Exploring Life Sciences Educators' Enactment of Resource-based Teaching in Three Rural Secondary Schools in South Africa-A Case Study

By

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Declaration

I, **Sindile Mahambehlala** declare that:

i. The research report entitled, "Exploring Life Sciences Educators' Enactment of resource-based teaching in Three Rural Secondary Schools in South Africa-A Case Study", except where indicated, is my original work.

ii. The thesis has not been submitted for any degree or examination at any other university.

iii. This thesis does not contain another person's writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then;
   a) Their words have been re-written but the general information attributed to them has been referenced;
   b) Where their exact words have been used their writing has been placed inside quotation marks, and referenced.

iv. The work described in this thesis was carried out in the school of Education, University of KwaZulu-Natal from April 2016 to June 2019 under the supervision of Dr. T. Chirikure.

v. Ethical clearance No. HSS/0255/017M was granted prior to undertaking the research.

Signed………………………………………………………. Date: 30 September 2019

As the candidate's supervisor, I, Dr. Tamirirofa Chirikure, agree/do not agree to the submission of this thesis.

Signed…………………………………………………. Date: 30 September 2019

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Ndiswele imilomo eliwaka yokubonga Thixo wentaba yase Ziyoni.

“Ingubo yengqondo yimbeko”

Dedication

This document is dedicated to my late parents; my mother Siphokazi Jeannette Mahambehlala and my father, Vuyani Hamilton Bolosha.

List of abbreviations

DoE	: Department of Education
ECDoE	: Eastern Cape department of education
ICT	: Information and Communication Technology
IKS	: Indigenous Knowledge Systems
NLM	: Nyandeni Local Municipality
ORTCD	: Oliver Reginald Tambo Coastal District
PCK	: Pedagogical Content Knowledge
RBT	: Resource-based teaching
RBTE	: Resource-based teaching environment
SMT	: School Management Team
ZPD	: Zone of Proximal Development

Abstract

The purpose of the study was to explore Life Sciences educators' enactment of resource-based teaching. Resource-based teaching refers to the use of teaching and learning resources by educators to mediate the subject curriculum. This study was prompted by the persisting poor performance of Life Sciences learners in the OR Tambo Coastal District and in South Africa at large. To answer the research questions, a qualitative case study was conducted. Six Life Sciences educators from three rural secondary schools in the Eastern Cape were purposively sampled. Two educators were chosen from each school. Data were generated through semi-structured one-on-one interviews, questionnaires, lesson observations and the analysis of documents. The data were later transcribed and analysed to isolate salient themes. The participants understood a resource as a teaching material whereas resource-based teaching was understood as a teaching strategy. It also emerged that Life Sciences educators enacted resource-based teaching through the use of interactive teaching aids, practical work, relevant technology, and resource persons. The participants' enactment of resource-based teaching was mainly influenced by various factors such as resource availability, the participants' understanding of resource-based teaching, and technical competence. It is concluded that the participants had a limited understanding of RBT and their enactment of RBT was very basic. Therefore, it is recommended that universities should expose pre-service educators to the use of traditional and unconventional resources, including modern teaching technologies. The researcher further recommends that educators should make use of the readily accessible natural ecosystems in their surroundings to mediate the Life Sciences curriculum and spark learners' passion for science.

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CHAPTER 1
INTRODUCTION

This was an exploratory study of Life Sciences educators' enactment of resource-based teaching (RBT) in three rural secondary schools in the Eastern Cape province of South Africa. The background, focus and purpose of the study, rationale, significance, research aims and the key questions of this study are highlighted in this chapter. Finally, the chapter presents the structural outline of the whole thesis.

1.1 Background to the Study

In the year 2012, the Department of Basic Education (DBE) introduced the Curriculum and Assessment Policy Statement (CAPS) in Grade 8 as a new curriculum meant to improve on the preceding National Curriculum Statement (NCS). Studies identified variations and inconsistencies owing to reform in the curriculum at three levels, the national, provincial, and the classroom level (Carl, 2012; Rogan & Grayson, 2003). Educators are responsible for enacting the curriculum at the most practical level, the classroom (DBE, 2011).

Studies show that educators are faced with persisting challenges during the enactment of the curriculum in the classroom (Crujeiras & Jiménez-Aleixandre, 2013; Njoku & Njoku, 2015). Rogan and Grayson (2003) identify a variety of factors that perpetuate poor implementation of the curriculum (such as Life Sciences curriculum) in developing countries, including South Africa. Lack of creativity, poor technical expertise of educators, shallow understanding of educational pedagogy, and a dearth of educational resources in schools were identified amongst factors inhibiting successful curriculum enactment (Mligo, 2018; Rumahlatu, Huliselan, & Takaria, 2016; Simmons & MacLean, 2018). In South Africa, there seem to be an overemphasis of the desired educational change and a neglect of the way that curriculum change is enacted in the classroom (Bantwini, 2009).

The South African government is doing a lot to resource schools and improve the quality of science teaching and learning to meet the country's need for skilled personnel. The Department of Basic Education (DBE) and non-governmental organisations (NGOs) are spending a lot of money by pumping material resources such as Science laboratories, smart boards, tablets, and Wi-Fi into schools for the teaching of Life Sciences (Orija, 2008). The use of resources supports the constructivist teaching and learning as emphasised in the Life Sciences CAPS. Constructivist teaching and learning approaches are thought to enhance conceptual understanding, and resulting in better performance of learners. The performance of the Eastern Cape matric learners in Life Sciences has been disappointing over the years as reflected on Table 1 below.

In the years 2015, 2016 and 2017, the Eastern Cape Province has consistently been the worst performing province in the South African National Senior Certificate (NSC) examinations followed by Limpopo province. The overall provincial pass rate has been below 70% for the three years (DBE, 2018). The NSC Life Sciences performance over the past three years (2015-2017) also shows a pass rate below 70% (Table 1).

Table 1
A summary of the Eastern Cape provincial Life Sciences pass rate

Year	**2015**	**2016**	**2017**
Number wrote	49 672	50 142	44 386
Number passed	29 753	30 932	30 412
Percentage passed	59.9%	61.7%	68.5%

The Oliver Regional Tambo Coastal District (ORTCD) was one of the densely populated districts in terms of Life Sciences enrolments in the Eastern Cape over the abovementioned three-year period. The district possibly greatly contributed to the recorded slight increase of 8.6% pass rate over the three-year period (Table 2).

Table 2

A summary of the ORTCD Life Sciences pass rate

Year	**2015**	**2016**	**2017**
Number wrote	6 714	7 492	6 058
Number passed	3 592	3 769	3 922
Percentage pass	53%	50.3%	64.7%

A low pass rate in Life Sciences discourages potential learners from studying the subject as they opt for the Social Sciences and Commercial subjects (DBE, 2018). It seems school Science has failed to excite and attract many learners in the world. The European Industrial Research Management Association (EIRMA) reports a decline of young people pursuing Science (EIRMA, 2009). Given that a few learners study Life Sciences in high school, fewer will pass well enough to be enrolled at tertiary institutions. There is also a widely-reported dropout rate at tertiary level as first year students seemingly fail to cope with the demands of learning at that level (Sjøberg & Schreiner, 2005). The Centre for Development and Enterprise report that this impacts on the country’s effort to address the scarcity of human resources in the fields of Medicine, Agriculture, and others that have Life Sciences as a prerequisite (CDE, 2007).

My interest in RBT was initially triggered in 2016 when I was working in the Limpopo province. I observed that educators were not aware of resource-based teaching. Educators taught Life Sciences using traditional teaching resources that do not fully encourage learner flexibility and autonomy such as textbooks and chalkboards. I also noted that Life Sciences educators in rural schools that were characterised by scarce and inadequate resources were reluctant to go an extra mile and design teaching materials and resources for their learners. Educators were also not willing to improvise and use unconventional resources in their teaching of Life Sciences for the benefit of the learners. They relied on the resources provided by the government. Thus, they did not integrate creativity into their lessons through the use of improvised teaching materials and modern teaching technologies as suggested in the Life Sciences CAPS. I was, therefore, convinced that educators might not be having a full grasp of RBT.

Lastly, when I reviewed literature prior to me undertaking this study, I discovered that high school learners complain that Life Sciences is boring, have no bearing on their aspirations, and is overloaded with too much information that must be memorised (Cimer, 2012). Other learners claim that Life Sciences topics are difficult and the subject is divorced from their life experiences (Ihejiamaizu, Ukor, & Neji, 2018). This necessitates a teaching strategy such as RBT to enhance the teaching and learning of Life Sciences and promote positive learning experiences for Life Sciences learners. Therefore, a proper enactment of RBT by Life Sciences educators may lead to better performance of Life Sciences in ORTCD and the Eastern Cape at large. In addition, more black learners may do Life Sciences in high school, which could ultimately lead to the elimination of the critical skills shortage in Medicine, Veterinary sciences, Agriculture, and other sectors.

1.2 Focus and purpose of the study

The focus of this study was to explore Life Sciences educators' enactment of resource-based teaching in their classrooms.

1.3 Significance of the study

This study focused on the way Life Sciences educators enacted RBT in their lessons in rural schools. Emphasis was on how they used resources to teach Life Sciences. Educators' reflections and observations made during their teaching of the subject were projected to have potential to help to throw light on the general understanding of RBT as a teaching strategy and how they enact it. This study also reveals gaps and shortcomings that inhibit educators' enactment of RBT in their lessons.

The findings of this study will add to existing literature on the subject in South Africa. In addition to Life Sciences educators, other beneficiaries of the findings of this study could be Departmental Officials and policy makers who might craft policies aimed at improving Life Sciences educators' effectiveness. Programme developers and planners of professional development initiatives for Life Sciences educators may be guided by the reflections of educators that participated in this study. The current study might also help in identifying those resources that are perceived as of great benefit to the learners and how the less frequently used resources can be optimised. This study is, therefore, significant given that resource-based teaching in high school Life Sciences teaching and learning is somewhat under-researched in South Africa.

1.4 Research aims and objectives

The purpose of this study was to:

1. Explore Life Sciences educators' understanding of resource-based teaching.
2. Investigate the way Life Sciences educators enact RBT in their classrooms.
3. Understand why educators enact RBT the way they do.

1.5 Research Questions

The study sought to answer the following questions:

1. What are Life Sciences educators' understanding of resource-based teaching?
2. How do Life Sciences educators enact resource-based teaching?

3. Why do Life Sciences educators enact resource-based teaching the way they do?

1.6 Research design and methodology

Jonker and Pennink (2010) describe a research paradigm as a lens or a way in which to think about the world. In this study, an interpretive paradigm was adopted to explore Life Sciences educators' understanding and enactment of RBT. According to Cohen, Manion, and Morrison (2011), an interpretive paradigm studies a persons' personal judgement of reality. A qualitative approach was adopted for the design of this study. According to Denzin and Lincoln (2011), qualitative research enables the researcher to visit the world (classroom) of the researched (Life Sciences educators) and enables him/her to interpret their experiences and behaviours. The qualitative approach was appropriate for this study because it gave the researcher an opportunity to understand and interpret Life Sciences educator's understanding of RBT and their experiences in enacting RBT in their lessons. This helped the researcher to understand Life Sciences educators' enactment of RBT.

A case study approach was adopted in this study to get a deeper understanding of how the six participants gave meaning to RBT in the teaching of secondary school Life Sciences. To collect data, the researcher opted four data collection methods, namely, questionnaires, lesson observations, individual interviews, and document analysis. The reason for using multiple data collection methods was to triangulate to enhance trustworthiness and the authenticity of the findings of this study. Content analysis was used as a guide to reporting main findings of this study.

1.7 Findings

The findings of the current study emerged from the analysis of the six participants' understanding of RBT in the teaching of secondary school Life Sciences. Research findings sought answers to the three research questions of the study. Each research question had a theme and subthemes that emerged from the findings.

1.8 Structure of the thesis

The thesis is organised into six chapters that describe the different stages of the study. The chapters are presented in succession.

Chapter 1 has begun with a detailed background to the study. The chapter has also outlined the purpose and focus of the study, the rationale, and significance of the study. The research aims, research questions, as well as the research design, findings and the structure of the thesis is highlighted in Chapter 1.

In Chapter 2, there is a review of literature that informed this study. The curriculum implementation theory, which is the theoretical framework of this study, is also presented and explained in further detail in Chapter 2.

Chapter 3 focuses on the research methodology that was followed in carrying out this study in order to answer the research questions and achieve/satisfy the research objectives. The chapter outlines that this research is framed in an interpretative paradigm and a qualitative methodology. It also reveals that this study is designed as a case study of six Life Sciences educators who teach Life Sciences in three rural schools in the Eastern Cape. The data collection methods adopted by this study are also discussed together with content analysis, a method used to analyse the collected data. The location of the study, validity and trustworthiness, including ethics that were subscribed to throughout this study are also discussed in Chapter 3.

The researcher deals with data presentation in Chapter 4. The chapter opens with a description of available resources in the Eastern Cape, followed by description of all three schools in succession. Lastly, data for each participant is described as guided by the three critical research questions of this study.

Chapter 5 is the presentation of the research findings. The findings are presented as themes and the discussions are based on the literature reviewed.

In Chapter 6 are theoretical-methodological, personal and academic reflections. The conclusion and implications of the study are finally presented, also in this chapter. The following chapter covers the review of literature related to the study.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Prior the review of relevant literature for this study in this chapter, there is conceptualisation of terms that are used throughout the study. In this chapter, RBT is linked to the theory of curriculum implementation, which is employed as a theoretical framework of the current study. Rogan and Grayson's (2003) theory of curriculum implementation played a significant role in assisting the researcher to navigate through literature and finding relevant studies on the enactment of RBT to address the three research questions of this study.

2.2 Conceptual Referents

This section presents the conceptualisation of terms that are used throughout this study. Terms such as a resource, a tool, scaffolding and zone of proximal development, and resource-based teaching are conceptualised to fit for use in this study. The conceptualisation of the prominent terms is an attempt of the researcher to project their (terms') meanings in the way they are used in this study.

2.2.1 Resource

The boom of technology has transformed several basic classroom practices and socio-economic enterprises such as libraries and information centres, which have made both the amount of information and access to it to grow exponentially (DeKunder, 2006). Teaching resources are fundamentally a requirement for successful teaching and learning of Life Sciences (Education, 2011; Ochieng'-Konyango & Asienyo, 2015). Hill and Hannafin (2001) define a resource as media, a person, a place or an idea that have a potential to support learning. This suggests that in a Life Sciences classroom, an educator is an important resource for imparting knowledge. An educator is, therefore, a pre-requisite to the successful enactment of RBT in Life Sciences lessons. Thus, educators are fundamentally the people responsible for creating opportunities for learners to meaningfully engage available teaching material during the lesson.

Studies show that people have different understanding of a resource, and that is based on their prior experiences or informal learning (Afify, 2018; Brown, 2017). In his study, Chandra (1987) for instance found that educators held different understanding of a resource, and because of that, they viewed their roles as educators very differently from one another. True to Chandra (1987) findings, in a sense Öztürk and Dagistanlioglu (2018) hold a different view of a resource. The latter define a resource as a teaching material.

Jones et al. (2015) view a resource as an essential ingredient in the classroom for supporting learners to study science. A resource, according to Okongo, Ngao, Rop, and Nyongesa (2015), plays two purposes in a classroom; teaching and learning. An educator uses a resource to explicitly express himself or herself and explain concepts or phenomenon that would otherwise have been impossible to describe in words, while learners use resources to enhance their understanding of what they learn, be it scientific processes or concepts.

Hill and Hannafin (2001) categorise resources into two, the static resources and dynamic resources. Static resources according to them, have evolved from the pre-digital era where they were mostly used for only one goal due to their static nature. The goal to which static resources are used is passing meaning that attempts to achieve established educational goals, outcomes and standards. Static resources are used in a teacher-centred approach where the educator decides what learners must know, how they should know it, and in what form. This can be attributed to Paulo Freire’s (1993) banking concept of education where Freire describes educators as depositories of information to passive minds of learners.

According to Hill and Hannafin (2001) print-based textbooks, encyclopaedias, magazines, and newspaper articles are static resources that have stable contents. In contrast, the same authors add posit that dynamic resources are flexible and accommodate a variety of learning styles in different contexts, meet diverse needs of classroom participants (educators and learners), and allow for learner autonomy. Dynamic resources are, therefore, ideal resources to be incorporated in a resource-based teaching environment (RBTE).

The Life Sciences Curriculum and Assessment Policy Statement (CAPS) document emphasises the need for every learner to have a textbook (Education, 2011). Preferably, learners should not share a textbook to allow effective teaching and learning of Life Sciences. The Life Sciences policy document specifies a range of resources to be used by educators and learners that,

> The Life Sciences classroom or laboratory should be equipped with charts, Bunsen burners or spirit lamps, hand lenses, bio-viewers and relevant bio strips, microscopes, a set of prepared slides and cover slips, reference books, blades or scalpels, models, field guides, identification keys, thermometers, glass beakers, test tubes, and chemicals, and if at all possible, access to appropriate DVDs and a DVD player (Education, 2011, pp. 19-20).

Lastly, it is evident that resources are an invaluable component of science teaching and learning, especially in rural schools where available resources hugely impact on the extent of learning. In addition, current understanding of a phenomenon impacts on understanding of a phenomena that is interrelated with it, especially if such understanding is based on the prerequisite knowledge of the initial phenomena. Therefore, since a resource and a tool fall under the same category, it may be common for educators to confuse resources with tools, especially if they are not paying too much attention to the detrimental effects in their daily teaching.

