state that autonomy is obtained through consent from participants. Autonomy was granted through teachers signing consent forms indicating their voluntary participation in the study.

Consent means participants giving their permission to participate in a research study being fully informed of its aims and objectives as well as understanding that their participation is voluntary and they possess the right to withdraw from taking part in the study at any point (Fleming & Zegwaard, 2018; Price & Walker, 2018). Every teacher received a thorough overview of the study, what the study entailed and what was expected of them as participants. Teachers were also informed that they were free to withdraw from the study at any time if they so desired. Mirza et al. (2023) state that before collecting data, researchers should seek consent from participants and make sure they understand exactly what is expected of them. Permission was therefore obtained before any data was generated.

Through means of confidentiality and anonymity the study also ensured that none of the participants' identities were disclosed. To protect the information provided by participants requires confidentiality; participants must be given assurance that any information they supply will be kept

confidential and their identities will be anonymous during the collection, analysis and reporting of data (Kang & Hwang, 2023; Thackray, 2018). Information generated should be protected, not disclosed to third parties and not accessible by unauthorised individuals. It should also not contain any identifiable information of the participant, nor by any means be linkable to a particular individual (Bos, 2020). In order to ensure that participants are never traceable, their real names and school identities remain anonymous, therefore pseudonyms were employed instead of their real names. In addition, participants received assurance that the University, myself, and my supervisor would be the only recipients of the information they provided. Kang and Hwang (2023) state that none of the participants should never have to worry about getting hurt as a result of their information they have provided getting exposed or being discovered.

Any study should be beneficial in addition to not causing any harm. Beneficence was thus also covered in the study. Beneficence means that the study being carried out should be of benefit to the participants, other researchers and even the community (Kang & Hwang, 2021; Pieper & Thomson, 2016; Varkey, 2021). In this regard, this study will contribute to the educational community by contributing its findings to the body of literature. The study will also benefit Life Sciences teachers and learners as well as curriculum developers.

4.9 Trustworthiness

Trustworthiness is defined by Kyngäs et al. (2020) as assessing the quality and worth of the complete study to check if the findings reflect the aims of the study based on the data provided by participants. According to (Ahmed, 2024; Cohen et al., 2013; Creswell, 2014; Kyngäs et al., 2020) four components make up the concept of trustworthiness in qualitative research: credibility, transferability, dependability and confirmability. Credibility is concerned with whether the research captures and represents the actual or accurate interpretations of the participants (Elo et al., 2014). To enhance and ensure the credibility of the findings, interviews were recorded using a voice recorder and later transcribed. Furthermore, during lesson observations I took some notes, recording all the important parts that would be significant during the analysing of the data.

Transferability concerns the aspect of applicability. According to Renjith et al. (2021) transferability is the ability to demonstrate that the research findings are applicable to similar situations or phenomena or the process of applying the results of one situation to other similar situations. Researchers can demonstrate that the findings are transferable to other contexts or

scenarios by using thick descriptions, as this will assure transferability (Lemon & Hayes, 2020). According to Korstjens and Moser (2018) readers can determine whether the findings are applicable to their own contexts by reading through the provided thick description and research methodology. A thorough explanation of the research methodology, an explanation of the research approach, and a summary of the data generation and analysis processes have all been included in this work to ensure transferability and detailed findings for readers to transfer to their contexts if applicable.

According to Stenfors et al. (2020) dependability pertains to the stability of the findings. It also considers if the same results would be obtained if the research had to be conducted again using the same methodology. Therefore, dependability requires that the study procedures and analysis must be described in sufficient detail to allow one to determine whether repeating the work will yield the same results (Ahmed, 2024; Shenton, 2004). In addition, Khalid and Alkudhir (2019) and Johnson et al. (2020) state that to ensure dependability, the researcher may use an outside person (third person) to verify if proper research methods were followed. To ensure dependability in this study I have clearly explained in detail the methodology and used three data generation methods. Moreover, my supervisor reviewed my study to ensure the appropriateness of the content and other research details.

Confirmability is concerned with the ability of the researcher to operate without bias; the results of the study are predicated on the information provided by the participants rather than the researcher's preferences (Johnson et al., 2020; Moon et al., 2016). To ensure confirmability, the researcher can provide an audit trail, which is a detailed procedure of data generation, data analysis, and interpretation of the data (Ahmed, 2024). I have included the specifics of data generation, data analysis, and interpretation procedures to ensure confirmability in this work.

4.10 Limitations

One of the limitations I encountered was the withdrawal of two participants shortly after consenting to participate in the study. I eventually continued conducting the study with the remaining four instead of six. Further to this, I also faced the challenge of participants being agitated because they thought I was somehow sent by the Department of Basic Education to assess their practices. I provided evidence once more, that I was a Master student, conducting a research study for my personal and professional development.

4.11 Chapter summary

The study's methodology was discussed in this chapter. The Interpretivist paradigm that the study used was covered in the first section of the chapter. The next section of the chapter covered qualitative research as the chosen research approach. The chapter also discussed purposive and convenient sampling methods, as well as the exploratory case study. The three methods for generating data—observation, semi-structured interviews, and reflective activities were discussed. A detailed discussion of the data analysis process was also included in the chapter. The chapter also discussed the ethics that were followed in carrying out this study, and concluded with a discussion of trustworthiness.