2.2.2 Tool

It is easy to confuse the concept *tool* with the concept *resource* due to the fact that they are sometimes loosely used interchangeably in education. Thus, it is imperative to describe these two similar concepts and illustrate the difference between them. (Song, Hannafin, & Hill, 2007) define a tool as a device that helps individual people to engage and use resources and ideas. This means that a tool is used complementarily with a resource. An example of an educational tool in this study is the internet. The internet (tool) can be used on tablets or computers (resources) during the teaching of Life Sciences.

Tablets alone will lack relevance in the classroom if they do not have internet as it (internet) enables the tablet to search information for teaching and learning. Jonassen, Reeves, Hong, Harvey, and Peters (1997) argue that tools empower learners with understanding by enabling them to present their knowledge in concrete ways. Hill and Hannafin (2001) maintain that the use of a tool largely depends on its intention for use. For instance, the internet is only used when there is a need to search information for teaching and learning purposes. The haphazard use of the internet in a lesson may degenerate the lesson (Zhang, Qin, & Ren, 2018). Based on Hill and Hannafin's definition, read together with the latter's definition of a tool, it can be concluded that tools are an essential component of a resource, especially the technological resources that are apparently fashionable as the country's education system shifts to paperless teaching and learning. Tools can be compared to the oxygen that people breathe, if it is not available, a person will die. During a Life Sciences lesson, tools are more effective when blended with relevant resources.

Hill and Hannafin (2001) identify four types of tools used in RBTEs, namely; searching tools, processing tools, manipulating tools, and communicating tools. The type of tools are described on Table 3.

Table 3

RBTE Tools and Examples Adapted from (Hill & Hannafin, 2001).

Tools	**Functions**	**Examples**
Searching	Enable location of resources	•Web-based tools (e.g., Yahoo, google) enable location of digital resources. • More traditional tools (e.g., ERIC, Psycho Lit) enable the location of print-based resources
Processing	Provide cognitive support	• Copy and paste functions in productivity tools allow the learner to collect various pieces of information from varied resources. • Brainstorming or diagramming enables the learner to organize the information in ways that enable them to identify gaps. • Mental model representation tools can assist learners with making connections between and across areas. • Templates and programming applications allow learners to generate unique representations of their knowledge.
Manipulating	Provide cognitive support	Using asynchronous communication tools. (e.g., e-mail, listservs, bulletin boards) to enable the exchange of reflective ideas when convenient for the learner. • Using synchronous communication tools (e.g., video conferencing, Web chat) when immediate answers are needed or when brainstorming ideas might be useful.
Communicating	Testing beliefs/theories	Using asynchronous communication tools. (e.g., e-mail, listservs, bulletin boards) to enable the exchange of reflective ideas when convenient for the learner. • Mental model representation tools can assist learners with making connections between and across areas. • Templates and programming applications allow learners to generate unique representations of their knowledge.
Communicating	Mechanism for exchanging ideas	Using asynchronous communication tools. (e.g., e-mail, listservs, bulletin boards) to enable the exchange of reflective ideas when convenient for the learner. • Using synchronous communication tools (e.g., video conferencing, Web chat) when immediate answers are needed or when brainstorming ideas might be useful

2.2.3 Resource-based teaching

In these days, RBT is a hot topic globally, and this conversation is important in Africa, particularly in South Africa as the country gradually shifts towards a paperless education system (Howie, 2010; Mokiwa & Phasha, 2013) In addition, RBT is not new in the field of education (Beswick, 1979; Boud, 1988). In 1975, the Council for National Academic Awards (CNAA) in Britain defined resource-based teaching as learning systems which depend wholly or in part on the use of resources by learners (CNAA, 1975). Similarly, Cooper (1993) defines RBT as a way of organising and delivering curriculum in a flexible but controlled way, taking into account learners' learning styles.

A prominent aspect of RBT from the two definitions is that it hugely speaks about the use of resources by educators to facilitate learning. It is also suggested from the CNNA and Cooper's definitions that RBT recognises learners' differences and abilities in the learning process. In support of this, Beach and Willows (2014) assert that RBT is one of the most useful, successful and acceptable teaching strategies, and it is easily adapted to different learning styles. Without a cornerstone of a proper use of resources to aid teaching and learning of Life Sciences as a scientific subject, a few learners can actively engage in meaningful learning of Life Sciences content.

The evolution of the definition RBT over the years (Clarke, 1982) has set the ground for Campbell, Flageolle, Griffith, and Wojcik (2002) to redefine it as an educational model that is designed to actively engage learners with multiple resources in both print and non-print forms. This means that RBT involves the incorporation of different teaching and learning tools, such as the internet, interactive whiteboard, PowerPoint slides, simulations, computer spreadsheets, and other tools used in Life sciences teaching and learning.

Similar to Butler’s definition, Sitepu (2010) defines RBT as a teaching strategy that can enable learners to construct meaning through their interaction with a wide-range of print, non-print (electronic), and human resources. Sitepu’s definition of RBT was adapted as a working definition for the current study.

A good understanding of RBT by educators in the teaching of Life Sciences is necessary so that they know what is expected of them during lessons. However, such understanding, according to Afify (2018), is determined by a grounded understanding of similar concepts such as tool and resource. In his study, Brown (2017) supports the latter and further states that the recognition of prior informal and related knowledge of concepts has a transformative effect on the understanding of targeted concepts (such as RBT).

Beach and Willows (2014) explain that RBT is not a universal solution to all the problems associated with curriculum enactment, and is not intended to be a replacement of basic classroom teaching. Thus, RBT should be used as an alternative teaching strategy to complement traditional teaching methods (Butler, 2012).

RBT is characterised by two important components; *flexibility* and *learner autonomy* (Cooper, 1993). Flexibility refers to the fact that RBT is associated with a variety of learning styles and delivery methods (Fry, Pearce, & Bright, 2007). This implies that RBT accommodates learners who learn best from listening to educators in the classroom and those who prefer to learn on their own, independently of the educator. Learner autonomy means that learners are encouraged to take more responsibility for their own learning by taking advantage of all the resources available to them to learn with minimal assistance from the educator. As a learner-centred teaching approach, RBT can use assignments and projects for self-supported study (Waterhouse, 1988).

Due to the fact that RBT allows flexibility and learner autonomy, it gives ample opportunities for learners to improve their information literacy (Melendres, 2012) because of their (learners') frequent interaction with resources during the learning process. Melendres (2012) further argues that the approach of having learners assuming more responsibility for locating the resources from which to learn increases lifelong learning skills.

2.2.4 Scaffolding

Resource-based teaching cannot be divorced from to the concept of scaffolding. During the Life Sciences teaching and learning process where RBT as a teaching strategy is in use, educators need to scaffold learners where necessary so as to improve their learning experiences (Massicotte & Guinel, 2017). Literally, scaffolding is a support structure that is normally erected around a building under construction. When the building is strong enough, the scaffolding can be removed and the building will remain strong and stable. In the emblematic sense used by Vygotsky (1978), scaffolding refers to the support provided by educators, which enables learners to perform gradually well in their studies. During the process of scaffolding, there is collaboration and negotiation that takes place between the educator and the learners (Weng, Lin, & She, 2017). Under these conditions, the educator becomes a facilitator who oversees learning (Vygotsky, 1978) rather than a transmitter of knowledge (Fernández, 2018).

Hammond (2001) describes scaffolding as a high challenge and high support. Put clearly, educators involved in scaffolding learners should give learners challenging tasks so that they can perform beyond their current capacity and reach the zone of proximal development (ZPD). Equally, educators also need to provide scaffolds that will enable learners to achieve these tasks. If the task is not challenging enough, this might lead to boredom of learners and, ultimately, make them to become demotivated (Guseva &

Solomonovich, 2017). Furthermore, if there is not enough support, they can become frustrated and may give up (Esteban-Guitart, 2018).

2.2.5 Scaffolding and the Zone of Proximal Development

The concept of scaffolding is linked to what Vygotsky calls the learner's Zone of Proximal Development (ZPD). The ZPD, according to Vygotsky (1978), refers to the range of tasks and activities that a learner can achieve with scaffolding, but which may be beyond his/her current abilities if he/she is unassisted. There is, therefore, a necessity for educators to gain skills that will enable them to assess and exploit learners' ZPD. Life Sciences educators, in particular, should develop a range of skills to enable them to effectively teach the subject (cite) and scaffold learners' ZPD. Pedagogic content knowledge (PCK) alone is not enough to teach Life Sciences. Educators need to develop skills that will enable them to skilfully transfer the message to the learners in ways that appeals to their learning styles, hence all Life Sciences educators according to Pritchard (2018) should possess the necessary technical and manipulative skills to effectively communicate the information to leaners and to motivate learners to take careers in Science, Technology, Engineering and Mathematics (STEM).

There are four scaffolding mechanisms rooted in constructivism learning theory that can be exploited in RBT environments (Hill & Hannafin, 2001). According to Hill and Hannafin (2001), the conceptual mechanism is crafted to enable learners to define and understand concepts. The metacognitive mechanism assists learners to establish what is known and what is not known, and improve their thinking processes. The procedural mechanism assists learners to master the procedure to use particular resources, while the strategic mechanisms capacitate learners to think deeply and constructively about the strategies to accomplish a task (Table 4).

Table 4

Types of Scaffolding Mechanisms and Examples Adapted from (Hill & Hannafin, 2001).

Scaffold mechanism	**Description**	**Function examples**
Conceptual	Mechanism designed to assist with defining things to order	• Creating an outline of a paper before you start to write or examining a map of a location to determine best ways to reach your destination (either in a paper or a physical place
Metacognitive	Assist with establishing what is known and how to think	Providing learners with structured "reflection reminders," which may come in the form of daily journal entries. • Enabling scaffolded inquiry so that as learners are engaging the process, they are assisted in ways that make the most sense for them
Procedural	Assist with how to use a resource	Providing and encouraging the use of help functions in productivity tools to assist the learner with trouble-shooting and problem-solving. • Creating Web site maps so the learner can get a sense of the scope of the site, as well as indicators of how varied elements in the site are linked together.
Strategic	Alternative ways to do a task	• Arranging for an expert consultant to demonstrate how to perform a task so learners can observe and ask questions while learning a new technique. • Creating "question pools" where learners can pose questions for others to provide responses, enabling multiple perspectives on a problem.

2.3 Enactment of resource-based teaching in Life Sciences

There are various ways in which science subjects' educators enact RBT. The ways are fundamental in determining the success of the techniques used to enact RBT. Most importantly, the enactment of RBT should be more learner centred to ensure that the goals of teaching and learning are achieved (Beach & Willows, 2014).

2.3.1 Classroom interaction

A vital part of ensuring a successful enactment of RBT is a good classroom interaction. This refers to actions of the educator and learners during the teaching and learning process as they engage the resources (Rogan & Grayson, 2003). A classroom where learners talk to each other while learning can be seen as an interactive classroom and that responds to the constructivist view of learning that is desired in the CAPS. Interaction is enhanced by the use of teaching material that encourages learners to talk to one another during learning. Life sciences educators enact RBT using resources that encourages classroom interaction because during RBT, learners should interact actively as supported by the constructivist view of learning. During enactment of RBT, an educator creates a conducive environment for discussion, groupwork and even pair work and by using teaching resources that encourages learners to talk to each other (Education, 2011).

Interactive teaching aids used to teach Life Sciences

According to DuŢĂ (2017), there are various types of interactive teaching aids (ITA) and resources used to teach science. Educators can make use of resource persons, models, and even educational posters. Resources provided by the DoE, according to DuŢĂ (2017), must enable educators to use technology as a focus for instruction instead of a distraction. Through the use of technology, and the ITA in particular, learners' and educators' roles may be redefined in a sense that learners may assume the role of educators while educators may assume role of scaffolders (DuŢĂ, 2017). Manifest to this, In their study, Trigueros, Lozano, and Lage (2007) have developed a computer-based interactive system to support the teaching and learning of probability in primary school mathematics. The findings show that the use of the computer-based interactive system was beneficial to educators when they did classroom activities that promoted learners' grasping of probability. It also emerged as a finding that the interactive teaching aid developed by the authors was effective in learning probability in the sense that learners engaged the computer system on their own throughout the classroom activities. Interaction between the learners and between learners and the computer-based interaction system was observed.

Gillen, Littleton, Twiner, Staarman, and Mercer (2008) used interactive whiteboards to multimodal teaching of primary school science curriculum. The focus was on allowing learners to use the interactive learning tools in their own learning while educators created opportunities for this learning to occur. It is clear, therefore, that using ITA in the teaching of Life Sciences is beneficial to both educators and learners, and it aligns with the constructivist view of learning (Vygotsky, 1978).

Resource person

In the teaching profession, there is no jack of all trades. Medley (2005) argues that educators cannot master every section of the subject they teach, especially in Life Sciences. Thus, educators should practice rotational teaching, where they invite educators from other schools to teach or revise certain topics with their learners (Agustin & Montebon, 2018). In addition, they should also invite other people with expertise to their classrooms, or take learners to conferences where they can get opportunities to engage with relevant subject experts (Medley, 2005). This carries a lot of benefits to learners. One, learners get a chance to hear different explanations of what was said by their educators. Two, learners get new knowledge explained explicitly and are able to ask questions freely.

In Life Sciences in particular, educators are encouraged to outsource people with expertise in certain fields such as Marine Biology, and professional personnel such as agronomists, professional nurses, lifestyle coaches, and village elders to share their wealth of knowledge and experience with learners (Education, 2011). It is likely that learners tend to understand better when they are taught by someone else (Agustin & Montebon, 2018). This also helps in avoiding being used to the same person and ending up being bored.

Smith (1980) demonstrates through his study that community resource people are valuable tools for use in learning Science and Mathematics. According to Smith (1980), community resource people concretely demonstrate the utility of learning Science and Mathematics and help high school learners to gain information about future careers in science. However, the findings of Duru (2015) show that educators refuse to invite other educators to their classrooms because they fear that they might be outperformed by their guests.

According to Pauka, Treagust, and Waldrip (2005), there is need to complement traditional knowledge with school science. In their study, Pauka et al. (2005) investigated high school learners' sources of explanations and understandings of natural phenomena in terms of their cultural and school sciences experiences. Their explanations were compared with experiences and views given by village elders on the same science natural phenomena. The village elders' explanations of the science phenomenon were largely based on evil spirits, spells, magic, religion, and their personal experiences while those of the learners were based on theoretical academic explanations. It was revealed in the second phase of the research through questionnaire narratives of 179 learners that learners' explanations were largely based on school learned knowledge and experiences, whereas a few of them (learners) explained science phenomenon the same way the village elders did. Perhaps the reason the majority of learners interpreted their explanations of science phenomena the way they did is that the school was a boarding school. Therefore, due to limited interaction with the community, learners were unable to learn social values that could have influenced their understanding of science phenomena. This is because there is a link between scientific knowledge and indigenous knowledge systems (IKS).

Models

The use of models has always been at the heart of Life sciences teaching and learning. Models bring reality to the classroom and offer solutions to the most complicated and complex questions about science phenomena (De Voogd & Salbenblatt, 1989). In their study, Davenport et al. (2017) introduced a model for teaching standard molecular biology. The model is that of a three-dimensional polypeptide protein folding molecule, which is, according to the authors, suitable to replace conventional text and pictures. The model was tested in a laboratory practical where learners were guided to do a step-by-step investigation into the nature of the protein folding, starting with the handedness of amino acids to the formation of secondary and tertiary structures. It was concluded that the model of a protein folding molecule was useful for teaching secondary school Life Sciences.

Models are effective when they are adapted for teaching specific Life Science topics and phenomena (Marbach-Ad, Rotbain, & Stavy, 2005). In Ethiopia, Edessa (2018) conducted a study by sampling 40 final year Life Sciences pre-service educators from four different educator training centres. All 40 pre-service educators were trained on how to plan their lessons using the elements of the conventional teaching methods and the 5E model cycles. A performance checklist was used to comparatively evaluate the effectiveness of the use of both modes of lesson planning and delivery. It emerged as a finding of the study that educators who used the 5E model were 93.5% more accurate than those who used conventional teaching methods (42.85%). In addition, adapting the 5E model had solved 50.65% of the problems Life Sciences educators faced when they used conventional teaching methods. The integration of the 5E model in Life Sciences teaching and learning according to Edessa (2018) supports the constructivist view of learning because learners learn to use the model on their own and develop intellectual superiority as they used the model, which results in self-preparedness for teaching Life Sciences.

Genetics is a Life Sciences topic that is appropriate to be taught using a model (Marbach-Ad et al., 2005). In their study, Marbach-Ad et al. (2005) present a technique for using a bread model in A-level molecular genetics classes. A questionnaire, which was administered to learners precisely after they were taught molecular biology, was used to compare the achievements of both the experimental and control groups. A post-test was also administered and analysed. A higher mean score of the experimental group compared to the control group was revealed in the analysis of the post-test that was administered. Their analysis of interviews also showed that learners passed and were affectionate about using a bread model to learn about molecular genetics in their Life sciences classes. The authors concluded that a model was an effective tool to teach molecular genetics in Life Sciences because learners understood the lesson better.

Chang (2000) emphasises that it is important for Life Sciences learners to be taught how to apply knowledge in a problem-solving manner to real life situations rather than memorising facts. According to the author, that can be done through the implementation of teaching approaches such as those that employ three-dimensional animal models to teach learners deductive reasoning and critical analysis. As a result, in Chang's study, a dinosaur model was used by Life Sciences learners to gain a skill of deductive reasoning and critical analysis to discover functional correlates of structures. Findings of this study revealed that Life Sciences learners found the use of the dinosaurs model fascinating, interesting, and what encouraged their active participation in the lessons is a sense that they engaged with the models on their own and with minimal guidance from the educator. It was also apparent in the findings that learners' leadership skills were developed through exercises involving the use of the model, and that collaboration amongst them was optimised.