CHAPTER 5

DATA PRESENTATION AND DISCUSSION OF FINDINGS

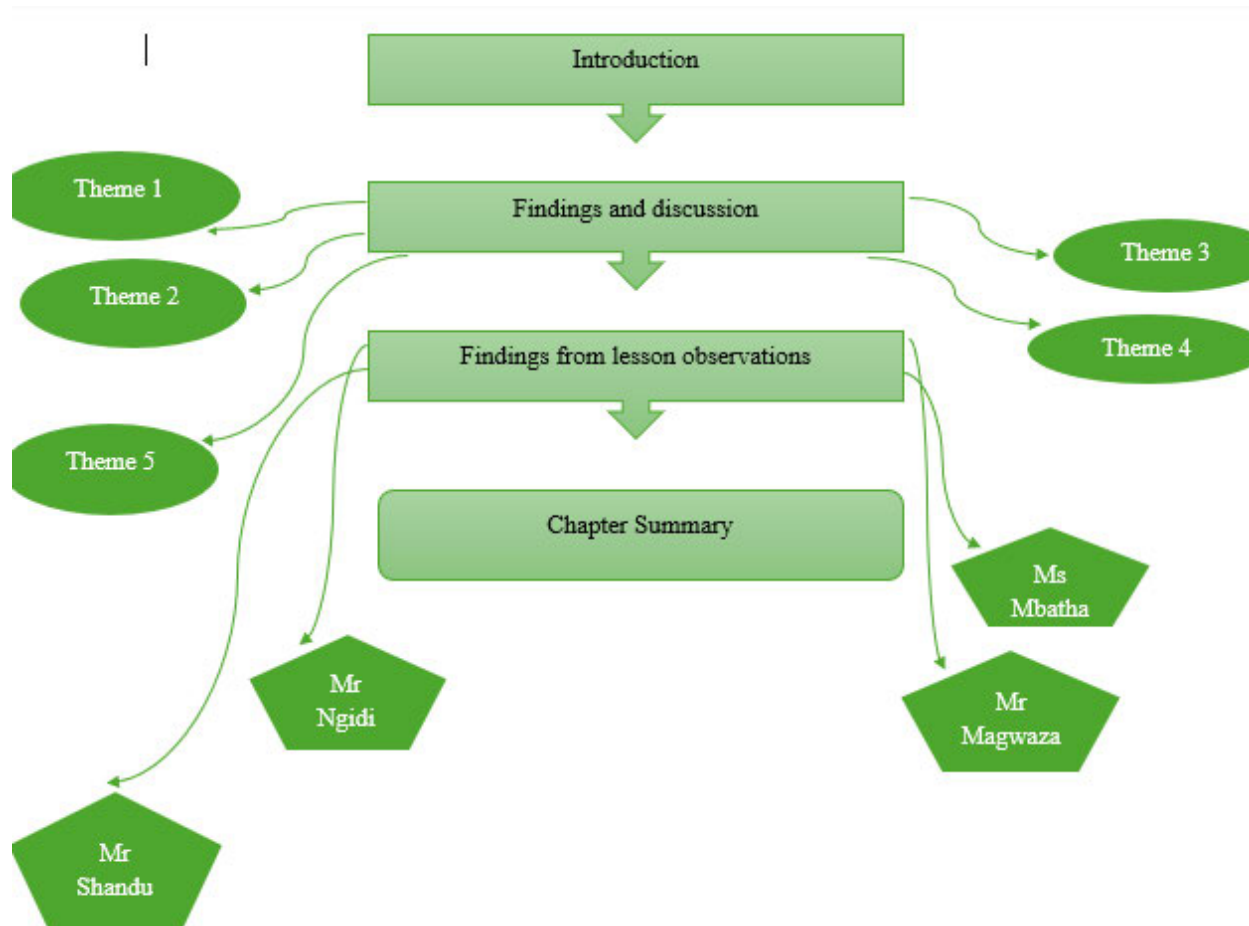


Figure 5.1: A flow chart showing the structure of chapter 5

5.1 Introduction

The previous chapter presented the research design and methodology used in this study. This chapter presents the findings that emerged from the data that was generated through reflective activity, semi-structured interviews and observations. The data was generated from four purposively and conveniently sampled teachers from four different high schools in Eshowe Circuit. The findings of the data generated are presented using a thematic analysis. The findings and discussions are consolidated according to themes discovered with the transcribed data. As shown in the table below, the participants were given pseudonyms to protect their identities. Direct quotes

from participants are provided to support the research findings of the study. The direct quotes are drawn from data generated through one-on-one semi-structured interviews and reflective activities.

Table 5.1: Profiles of participants sampled

Participants	School	Qualification	Experience	Grade	School Context
Mr Shandu	Sydney Sec	Secondary Teachers Diploma and ACE in Mathematics.	23 years	12	Well-resourced school in an urban area
Ms Mbatha	Siyakhula High	BSc degree in Biochemistry and PGCE.	8 years	11 and 12	Under-resourced school in a rural area
Mr Magwaza	Khuthala Sec	BSc in Environmental Sciences and PGCE	8 years	11 and 12	Under-resourced school in a rural area
Mr Ngidi	Ibutho High	Bachelor of Education, specialising in Psychology and Life Sciences.	13 years	11 and 12	Well-resourced school in a township

5.2 Findings and discussions

The findings and discussions of this study are presented through thematic analysis. The common patterns that were identified from the transcribed data served as the themes. As evident in table

5.2, the themes that have been identified have been linked and arranged according to the research questions. The five themes have been used to arrange participants' responses for analysis.

Table 5.2: Themes and research questions

Key Research Questions	Themes
a) What educational technology resources are teachers integrating in the teaching of grades 10-12 Life Sciences?	Theme 1: Integrating hardware resources as a teaching tool Theme 2: Integrating software resources as a teaching tool
b) How do teachers integrate educational technology resources in teaching grades 10-12 Life Sciences?	Theme 3: Integrating EdTech resources using whole class and group work approaches Theme 4: Integrating EdTech resources to assess content
c) Why are teachers integrating educational technology resources in the teaching of grades 10-12 Life Sciences the way that they do?	Theme 5: Integrating EdTech resources for lesson enrichment

5.2.1 Theme 1: Integrating hardware resources as a teaching tool

This theme sought to identify the types of EdTech resources that Life Sciences teachers integrate when teaching Life Sciences. Drawing from the interview data, participants' responses indicated that they used both traditional and modern hardware (HW) resources. HW resources seem to be the prominent EdTech resources that teachers integrate in the teaching of Life Sciences because they are mentioned frequently compared to SW resources. For example, Mr Shandu shared: *“The resources that I use are charts, models for certain topics, different textbooks to prepare my own notes then use the overhead projector machine to display those notes. I also use a cellphone”*.

Similarly Ms Mbatha said: *“I use different textbooks, models, charts, laptop together with the overhead projector to display videos”*

Mr Magwaza revealed: *“I use the overhead projector to deliver the content, practical equipment like the chemicals, textbooks, chalkboard and charts to show organs”*.

Mr Ngidi explained: *“I use the prescribed textbook, models, overhead projector to project videos and slides, laptop and cellphones”*.

Participants’ responses show that they all integrate EdTech resources in their Life Sciences classes. Some of these EdTech resources include HW resources such as Overhead Projectors (OHPs) as attested by all participants. Given that all participants use it, it seems to be the preferred HW resource among the participants. Mr Shandu revealed that he displays notes on the OHP, suggesting that he uses this overhead projector (modern HW) for the same educational purpose that the chalkboard (traditional HW) serves, while Ms Mbatha and Mr Ngidi adopt the OHP HW resource for a more advanced task such as projecting videos for learners to interact with. This indicates that although teachers use the same HW resources, their purposes for using them differ.

Furthermore, it was discovered in the findings that three participants acknowledged using charts and models, making them also popular HW resources. The use of both traditional and modern EdTech shows that teachers were benefiting from both the traditional HW (charts) and the modern HW (models) for Life Sciences illustrations. However, only one participant mentioned the use of the chalkboard as a teaching resource. A chalkboard is one of the anchoring traditional resources in education and this study shows that only one (Mr Magwaza) out of four participants uses it. This implies that the rest of the participating teachers are more comfortable in using modern HW than traditional HW resources.

When probed further, Mr Magwaza explained that *“there is a shortage of resources in the school, such that I use my own projector. For practicals, I borrow chemicals and apparatus from other schools, or the educational centre located in town. Even the textbooks they are not enough, so learners share”*. This indicates that although Mr Magwaza may be integrating EdTech resources in his teaching, he still faces challenges with the shortage of some of these EdTech resources. It is worth noting that, as a teacher from an under-resourced school, Mr Magwaza does not allow the background of his school to limit him from integrating EdTech resources to deliver his lesson. He goes to the extent of buying EdTech resources or borrowing them from neighboring schools and educational facilities.

Regarding the use of HW resources that were traditionally not available on school premises for educational purposes, only Mr. Shandu and Mr. Ngidi mentioned using "cellphones" alongside WhatsApp as examples. Connectivism emphasises the use of technology and social media to stay

connected and share ideas with others (Makina, 2016; Ravenscroft, 2011). Therefore, the use of WhatsApp gives learners and the teacher the opportunity to engage with each other to exchange knowledge. Moreover, both these teachers are teaching in well-resourced schools and have the opportunity of experiencing teaching outside of school premises. Therefore, this may imply that the background of the school and learners they enrolled allow for the use of cellphones in education. Also, this suggests that these participants taught learners who can afford cellphones and data to take learning back home digitally. By virtue of teaching in a well-resourced school, Mr Shandu and Mr Ngidi can go beyond using professional HW resources as a means to integrate EdTech in their teaching. This is in line with Azubuikwe, Adegboye and Quadri (2021) who state that children from richer socio-economic backgrounds remotely engage academically since they have access to internet connectivity, computers, and mobile phones. Moreover, teachers may provide these learners with academic support while they are at home. Thus, this indicates that the digital divide does exist in South African schools as there are teachers that effectively use WhatsApp and cellphones to engage with content with the learners while teachers from under-resourced schools are not afforded this opportunity.

5.2.2 Theme 2: Integrating software resources as a teaching tool

This theme illustrates the SW resources that participants integrated into their Life Sciences teaching. Since software (SW) resources depend on HW tools to function, the SW identified in this theme was linked to specific HW resources. Drawing on the data from the interview, participants' responses indicated that while they do integrate a few of these resources they do so minimally.

Mr Shandu explained: *“We have a WhatsApp group which I use to share anything pertaining to Life Sciences with the learners, and here at school we have a certain programme with uploaded videos which learners access to view the videos”.*

Ms Mbatha shared: *“I teach using videos which I display using the laptop and the overhead projector”*

Mr Ngidi also shared: *“I prepare slides and videos then I project on them on the overhead projector, I send learners some documents using WhatsApp, and I also use a site called Physics Stepforth”*

Among SW resources, videos stand out as the most prominent option, being the most commonly used by participants compared to other SW resources. However, it is worth noting that participants displayed these videos using different HW resources. On the one hand, Mr Mbatha and Mr Ngidi, used the OHP to project the videos. The use of videos by teachers aligns with the principle of Connectivism that acknowledges that learning is also possible through means of technological resources as knowledge can also be stored digitally other than humanly in the form of videos, and social media posts (Handabura, 2020) . On the other hand, Mr Shandu and Mr Ngidi used other SW platforms either found in their school or subject-specific websites such as “physics stepforth”. The use of websites allows the learners to expand the knowledge they already possess in Life Sciences and obtain new knowledge, which will come in handy the next day. This aligns with the principle of Connectivism stating that learning something useful for tomorrow is more vital than knowing what we already know today, meaning that gaining new information is more valuable than what we currently know (Yin & Hanif, 2024). WhatsApp was integrated into teaching Life Sciences by the teachers in well-resourced schools, which attests to the privilege of teaching in such a school context. Overall, it is evident in this study that all participating teachers used specific SW resources according to their school background, personal knowledge, and accessibility to resources.

5.2.3 Theme 3: Integrating EdTech resources using whole-class and group work teaching approaches

This theme sought to understand how teachers integrate EdTech resources to support the teaching of Life Sciences. Drawing on the data from interviews, participants’ responses showed that they are aware of various teaching strategies to apply in a lesson, but they are not aware of how to use these strategies alongside EdTech resources. During observations, it was noted that the use of EdTech resources in the teaching of Life Sciences had no structured influence. In other words, from different observations, a certain EdTech resource served different purposes. In lesson 1, for example, a teacher used the chalkboard to write the key concepts. In lesson 2, the teacher used the chalkboard for a class exercise where the questions were written on it. For lesson 3, there was no use of it at all. This suggests that teachers incorporate EdTech resources creatively and spontaneously.

In addition, the findings reveal that participating teachers integrated EdTech resources in teaching Life Sciences using teacher-directed teaching methods but switched to learner-centered methods

in specific circumstances. Then, drawing from lesson observations, participating teachers showed the EdTech resources they integrate when implementing different teaching methods and how they integrate them. Therefore, to analyse this theme, data obtained from both the interviews and observations were used.

In an interview, Mr Shandu stated: *"I do a whole-class teaching most of the time due to certain reasons. Firstly, because the number of learners in the class is large so it would not be easy to do individual teaching for all these learners. But I do switch to one-on-one when learners by themselves, ask me something specific then I focus on that specific learner"*.

Similarly, Ms Mbatha explained: *"I go for whole class teaching, I have too many learners"*.

Mr Magwaza affirmed: *"Mainly, I teach the whole-class, but there will be topics where I would feel like they would be well taught in other methods. Most topics in Life Sciences require that the teacher transfers information to the learners hence I teach them as a whole"*.

Similarly, Mr Ngidi responded: *"I teach whole-class because in this school we have high numbers so it is challenging to teach them one by one. I do one-on-one if there are questions from learners individually, or if there are concerns then they do come to me for one-on-one"*.

The findings reveal that all participants share the use of the whole- class approach as a common strategy to teach Life Sciences because of the large number of learners they have in their classes. In other words, participants deliver Life Sciences content using only one approach. The use of only whole-lass approach is in contrast with the notion of Connectivism that believes a concept is understood and a problem is solved using diverse approaches (Dennis, 2020). Furthermore, during interview sessions, participants did not speak about how they use EdTech resources in conjunction with whole- class teaching. However, when lesson observations were conducted, teachers demonstrated how they used the available EdTech resources together with whole-class strategy.

The most incorporated EdTech resources during whole- class was the chalkboard. During observations, the researcher noted that all the participants used the chalkboard for instructional purposes such as writing summary notes while teaching. Another EdTech resource that Mr Shandu, Mr Ngidi and Mr Magwaza used for instructional purpose was the OHP which they used for content delivery such as displaying notes that they would refer to as they teach. The textbook was another EdTech resource which was frequently integrated by teachers with the whole class strategy,

though for different purposes. While Mr Ngidi never used it at all, the other participants integrated it to assess learners formatively. Ms Mbatha also used the textbook for visuals where she would teach and show learners pictures to demonstrate certain diagrams or organs. Mithans and Grmek (2020) note that a textbook has a variety of uses. This is evident in how teachers used it for different purposes.

During whole-class teaching, teachers integrated different EdTech resources to give the learners the opportunity to link theory to visuals for a better understanding. Mr Shandu and Mr Ngidi made use of *anatomical models, pictures and videos* which they used OHP and Laptops to project. Both these teachers were from well-resourced schools. Ms Mbatha relied on *charts* for visual and demonstration. Therefore, this suggests that the experiences of teachers from well-resourced schools and under-resourced schools are different and not on the same level. Teachers from well-resourced schools rely more on modern HW resources for visuals which are far more sophisticated than traditional HW resources such as charts. The use of *Anatomical models* gives learners the hands-on experience of learning as they get to physically touch the inner and outer parts of different organs and elements, which is not possible when using a *chart*. This is in line with Yilmaz (2023) maintaining that using models has a significant impact in Life Sciences because it allows teachers to better illustrate and explain certain structural elements both verbally and visually, which helps learners grasp the content better.

It is evident that during whole-class teaching, the participating teachers mostly integrate HW resources. It is also worth noting that their ways of integrating some of these HW resources to teach Life Sciences are almost the same, such as how all participants make use of the chalkboard to write summary notes. Furthermore, the researcher observed that although participating teachers make use of modern HW resources they blend the modern with traditional HW resources. For instance, Mr Shandu was making use of chalkboards as a traditional EdTech resource but would also use the OHP which is a modern EdTech resource.

5.2.4 Theme 4: Integrating EdTech resources to assess content

This theme sought to understand how teachers integrate EdTech resources to assess Life Sciences content. Drawing on the data from the interviews, the participants only seemed to be aware of how they integrated EdTech resources during formative assessments. Moreover, it appears that participants draw from HW resources when assessing formatively. For example, Mr Shandu stated:

“Informally, I use activities that are in the textbook, but not much of them, most of the time I prepare my own activities using previous exam papers, then formally, I assess them through assignments, written tests, and examinations”.