Educational Posters

Educational posters are interactive teaching tools such as drawings, charts, banners, and wall posters. Described below are educational posters that can be used by educators in the teaching and learning of Life Sciences.

1. <u>Drawings</u>

A drawing, according to Wright (1990), is an interactive teaching aid that helps educators mostly to present pictorial materials of an activity. However, many educators, especially females, are not proficient in drawing (Watts & Christopher, 2012), but Block (1993) states that there is no good and bad drawing, as long as the messages is conveyed. A drawing during teaching and learning is divided into two categories. First, educators draw on the chalkboard to illustrate or present a new phenomenon or to explain aspects of popular phenomena that are confusing to learners; for instance, osmosis and diffusion. Second, drawing becomes useful when an educator draws an activity for learners to complete. In both instances, drawings are done during formative assessment. Moreover, "drawing on the chalkboard is flexible and appropriate for the introduction and presentation of a lesson" (Wright & Haleem, 1995, p. 8). The same authors emphasize that "texts and pictures can be erased, added, and substituted quickly" in the drawing than handing out ready-made pictures (p.5). Using drawings on the board can also be done concurrently with flashcards and pictures from magazines

2. <u>Charts</u>

Just like drawings, charts and banners (posters) are important interactive teaching aids that play a huge role during teaching and learning. Charts are characterised by their complexity, ability to illustrate a scene, and they contain a lot of objects in detail (Wright & Haleem, 1995, p. 45). Joklova (2009) adds that charts are huge enough for whole class view and can be of use instantly and frequently. Because of their design, charts can be used for the introduction of new phenomena because they create a practical context and display details of the content that learners need to know. Hill (1990) concurs with the latter and posits that big posters are tight-fitting for introducing a new unit because they capture attention.

In their study, Kewaza and Welch (2013) opine that charts and posters are ideal for teaching in overcrowded primary school classrooms. Using a mixed methods to conduct the study, they triangulated surveys, interviews, and questionnaires to collect data based on the size of the classes, the instructional methods used to teach reading skills to primary learners, the effects of big classes on teaching materials used to teach and the effects of enrolments on educators' attitudes in big classes. From the 80 sampled educators, 48 commonly used charts to teach in their lessons. It emerged as a finding that using charts to teach primary school learners was beneficial in a sense that it enabled the educators to involve all learners during the lesson. It also came as a finding that educators had better classroom control when they employed charts and wallpapers to teach and the lessons were not strenuous to them. Moreover, it was found that educators preferred teaching overcrowded classrooms using interactive teaching aids over traditional teaching materials such as chalkboards and textbooks due to ease of teaching and benefits associated with the ITA.

Charts become useful tools of teaching Life Sciences when the educator is well prepared and knows exactly which charts, he or she is going to use and how he/she is going to use them. This directly saves time and increases the chances of lesson productivity in terms of the actual learning that takes place.

3. Banners

Studies reveal that banners are widely used by businesses, companies and NGOs for advertising their products (Dix, Bellman, Haddad, & Varan, 2010; Pasqualotti & Baccino, 2014). In their study, Dix et al. (2010) found that the use of banners minimised the changing of TV channels during adverts by 40% in Australia. Therefore, the use of interactive banners for learning Life Sciences might encourage learners to engage freely and with minimal self-distraction from the lessons because they may be hands-on in the process.

In a Life Sciences classroom for instance, educators may instruct learners to design banners about any science phenomena and do a presentation of it. Through that exercise, learners may develop a sense of responsibility and a deeper understanding of that particular phenomenon. In Central America, Montgomery, Miller, Foss, Tallakson, and Howard (2017) used banners to teach kindergarten about the Universal Declaration of Human Rights that was adopted by the United Nations General Assembly in 1948. The authors used an art-based project where they instructed 18 kindergarten learners to design banners where they express their views, emotions, and feelings about the injustices and educational inequalities around the world. A comparison of their school and one under-resourced partner school in El Salvador was made during the process. Their banners had drawings that described their beliefs regarding children's rights to education. This was also an awareness about school inequalities. The findings of their study indicate that kindergarten children were able to recognize their educational rights and that they were privileged as compared to their partner school in El Salvador.

It was also revealed in that study that through the use of banners by children in raising critical issues, children can demonstrate active citizenship. Thus, the National Catholic register in Central America has been pleading with the DoE to adopt the use of banners in education (Register, 1998).

2.3.2 Science practical work

The implementation of a science subject curriculum is far from complete if practical work is omitted (Rogan & Grayson, 2003). Lock (2010) states that Life Sciences teaching and learning is incomplete without science practical work. According to Lock (2010), science educators have an obligation to enact practical work during their teaching to make Life Sciences relevant to learners. Lock's study was a critical analysis of empirical research from 1963 to 2009 in the United Kingdom. From the 13 published studies offering empirical evidence on fieldwork in high school Life Sciences, the author discovered that all findings suggested that fieldwork is an essential aspect of Life Sciences teaching and learning. However, a concerning finding of Lock's study was that the provision of fieldwork in Life Sciences was declining mainly due to deforestation and school financial constraints and it was recommended that policy makers and those responsible for pre-service educator training prioritise fieldwork as an instructional strategy.

There are many types of practical work that Life Sciences educators use in their teaching (Lock, 2010). According to Lock (2010), fieldwork, investigations, demonstrations, simulations, and modelling are some types of practical work that Life Sciences educators use during their teaching and they are explained below in succession.

2.3.2.1 Fieldwork

In their study, Bogut, Popović, and Mikuška (2017, p. 127) define fieldwork as "any curriculum that involves leaving the classroom and engaging in teaching and learning activities through first-hand experience of outdoor phenomena". During fieldwork experiences, educators develop a stronger, positive, and productive relationship with their learners. In addition, through fieldwork, learners collaborate and exchange knowledge and experiences by scaffolding each other during the learning process (Wandersee & Clary, 2006).

Fieldwork has always been a traditional practice in the Life Sciences and environmental sciences field (Bogut et al., 2017; Tilling, 2018). The opportunities that fieldwork provides are important to Life Sciences learners, in a sense that through field work, they develop conceptual, cognitive, organisational, and social gains (McCabe, Munsell, & Seiler, 2014) because fieldwork demands the application of higher order thinking processes that are otherwise very difficult to create in a traditional classroom. Group work employed as learning opportunities during fieldwork creates solid interrelationships, which perpetually influence the social development traits of the learners.

Fieldwork is not only a necessity for learners, it also helps in shaping educators' attitudes towards the environment and their conservation behaviour (Rachmatullah & Minsu Ha, 2018). In Indonesia for instance, Rachmatullah and Minsu Ha (2018) carried out a study to explore the attitudes of 283 pre-service Life Sciences educators and their self-reported behaviour towards the environment. It was discovered through the study that the exposure of preservice Life Sciences educators to fieldwork ensured that they remain environmentally aware and that they began to be more caring and concerned towards reserving natural resources and understanding the natural ecosystem, including its importance. They also reported that they will be committed to teaching about environmental awareness to their learners, and will expose them to similar experiences whenever they got a chance to do so.

In addition to the determination of educators to do fieldwork, McCabe et al. (2014) notes that schools built close to the forest were likely to be doing more field work than those located far away because of the accessibility of the forests. McCabe et al. (2014) further states that financial limitations usually impede schools located far from forests from doing field activities.

However, as much as there is a global need to teach learners Life Sciences using fieldwork, there seem to be a worrying declining quantity and quality of fieldwork done over the past few decades across the world, especially in England (Tilling, 2018). Proponents, according to Tilling (2018), believe that scientific ecology can best be taught through Geography fieldwork than Life Sciences. This raises alarming concerns on the quality and credibility of Life Sciences educators who are obliged to expose learners to fieldwork.

Educator training institutions need to adequately train educators and give them necessary skills to facilitate the fieldwork of their learners(Tilling, 2018).

2.3.2.2 Educational excursions

In Australia, Munday (2008) studied the perceptions of educators about their roles and values of excursions in the teaching of Geography to secondary school learners. The authors posit that excursions are fundamental in learning Geography as a practical subject; however, the problem is readiness of learners to embark on fieldwork experiences. The study focused on the ability and expertise of educators to enact educational excursions in their school. Questionnaires were distributed to collect quantitative data to 60 educators scattered both in urban and rural schools of Victoria in Australia. The findings of the study show that educators understand the importance of educational excursions in Geography education but they find difficulties in planning them, including transportation problems, and costs associated with transporting learners to such places of curriculum interest. It was reported in the study that educators overcome these challenges by working collaboratively with others from other schools. The participating geography educators who had a firm understanding of the theoretical philosophies and policies of the state of geography education found the conduct of excursion both rewarding and difficult.

Prior visiting the natural environments, learners may have different expectations regarding environmental education experiences and their attitudinal and behavioural orientations may vary. In Australia, Ballantyne and Packer (2002) investigated learners' perceptions of learning in natural environments. Questionnaires that were distributed to 580 secondary school learners revealed that learning in natural environments is attractive to learners, especially those with an urban background. It was also revealed that educational excursions to natural environments significantly affected learners' attitudes towards the environment in the sense that their desire to look after the environment increased, their behaviour in natural environments, and their household environmental practices also improved for the better.

In South Africa, De Beer, Petersen, and Dubar-Krige (2012) conducted a study to describe the value of an educational excursion for pre-service educators enrolled in a university. The study presents a comparison of the nature of learners learning during an excursion with those learning in the traditional classroom and it is argued that both scenarios are two different activity systems. Veresov’s notion of dramatical collisions and the Cultural-Historical Activity Theory were used as a lenses to make meaning of the pre-service reflections from the questionnaire and focus group interview data gathered. The study particularly highlighted and explored the unforeseen dynamics and tensions created during the excursion. The focus was on the importance of social interaction and its ability to afford learners the ability to work cooperatively in a natural setting. It emerged as a major finding of the study that excursion provides a different learning environment for personal and professional development and this assists learners in planning their trajectory.

In their study, Griffin and Symington (1997) investigate the feasibility of moving from task-orientated to learning-orientated strategies on school excursions to museums. A sample of 12 school groups comprising of 29 educators and 735 learners in 30 classes ranging between Grade 5 and Grade 20 was used. Lesson observations and interviews before, during, and 2-3 weeks after the visit were used to collect data. The results of their study show that Life Sciences educators used mainly task-orientated teaching practices and made little link between topics studied and museums. Also, there was little congruence between observed practices and what was suggested in the literature in terms of effective planning and management of school excursions. A framework to guide educators when planning learning-oriented excursions based on synthesis of knowledge of natural learning behaviours exhibited by family groups in museums and lessons from constructivist theory of learning was proposed by the authors.

2.3.2.3 Demonstration

In their study, Sunassee, Young, Sewry, Harrison, and Shallcross (2012) sampled 981 high school learners and 25 educators from both advantaged and disadvantaged areas of the Western Cape in South Africa to do climate change awareness through practical chemistry demonstrations. Questionnaires and demonstrations were completed and done by both groups of participants. A demonstration named ‘A pollutant’s Tale’ was done. It emerged as a finding that both educators and learners enjoyed the demonstration. Most importantly, learners were made aware of the effects of climate change on the environment and their attitudes towards science and the learning of science concepts was improved. The findings of their study reveal that this outreach initiative was instrumental in sparking an interest in the learners’ minds not only about chemistry but about science in general.

2.3.2.4 Investigation

As mentioned earlier, investigation is a type of science practical work. In her study, Partridge (2006) did a hands-on activity using lemons, LEDs, copper leads and assorted fruit and vegetables to engage a group of primary school learners in an investigation that encouraged them to think critically and inquire further. The learners were required to investigate if lemons can produce enough energy to make a light work. During the investigative activity, learners worked in groups setting and conducting the practical investigation on their own and merely following the procedure described by the educator. They discovered that although a lemon ‘battery’ was an interesting idea and that energy was produced, the voltage created was too small to create enough energy for home use. In addition, through the investigative activity, the learners’ literacy (reading, writing, speaking, and listening) numeracy and thinking (inquiry and reflection) were greatly improved.

2.3.2.5 Simulation

Simulations are important in science, especially when schools do not have resources to do the actual practical work (Mihindo, Wachanga, & Anditi, 2017). Simulations can replace science investigations. In their study, Shegog et al. (2012) used a molecular biology simulation to improve on learners' academic achievements and attitudes. The authors used a transgenic mouse model to study causes and potential cures for human genetic diseases. By law, high school learners are not allowed to be exposed to a laboratory experience involving the process of the development of transgenic animal models due to health risks involved. Computer-based simulations are, therefore, a best method to do this. During the study, a computer-based simulation of the production of a transgenic mouse was used to expose high school science learners to laboratory protocols involved in the process. Further, the science high school learners evaluated a simulation on preparing a gene construct in the molecular biology laboratory.

Findings show that learners who used the simulation increased their procedural and declarative knowledge regarding molecular microbiology compared to those in the control group. It was also discovered as a finding that computer simulation of complex transgenic protocols has a potential to provide a virtual laboratory experience as an adjunct to conventional educational approaches.

Computer simulations, according to Mutch-Jones, Gasca, Pallant, and Lee (2018), offer a variety of advantages that include allowing educators to demonstrate inner workings of complex systems that are impossible to observe another way. According to Wekesa, Kiboss, and Ndirangu (2006), simulations also enable learners to investigate phenomena that are difficult to learn within the confines of the classroom. Additionally, simulations have the ability to support learners' open-ended exploration and systematic experimentation, and can enhance their understanding of science processes and disciplinary core ideas (Mutch-Jones et al., 2018).

2.3.3 Science in society

Science influences learners attitudes, interests, judgements, values , and uncertainties (Flohic, 2017). The Life Sciences CAPS necessitates for educators to make learners aware that science is all around us. Science and technology share a learning outcome in science, society and the environment which according to the Revised National Senior Curriculum of 2002 (RNSC), learners ought to attain as they demonstrate an understanding of the interrelationship between science and technology, society and the environment, and science and society. Learners should be made aware of the impact of science and technology on the environment, and on the lives of people (Education, 2011). Science assist humans in increasing their understanding of how the world works, while technology makes discoveries. The society is therefore not divorced to science as it influences how learners interpret scientific phenomena.

2.3.4 Assessment

Whenever one plans how to teach, he/she must also plan how to assess (Schneider & Bodensohn, 2017) because assessment is an integral part of teaching and learning (Rogan & Aldous, 2005). Assessment in education is important because it give the educator an overview of learner’s progress and enable him/her to plan how teaching and learning should unfold. There are forms of learning assessment that are highly recommended in science education because they promote enquiry learning e.g. demonstrations, investigations, and science projects (Bogut et al., 2017; Page & Reiss, 2010). Assessment is an important tool to track the effectiveness of the enactment of RBT in Life Sciences lessons.

2.4 Why Life Sciences educators enact RBT

According to de Jager (2013), curriculum developers neglect to monitor the curriculum implementation stage in South African schools hence they encounter the challenges they do. In their study, (Rogan & Grayson, 2003) argue that the factors impacting negatively on curriculum implementation would have been minimised if a link existed between curriculum development and its implementation. Thus, during the planning and decision-making stages, these factors could have been identified and minimised by consensus of applying various strategies to litigate them. As a result, policy would be interpreted the same way by everyone.

2.4.1 Teacher factors

Different personal and contextual factors affect the way educators enact a new curriculum. Likewise, the enactment of Life Sciences curriculum as in RBT is not immune to the impact of the teacher factors. Some educators underwent training programmes that did not adequately capacitate them to make use of specific teaching resources used in modern Life Sciences classrooms (Sierra Llorente, Romero Mora, & Palmezano Córdoba, 2018). Consequently, they may not be so confident in using certain teaching resources and may lead to them under-utilising those resources in their teaching. The capacity of the school to support innovation of educators according to Rogan and Grayson (2003) may be enhanced by looking at educators' professional development needs and addressing them.

2.4.1.1 Technical competence

In South Africa, there is a national outcry of skills shortage across all sectors (van der Walt, Thasi, Jonck, & Chipunza, 2016; Van Romburgh & Van der Merwe, 2015). Sierra Llorente et al. (2018) maintain that emphasis is put on what educators teach instead of how they teach. Studies show that both pre-service and in-service educators are inadequately trained to use modern technologies in education for teaching and learning purposes (Dlamini & Mbatha, 2018; Gülbahar, 2008). Educators' technical competence differs with age. The majority of older educators have difficulty understanding technology compared to younger ones. Consequently, that affects the way they enact RBT in their lessons since they prefer to use traditional teaching resources over modern technologies (Ozkan, Semko, & Willis, 2004). This, according to Loredana (2010), has a tendency to encourage rote learning, which does not encourage learner participation. It also perpetuates disinterest in learners who are usually reportedly bored and exhausted in classes while attending technology-orientated lessons, whereas learners should be active role players in their own learning and participate fully in the learning process (Loredana, 2010). It is, therefore, necessary for the DoE to consider upskilling pre-service educators by preparing them for the role they should play in a technology instruction-orientated classroom so that learners' learning experiences can be enhanced (Ozsevgec, 2011).

An examination of pre-service and in-service educators' technology training experiences was done by Williams (2017), who discovered that in-service educators have varying degrees of technology experiences from their universities where they undergo training for professional development in the field. Educators' experiences ranged from no experience to moderate experience. Williams (2017) recommends that classroom technology should be incorporated in educator training programmes to equip educators with newly developed skills for delivering effective lessons. The study also recommended that pre-service educators' skills be aligned with the requirements of the technology tools that they will be using when they go to teach in schools.