Mr Magwaza stated: *“The designing of activities is always guided by CAPS and examination guidelines, most of the time I create questions using past exam question papers, I also use the activities from the textbook and the revision documents provided by the Department of Education, at times I create questions and write them on the chalkboard especially on specific topics such as Genetics. Still on informal assessments, I design topic tests according to my pace, then we have formal assessments which can be practical examinations, written examinations and test”.*

Mr Ngidi also stated: *“During the learning process I assess learners informally, where I create my own questions so whatever question that comes up in my mind, I ask them or write them on the chalkboard, then after I am done with the lesson, I go to the previous question papers. Formally, I assess them using practicals, tests, exams and assignments”.*

Participants seem to be aware of different types of assessments. For example, they used formative assessment to informally evaluate the learnt content. Formative assessment is an evaluation that is carried out during the teaching and learning to monitor the progress of the learners without grading (Bennett, 2011; Pramesti, 2023). They also make use of relevant and available EdTech resources to support the process of assessing in Life Sciences and appear to use HW resources more when engaging in formative assessments. For instance, Mr Shandu and Mr Magwaza utilised the textbook to formatively assess the learners as they both mentioned that they sometimes give learners activities found in the textbooks. Furthermore, it seems that the use of past examination papers to assess the learners is also prominent in Life Sciences.

During lesson observations, the researcher noted that they compile the questions they gather from past examination question papers into worksheets and then provide the learners with the worksheets to do as class activities or homework. Additionally, it seemed that the chalkboard as an EdTech resource is quite important for informal assessments because Mr. Ngidi and Magwaza discussed using it when assessing informally. They both stated that they create their own questions and then use the *chalkboard* to write them. Even Mr Shandu, when probed further, also mentioned that *“I give learners class activities and when they are done, we do corrections which I sometimes write on the chalkboard or give each individual a chance to write the correct answer on the*

chalkboard". This suggest that these participants came to class with prepared questions and copied them onto the chalkboard for learners to respond to.

5.2.5 Theme 5: Integrating EdTech resources for lesson enrichment

This theme sought to understand the reasons behind teachers using the EdTech resources that they use when teaching Life Sciences. Drawing from the interviews, the participants' responses indicated that teachers use EdTech resources with the purpose of enriching the lessons in different ways. In this regard:

Mr Shandu explained: *"I use EdTech resources because they make understanding of concepts easier; it enables learners to observe while learning is taking place. With resources such models and charts I use them for demonstration. Then with the OHP I am able to display the work that I am teaching to the learners. Also, I use these resources because CAPS highlights and recommends them for practice"*.

Likewise, Ms Mbatha stated: *"Resources enhance my teaching and make me deliver my lessons effectively; so, using technology helps create a clear picture in learners' minds of what is taught so that they understand it better. EdTech resources make it possible for learners to link what is in the textbook to what they can see. In other words, resources provide illustrations for learners to get a better understanding of what is being taught to them. Also, I am guided by CAPS as the major document to use resources."*

Mr Magwaza expressed: *"It is for personal reasons mostly; technology seems to make my lesson more interesting and easier; it attracts learners' attention. With resources, I am able to deliver the subject matter to the learners in a manner that will be easy for them to grasp"*.

Mr Ngidi stated: *"Technology makes things easier, I would say. It even takes learners to the practical part of things in Life Sciences, learners are so much in line and aligned to technology. So, with them instead of basing their focus on theory, the good thing about technology is that at some point you get to watch and listen, which makes things much easier"*.

It is evident in the above responses that all participants use EdTech resources for lesson enrichment as it makes it easier for their learners to understand Life Sciences content. This is supported by Khoza (2021) who asserts that a teacher being in possession of and using EdTech resources can enhance the teaching of their subjects. Furthermore, it appears that all participants viewed the

integration of EdTech resources as an aid to simplify content. For example, Mr Shandu and Ms Mbatha mentioned using *charts* to convey complicated concepts in a simple manner. Moreover, Mr Ngidi mentioned that “*resources take learners to the practical part of things in Life Sciences*”. In other words, using EdTech resources learners are able to physically interact with the topic being learnt about. Although Mr Shandu and Ms Mbatha may be using EdTech for their own reasons, they also draw influence from the curriculum as they both mentioned the use of EdTech resources being directed by CAPS.

5.3 Findings from lesson observations

As the researcher, the researcher observed four different participants from four different high schools. Using various EdTech resources, the four participants delivered different lessons of Life Sciences in different grades. Mr Shandu of Sydney Secondary school presented lessons on plant hormones, and nervous co-ordination in grade 12. Mr Ngidi of Ibutho High presented lessons on Excretion and Gas Exchange in grade 11 and Evolution in grade 12, while, Mr Magwaza of Khuthala Secondary school presented lessons on the Out of Africa Hypothesis and Plant Hormones in grade 12. Lastly, Ms Mbatha of Siyakhula High school presented lessons on Gas Exchange and Excretion in grade 11. Despite teachers teaching the same topics, they approached them differently using different EdTech resources. Although lessons covered different topics, the primary focus was on the EdTech resources they use and how they use them during the teaching of these lessons. Two teachers (Mr Shandu and Mr Ngidi) were observed three times and then the other two teachers (Ms Mbatha and Mr Magwaza) were observed twice. An observation schedule was used to write down the details about the observed lessons (see annexure F).

5.3.1 Mr Shandu’s lesson at Sydney Secondary School: Day 1

The lesson took place in a school located in an urban area, well-structured and with teaching resources. The lesson was conducted in the Science laboratory which was well organised and conducive to the teaching and learning of Life Sciences. Around the laboratory there were sinks, chalkboard, wall charts, overhead projector, old chemicals and apparatus, and models on the sides, some of which had been made by the learners from previous years. There were 25 learners in the lab, each of whom had their own textbook and were seated at their own desk.

The lesson (grade 12) was on nervous co-ordination. The following EdTech resources were used by the teacher during the lesson: model (Eye), prepared notes from different textbooks, overhead

projector, worksheets, chalkboard, and the exam guideline. Mr Shandu taught the lesson using the whole class strategy. He taught his lesson while standing in the front, not moving around. Before beginning his lesson, he posed a few questions to the learners, asking them what they know about the eye, just to get their prior knowledge. Following that, he then projected the prepared notes using the overhead projector; the notes had all the different parts of the eye and their use. He would read what was on the notes then in his words elaborate further. While explaining, he used the model to demonstrate all the parts of the eye that are listed on the notes. During this time, learners sat quietly and showed that they were listening attentively, as they would pose questions, and he would also ask probing questions to the learners.

After the teacher had finished teaching what he had prepared for that day, he distributed a summary of the lesson to the learners that they had to stick in their workbooks. He then used the chalkboard to write a few questions that the learners had to answer in their workbooks. Those questions came from the textbook and past exam question papers. Learners were given a few minutes to complete the activity, and while they were busy writing, the teacher moved around the classroom observing them.

5.3.2. Mr Shandu's lesson at Sydney Secondary School: Day 2:

This lesson was a continuation of the previous one on nervous co-ordination. The following EdTech resources were used by the teacher during the lesson: model (Ear), overhead projector, and a laptop, prepared video, chalkboard, textbook, and worksheet. Mr Shandu taught the lesson using the whole class strategy. He taught his lesson while standing in the front, not moving around. To begin the lesson, he played a video on the auditory senses of a human being, which he projected on the OHP. After the video he then began his lesson on the ear, explaining all the parts of the ear; he used the chalkboard to write the parts of the ear and their definitions.

Mr Shandu would explain each part, write it on the chalkboard and its definition, then come back to explain it further to the learners while demonstrating it using the model. During this time, learners sat quietly and showed that they were listening attentively as they would pose questions, and he would also ask them probing questions. After the teacher had finished teaching what he had prepared for that day, he then gave learners just a few minutes to write the notes that were on the chalkboard in their workbooks. When the learners were done, he instructed them to do an activity that was in their textbooks as classwork, and while they were busy writing the activity, he moved

around the classroom observing and distributing a worksheet which had questions that the learners had to do as homework.