Wood (2018) maintain that educators might be playing a leading role in producing scarce skills personnel in a country, but they need training too. Scholars agree with (Wood, 2018) that educators must be upskilled and capacitated to use technology tools to teach effectively (Mutz, 1999; Trotter, 1999; Williams, 2017). Gulbahar and Guven (2008) conducted a survey on ICT usage and the perceptions of educators towards ICT use for teaching. The findings showed that although educators are willing to use ICT resources and are aware of their (ICT tools) educational potential, they face a problem in relation to accessing the ICT resources and the fact that they do not have technical skills to use ICT resources for learning.

A mixed methods study conducted by Jita (2016) show that pre-service educators are more competent in non-technology related skills compared to the technology related knowledge fields. Significant variations emanating from their unequal learning opportunities were noted in their ICT competencies. Jita's study found that the more lecturers use ICT tools in their teachings, the better pre-service educators learn to use ICT tools in their own teaching.

The onset of the fourth industrial revolution necessitates the professional training of educators in ICT and use of teaching technologies. There is a rising need to provide media education that responds to the challenges of the information society, training needs of educators, development of innovative approaches to implement effective media education models into education (Sukhomudrenko, 2016). Due to the rising trend of information access in education modernization, there is a dire need to advance educators' training levels as the educators are obliged to use information technologies in their teaching. Special attention should, therefore, be paid to the implementation of new forms of learning that integrate the use of computer resources and other technical gadgets. Like in many parts of the world, the Ukrainian education system has intensively upgraded its services and implemented new multimedia technologies in the education process at all levels of schooling, from kindergarten to tertiary level. Therefore, the Ukrainian DoE prioritises the training of educators for the use of modern educational technologies. In his experimental study, Sukhomudrenko (2016) looked at the implementation of educational technologies into the education process. In the process, computer programs, textbooks, and methodological recommendations were developed for educators.

According to Al-Hazza (2017), education training programmes should be tailor-made to compulsory use of tablet technologies. In his study, Al-Hazza (2017) used qualitative data collection instruments such as interviews and journal entries of the pre-service educators to gather their (educator's) experiences in devising literacy learning experiences using tablets. It was discovered that although educators were good and confident users of electronic devices, they had difficulties in preparing lessons that enhance learners' literacy when using tablets. This is so because even educators themselves were not adequately skilled to use tablet technologies and the internet. A mixed methods approach was used to examine 21 pre-service educators' experiences of the potential of tablets to enhance reading skills of learners. The questionnaires were used to gather information about the daily habits of educators when it comes to use of electronic devices and their (educators') views on enhancing learner literacy.

2.4.1.2 Teaching philosophy

Bowne (2017, p. 59) define a teaching philosophy as "a narrative essay which reflects an individual's beliefs and values about teaching and learning, often including concrete examples of the ways in which that individual enacts those beliefs." A teaching philosophy entails specifications of how an educator educates him/her learners. Educators therefore bring into the classroom different beliefs about teaching and learning based on their experiences of pre-service training courses (Williams, 2017). The beliefs of science educators may entail the meaning of science and the cordial relationship between teaching and learner's learning of science. Teaching philosophy also entails the use of appropriate teaching approaches which emphasise links with the environment, and how the educators addresses misconceptions in the Life Sciences classroom.

Kalaw (2018) assert that a teaching philosophy provides a focus for teaching activities and also describes the teacher's identity. The ability of an educator to impart knowledge to others emanates from him/her knowing the subject in depth and being able to motivate learners to think critically and longing for knowledge. A teaching philosophy reflects that an educator in a lifelong learner and that he finds a variety of teaching strategies useful in his teaching, and that he timeously examines them to improve them. Thus, an educator should create a healthy classroom environment as guided by his/her teaching philosophy because such an environment encourages active learning because learners are relaxed and excited. Bowne (2017) is of the view that thought-provoking questions will lead to scientific discoveries as they engage in investigations. Thus, educators' beliefs are important in shaping lessons and their content knowledge contributes to a variety of learning styles that could be adopted by their learners.

2.4.1.3 Content knowledge

Most South African educator training programmes used to emphasise pedagogical content knowledge above subject knowledge. Certain education colleges prescribed a curriculum whereby a student teacher enrolled for a Senior Teachers Diploma would study general science didactics, irrespective of having done any science subject. These students would then qualify to be science educators without having done or being exposed to any scientific content knowledge. This impacted negatively on classroom practice because science content knowledge has a big influence on classroom practice. Duruk, Akgün, and Tokur (2019) as well as Mikeska, Kurzum, Steinberg, and Xu (2018) maintain that educators with a strong science content knowledge can develop good questions to assess learners understating of science phenomena. However, Mikeska et al. (2018) describe that educators with shallow science knowledge lacks the ability to scaffold learners to comprehend knowledge for the development of conceptual progression.

Scholars like Nehm, Kim, and Sheppard (2009) as well as McCourt et al. (2017) agree that educators teach the way they were taught. The same authors maintain that educators who view science as a body of knowledge for solving problems, will plan their teaching and assessment tasks for learners to use in a similar manner. Grayson (2010) states that the majority of science educators in South Africa teach content they are comfortable with and skip the rest regardless of its relevancy to the child. Grayson (2010) urges educators to improve on their content knowledge because it is a pre-requisite for greater performance in classroom practice since it provides educators with an understanding of science before they make learners to understand

2.4.2 Learner factors

Life Sciences learners are confronted with many challenges in using resources for their learning, that is, personal, family related and schooling challenges. Keller (2017) identified that Life Sciences learners had poor levels of microscope skills. According to the author, poor microscope proficiency could lead to learners failing in higher level courses if not addressed early. It was revealed in the study that Life Sciences learners were poorly prepared for success in Science, Technology, engineering, and mathematics courses. To improve learners' microscope skills, the author implemented formative assessment approaches on top of summative assessment approaches. Results revealed that doing formative assessments familiarised learners to the microscope and eventually led to the improvement of microscope skills. The educator, through this study, was also able to identify learners' challenges and modify his approach in a more effective manner than would have been possible using summative assessment alone. This means that daily activities such as classwork and homework are essential ingredients to improving Life Sciences learners' microscope skills.

2.4.2.1 Poverty

According to Wiseman (2012), learner poverty is the most significant influence on science teaching and learning and it implicates educators as they are obliged to account on the progress of their learners. Learner poverty also implicates school factors on the learning process of learners in high poverty-stricken communities. To that effect, learner poverty is the strongest determiner of poor performance in science teaching and learning and surpasses school factors (Hargis, 2001; Wiseman, 2012). Wiseman (2012) did a cross-national comparative qualitative study to gather evidence on the impact of learner poverty on teaching and learning from South African and international samples. The cross-national comparison compared South Africa with 40 other countries through the use of internationally comparative second hand data from the 2003 Trends in International Mathematics and Science study of eighth-grade science assessments and background questionnaires. The hypothesis that learner poverty is the most stable and strong indicator of science teacher practice and learner's performance in South Africa compared to education systems around the world was tested using the collected data. Hierarchical linear modelling was used to analyse the cross-national data. It was discovered that indeed the hypothesis was correct.

It was, therefore, evidenced that because of poor socio-economic backgrounds of the majority of science learners around the world, their exposure to the internet was affected (Hargis, 2001). As a result of this, when internet is introduced to young learners, they tend to lose focus. It was recommended by Hargis (2001) that during teaching and learning, these young learners must be monitored and guided.

2.4.2.2 Support to learners

According to Maclellan (2014), teachers' lack of confidence on their learners creates a barrier because learners might not be provided with the necessary support they need. Learners' diverse background is another barrier contributing to their drop in academic potential due to lack of academic support from educators, and the provision of basic needs from their parents. Again, because of diversity, various teaching modes are required to enable all learners to acquire the necessary knowledge and scientific skills. McEntire (2011) argue that educators should emphasise the development of thinking and reasoning processes more than the acquisition of scientific knowledge. In their lesson presentations, educators must employ enquiry methods to give learners the chance to develop solutions for themselves by themselves if the development of thinking and reasoning skills are to be achieved. Educators must provide appropriate guidance to learners. They should also transmit knowledge to learners in a simple structured way, and by giving straightforward problems that require simple solutions for learners to solve. Chander (2012) recommends this approach because certain learners lack confidence because of poverty (Wiseman, 2012), and she is of the view that scaffolding techniques can solve this problem

2.4.2.3 Language

South Africa is a culturally diverse nation with eleven spoken languages. A typical South African classroom is diverse and is characterised by unique needs of learners (Rivombo, 2016). Due to classroom diversity, language is central in the South African classroom (Mthiyane, 2016). From the eleven spoken languages in South Africa, only English is the language of instruction. However, the incremental introduction of CAPS in 2012 brought some light by allowing home language to be used as a medium of instruction in the Foundation Phase (Education, 2011). The use of language by educators should be simple and easy for learners to understand. Educators must also apply code switching to enhance learners understanding.

2.4.3 Physical resources

There are a variety of educational physical resources that are used in the teaching of Life Sciences. The use of resources enhances learning, conceptual understanding, and increases learner participation (Hemenway, 2000; Ozkan et al., 2004). Therefore, it is a necessity for educators to employ a variety of resources in their lessons for successful teaching and learning to take place. Hemenway (2000) argue that the interaction of educators, learners and the content with the available resources is crucial for learning during the enactment of RBT. In their study Cohen, Raudenbush, and Ball (2003), introduce the classroom diversification paradigm which is concerned with the efficient use of resources during classroom practice. Educators should be good classroom managers, and should employ a variety of teaching methods that encourages learners to use resources to maximise learning. Buildings in the form of libraries, laboratories, classrooms, and others are resources that might have a substantial impact on the attainment of educational goals. Teaching methods and strategies to be prioritised is RBT and scaffolding practices. Ozkan et al. (2004) allude that the availability of resources in school does not ascertain change, how they are used is what greatly impacts on the outcomes

2.4.3.1 Improvised material

The use of improvised instructional material in science teaching and learning is not new in education research (Bullen, 1983; Davis, 1953). The use of improvised teaching material gained momentum in the eighteenth century. Since the majority of schools in developing countries are under-resourced (Bantwini, 2009), educators have opted to use unconditional materials to impart knowledge to learners. In Ghana, Yeboah, Asante, and Opoku-Asare (2016) conducted an exploratory study involving Primary, Junior, and Senior High School Art educators from Kumasi Village. The educators created instructional resources using recycled waste material from the environment and taught their learners using those improvised resources. The study found that lessons where the use of the developed improvised instructional resources were employed were more practical, interactive, interesting, and real to learners and alternatively enabled them (learners) to perform better in their studies. The findings were similar to the findings of a study by Okori and Jerry (2017) who discovered that the use of improvised material enhances performance of learners. The authors further recommend that the DoE provides adequate resources to schools and fund training workshops for science educators to keep them enlightened with the latest developments in their subjects. The authors argue that this could lead to adequately skilled educators who produce good Life Sciences matric results.

Dragojlovic and Jones (1999) state that science educators can use small glass vial filled with a methanol solution, salt and a wick made of single-ply toilet tissue to replace an alcohol burner when doing science practical work. Educators are, according to Dragojlovic and Jones (1999), obliged to carry the mandate of doing science practical work regardless of the availability of resources, and as long as they can find alternatives to design unconditional instructional material. The Life Sciences policy document is in agreement with Dragojlovic and Jones's statement that educators should improvise to carry out science practical work (Education, 2011).

Bhukuvhani, Kusure, Munodawafa, Sana, and Gwizangwe (2010) investigated the way pre-service educators used improvised instructional material to teach science. The authors purposively sampled 11 Bachelor of Science Education Honours students and the results showed that the majority (90.9%) of the students used improvised laboratory experiment in their teachings. It was apparent in the study that although the pre-service educators understood and knew the benefits of virtual laboratory teaching, they however did not use technological resources in their teachings. It was recommended in the study that educator training programmes need to focus on using technology for instructional purposes and infusing educators' technical skills rather than familiarising them with technology for teaching with less practice. According to the authors, effective technology integration in pre-services educators' training programmes is likely to support learner-centred learning.

The use of improvised instructional material has proven to be successful in Nigeria. According to the findings of a study conducted in Nigeria by Iji, Ogbole, and Uka (2014), improvised instructional material increased learners' achievements in Mathematics. The study adopted a quasi-experimental design using a sample and non-randomised pre-test and post-test control group. The study sampled 1680 learners from Makurdi Metropolis. The findings revealed that the experimental group that was taught Geometry with improvised material improved on their understandings of Geometry better than the control group, which was not taught using improvised teaching materials. The authors recommended that Mathematics educators should use improvised materials to teach the Geometry section of Mathematics in their lessons.

The use of improvised instructional material in science education has shortcomings. However, Akuma and Callaghan (2016) propose a framework to be used to reduce instructional challenges encountered when using improvised equipment and materials to teach science in high schools. There are environmental concerns linked to the use of improvised materials for science practical work.

2.4.3.2 Technology

The widespread use of the internet has made the education fraternity a technical resource-intensive space. This consequently raises a need to resource schools with technology devices to support teaching and learning. A technology equipped school is likely to perform better than the one which is under-resourced (Bantwini, 2009).

An early study advocated the use of resources such as PowerPoint slides, filmstrips, television, videotapes, and videos to teach science (Sigda, 1983). According to Sigda (1983), technology can be used to replace first-hand experiences in cases where they are impractical to practice in the classrooms. Providing information about inaccessible places and times, describing and displaying unusual Life Sciences phenomena, coping with perishability, and reducing expenses are some of the events where the use of technology is considered instrumental (Sigda, 1983). Moreover, Bourdeau (2009) argues that the Corroboree website engages learners who are studying Life Sciences and technology online to exchange information well with other learners from different schools.

2.4.3.3 Computer

In science education, a computer has always been used to enhance teaching and learning of certain subjects (Acioli, 2019). In Life Sciences, a computer is widely used to teach content and scientific experiments (Mutch-Jones et al., 2018; Shegog et al., 2012). Computers are also used by educators and learners to project scientific phenomenon that are accessible from various websites in electronic form (Katircioglu & Kazanci, 2002).

There is extensive research that has been done in this branch of computer science in education because the use of computer games for teaching for instance forms part of our society and culture (Oblinger, 2004). Studies show that people who use computers the most in their homes are children, particularly boys who find computer games appealing to them (Downes, 1999; McFarlane, Sparrowhawk, & Heald, 2002; Mumtaz, 2001). Research in computer science shows that games affect the way children perceive science and the world as they grow up outside school (Kafai, 2001; Kirriemuir & McFarlane, 2004). A study by Papastergiou and Solomonidou (2005) explored domestication of the internet in Greece and reported that children aged 12-16 years spent most of their time playing online games. Frequent interaction with computer games increased their abilities to use computers for formal learning of science.

In contrast, children of school-going age often spend most of their valuable time playing instead of their school work (Prensky, 2003). This negatively affected their view of formal learning as they often found it boring and meaningless (Facer, 2003; Harris, 1999). Studies report that children's prior gaming experiences create a disconnection between formal education and informal learning through digital games (Mumtaz, 2001; Oblinger, 2004). However, games can be an effective medium of learning science with its positive learning environment that includes student centeredness, element of enjoyment, and development of skills such as critical thinking and problem solving (Kafai, 2001; Oblinger, 2004; Prensky, 2003). Educators need to carefully select appropriate RBT tools before they start any lesson to achieve the intended aims and objectives of the lesson because it is very easy to divert focus when using game-based learning.

Prensky (2003) have popularised an earlier assertion by Kirriemuir (2002) who argued that gaming activities should be incorporated into formal education. Kirriemuir (2002) proposed that the design of educational programmes for lower grades should include a gaming element to invite learner's interest and incite motivation. However, limited evidence transpires from the literature reviewed on the potential of gaming to facilitate concrete learning in science subjects such as Life Sciences (Kafai, 2001; Kirriemuir & McFarlane, 2004).

In view of the above, a study by Klawe (1999) concluded that in Mathematics of grades 4-8, children's motivation and academic achievement were improved through games while another study involving learners aged between 8-12 years revealed contradictory results as the learners failed to articulate underlying Mathematics concept (Young & Upitis, 1999). Gaming is, therefore, not consistent to learning of science subject content; however, it is useful for inciting learning and challenging learners' critical thinking and problem solving when used appropriately. When educators are using gaming in Life Sciences, they must carefully employ it for motivational purposes and monitor it strictly.

In Greece, a study was conducted to fill the gaps that arise from gaming literature (Papastergiou, 2009). The study compared a computer game for learning computer memory concepts in High school computer Science curriculum with a similar application with the same learning objectives and content but with no gaming aspect. The findings of that study indicate that the gaming approach was most effective than the non-gaming application because it promoted learners' knowledge of computer memory and motivation. The study concluded that in high school computer Science (including Life Sciences), scholastic digital games may be used as motivational learning environments despite learner's gender.

In Kenya, Kiboss, Ndirangu, and Wekesa (2004) carried out an experimental study to investigate the usefulness of a computer-mediated system (CMS) instruction program in improving learning of cell theory (division) by secondary school learners. This study was triggered by early studies in the Science discipline that reported on inappropriate instructional methods employed by Life Sciences educators to teach, and a lack of instructional resources. The problematic areas concerned were concepts such as mitosis, meiosis, chromosome, and chromatids. A sample of 102 learners (59 boys and 43 girls) was randomly selected from three secondary schools in the same education district and exposed to identical content on cell division for three weeks.

The learners' academic outcomes in cell theory were assessed by three dependent measures which are; the Biology Achievement Test (BAT), the Biology Classroom Environment Questionnaire (BCEQ), and the Pupil Attitude Questionnaire (PAQ) (Kiboss et al., 2004). The findings of the study showed that the CMS was effective to teach cell division because the results of the participants were much higher than their counterparts in the regular school program. Gender was reported as not influential in the outcomes of the subject. Similarly, Vanderbeck (2017) discovered that Grade 8 learners' performance in Mathematics was improved after they have spent more time on a computer.

2.4.4 Online resources

In Hong Kong, So and Ching (2012) evaluated the choice of educators for online resources and how they create learning environments. The findings indicated that educators were able to select online resources needed to reach set objectives and scaffolds and create conducive learning contexts. Armatas, Holt, and Rice (2003) also concluded that the designers of learning programmes for online educational resources need to consider individual differences and experiences when designing programs as they greatly influence their effectiveness.

In Canada, Beach and Willows (2014) carried out a research to understand the factors motivating educators to use Internet-based resources. The researchers used the virtual revisit think aloud method to examine these factors and generated the data using computer software. The study comprised 11 primary school educators who volunteered to participate. Data was collected using individual observations which occurred at a computer terminal. The findings of the study indicate that educators developed competency in analyzing information, became critical thinkers, and produced themes related to higher cognitive processes as they interacted with the internet-based resources using the virtual revisit method. Thus, internet is a powerful resource that can be useful to both learners and educators during the instruction of Life Sciences.

Khoza (2012) examined the use of online resources to teach a curriculum module in a university in South Africa. The participants of the study were eight postgraduate (Honours) learners and one facilitator. The focus was on their experience on the use of the four-popular teaching and learning resources namely; online chat, discussion forum, Facebook, and Blogs. Findings from the study indicate that online chat were effective because the facilitator used them to break up the ice, which then gave a chance for active participation even to the shy learners.

Matusiak (2013) was interested in interrogating learners' experiences in learning with image and multimedia resources. The findings show that images assist with mnemonic and descriptive functions as learners are introduced to new concepts. Learners were able to remember the details of the processes they learnt through the images. However, their role was restricted in some cases which required them to synthesize and analyze knowledge. The study also concluded that digital technology enables access to information resources and increases the possibilities for knowledge representation. The study further suggests more research on images and multimedia in the digital environment.

So (2012) carried out a study to create a framework of a resource-based e-learning environment for Science primary classrooms. The aim of the study was to design learning environments and to investigate how educators integrate online resources in their teaching of Science topics. The results of the study show that the instructional design of the educators was authentic. It was also reported from the study that a sense of autonomy and intrinsic value of learning in learners can be enhanced when they can make a choice as they engage with the online resources.

In view of that, Khoza (2015) explored e-learning environments in his interpretative case study of two groups of learners and a facilitator, who were involved in the teaching and learning of a post graduate research module in a South African university. The findings of the study show that all the learners highly recommended the facilitator. This suggests that the facilitator created conducive e-learning environments because the module achieved a 100 per cent pass rate with several distinctions. Also, the students knew what was expected of them. Results indicate that the resources used worked well for the module.

2.4.4.1 Film and Videos

Studies show that films and videos have been widely used to enhance the teaching and learning of science subjects across the world (Hockly, 2016; Klemenc-Ketis & Kersnik, 2011). The establishment of the use of film to teach Life Sciences can be traced back to the sixteenth century (Allen, 1975). In her study, Allen (1975) investigated the effects of viewing a film that shows a simplified biological food chain and the actions of predation in the food chain. The study was aimed at describing the educational potential and uses of a film for teaching and learning. Results of the pre-test and post-tests from the three experimental groups that were used in the study revealed that the use of film for educational purposes was beneficial for elementary school children because it was able to show natural processes that would have been impossible to describe without the use of film representation. It was also discovered that elementary learners were more aware of the factual part of the film.

The use of films for learning was not only proven to be effective in teaching school children (Allen, 1975), but it was also proven useful in both regular and special schools (Hockly, 2016). Using films to teach is a multidisciplinary approach and is proven to be useful in teaching learners of other disciplines such as nursing (Masters, 2005) and medicine (Klemenc-Ketis & Kersnik, 2011). In her study, Masters (2005) evaluated two groups of learners' perceptions of viewing films as an alternative to clinical time in a psychiatric mental-health course. Learners enjoyed learning through the film and gave it a high rating on the 12-item and 7-point Likert scale that were used to assess their belief about the value of films as a learning experience. The study concluded that the use of films to teach nursing was a creative way of engaging learners in learning about complex science phenomena.

Films are not only used to teach complex concepts and content (Allen, 1975; Hathaway, 2013). They are also used to teach professional behavioural patterns that are difficult to teach and assess (Klemenc-Ketis & Kersnik, 2011). Klemenc-Ketis and Kersnik (2011) conducted a qualitative case study of eleven fourth year Medicine learners from the University of Maribor. The study was aimed at testing the relevance and usefulness of movies in teaching professionalism to fourth year learners through an elective module on professionalism. Questionnaires and interviews were analysed through thematic analysis and the results revealed that learners recognised the importance of communication, compassion, palliative care, and the doctors' personal care when working with patients. The participants also reflected on their attitudes towards life, death and dying, and they began to value human life. The study concluded that the controlled environment of movies enabled learners to realise their values, beliefs, and attitudes towards features of professionalism without feeling that their personal honour has been compromised.

Literature has shown that learners generally have a negative attitude towards science

(Fancher & Gutkin, 1971; Onel & Firat, 2019; Vodopivec et al., 2002). Despite that, there are positive effects associated with the use of films in teaching high school science (Dubeck, Bruce, Schumacker, Moshier, & Boss, 1990). In their study, Dubeck, Moshier, and Boss (1995) maintained that the use of films to teach Life Sciences can improve learners' attitudes towards science. The same authors argue that films are instrumental for reversing the negative attitudes that learners usually bring to the Life Sciences classroom. This, according to Dubeck et al. (1995), stimulate the learners' interests in subjects such as Physical Sciences, and Life Sciences that were anticipated to be boring and difficult.

Despite the fact that films were an excellent resource for teaching complex Life Sciences phenomenon and terminologies, there are implications associated with their use in the classroom (Mallinson, 1952). According to Mallinson (1952), the most effective ways of using films have not yet been established. Mallinson (1952, p. 37) argues that "it is unwise to assume that any film used at any time may offer a fruitful educational experience". In some cases, what was ideally supposed to be a great lesson can turn out to be a disaster. Mallinson places implications associated with the use of films for teaching Life Sciences into four categories. First, there are many films available for use in the teaching and learning of Life Sciences across all grades and that is likely to cause confusion to educators. Second, as much as films have saturated the space, there is difficulty in obtaining precise films for use in specific topics at a specific time because educators frequently reported that they "can't get films when desired". Third, the majority of available films designed for Life Sciences teaching and learning contained errors and misconceptions, and thus caused confusion to learners.

2.4.4.2 Social networks

Social networks have been found appropriate for teaching science across the world (Keller, 2017; Pai et al., 2017). The section below describes studies that demonstrates the effectiveness of social media in the teaching and learning of science subjects, including Life Science.

Facebook

Studies show that networking is useful for classroom instruction (Balakrishnan, 2014). Facebook, for instance, is useful to encourage science discussions in an overcrowded classroom (Pai et al., 2017). In their study, Pai et al. (2017)used Facebook to engage learners in active scientific discussion about Life Sciences phenomena, to build community within the learner body in class, and to promote communication between learners and educators. After the Facebook page as created, learners joined and completed main class assignments which required reading, discussing, and writing about a science news article found in Facebook. It was discovered in the study that due to the fact that the bulk of the learners were familiar with Facebook, it was then effective in engaging them (learners) in the classroom discussion. It was then recommended that Life Sciences educators should incorporate Facebook in their teaching to enhance learners learning experiences.

According to Dohn and Dohn (2017), the use of Facebook for educational purposes is not clearly defined. In their deductive case study, Dohn and Dohn (2017) investigated the integration of Facebook to secondary school Life Sciences instruction. It was discovered in the study that linking formal and informal communication practices on Facebook created barriers in communication. The barriers were as a result of distractions, ethical issues, and certain depreciation of the activities ensuing from Facebook communication platform. However, a good thing about the use of Facebook for teaching and learning was that it maintained learners' interest and opened up new learning possibilities for them. The study concluded that the use of Facebook for educational purposes was not clearly defined. It had both benefits and serious shortcomings.

A study was done to investigate the motives of creating and maintaining Facebook for university learners in the United States. Facebook was identified as an invaluable tool to enhance learners' experiences of learning high Natural Sciences (Meneses & Álvarez Morán, 2013). The impact of Facebook in education is incomparable in the sense that Facebook is multidisciplinary (Delello, McWhorter, & Camp, 2015; Mandavgane, 2016). A quasi-experimental design study was conducted to investigate the extent to which Facebook enhances learners' learning experiences of Natural Sciences in a school in Ghana. The independent variable was the enactment of Natural Sciences as a subject on Facebook while the impact of the enactment of Natural Sciences on Facebook to learners was the dependent variable of the study. The study found that the social network Facebook is ideal to support the pedagogical process of enquiring Natural Sciences content and concepts, and greatly improving learners’ academic performance.

In her study, Indu (2018) investigated the implications of Facebook and WhatsApp amongst secondary school learners in India. The focus of the study was on the purpose and the frequency to which the learners use the two social networking platforms. The author defines social media as the use of the internet and web applications for communicating. A survey research design was used to gather information from 80 secondary school learners about their usage of social media in terms of the purpose for using it and hours spent on Facebook and WhatsApp, the number of learners who have Facebook and WhatsApp accounts, and their thoughts about the effectiveness of social media for learning. A questionnaire was administered and completed by the learners. A percentage analysis was used to analyse the 100% response rate. The results show that 75 of the learners were on Facebook, 79 had WhatsApp. It was also noted that both types of social media were commonly found amongst the learners. Learners in this study spent long hours on these social networks collecting information and news, passing time, and finding friends for chats, and gather likes and comments. The majority of learners sampled in this study agreed that Facebook helps them to study. It was also pointed out that social media sites have shortcomings too. It was recommended that the university conducts awareness seminars to teach learners about negative impacts of Facebook and WhatsApp as well as the positives impacts to learning.

WhatsApp

The rapid development of the education system was influenced by the growth of technology, which became accustomed in our daily lives such that the majority of people have a smartphone and uses WhatsApp, Facebook, twitter, Instagram, telegram, and other social networking applications. It is undisputable that the 21st generation learners have become addicted to these social networks and applications and solely use them for social relationships and fun. Smart phones and social media have entered in many aspects of our lives due to the fact that we are living in an era of technology. As a result, many fields and professions are using social media to improve communication between colleagues and between learners and instructors (Alshammari, Parkes, & Adlington, 2017; Keogh, 2017).

In Medical Education, social media tools are gaining recognition and momentum as well. The use of WhatsApp for educational purposes has been widely researched but not exploited. In Medical Education, Dar et al. (2017) explored the potential of using WhatsApp as an instructional strategy for 4th year MBBS learners in ophthalmology. Two WhatsApp learners' groups were used, one with males and the other with females. To conduct the study, lecture topics and images of taught topics were shared on the two WhatsApp groups. Learners were encouraged to ask questions in the groups for clarity. Learners were then requested to give their feedback on the activity of the WhatsApp groups after ten lectures. The feedback was collected via a series of questionnaires that were administered post lectures. From the 234 respondents, 145 (62. 0%) of them were females and 86 (36.8%) of them were males and all of them filled the anonymous questionnaire. Results revealed that 189 learners used social media to learn Medicine while only 45 of them were allegedly not using WhatsApp to lean Medicine. It was also found in the study that 67 of the learners were using both WhatsApp and Facebook, 65 learners used Facebook only, and 57 learners used WhatsApp only. The study also revealed that 60% of the Medicine learners used social media more than twice a day and 80 % of them were females. The study concluded that WhatsApp was beneficial in enhancing learners' motivation, improving the learning experiences of undergraduate learners complementary to traditional teaching practices of the educator.

The history of the emergence of WhatsApp shows that it developed from natural flow amongst learners. As a result, it was adopted as a tool of educational technology after it was used by various educators and proven useful to enhance learners' learning experiences. Cetinkaya (2017) emphasized the significance of WhatsApp as an educational tool that assisted learners to master concepts and science phenomena. In the study, Cetinkaya (2017) strived to identify the benefits and drawbacks of using WhatsApp in teaching high school learners. A survey model was used together with open-ended questions that were asked to 145 learners together with semi-structured interviews that were done with 6 learners to answer the research question of the study. Content analysis and phenomenological analysis were methods used to analyse data. The study discovered that benefits and drawbacks of using WhatsApp for educational purposes normally used by learners were for communication purposes, are listed as technique, education, and academic. Results show that WhatsApp has the potential to provide natural and unstructured learning environments. It was advised that educators should adopt the use of WhatsApp to teach.

2.5 The challenge of resource provision in South African schools

Educators in rural schools are subjected to the worst working conditions such as lack of teaching resources and classrooms, lack of electricity, pit toilets that pose a health risk to them and learners, fatigued learners due to long travelling distances to schools, old learners (Friedrichsen, Linke, & Barnett, 2016), and other conditions which may impede successful enactment of RBT. The availability and quality of teaching resources has an effect in educator's enactment of RBL especially in rural schools.

Lack of resources seems to be a persisting challenge continentally. Maebuta and Phan (2011) conducted a study to trace the results of rapid educational reforms such as the introduction of community high schools in rural villages to increase educational access in rural parts of the Solomon Island and improve delivery of quality learning in schools. A case study design approach was used to examine how educational reform affected delivery of quality education using available resources. In-depth interviews with school principals and educators showed that scarcity of teaching resources impeded delivery of quality education in these schools. Site visits to these schools also revealed that lack of financial resources, inadequate teaching and learning resources, lack of qualified educators, and lack of community support hindered provision of quality learning. It was recommended in the study that low educator-learner ratio and the ongoing lack of resources could be addressed by amalgamating the existing small rural community high schools into regional boarding schools.

The shortage of resources in schools impedes the enactment of RBT in subjects such as Life Sciences, Mathematics, and Physical Sciences. In America, there are generally low numbers of male educators as compared to females in publicK-12 schools (Chmelynski, 2006). This discrepancy, according to Chmelynski (2006), has potential to discourage learners, especially boys as they may not find inspiration from female educators. That could then result in huge numbers of learners dropping out of school due to absence of male figure role models. Consequently, that could also result in low numbers of university students taking up science-orientated careers in tertiary education. Educator shortages can be blamed on the high rate of migrating educators to other parts of the world such as the United Kingdom (De Villiers, 2007). According to De Villiers (2007), a bulk of South African educators are migrating to England due to economic incentives, and good living conditions in the United Kingdom. Consequently, due to decreased numbers of educators, South Africa is left with no choice than to recruit foreign educators (De Villiers, 2007).

In South Africa, there is not just a persisting shortage of educators (O'Brien, 2010), but also a decay of skilled educators (Kidane & Worth, 2014). Despite the efforts made by the DoE from which about 6000 educators graduate in South African universities annually to meet the demand of more than 12.1 million learners (Evoh, 2007), resources are still scarce in rural schools

According to Nyathi (2017), the majority of schools in rural areas are characterized by meagre resources, a dire shortage of science teaching materials, inadequate resources, and inexperienced educators. Learners' potential remains untapped as these factors hinder effective teaching and learning. As a result, it is extremely difficult for learners coming from these schools to get access to science-orientated careers because of their poor training and exposure to the nitty-gritties of science in high school.

In their study, Kidane and Worth (2014) found that inadequate teaching aids and materials were impeding proper teaching and learning of Agricultural Sciences in public schools in KwaZulu-Natal province, South Africa. Kidane and Worth (2014) collected learners' perceptions of the Agricultural education programme. It emerged as a finding of the study that from 375 learners who participated in the study, 97% of them indicated in their interview narratives that there was a shortage of trained Agricultural subjects educators and unavailability of proper Agricultural infrastructure such as land and Agricultural workshops and laboratories, including direct support (financial). The authors recommended that departmental officials such as subject advisors who are tasked with overseeing Agricultural subjects in high schools must establish mechanisms to provide resources in schools and train Agricultural educators. The existing teaching and learning crisis related to Agricultural subjects teaching in high schools can be minimized by giving attention to the provision of proper teaching and learning infrastructure (Kidane and Worth (2014).

Inequalities exist in the distribution of resources in South Africa because classroom shortages still characterise the post-apartheid South Africa (Pereira, 1999). The media has been saturated by worrying news of consistent shortages of classrooms in developing countries, especially in South Africa. According to Smith Amos (2017), there is an acute shortage of classrooms in Florida and that stimulated the school governing body to boycott the Ministry of Education (MoE) officials mandated to resource schools with funds. They suggested the funds be channelled to build classrooms and for recruiting foreign educators to teach learners reading and writing skills.

Bimstein, Gardner, Riley, and Gibson (2008) conducted a study to evaluate the educational, personal, and cultural attributes that motivated or inhibited dental learners' participation in charitable and educational excursions to underserved communities. Interviews, focused on learners' expectations and experiences, were conducted with learners who participated in the excursions and with those who did not. A survey of a larger group of learners, including those interviewed, was also conducted. The study found that skill development, educational opportunity, and philanthropy were the most important motivators for the participation in educational excursions. Cost and time commitments were the strongest inhibitors to participation. Exposure to infectious diseases, substandard working and living conditions, threat of crime, and language barriers were mostly considered as not important.