5.3.3 Mr Shandu's lesson at Sydney Secondary School: Day 3:

Still at Sydney Secondary School, the lesson was a Grade 12 one on plant hormones. The following EdTech resources were used by the teacher during the lesson: prepared notes from different textbooks, overhead projector, worksheets, chalkboard, and the exam guideline. Mr Shandu taught the lesson using the whole class strategy. He taught his lesson while standing in the front, not moving around. Before beginning his lesson, he posed a few questions to the learners just to get their prior knowledge. Following that he then projected the prepared notes using the overhead projector. He would read what was on the notes then in his own words elaborate further. During this time, learners sat quietly and showed that they were listening attentively, as they would pose questions, and he would also probe the learners with further questions.

After the teacher had finished teaching what he had prepared for that day he then distributed to the learners the worksheet he had brought with him. The worksheet had three activities and learners were instructed to do the first activity as classwork and the last two activities as homework. Learners were given a few minutes to complete the activity, and while they were busy writing, the activity the teacher moved around the classroom observing them, and once the corrections were done, in which learners would verbally give answers, the teacher would write them on the chalkboard. He reminded the learners to complete the rest of the activities as homework.

5.3.4 Analysis of the observed lessons

The lessons observed revealed that Mr Shandu utilises EdTech resources in his teaching of Life Sciences and makes good use of HW resources. In his teaching, Mr Shandu had different activities planned out and utilised different EdTech resources to support them. For example, for the whole class method the teacher integrated different HW resources. The use of HW resources aligns with the Connectivist idea that learning can happen not only just by human interaction but also through technology (Handabura, 2020). Moreover, when he switched to assessing he also had HW resources planned to use. Therefore, it is evident that Mr Shandu does integrate EdTech resources when he teaches Life Sciences. It is also evident that Mr Shandu during these lessons played different roles. He was both an instructor and an assessor. It was evident that he was an instructor

when he conducted the lesson himself and played his role as an assessor when he gave learners classwork.

5.3.5. Mr Ngidi's lesson at Ibutho High School: Day 1

Mr Ngidi's school is located in a township. The school has adequate infrastructure. The lesson took place in an old unmaintained laboratory. The classroom had 42 learners, and they shared desks in pairs, but each learner had their own textbook. The teacher used the following EdTech resources for the lesson: chalkboard and notes in the form of a worksheet.

Using the whole class strategy, Mr Ngidi began the lesson by introducing the new topic, which was a grade 11 one on Excretion. He then posed a few questions to get learners' background knowledge on excretion. The teacher then began his lesson, defining terms and writing the definitions on the chalkboard. He continued teaching. He did not pose questions to the learners and no questions were asked by the learners. While teaching, Mr Ngidi kept reminding the learners of the definition of excretion. All the important words were written on the chalkboard. The teacher then distributed worksheets to the learners and asked them to look at the diagram of what was taught. In the worksheet there were also questions, a few of which they discussed as a class. Then the rest of the questions the learners did as a class activity. While learners were busy with the activity the teacher walked around the class observing. Learners were not given any homework.

5.3.6. Mr Ngidi's lesson at Ibutho High School: Day 2

This lesson was on Evolution (grade 12). The following EdTech resources were used by the teacher during the lesson: chalkboard, slides, laptop and overhead projector, and worksheets. Mr Ngidi taught the lesson using the whole class strategy. He began the lesson by testing their prior knowledge. He asked the learners questions on grade 10 work, reminding them about History of Life, Fossils and how Fossils are determined and what kind of reading do they use. Only a few learners answered the questions. Mr Ngidi then gave them a short summary just to awaken their memory and to enable them to link that work with the topic they were doing that day.

Mr Ngidi then further explained to the learners what Evolution is and the important aspects of Evolution and made a few examples. While explaining he also wrote the summary on the chalkboard. He then connected his laptop to the OHP and projected the prepared slides. In the slides there were pictures that showed the two different theories of Evolution. While showing the

pictures to the learners he also explained what the picture meant, linking it to the two theories. As he did that, he also wrote on the chalkboard.

After completing the lesson, the teacher then distributed five worksheets in each of which there were two activities. The first four activities they did together in class, as some sort of discussion and then the rest of the activities were given to learners as homework.

5.3.7 Mr Ngidi's lesson at Ibutho High School: Day 3

This lesson was a grade 11 one on Gas Exchange. The following EdTech resources were used by the teacher during the lesson: exam guidelines, printed notes, two models (Skeleton and upper body model), and the chalkboard. Using whole-class teaching, Mr Ngidi began his lesson by posing a few questions to the learners to get their background knowledge on the topic.

Following that, the teacher asked learners to open their printed notes and then he started teaching. He would teach and make reference to the printed notes, which had some diagrams. He also used the chalkboard to write certain terms and their meanings. He then moved on to explaining some of the organs that are involved in gas exchange and demonstrated those organs using the upper body model brought to class. To explain organs that are not visible on the model, he would draw them on the chalkboard.

Mr Ngidi would teach and then open the floor for learners to ask questions, but before answering he would first allow the other learners to respond to them and thereafter, he would intervene. The lesson ended before he could finish, which meant that learners did not get to do any activity in class. However, they were given homework that was taken from the exam guidelines.

5.3.8. Analysis of the lesson observed

Mr Ngidi's lesson was dominated by traditional HW resources. This is evident in the use of chalkboard and worksheets throughout the lessons. It appears that Mr Ngidi when using the above-mentioned EdTech resources sticks to the whole class strategy.

5.3.9 Ms Mbatha's lesson at Siyakhula High School: Day 1

The lesson took place in a school located in a rural area, without sufficient teaching resources. The lesson was conducted in an overcrowded classroom of 74 learners sharing a two-seater desk in 3s. Inside the classroom there was only one EdTech resource, the chalkboard. The classroom was so overcrowded that the teacher could not move around, and the noise level was uncontrollable.

The lesson was a grade 11 one on Gas Exchange. The following EdTech resources were used by the teacher during the lesson: exam guidelines, textbook, and the chalkboard. Ms Mbatha was another teacher who taught the lesson using the whole class strategy. For her, circumstances were not allowing her to switch to another method, as there were too many learners. Ms Mbatha also taught her lesson while standing in the front. She began her lesson by instructing the learners to take out their textbooks. The textbooks were not enough for every learner to get their own, so they shared in pairs. To begin her lesson, she posed a few questions to the learners to get their background knowledge on the topic.

Following that the teacher asked learners to open their textbooks and then she started teaching, but as she was teaching, she had very limited space to move. She would teach and refer to the textbook for diagrams. She also used the chalkboard to write certain terms and their meanings. The chalkboard was not large enough, with some parts broken, as she had to write and erase because of space. She then moved on to explaining some organs of the organs involved in gas exchange and demonstrated those organs using the visuals from the textbooks which were not clear. Ms Mbatha had to constantly ask learners to keep quiet; there were times when she would stop teaching so that they would keep the noise down. Learners were given some time to do an activity which was obtained from the exam guideline.

5.3.10 Ms Mbatha's lesson at Siyakhula High School: Day 2

The second lesson observed was on Excretion (grade 11). The following EdTech resources were used by the teacher during the lesson: textbook, chalkboard and chart. Ms Mbatha taught the lesson using the whole class strategy. She taught her lesson while standing in the front, not moving around. To begin her lesson, Ms Mbatha posed a few questions to the learners just to get their prior knowledge. She posed questions that would take learners back to their grade 10 work.