Similarly, Makhubela, Kramers, Belyanin, Dirks, and Roberts (2017), through their study expressed a concern of financial resources that impeded educational excursions to fossil sites. The study reported reflections of seven high school educators from three different schools who organised educational excursions to fossil sites. From the three schools, only one reported to have been subsidised by the school funds for the trip. Educators of the other two schools reported that they had to fundraise to pay for the expenses of the trip. It was also reported that other learners could not attend the trip due to the fact that they did not have the money for transportation. It is therefore apparent that a shortage of resources is linked to financial constraints in the schools.

2.6 School ethos and management

The school ethos and management are interwoven, have both positive and negative influences, and are easily detectable as one enters the school premises. The atmosphere that prevails in the school have a potential to influence the way educators enact RBT in their lessons (Barrs, 2005; Litva & Peters, 2008). Ö. Ali (2019) posit that a positive atmosphere or ethos is desirable in all schools because it helps to form a strong sense of social cohesion amongst educators and learners. The school ethos reflects the appearance of the school to distant observers in terms of the relationship between educators, learners, the relationship between the staff and the SMT, and even the relationship between the school and the society. Nuzzi (2016) adds that school ethos as the values, principles, and the direction to which educators are obliged to take. Rogan and Grayson (2003) further describe ethos as the general overview of the school. The latter further describe that school ethos depends on how the community of a school behaves.

For instance, if the SMT is not supportive to educational excursions, the enactment of RBT may be compromised.

2.7 Professional development of Life Sciences educators

Given the fact that majority of educators are under skilled in using resources and keeping abreast with scientific developments, there is a need to upskill educators. The education system is evolving every day and there is need for educators to adapt to changing education system to meet its requirements (Hajisoteriou, Maniatis, & Angelides, 2019). Professional development is part of the hotly debated process of educational reform because Theohari (2019) argues that the training of educators is costly and inconveniencing but it is a necessity. Theohari (2019) further states that in-service training of present staff is better than hiring new educators who lack experience. Pharis, Wu, Sullivan, and Moore (2019) are in agreement with Theohari (2019) that it is cost-effective to upskill existing work personnel so as to ensure sustainability and effectiveness. In the education sector, educators undergo regular trainings to prepare them for updated technologies (Hajisoteriou et al., 2019).

The ICT is one of the fastest evolving branches of the education system as it changes daily and needs highly technical users (Romero-Martín, Castejón-Oliva, López-Pastor, & Fraile-Aranda, 2017). In their study, Dlamini and Mbatha (2018) report on South African ICT educators' professional development needs. A questionnaire survey was used to collect data from the ICT educators who were affiliated to an educators' union. The questionnaire was crafted using clues from the Second Information Technology in Education (SITES), which included, amongst others of its constructs, the characteristics of educators, educators' pedagogical practices of using ICT, school factors and school system, and other external factors that have an influence on the way educators use ICT in their lessons.

The findings of the study stressed the need to train in-service educators in ICT skills such as using ICT to teach in multicultural environments, training on the strategies to manage an ICT-orientated lesson. It also emerged as a finding that despite governments' huge expenditure and investments in ICT tools and infrastructure, educators' inequalities in ICT competence still persist. Dlamini and Mbatha (2018) maintain that the investments made in ICT education in South Africa are politically motivated and that educators are being neglected in decision making processes, while preference is given to political visions that advance the ideology of the political organisation from which the educators' union that participated in this study subscribes to.

Educators around the world are generally dissatisfied with their working conditions (Geiger & Pivovarova, 2018; Mfaume & Bilinga, 2017). There is also a public outcry that they need to be equipped with technical skills for the 21st millennium classroom technology (Romero-Martín et al., 2017). In Pakistan, educators continue to express unfavourable working conditions (T. Ali, 2018). In his study, T. Ali (2018) investigated educators' working conditions and their professional development needs. Ali's study found that educators were poorly skilled for using technology resources and some science laboratory practical apparatus such as Bunsen burners. The study found that educators can perform much better if they can be involved in the education process by being supplied with physical and structural resources, including psychological incentives. T. Ali (2018) emphasises that it is the responsibility of the DoE to send educators to workshops and seminars where they will undergo professional development and professional growth.

The widespread use of the internet has provided unlimited opportunities for educators to explore other interesting teaching avenues such as online teachings (Bernstein, 2013; Flannery, 2013).Online teaching requires computer skills and technical skills for one to blend his lessons to appeal better to learners because online teaching is different from traditional teaching methods. Therefore, teaching methods used in traditional classroom settings may not necessary be effective in online teaching (Roy & Boboc, 2016). As new as online teaching is, there is need to develop educators in online platforms (Philipsen, Tondeur, McKenney, & Zhu, 2019). In the United States in Ohio, according to Roy and Boboc (2016), there is a rise in K-12 enrolments, which results in an increased demand for online educators hence the available outcry about the need for professional development of online educators (Philipsen et al., 2019). Roy and Boboc (2016) highlight that face-to face teaching skills are not always transferable to online settings and, therefore, a good face to face educator may not necessarily be a good online educator. Due to online teaching paradigm shift, online educators need to be technically competent and up to date with new developments of online teaching (Roy & Boboc, 2016). Online teaching, according to Roy and Boboc (2016), can be very stressful to educators if they are inadequately skilled and not well-prepared for their lessons. The authors envisaged that the findings of the study will help the DoE officials to develop programmes designed to address educators' professional developmental needs, particularly for online teaching.

It seems like the need for educators' professional development is common across a range of disciplines (Germann & Barrow, 1995). In Missouri in the United states for instance, Life Sciences educators were reported by Germann and Barrow (1995) to be needing professional development programmes in the form of in-service trainings. Their preferences for in-service courses, reasons for their non-participation in in-service opportunities were also described in the study.

In mathematics, Caddle, Bautista, Brizuela, and Sharpe (2016) dispute the widespread analogy 'one-size-fits-all'. The team of researchers argue that mathematics is a different subject and needs to be treated with caution when it comes to professional developmental initiatives because most have limited potential to foster educators' learning. Existing professional development programs are designed without attention to educators' motivations and needs. In the same authors indicate that middle school mathematics educators that engage in professional development initiatives vary hugely in terms of their strengths and weaknesses. The study was a multiple case study of three educators who were selected from 54 educators who were teaching Mathematics in Grades 5-9 in the northern United States schools. The results of the study show that the three educators were differently motivated to teach Mathematics, and that they differed in their self-perceived needs regarding Mathematical content, classroom interaction, and learners' thinking. The authors conclude that it is important to integrate educators' voices when designing and implementing professional development programmes and initiatives.

There is growing social controversy surrounding the teaching of evolution, a section in high school Life Sciences, which the majority of educators are omitting when teaching

(Friedrichsen et al., 2016). In their study, Friedrichsen et al. (2016) surveyed 276 Life Sciences educators and asked them about their content understandings of evolution topics, how they taught certain evolution topics, the extent to which they were familiar to certain evolution topics, obstacles they see as barriers to their teachings of evolution topics, and most importantly, their self-reported professional development needs related to teaching evolution. Educators identified lack of good science laboratories and supplemental materials as their two biggest obstacles they encounter in teaching evolution topics. Educators were also not familiar with available evolution education resources and expressed interest in many aspects of professional development with over 75% of them reporting that they wanted great emphasis placed on every topic listed. Notably, educators reported that they wanted professional development that placed huge emphasis on science laboratories, investigations using real data or live organisms, evolution simulations, contemporary evolution examples, and misconceptions.

Life Sciences educators are leading role players in negotiating the adjustment of their professional development practices in accordance to changing curriculum (Qian, Hambrusch, Yadav, & Gretter, 2018). Eighth Life Sciences educators from moderately resourced schools located in Durban, South Africa were engaged in a dialogue where they reflected on their preferred professional development based on changing curriculum times in the Qian et al. (2018) study. The findings of the study show that Life Sciences educators are resilient to the changing curriculum times, their collegiality and agentic actions allow for division of labour, sustainable ties, and strategies for walking the talk. The study concluded that the agentic forms of educators’ professional development can be moderately transferred to similar contexts and even to less resourced schools. It was noted in the study that educators are not included in the decision-making processes of their professional development, and the curriculum reform illogically contributes to reproducing and producing the existing inequalities of context. Therefore, the integration of educators into the planning, designing, and execution of professional development initiatives is vital for good results.

The review of literature reveals that RBT has been studied globally and intensely outside Africa. Many studies were done in developed countries and there is a dearth of studies done in developing countries such as South Africa. Furthermore, most of the studies done in South Africa were at tertiary level while the current study explored RBT at secondary school level. This study was conducted in rural secondary schools whose context typifies that of several other schools across the country, with the aim of contributing valuable insights into enactment of RBT by Life Sciences educators in rural secondary school settings and why they do it the way they do.

2.9 Theoretical framework

Resource-based teaching is not tied to a single learning theory or to any specific pedagogy (Hill & Hannafin, 2001). Studies show that RBT can be linked to many other theories such as constructivism, the socio-cultural theory, and cultural-historical activity theory (Fisher, Denning, Higgins, & Loveless, 2012). The current study is anchored in the theory of Curriculum Implementation (Figure 1) which was crafted by Rogan and Grayson (2003) with the characteristics of a developing country in mind. Rogan and Grayson (2003) were of the view that curriculum 2005 cannot be implemented in a short period of time or in one large step. They believed that small steps should be taken to phase-in the curriculum while taking into consideration the context of the school. The theory of curriculum implementation according to Rogan and Grayson (2003) is based on three major constructs, namely, Outside Influences, Capacity to Support Innovation, and the Profile of Implementation.

Each construct, according to Rogan and Grayson (2003) has a number of dimensions. For instance, Outside Influences has the five dimensions namely; support to learners, monitoring, change forces, professional development, and physical resources. The construct Capacity to Support Innovation has four dimensions which are; physical resources, teacher factors, learner factors, and the school ethos and management while the construct Profile of Implementation consists of classroom interaction, science in society, assessment, and science practical work.

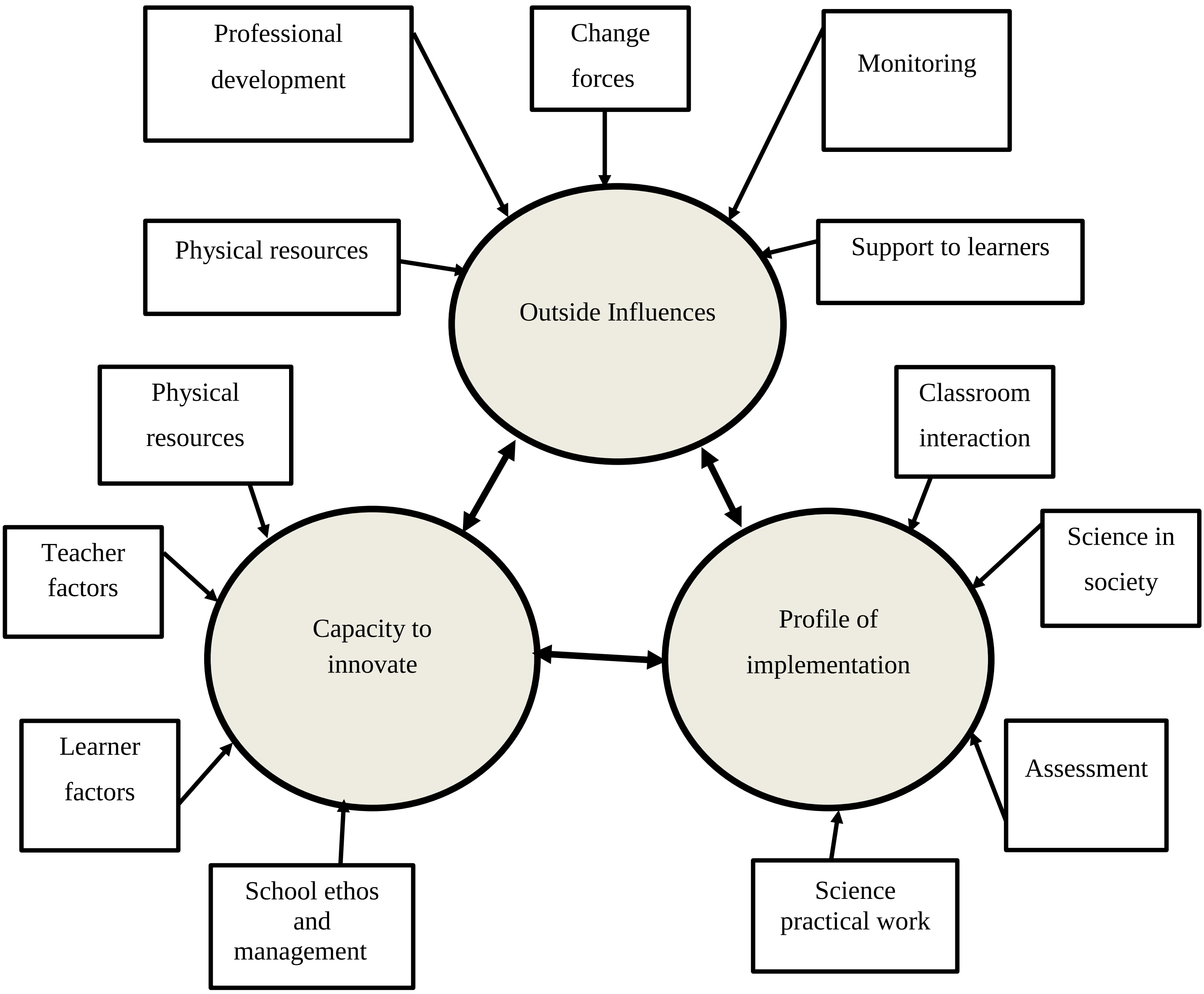

Figure 1. A model of the curriculum implementation theory as adapted from (Rogan & Grayson, 2003).

The construct *Outside Influences* describes the actions undertaken by people and organizations that are outside the school and have an influence on the implementation of the curriculum in a school. Secondly, the construct describes the kind of forces used by external organizations to provide support or apply pressure for enacting changes that are necessary for curriculum implementation in a school. Third, the construct also deals with a number of issues such as material support like the provision of physical resources such as the school infrastructure, stationery, practical apparatus, and human resources such as learner support agents to support innovation in a school. Fourth, it also deals with directly supporting learners with for instance, support groups, peer education and mentorship programmes, social welfare interventions programs, school lunch programs, and after school tutorship for instance and lastly, the construct also describes the professional support given to the school in terms of educator's professional development(Rogan & Grayson, 2003).

The construct Capacity to Innovate, as stipulated by Rogan and Grayson (2003), describes the capacity of the school to support innovation such as the enactment of RBT. The availability and state of physical resources in a school is likely to affect the capacity for the enactment of RBT in Life Sciences lessons. According to Rogan and Grayson (2003), teacher competence is likely to affect the enactment of RBT. Educators' poor levels of technical competence are also likely to negatively affect their enactment of RBT whereas those who are highly competent may enact RBT more efficiently and effectively. Learners' attitudes and their socio-economic background are also likely to affect the enactment of RBT in Life Sciences lessons in the sense that learners from poorly-resourced rural schools may not be exposed to proper learning resources as compared to their counter parts in urban well-resourced schools. Therefore, learners' learning experiences will not necessarily be the same and their engagement with the resources will definitely not be equal due to unequal exposure to learning resources. Lastly, the school's atmosphere and managerial strategy may also influence the enactment of RBT in the sense that the school management team (SMT) members who understand RBT may make means to fund Life Sciences educational excursions and supply Life Sciences educators with as much resources as they may need.

The construct Profile of Implementation is paramount as it is a determinant for the feasibility of curriculum implementation (Rogan and Grayson (2003). The profile of implementation describes the environment where Life Sciences lessons are usually conducted and observed to see the enactment of RBT. Science in society describes how educators integrate Life Sciences to the society surrounding the school. Rogan and Grayson (2003) argue that Life Sciences should be made as practical as possible by integrating social elements into it to enable learners to understand it better. When enacting RBT, it is important for an educator to engage in formative assessment regularly to diagnose the extent of learning to judge whether RBT was successfully enacted or not. Lastly, science practical work is an integral part of Life Sciences teaching hence educators are obliged to engage in science practical work for RBT is to be successfully enacted (Rogan & Grayson, 2003). The three constructs are discussed in detail below.

2.9.1 Support from Outside Agencies

In the current study, outside agencies are defined as all the external organizations such as donors and NGOs, including the DoE that is obliged to facilitate initiatives that support the implementation of a curriculum such as RBT (Bantwini, 2009; Rogan & Grayson, 2003). In developing countries like South Africa, schools are often funded by agencies that are largely composed of international donors from other countries (Johnson, Monk, & Hodges, 2000). For instance, school A is twinned with a well-resourced school in the United Kingdom. According to the principal of school A, Chipping Norton (pseudonym), the twin school, donates money to school A yearly and had since established a learner and educator exchange programme between the schools.

In South Africa, outside agencies include the National Department of Education that is obliged to develop policy at micro (national) level while the nine provincial education departments are responsible for the implementation of that policy at meso (provincial) level and for monitoring the daily operations of the schools under their jurisdiction (Bantwini, 2009). The support for innovation in South Africa is somewhat different from other countries in a sense that it is provided by donors from Europe, North America, and the Far East countries (Bantwini, 2009) which inject their donations to NGOs to deliver the resources to schools and support the enactment of RBT at a micro (school or classroom) level (Rogan & Grayson, 2003).

Donor organisations are grouped into three categories under the construct Capacity to Innovate; government departments, unions, and NGOs (Rogan & Grayson, 2003). Various external organisations provide innovation to the school in unique ways and monitor progress through mentoring programmes for educators to see if they are actually being innovative by enacting RBT for instance (Haigh, 2006; Silova & Steiner-Khamsi, 2008). The government, through the DoE, may easily influence changes in section 20 and 21 schools as the schools are fully under departmental administration, whereas an NGO may influence change and innovation through holding the government accountable and by supplying the schools with materials and tools for use in a RBTE. The external donors may also provide in-service training opportunities for educators to upskill them for modern classroom technologies. They can also influence the enactment of RBT by supporting learners to be familiar to the enactment of RBT for learning so that educators can focus on enacting RBT rather than silencing overexcited learners (Hargis, 2001).

2.9.2 Capacity to Innovate

South African schools are generally diverse in terms of their culture, traditions, the extent of development, and the atmosphere that prevails in them (Carignan, Pourdavood, King, & Feza, 2005; Niemann, 2006). These factors determine the daily operations of the school and consequently its performance. The construct Capacity to Support Innovation according to Rogan and Grayson (2003) is a driving force that enables people to judge the successes and failures of schools in developing countries, including South Africa. Indicators of the school's capacity to support innovation are, according to Rogan and Grayson (2003), the availability and the nature of physical resources in a school, factors that affect educators, learner factors and the ethos and management of the school.

According to Rogan and Grayson (2003), physical resources are a major factor that influences the capacity of a school to support innovation and ultimately the performance of a subject such as Life Sciences. The authors argue that poor performing schools are likely to be those that are inadequately resourced. Furthermore, educators alone cannot have much impact if they work using poor and inadequate resource because those resources are likely to demotivate learners for engaging in meaningful learning

Rogan and Grayson (2003) assert that the educators' background, levels and quality of tertiary training, their confidence levels, and their teaching approaches can positively or negatively affect innovation. Educators who lack Pedagogical content knowledge (PCK) because of poor training are a threat to innovation and the education fraternity (Rogan and Aldous (2005). Johnson et al. (2000, p. 181) emphasise the need for educators to embrace innovation by differentiating between a "deficit (educator blaming) view and selection (environmental pressure) view" to their (educators') PCK and classroom actions. This might help to diagnose weaknesses in the capacity of a school to enact RBT. Honesty of educators as they reflect on their teaching practices of Life Sciences is paramount to facilitate this change. Educators should submit if they are struggling so that they can get help and improve on their practices.

According to Bell and Gilbert (1996), educators must not be isolated from their colleagues if the aim is to optimally capacitate them to innovate. When educators collaborate with each other, they share ideas on how to best enact RBT in their lessons and in similar contexts such as field trip activities.

Rogan and Grayson (2003) assert that “schools in developing countries are more dependent on the quality of leadership” (p.1187). The prosperity of South African schools, therefore, depends on the skills (leadership style) and capacity of the SMT to support innovation. The dimensions pertaining to general ethos and management of the school need to be taken into consideration if one desires successful enactment of RBT in rural schools (Rogan & Grayson, 2003). The two factors (capacity to innovate and the school ethos and management) are not the same but can be used interchangeably in rural contexts. As the capacity of the school to innovate changes, the relative importance of the school ethos and management also change from simple to more sophisticated ways. Studies show that the leadership role of school principals, when it comes to implementation, is essential (Berman & McLaughlin, 1977; Fullan, 1991; Hall & Hord, 1987), and if the principals lack management skills, very small to no innovation will be implemented. The principal in such cases needs to restore order and discipline using his managerial strategies. When order is restored effectively, innovation will begin to slowly manifest. This construct is also presented in a series of four levels, in which, unlike the Profile of Implementation, the levels represent a progression from level one to level four and the ultimate goal for a school is to achieve level four for all sub-constructs (Rogan & Grayson, 2003).

2.9.3 Profile of Implementation

In this study the implementation of a curriculum is conceptualised to the enactment of RBT in Life Sciences lessons. This section focuses on the Interface of Learning and Instruction. Put clearly, the classroom or any learning environment such as the ecosystem or forest is a site of the enactment of RBT. The classroom is a place where educators and learners meet to engage resources to support them (learners) to learn. Rogan and Grayson (2003) describe the Profile of Implementation as a construct that shows how the ideas of a proposed curriculum are put into practice. Successful curriculum implementation is influenced by a variety of factors, which include educators who deliver it. This then makes an educator a strong role player in the implementation of Life Sciences curriculum at a school level. Implementation of the curriculum does not solely take place inside the Life Sciences classroom but can also happen outside the classroom depending on the demands of that particular lesson. This was highlighted by Rogan and Grayson (2003, p. 1181) who state that "there will be many ways of putting curriculum into action" and these include the enactment of RBT.

In this study, the theory of Curriculum Implementation was adapted with its levels and their descriptions. According to Rogan and Grayson (2003), the Profile of Implementation attempts to understand, analyse, and express the extent to which the ideas of a curriculum are put into practice. This construct deals with the actions of educators and learners during the teaching and learning process, the integration of science to the society, how learners are assessed at different levels, and how practical work is done in during lessons. This construct also deals with the effect and lack of science practical laboratories and apparatus on educators for doing practical work and for learners for having science practical experiences.

According to Rogan and Grayson (2003), the profile of implementation naturally enables curriculum planners at a school level to know where they are by determining their strengths and weaknesses. The context and capacity of the school is a crucial factor to take into consideration when educators are embarking on the process of curriculum implementation. As a result, the enactment of RBT in Life Sciences lessons should not be a once-off event but an on-going process in which educators determine their direction and phase of instruction (Rogan & Grayson, 2003). This can be attributed to the concept of Curriculum Development in which Hargreaves and Hopkins (1991) assert that the members of a particular school, including the Life Sciences educators, draw up a plan to influence change in a way that is convenient and feasible for the culture and the context of the school. Rogan and Grayson (2003) identify the nature of the classroom interaction, assessment practices, the integration of Science with social elements, and the use of Science practical work in Life Sciences lessons as important dimensions of the Profile of Implementation.

These dimensions are, however, not only in Life Sciences, but in different subjects in different ways. The dimension 'Science practical work' for instance applies only to Science while 'classroom interaction' and 'assessment' could be modified with minor changes for other subjects (Rogan & Grayson, 2003). Science and society are a very important dimension in Life Sciences in a sense that they seek to promulgate one of the aims of Life Sciences, which is to integrate Science into society (Education, 2011).

The constructs of the Profile of Implementation dimension comprise of four levels that shift gradually from an educator-centred approach (level 1) towards a more learner-centred approach (level 4) (Hattingh, Aldous, & Rogan, 2007). According to Rogan and Aldous (2005), educators located in level four have greater experience, wisdom, and knowledge of how to implement the curriculum than those that are located in level one.

This, however, does not mean that level four practices are superior to level one or two practices, but merely depend on the demands of the curriculum to be implemented. There is also "an increasing emphasis towards learner-centred and standard-based approaches" as one moves from level one to level four (Rogan & Aldous, 2005, p. 317). According to Rogan and Aldous (2005, p. 317), the levels are "not prescriptive of what should be done, but rather suggest the mastery and use of an array of teaching and learning strategies". The four dimensions are "to a large extent, independent of one another" because a single educator may display different levels for different dimensions (Rogan & Aldous, 2005, p. 317). For instance, the educator might be on level two for the dimension classroom interaction while he/she may be at level four for the dimension science practical work.

The educator is at liberty to jump from level one to level four practices because all practices have merit in Life Sciences (Hattingh et al., 2007). The levels of the Profile of implementation embrace the constructivist view of learning as outlined in the Life Sciences policy document where the lesson is described to gradually increase independence of learners and the introduction of more learner centred and sophisticated classroom interaction and assessment practices (Education, 2011). Figure 2 shows the levels of the profile of implementation.

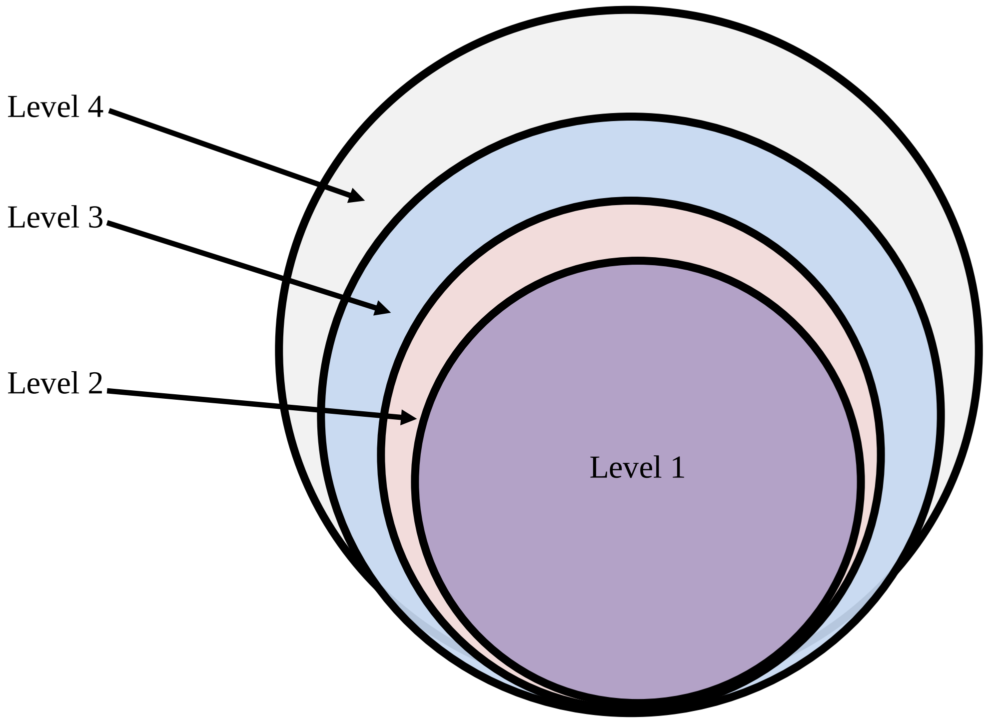

Figure 2. The Profile of Curriculum Implementation as adapted from (Rogan & Grayson, 2003, p. 1186)

The higher levels, level 3 and 4 of the profile of implementation integrate the practices of the lower levels, level 2 and 1 instead of replacing them (Rogan & Grayson, 2003). The levels of the profile of implementation are different to those presented in the model that was proposed by Beeby (1966), which consisted of distinct stages of primary school curriculum. Beeby's model was criticised for having a teleological bias and for not being sufficiently distinct by taking a broad view on the experiences of British-tradition South Pacific school systems, and by equating the Western teaching with good teaching which was not applicable to many countries. The problem with Beeby's model is the lack of clear difference between empirical issues and the ethical judgements contained in its structure (Guthrie, 1980)

The model by Beeby (1966) was also criticised for its aspects, which include the unsubstantiated and inappropriate distinct stages that are not indicative of the complexities that exist within an education system. The model was further criticised for its focus on the educator while making no mention of other important aspects of the school context (Guthrie, 1980).

Rogan and Grayson (2003) Profile of Implementation is, therefore, a heavily renovated construct of the theory of Curriculum Implementation as compared to earlier work by Beeby in the sense that it incorporates relevant aspects that are necessary for the enactment of RBT. Those important aspects were, according to Rogan and Grayson (2003), referred to as dimensions and they include; assessment, science practical work, science in society, and the nature of classroom interaction(what the educator and learners do to/with the resources). When educators provide ample opportunities for learners to interact with the resources independently on their own and when educators scaffold learners to move from level 1 to level 4 of the Profile of implementation, the goals of the construct are achieved (Rogan & Grayson, 2003).

South Africa is a developing country that adapted to the inclusion of modern technologies in education, particularly in secondary school education (Mentz & Mentz, 2003). The Life Sciences curriculum and policy statement lists a variety of resources for educators to use when planning and delivering their daily lessons (Education, 2011). The same policy statement does not describe how educators should use the resources in their lessons. Rogan and Grayson (2003) describe the new education dispensation in South Africa as one that put emphasis on the ‘what’ part instead of the ‘how’ part. The implication of putting emphasis on the ‘what’ part is that brilliant ideas from educators are neglected and never get a chance to be implemented in the classroom (Rogan & Aldous, 2005).

Porter (1980) asserts that the national government presides over educational change in terms of policy and legislation but barely monitor how that policy and legislation is implemented. Rogan and Grayson (2003) postulate it better when they assert that “much work on implementation issues needs to be done in South Africa if the promises of the new curriculum are to make any impact in schools, and start to provide the next generation with a better education” (p.1173). In his study, Vespoor (1989) concludes that the large scale programs that were supported by 21 world banks have put emphasis on the adoption of programs but paid little attention to their implementation.

2.10 Link between theoretical framework and the study

This study drew on three theoretical constructs from the theory of curriculum implementation (Rogan & Grayson, 2003). The constructs of Rogan and Grayson’s theory were adapted because the successful enactment of resource-based teaching hugely in part depends on outside influences, the capacity of the school to support innovation and the profile of the school for implementation of Life Sciences curriculum. Rogan and Grayson’s theory also provided a methodological path to getting educators’ understanding and their enactment of RBT. The theoretical framework, as adopted by the current study, was further instrumental in giving context to, and describing, why educators enacted RBL in the manner they did.

Currently, education reform in South Africa is divorced from the realities of everyday schooling (Govender, 2018). Scholars like Jansen (1998) argue that the South African post 1994 curriculum reform is rooted in the adoption of ready-made Western educational models without looking at the feasibility of implementation in schools. As a result, the past educational reforms that were effected after 1994 have dismally failed to suit the demanding contextual dynamics of South Africa (Erduran & Msimanga, 2014; Govender, 2018). The theory of curriculum implementation that was proposed by Rogan and Grayson (2003) is a relevant tool to use in the enactment of educational reform (such as RBT) in South Africa because it has been tailor-made to equip the implementation of educational reform in developing countries.

All the three constructs and sub-constructs of Rogan and Grayson's theory are tailor-made to reflect the realities that are similar to South African rural schools. For instance, the South African education system relies heavily on external donations for resource provision and tackling learner factors that impedes them from successful learning. The NGOs for instance, sponsor schools with textbooks, desks, and even food parcels. Orphaned children are also adopted by the NGOs and assisted with their social and academic needs through the intervention of NGOs and external agencies. This is clearly articulated by the construct Outside Influences of Rogan and Grayson's theory of curriculum implementation.

Outside influences that have a bearing on the enactment of Life Sciences curriculum, and the capacity of the school to support enactment are taken into consideration. Rogan and Grayson's framework of curriculum implementation is suitable in the sense that it also assesses the feasibility of the enactment of Life Sciences curriculum through the profile of the school. RBT is, therefore, not divorced from curriculum enactment and that explains why it is a relevant theoretical framework for this study.

2.11 Conclusion

This chapter has reviewed the literature that underpinned the focus of this study. From the literature, it is evident that RBT is an effective approach for delivering Life Sciences as a subject in secondary school. Myriad studies on specific RBT tools, environments, and features have been reviewed. The review includes the merits and demerits of studies on this pedagogical concept, RBT. In addition, the theoretical framework that is the backbone of this study was presented. The theoretical framework of this study enabled the researcher to design the research instruments and to answer the research questions of this study. The theoretical framework was also used to enhance the understanding, analysis, and documentation (compilation) of the experiences of Life Sciences educators in enacting RBT in their teaching practices. This has been done through the guidance of the three constructs of the framework, namely the Profile of Implementation and the Capacity to Innovate and Outside Influences. The framework was also used to derive the structure of the methodology, which is a case study positioned in an interpretive paradigm using a qualitative approach to explore Life Sciences educators' enactment of RBT. The theoretical framework was also used as a guide for the data of the results of educator's enactment of RBT in Life Sciences lessons. The next chapter is on the paradigm, the methodology and the design employed in this study.

CHAPTER 3
RESEARCH METHODOLOGY AND DESIGN

3.1 Introduction

The literature reviewed in Chapter 2 provided an overview of resource-based teaching, educators' enactment of RBT, and why educators enact RBT in the way they do. In the preceding chapter, the researcher also presented the theory of curriculum implementation that underpinned this study. In this chapter, the researcher focuses on the methodology used in this study, including issues such as the research approach, research paradigm, research design, and the participants. Furthermore, data generation methods, data analysis, issues of validity and trustworthiness, ethical considerations, the delimitations and location of the study are also explained in detail.

3.2 Research Questions

The choice of methodology for this study was informed by the three research questions of the study. The questions that this study sought to unpack are:

1) What are the Life Sciences educators' understandings of resource-based teaching?

2) How do the Life Sciences educators enact resource-based teaching?

3) Why do Life Sciences educators enact resource-based teaching the way they do?

The research questions are key in that they informed both the methodology and the data collection instruments. This study was guided by an interpretive paradigm and a qualitative approach methodology, which both guided the researchers' philosophical framework throughout this study. The case study method supported the methodological approach employed in this study. To conduct an in-depth study on the enactment of RBT by Life

Sciences educators, a case study method proved to be appropriate. Figure 3 depicts the structure of the methodology used in this study.