Following that, she then started teaching. She defined what Excretion is and wrote the definition on the chalkboard. Moving forward, she explained all the organs involved during Excretion and how they are involved and would write on the chalkboard. After that, she took out the chart, she had brought to the class that showed all the organs involved in Excretion and their labelling. The chart was passed round to all the learners to observe carefully. After she had finished teaching, she gave the learners an activity to do, which was in their textbooks. While they were busy writing,

she stood by the door observing them. When they had finished, they made corrections which Ms Mbatha used the chalkboard to write the answers.

5.3.11. Analysis of observed lesson

The environment that Ms Mbatha teaches in is not conducive. First of all the school does not have a Science Laboratory, so they are forced to conduct their lessons in the classroom. Even in that classroom, there is not enough space to enable the teacher to adopt different strategies, such as group discussions, hence she sticks to whole class teaching. Regardless of these challenges, she still uses EdTech resources, and it appears that she uses traditional HW resources.

5.3.12 Mr Magwaza's lesson at Khuthala Secondary School: Day 1

Mr Magwaza's school is in the deepest rural area with a poor infrastructure and a lack of the necessary teaching resources. The lesson was conducted in a classroom with broken windows and desks. The learners shared the desks seated in pairs. Although the school's enrolment is very low, Mr Magwaza had an overcrowded class as there were 52 learners when the researcher came to observe. Inside the classroom there were no EdTech resources except for the chalkboard.

The EdTech resources that were used were the following: chalkboard, textbook, overhead projector and a laptop. The teacher began the lesson by doing corrections for the homework which they had been given the previous day. Learners responded verbally and he would write the answers on the chalkboard. After corrections were done, Mr Magwaza then began the lesson on the Out of Africa Hypothesis. He posed a few questions to obtain learners' background knowledge on the topic. The teacher then continued teaching while learners sat quietly and listened. He taught learners while having some notes displayed on the overhead projector using the laptop (which he said were his personal resources). As he was teaching, he would use the chalkboard to explain some terms. After the lesson was concluded, learners were given a few minutes to do an activity which was obtained from the textbook. Learners share these textbooks in pairs. Upon completing the activity, the teacher then gave learners a question to discuss in pairs and each duo was given time to share their answers. The teacher taught the lesson while standing in front the entire time and used the whole class teaching method. Learners were given homework from the textbook.

5.3.13. Mr Magwaza's lesson at Khuthala Secondary School: Day 2

The EdTech resources that were used in Mr Magwaza's grade 12 lesson on Plant Hormones were the following: chalkboard, exam guidelines, and the textbook. The teacher began the lesson by

obtaining background knowledge from the learners, which he did by creating a few scenarios verbally and thereafter posing a few questions. Following that Mr Magwaza then started teaching Plant Hormones. He continued teaching while learners sat quietly and listened. Mr Magwaza would teach and write key concepts on the chalkboard with their definitions. While he wrote on the chalkboard, learners would write notes in their workbooks.

After the lesson was concluded, learners were given a few minutes to do an activity that was obtained from the textbook. Learners share these textbooks in pairs. Learners did not complete the work in class, and they were instructed to complete it at home with additional work that was obtained from the exam guidelines.

5.3.14. Analysis of the lesson observed

Mr Magwaza's school was in a very poor area, and lacked many EdTech resources, particularly the modern EdTech resources. Only the chalkboard and the textbooks belonged to the school, but the modern EdTech resources such as the OHP and laptop he used to teach Life Sciences belonged to him. Although Mr. Magwaza used the whole class strategy in one of his lessons, the researcher saw him transition to the group work approach. However, no EdTech resources were used during that time.

5.4 Chapter summary

This chapter presented the study's findings. The findings resulted from the analysed data generated from semi-structured interviews and observations of four participants teaching Life Sciences. The findings were analysed and discussed according to the themes that emerged. The chapter began by providing a table-based overview of the data analysis process. After that, the data was analysed and presented in five themes. Additionally, the chapter discussed the findings of two participants' three lesson observations and the other two participants' two lesson observations. The chapter also analysed the findings of each participant's lesson observations.

CHAPTER 6

SUMMARY, RECOMMENDATIONS AND CONCLUSION

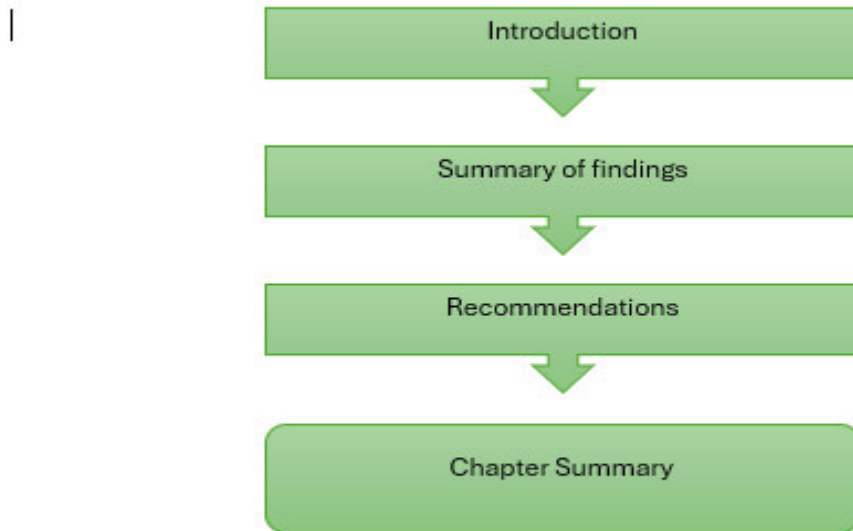


Figure 6.1: A flow chart showing the structure of chapter 6

6.1 Introduction

The findings that emerged from this study have been discussed in the previous chapter. This chapter presents the summary of findings, conclusions and recommendations. The chapter begins with a summary of the findings in relation to the three key research questions. This is followed by an overall summary of the findings. Additionally, the chapter will list three recommendations. Lastly, the chapter will conclude with the chapter summary.

6.2 Summary of findings

This section provides the summary of findings that were generated in chapter five of the study following the five themes that emerged. The findings are summarised following the three research questions of the study.

Key Research Question 1: What educational technology resources are teachers integrating in the teaching of grades 10-12 Life Sciences?

The findings reveal that teachers are more invested in hardware resources when teaching Life Sciences because all the participants stated that they integrate a good deal of them in comparison to other types of EdTech resources. The findings reveal that the hardware resources that teachers attested to using is a combination of both modern and traditional hardware resources. It is also worth noting that teachers are knowledgeable about similar hardware resources (OHP, textbooks, models, and charts) as they mentioned the same hardware resources when teaching Life Sciences. From the findings the cellphone was the only different hardware resource that only teachers from well-resourced schools used. While the findings reveal a number of hardware resources software resources were also integrated by teachers in teaching of Life Sciences, though in a minimal manner. The findings further revealed that the use of software resources depended on the school context, with teachers from well-resourced schools being exposed to much more advanced software resources such as websites and WhatsApp.

Key Research Question 2: How do teachers integrate educational technology resources in teaching grades 10-12 Life Sciences?

According to the findings, teachers integrate EdTech resources but are unable to explain how they use them. This was evidenced by the fact that when they were asked how they integrate EdTech resources into the teaching of Life Sciences, they only described how they teach the subject rather than how they operate the EdTech resources. It was discovered that due to their particular situations, teachers rely more on whole-class teaching. How teachers use EdTech resources to teach Life Sciences in conjunction with whole class teaching was clarified through lesson observations. The findings further showed that several EdTech resources are integrated according to their intended use. For example, the OHP was used to display notes or pictures, and the chalkboard was used to write key points. Additionally, the findings showed that teachers share a common knowledge of how to use EdTech resources such as the OHP and chalkboard because they all use them for the same educational goal while delivering Life Sciences content. However, the findings showed that each teacher used textbooks differently, depending on their needs and reasons. For example, two participating teachers used it only for assessing while one teacher used it for both assessing and visuals. Furthermore, there was a difference in how teachers use EdTech

resources for visuals and demonstration. While under-resourced schools depended on more traditional EdTech resources, including textbooks and charts, well-resourced schools appear to use modern EdTech resources, like anatomical models. Findings further revealed that teachers use EdTech resources to formatively assess learners in the Life Sciences. For instance, findings showed that teachers assign homework and class activities using worksheets. Similarly, textbooks appeared to serve the same purpose as worksheets; the main distinction was that textbook activities were not used as often. However, the chalkboard appeared to serve a different purpose, for noting down unplanned activities.

Key Research Question 3: Why are teachers integrating educational technology resources in the teaching of grades 10-12 Life Sciences the way that they do?

The findings reveal that more than anything the integration of EdTech resources is mainly to improve the teaching and learning process in Life Sciences lessons. However, findings also revealed that some teachers were integrating EdTech resources because they are a requirement in the Life Sciences policies such as CAPS. For instance, two teachers revealed using EdTech resources as prescribed by the CAPS curriculum which is currently implemented in South African schools.

6.2.1 Conclusion based on the findings

In conclusion, this study found that teachers teach Life Sciences mostly using the whole-class teaching approach while integrating both hardware and software resources. Although teachers are integrating hardware and software resources, they are found to be drawing on similar resources. In addition, the study also found that teachers do assess using EdTech resources, but they mostly make use of hardware resources to formatively assess Life Sciences content.

6.3 Recommendations

This section provides three recommendations based on the study findings. These recommendations are made for teaching practice and future research.

6.3.1 Recommendation 1

It was notable from the findings that teachers were integrating similar hardware and software resources such as the OHP, textbooks, laptops, charts, videos, WhatsApp and anatomical models. The study recommends that the Department of Education design workshops that will equip Life

Sciences teachers with the necessary knowledge of other hardware and software resources which can expand teachers' knowledge of these different resources.

6.3.2 Recommendation 2

Since the study findings show that there is an imbalance in the integration of modern and traditional EdTech resources in the well-resourced schools and under-resourced schools, the study recommends that the Department of Basic Education provides the under-resourced schools with modern EdTech resources such as anatomical models, OHP, and computers so that they reap the same benefits as well-resourced schools. Furthermore, it is recommended that schools and Life Sciences teachers look for sponsors that may provide them with the necessary EdTech resources for teaching.

6.3.3. Recommendation 3

This study was based on the integration of EdTech resources in the teaching of Life Sciences. The findings revealed that there were EdTech resources that were used in well-resourced schools and not in under-resourced schools, so this study recommends that further studies be conducted on the integration of EdTech resources using a larger sample and including other districts contexts. Future studies can also include teachers from different subjects to explore their knowledge and integration of EdTech resources.

6.4 Chapter summary

In this chapter, the summary of findings, conclusions and recommendations have been discussed. The chapter began by presenting a summary of the findings according to the three key research questions. Additionally, the chapter also listed three recommendations according to the study findings. The findings reveal that teachers integrate EdTech resources but mostly hardware resources and they do so in whole class teaching for personal reasons depending on their classroom environment and available EdTech resources.

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ANNEXURES

Annexure A: Consent letter

CONSENT LETTER FOR TEACHERS

Title of the study: Integration of educational technology resources in the teaching of grades 10-12 Life Sciences.



Curriculum Studies,
School of Education,
College of
Humanities,
University of
KwaZulu-Natal
Edgewood Campus
17 October 2023

Dear Teacher

INFORMED CONSENT LETTER

My name is Zothani Minenhle Thela. I am a Masters candidate at the University of KwaZulu-Natal, Edgewood Campus, School of Education. This letter serves to invite you to be part of the research study I am conducting for my Master's degree in the Department of Curriculum studies, under the supervision of Dr CB Mpungose. The title of my research is integration of educational technology resources in the teaching of Grades 10-12 Life Sciences.

In the world that is led by the new development of technology, teaching of different subjects constantly forces teachers to use educational technology resources daily to enhance their lessons. The main purpose of the study is to explore the integration of educational technology resources in the teaching of grades 10-12 Life Sciences.

The study further intends to achieve the following objectives:

- a) To explore teachers' integration of educational technology resources in the teaching of grade 10-12 Life Sciences.
- b) To understand how teachers integrate educational technology resources in the teaching of grade 10-12 Life Sciences.
- c) To understand why teachers integrate educational technology resources the way they do in the teaching of grade 10-12 Life Sciences.

You are invited to please participate in the study because you are a Life Sciences teacher who has taught Life Sciences for more than five years. Should you agree, your participation in the study will include reflective activities, where I will ask you to reflect on your experiences in using educational technology resources in teaching Life Sciences for the past five or more years. Furthermore, I will ask for one lesson to observe as you teach Life Sciences just to see how the educational technology resources are used in teaching Life Sciences. I will also ask you some questions in a one-on-one interview, that will take an hour or less in duration. The date and time will be negotiable to ensure that it does not affect your duties.

This study has been ethically reviewed and approved by the UKZN Humanities and Social Sciences Research Ethics Committee.

Please take the time to read the following information carefully.

- You are given a choice to participate or not participate in this study.
- The interview may last for 60 minutes. Reflective activity will be sent to you via email.
- Confidentiality is guaranteed as your input will be generated in person and data will be stored in a secured storage and kept confidential.
- When reporting findings, pseudonyms (false name) will be used instead of your full real name (e.g., Mr Shandu).
- Your involvement is purely for academic purposes, there are no financial benefits for you.
- You are free to withdraw from the research at any time, without any consequences.

- If you are participating in the interview session, please indicate (by ticking) whether you agree to the audio recording of the session.

Thank you

Yours sincerely

Zothani Minenhle Thela

Please contact the researcher if there is anything that is not clear or if you need more information.

Researcher's contact details:

Zothani M. Thela

Email address: 215037581@stu.ukzn.ac.za

Cell phone: [REDACTED]

My supervisor is Dr Cedric Bheki Mpungose. He is located at the School of Education, Edgewood Campus of the University of KwaZulu-Natal.

Supervisor's contact details:

Dr Lerato Sokhulu

Email address: sokhulul@ukzn.ac.za

Cell phone: 031 260 3549

You may also contact the Research Office at:

University of KwaZulu-Natal

Humanities and Social Sciences Research Ethics

Govan Mbeki Centre

Tel +27312604557

Email: HSSREC@ukzn.ac.za

Thank you for your contribution to this research study.

DECLARATION OF CONSENT

I (Full name of the participant) hereby confirm that I have been informed about the study titled ‘Integration of Educational Technology Resources in the Teaching of Grades 10-12 Life Sciences’ by Zothani Minenhle Thela. I understand the contents of this document and the nature of the research project, and I consent to participate in the research project.

- I understand the purpose and procedures of the study.
- I have been given an opportunity to ask questions about the study and have had answers to my satisfaction.
- I declare that my participation in this study is entirely voluntary and that I may withdraw at any time without negative consequences.
- I voluntarily give permission for the interviews to be audio-recorded.
- My identity will not be disclosed, and pseudonyms will be used to protect my identity.
- If I have any further questions/concerns or queries related to the study, I understand that I may contact the researcher at:

Zothani. M Thela

Email address: 215037581@stu.ukzn.ac.za

Cell phone: [REDACTED]

- If I have any questions or concerns about my rights as a study participant, or if I am concerned about an aspect of the study or the researcher, then I may contact:

University of KwaZulu-Natal

Humanities and Social Sciences Research Ethics

Govan Mbeki Centre

Tel +27312604557

Email: HSSREC@ukzn.ac.za

Additional consent

- I am willing to be part of the project interviews. I am also willing to allow recording by the following equipment:

Instrument	Willing	Not willing
Audio recording		

NAME OF PARTICIPANT

.....

SIGNATURE OF PARTICIPANT

.....

DATE

.....

Annexure B: Reflective Activity**REFLECTIVE ACTIVITY**

This Reflective Activity is about the integration of educational technology resources in the teaching of Grades 10-12 Life Sciences. You may use various sources to complete this activity.

Why do you integrate educational technology resources when you teach Life Sciences?

Towards which goals are you using the educational technology resources to teach Life Sciences?

With what resources do you teach Life Sciences?

How are learners assessed in Life Sciences using EdTech resources?

What is taught in Life Sciences lessons using EdTech resources?

How are Life Sciences lessons conducted when using educational technology resources?

How do you facilitate the teaching of Life Sciences using educational technology resources?

Where do you hold your Life Sciences lessons?

How do you design your teaching and learning activities when you teach Life Sciences using EdTech resources?

What is the time allocation for Life Sciences subject or lessons? When do you hold the Life Sciences lessons when you integrate educational technology resources?

Annexure C: One-on-one interview guide questions

Integration of Educational Technology Resources in the teaching of Grades 10-12 Life Sciences.

- What grades do you teach?
- Tell me about your experience in teaching Life Sciences.
- Tell me about your qualification (s).

Question 1: Why do you integrate educational technology resources when you teach Life Sciences the way you do?

Sub- questions:

- 1.What personal rationale/reason that makes you integrate EdTech resources?
- 2.What professional rationale/reason makes you integrate EdTech resources?
- 3.What social rationale/reason that make you integrate EdTech resources?

Question 2: With what resources do you teach Life Sciences?

Sub- questions:

- 1.What software resources do you use when teaching Life Sciences?
- 2.What hardware resources do you use when teaching Life Sciences?
- 3.What ideology resources do you use when teaching Life Sciences?

Question 3: How are your Life Sciences lessons done using EdTech resources? And what EdTech resources you use to support the process?

Sub-question: Are you lessons conducted one-on-one? Whole class? Or small group?

Question 4: Towards which goals are you teaching Life Sciences using EdTech resources?

Sub- questions:

- 1.What are your aims for integrating EdTech resources to teach Life Sciences?
- 2.What are the objectives of integrating EdTech resources in the teaching of Life Sciences?
- 3.Indicate learning outcomes of integrating EdTech resources in the teaching of Life Sciences.

Question 5: What is taught in Life Sciences lessons?

Sub- question Is it personal content, formal content or informal content? Please elaborate.

Question 6: How do you design your teaching and learning activities using EdTech resources?

Sub- questions:

1. Teacher-centred activities
2. Content-centred activities
3. Learner-centred activities

Question 7: How do you facilitate your own teaching during the teaching of Life Sciences?

Sub- question:

1. Is your role a researcher, instructor or facilitator when integrating EdTech resources to teach Life Sciences?

Question 8: Where do you hold your Life Sciences lessons?

Sub- questions:

1. Online platform, substantiate which platform
2. In the classroom (face to face interaction)?
3. Blended learning

Question 9: When do you hold the Life Sciences lessons?

Sub- questions:

1. During your own personal time
2. During school times
3. Both during school times and your personal time
4. On weekends only

Question 10: How do you assess learners in Life Sciences using EdTech resources?

Annexure D: Ethical Clearance



02 September 2024

Zothani Minenhle Thela (215037581)
School of Education
Edgewood Campus

Dear ZM Thela,

Protocol reference number: HSSREC/D0006411/2023

Project title: Integration of educational technology resources in the teaching of Life Sciences

Amended title: Integration of educational technology resources in the teaching of grade 10-12 Life Sciences

Degree: Masters

Approval Notification – Amendment Application

This letter serves to notify you that your application and request for an amendment received on 30 August 2024 has now been approved as follows:

- Change in title
- Change in supervisor

Any alterations to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form; Title of the Project, Location of the Study must be reviewed and approved through an amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

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

Best wishes for the successful completion of your research protocol.

Yours faithfully



Professor Dipane Hialele (Chair)

/nng

Humanities & Social Sciences Research Ethics Committee
UKZN Research Ethics Office Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Tel: +27 31 260 8350 / 4557 / 3587
Website: <http://www.ukzn.ac.za/research-ethics/>

Founding Campuses: ■ Edgewood ■ Howard College ■ Medical School ■ Pietermaritzburg ■ Westville

INSPIRING GREATNESS

Annexure E: Gatekeepers Letter



KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

OFFICE OF THE HEAD OF DEPARTMENT

Private Bag X9137, PIETERMARITZBURG, 3200
Anton Lembede Building, 247 Burger Street, Pietermaritzburg, 3201
Tel: 033 392 1051

Email: buyi.ntuli@kzndoe.gov.za

Ref. 2/4/8/7599

Miss Zothani Minenhle Thela



Lane

Dear Miss Thela

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **"INTEGRATION OF EDUCATIONAL TECHNOLOGY RESOURCES IN THE TEACHING OF GRADE 10 -12 LIEFE SCIENCES."**, in the KwaZulu-Natal Department of Education institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from the **11th October to 31st December 2025**.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Mrs Buyi Ntuli at the contact numbers above.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report/dissertation/thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.



Head of Department: Education

Date: 11th October 2023

Annexure F: Lesson Observations Schedule

Project title:

Integration of Educational Technology Resources in the teaching of Grades 10-12 Life Sciences

The focus will be on observing the type of EdTech resources teachers use when teaching Life Sciences and how they use these EdTech resources to support their lessons.

1. General information

Name of the school		Date of observation	
Teacher's name			No. of learners
Topic			

2. School context (brief description of the school):

3. Types of resources used:

4. Content delivery and resources used and how:

Annexure F: Turnitin Report

Feedback Studio - Google Chrome
 ev.turnitin.com/app/carta/en_us/?u=1051610723&lang=en_us&student_user=1&o=2546589960&ro=103

feedback studio ZOTHANI THELA Integration of Educational Technology Resources in the teaching of Grade 10-12 Life Sciences.docx

1.1 Introduction

This chapter discusses the synopsis of the study to provide a brief insight into how the study has been conducted. The chapter begins by laying out the background and context of the study. Further to that the chapter highlights the problem statement, discusses the rationale and the significance of the study. The location in which the study was conducted is provided. Moreover, the chapter further explains the purpose of the study and stipulates the research questions and objectives that guided the study. A brief description of the methods employed to conduct the study is also discussed. Additionally, the chapter briefly discusses the ethical principles addressed by the study and concludes with a brief overview of the chapters.

1.2 Background and context of the study

According to Shah (2022) as we live in the 21st era, the digital age, everything has changed, even including how we live, work and think. To the extent that technology has emerged as a significant force of change that has exposed children to the world of

Match Overview

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Annexure G: Confirmation letter from the editor



Date: December 19th 2024

To Whom It May Concern

I am writing to confirm that the dissertation entitled
**Integration of Educational Technology Resources in the Teaching of Grade
 10-12 Life Sciences**

by

Zothani Minenhle Thela

Supervisor:

Dr. Lerato Hlengiwe Sokhulu

has been edited for English language grammar, spelling and usage.

N.B. This letter is issued on the understanding that all corrections and amendments recommended, all anomalies and omissions highlighted, and all clarifications and reformulations requested have been addressed by the candidate to the satisfaction of the supervisor.