3.3 Outline of methodology for this study

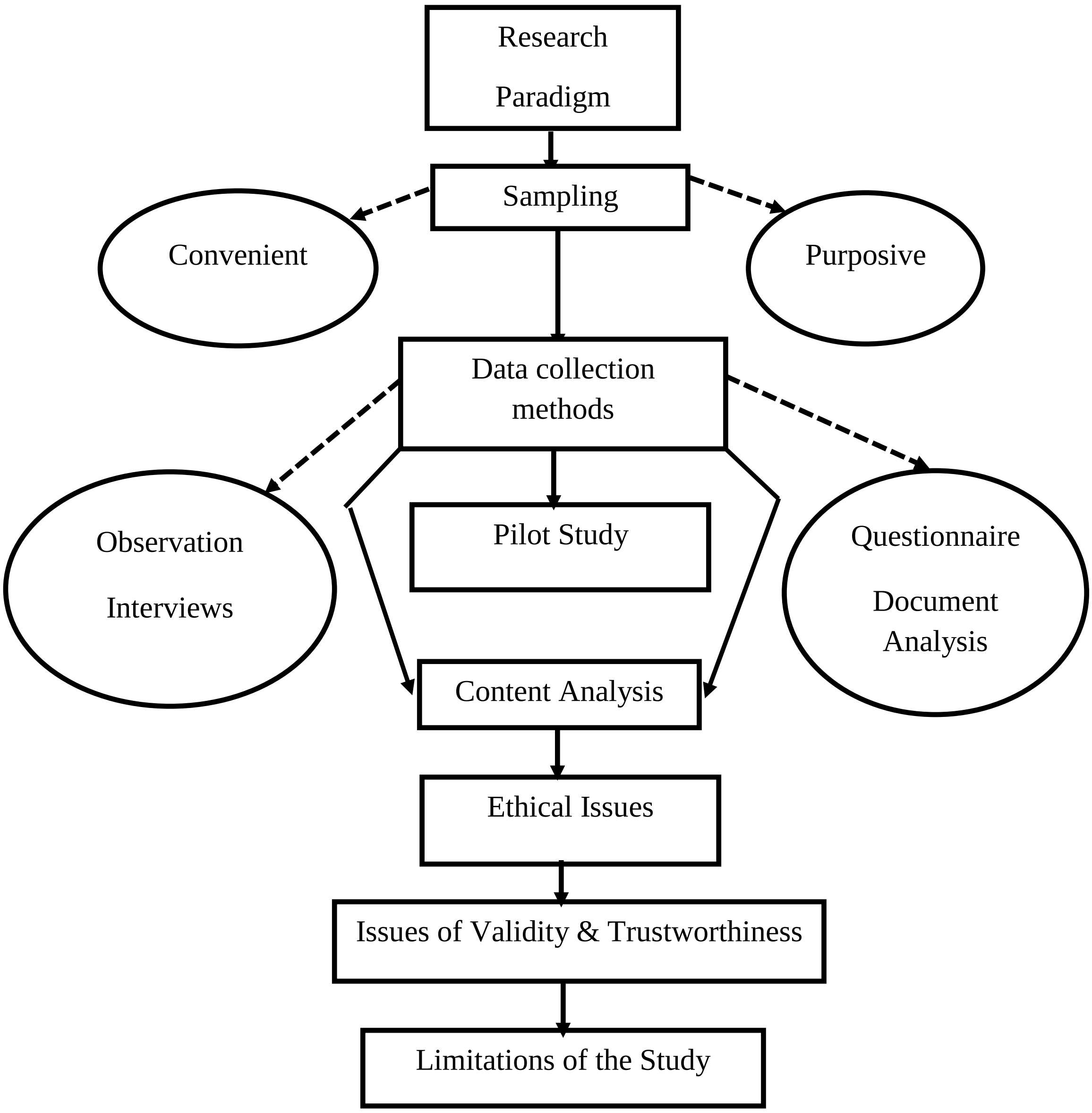

Figure 3. Chapter 3 flow model

3.4 Research Paradigm

A research paradigm, according to Jonker and Pennink (2010), is a set of assumptions and beliefs pertaining to how the world is viewed, which then serves as a thinking framework that guides the behaviour of the researcher. Similarly, Weaver and Olson (2006) define a paradigm as certain rules and standards that guide a researcher's beliefs and actions. Researchers have different beliefs about reality, and that is why they differ in the way they present their studies. Thus, Jonker and Pennink (2010) assert that a research paradigm can be viewed as a lens or a way in which to think about the world.

In this study, an interpretive paradigm was used because of its methodological approaches that provide an opportunity for the actions, concerns, and voices of research participants to be heard (Mack, 2010). According to Hennick, Hutter, and Bailey (2010), an interpretive paradigm seeks dynamic and contextual multiple realities. The researcher chose to use an interpretive paradigm because it enabled him to collect different experiences, practices, and reflections of Life Sciences educators' enactment of RBT. Cohen et al. (2011) assert that an interpretive paradigm examines an individual's personal judgement in relation to reality. This paradigm also allowed the researcher to work closely with the research participants and to document in detail their understanding, experiences, and their enactment of RBT.

Mack (2010, p. 8) argues that "social reality is seen by multiple people and the multiple people interpret events differently". In the current study, the researcher put into consideration that multiple realities exist and expected participant educators to report different opinions, experiences, and enactment of RBT. The researcher also expected participants to report different reasons for enacting RBT the way they did.

The researcher adopted an interpretivist epistemology to understand how educators enacted RBT when they taught Life Sciences during their lessons. The meaning constructed by the researcher from the actions of the participants was written in the form of themes that emerged as findings. Cohen, Manion, and Morrison (2007, p. 19) state that the role of the researcher in an interpretivist paradigm is to “understand, explain, and demystify social reality through the eyes of the participants”. For that reason, the researcher used the descriptions of participants’ understanding, experiences, opinions, and behaviours on their enactment of RBT in Life Sciences lessons as the data (Neuman, 2002).

3.5 Research methodology

Patton (2002) asserts that either a qualitative, quantitative approach, or mixed methods can be adopted when conducting research. In this study, data of the experiences of educators were gathered using a qualitative methodology. Qualitative research is concerned with understanding participants’ feelings, beliefs, ideals, thoughts and actions of social or human problems (Creswell & Poth, 2017; Rosnow & Rosenthal, 2008). The use of a qualitative methodology in this study was appropriate to generate answers to questions about how and why individuals feel about the experiences they were subjected to (Cohen et al., 2011). A qualitative methodology enabled the researcher to gain an in-depth understanding of the participants’ experiences on the enactment of RBT. This was achieved by asking questions that informed the researcher and those which stimulated the participants to reflect on the reasons why they enacted RBT in the manner they did (Mouton, 1996). The identification of key research questions is the starting point of a robust study. Hence the research questions of this study were crafted to pave a way to interrogate participants’ enactment of RBT.

According to Denzin and Lincoln (2011), qualitative research takes the researcher into the world of the researched to interpret their behaviours and experiences. The researcher visited the participant’s classrooms when they delivered their lessons and recorded their actions as they enacted RBT. The task of the researcher was to try to describe, understand and interpret how Life Sciences educators facilitate learner’s use of resources in their classrooms

(Merriam, 2002). The qualitative approach gave the researcher an opportunity to understand and interpret Life Sciences educators' experiences in enacting RBT. It also enabled the researcher to capture and report about participants' responses by making use of direct quotations in instances where the responses were good (Eysenck, 2004). Also, a qualitative approach was appropriate for this study because it enabled the researcher to analyse data through content analysis so as to develop themes that emerged as findings of this study. This way, a profound insight into participants' actions and experiences were revealed.

3.6 Research Design

A case study research design was employed in this study. A case study allows the use of a variety of research methods (Yin, 2009) or "…multiple sources of data found in the setting" (MacMillan & Schumacher, 2014, p. 28). A case study design was the most suitable research design for this study because it granted the researcher the ability to make use of any form of qualitative data relevant for the study.

A case study also focuses on real people in a situation (Cohen et al., 2011, p. 289) and "strives towards a holistic understanding of how participants relate and interact with each other in a specific situation and how they make meaning of the phenomenon under study". A case study research design is appropriate for "how" and "why" questions (Yin, 2009). In this study, a case study research design was employed to address the research questions. It allowed the researcher to select RBT, a phenomena that he is familiar with and has access to (Rule & John, 2011, p. 1).

3.7 Data collection methods

According to Creswell (2014), data collection focuses on the collection of information either through interviews, observations, the analysis of documents and/or other techniques used to collect data from participants. Thus, qualitative data collection methods were used in this study. To ensure triangulation and authenticity of the findings, a combination of methods were used (Rule & John, 2011). Cohen et al. (2011) define triangulation as the use of two or more data collection methods in a study. The data were generated using instruments that show explicitly that “knowledge is gained through personal experiences” (Mack, 2010, p. 8). A questionnaire, observations, document analysis, and individual interviews are the four data collection methods that were used to collect data for this study (Merrian, 2009; Rooshenas, Paramasivan, Jepson, & Donovan, 2019).

The instruments enabled the researcher to gather data that were valid and acceptable for this study (Wahyuni, 2012). The data collection methods were helpful in providing a ledger of evidence that guaranteed credibility, trustworthiness, honesty, dependability and authenticity of the study (Bodgan & Biklen, 2013; Yin, 2009). During the process of data collection, the researcher adopted an emic approach when he interacted with the participants by interviewing them and also through observing them as they taught Life Sciences (Neuman, 2002). The use of the mentioned methods enhanced the validity of the study.

3.7.1 Questionnaire

According to Leedy and Ormrod (2014), a questionnaire is a useful instrument for generating data beyond the physical reach of the observer through carefully laid down questions meant to be answered by respondents. McLeod (2014) suggests that people should think of a questionnaire as a kind of written interview which can be carried out face to face, telephonically, or by post. Cohen et al. (2011) points out that a good questionnaire must be simple and have easily understood questions such that individuals can interpret and make meaning of them.

A questionnaire was used to collect data for this study. The rationale was to obtain in-depth information of Life Sciences educators’ enactment of RBT and why they enact it the way they do (Bergman, 2008). The questionnaire was also used because it was convenient for the participants (Bryman, 2008) as they needed more time to complete it without any interference.

Educators reflected through a series of open-ended questions as an activity to voice out their experiences on enactment of RBT (Babbie, 2013). Reflective activities are common in social research (Cohen et al., 2007) and that alone enabled the researcher to gather participants' experiences in teaching Life Sciences through the use of available resources (Bernard & Bernard, 2012). The participants' demographic information, academic qualification, and their teaching experiences were vital for this study because they had a major bearing on the way they executed their duties.

The questionnaire, as mentioned earlier, had closed and open-ended questions. The closed-ended questions were designed in a way that provoked quick responses to research question one and two to guide the responses to be precise. The researcher was aware that the closed-ended questions limited the respondents to the set of options provided to them. This was done to prevent the respondents from being astray from the focus of the study. The use of the open-ended questions in the questionnaire was for objectively collecting data from the participants without their views being influenced by the researcher's viewpoint (Berk & Winsler, 2002). The design of questions was in contrast to the closed-ended questions where participants were given a few options to pick their responses from. The questions that were crafted for the questionnaire were limited to seven in order to avoid respondents' fatigue (Bergman, 2008). The questionnaire data addressed all three research questions of this study.

3.7.2 Face to face interviews

A semi-structured interview is the commonly used type of interview in qualitative research (Bernard, 2011) and case studies (Bassey, 1999; Rule & John, 2011; Yin, 2009).

Creswell and Plano Clark (2011) state that interviews are largely used in qualitative research because they provide rich descriptive data that helps the researcher to understand the participants' understanding of knowledge and social reality. In the event of this study, first hand data were generated using a series of semi-structured interviews whereby the researcher interviewed six Life Sciences educators to collect data pertaining to their understandings of RBT, how they enacted it and why they preferred to enact it the way they did. The interviews proved to be useful because through prompts and probes, the researcher was able to ask thought-provoking questions that provided answers to the research questions. The respondents were also at liberty to express themselves openly and freely during the interviews.

The same sets of questions were asked to all six respondents to compare and contrast their responses. All six respondents were interviewed individually and at a place and time that was convenient to them. Nikita and Zane for instance were in the same school but were interviewed separately at different times and places. The researcher conducted the interviews in a private space to minimize distractions and help the respondents to stay focused during the interviews (Gillies & Boyle, 2010). The interviews were audio-recorded on consent of the participants. A cell phone recording application was used for later transcription of the interview to enhance the accuracy of the data. Audio recording was advantageous in that it allowed the researcher to concentrate on the interview and later play it in order to gain the full import of the participants' responses (Klave & Brinkman, 2009).

3.7.3 Observation

Doing lesson observations in the research process is paramount because it allows researchers to know better about the phenomenon under study as compared to them asking questions to the participants (Wilkinson & Birmingham, 2003). Data generated from lesson observation cannot be equated to that collected through questionnaires and interviews since it is first-hand data that cannot be reproduced or falsified (Wilkinson & Birmingham, 2003). Rule and John (2011, p. 67) are in agreement with the latter and opine that “observing an educational action such as a lesson being taught, provides useful first-hand and unaltered data for a case study”. Thus, Marshall and Rossman (2011) put it clear that observation is the backbone of all qualitative studies. The researcher, therefore, made use of a series of lesson observations to generate data on how the participants enacted RBT and why they enacted it the way they did.

The researcher employed a non-participant observation that enabled him to be as unobtrusive as possible so that neither his presence on the scene nor his method of collecting data disturbed the lesson (Rule & John, 2011). Cohen et al. (2011, p. 459) refers to this kind of observation as a structured observation where an “observer adopts a passive, non-intrusive role, merely noting down the incidence of the factors being studied”. In the event of this study, the researcher observed how participant educators facilitated the use of resources by learners and how learners responded to the use of those particular resources. The observations that were made were entered in an observation checklist (See Appendix F) which was prepared before doing the actual lesson observations. The checklist was developed to crosscheck issues such as available resources in the classroom, classroom environment, educators; actions, and learners’ responses. The information gathered helped the researcher to understand why Life Sciences educators enacted RBT the way they did.

During data collection, the researcher adopted the role of an overt observer in the classroom where he observed every detail in the teaching of Life Sciences as he was seated at the back and making reference to his observation checklist that guided his observation using a set of field questions (Rule & John, 2011). The actions of educators were the focus of the observations made and they helped the researcher in answering the second and the third research questions of this study, whose focus was on how and why the participants enacted RBT the way they did respectively. The actions under focus were the type of resources used by educators, frequency of use, the way the educators used the resources to teach Life Sciences, and how the learners used the resources.

3.7.4 Document analysis

Documentary analysis was also used as a data collection tool to get information that was related to participants' enactment of RBT in Life Sciences lessons. Documents are described by McMillan and Schumacher (2010) as records of past events which could be printed materials that may be official or unofficial, public or private, published or unpublished, or prepared intentionally such as lesson plans.

The documents were useful in producing a ledger of information that helped to address the second research question of the study (McMillan & Schumacher, 2006). Documents used in this study were lesson plans, which were analysed to gain an in-depth understanding of how the participants enacted RBT. Rule and John (2011) hint that researchers should not take documentary analysis at face value, but scrutinise them for an in-depth understanding. The rationale behind the analysis of documents was to develop an understanding of how the participants enacted RBT in Life Sciences.

3.8 Pilot study

A pilot study, according to Polit, Beck, and Hungler (2001) is a small version of a real study, which is done in preparation for the impending main study. In the event of the current study, a pilot study was carried out to diagnose if the research instruments would collect the intended data that would answer the three critical research questions. The pilot study was also intended to ascertain the level of clarity, the length of time suitable for the interviews and to improve the credibility of research instruments (Opie, 2004). The pilot study was useful in preparation for the actual study because it offered signals regarding the suitability of the methods and instruments to be used in the final study.

The data collection instruments were improved in such a way that they collected the required data. The researcher identified the respondents' failure to answer specific questions, and any comment they made were written in the margin in order to improve the interview guide questions (Simon, 2004). Six participants, two from each of the three different schools were selected and agreed to participate in the pilot study out of their free will. Lesson observations were done and questionnaires were administered to all the six participants, followed by interviews. Their plan books were also collected and analysed.

This process sharpened the researcher's observational skills and detailed note-taking during the lesson observation. This process, through the observation schedule, also enabled the researcher to identify requisite RBT practices that could be used to answer the questions of the study (Leedy & Ormrod, 2014). The pilot study alerted the researcher to the fact that answers to Research Question Three were not as easily identifiable as the others since the question sought far more that what met the eye.

Through pilot testing, a discovery was made that the questionnaire contained jargon that confused the understanding of the participants. The term resource-based teaching was somewhat misunderstood by most of the participants as four of them thought that it was based on educators using highly technical resources to deliver rote lessons. To address this confusion, the researcher added an explanation and the use of words which were within the scope of knowledge of the participants. The words were written with bracketed explanatory notes as follows: resource-based teaching (teaching with resources).

The pilot study interviews lasted for about twenty-five minutes each. The pilot study helped the researcher to improve on data collection techniques in the field (Creswell & Plano Clark, 2011), for example how to make the participants to open up and speak. Six participants with similar working conditions to the participants in the real study were used to collect data through interviews. During the course of the interview, the researcher noticed that he was not being too assertive in the manner he asked questions. His voice was jerky and he tended to spend a lot of time explaining points unnecessarily, thereby making the questions long and vague. This made it difficult for the participants to get the sense of the question. One participant felt the time taken was too long and kept signalling for the interview to end saying she had other school commitments. The pilot study helped in reducing interview times by ten minutes each (Leedy & Ormrod, 2014).

3.9 Location of the study

This study was conducted in Oliver Regional Tambo Coastal District (ORTCD) of education which is under the jurisdiction of Oliver Regional Tambo district municipality (ORTDM). All three schools are located in Nyandeni local municipality (NLM). The ORTDM is one of the most populated municipalities in the Eastern Cape, with a broad base of youth and many of them being children of school-going age. Geographically, the district is in the coastal line of the Eastern Cape Province, in the former Transkei region and it is here where many of the Mpondo tribe people originate from.

3.10 The participants

According to Flick (2009), the process of sampling is important for data collection, interpretation and presentation of findings. Sampling is important because it enables researchers to choose participants and data collection methods decisively (Creswell, 2009). Purposive and convenient sampling were used as the principal methods of choosing participants in this study.

Rule and John (2011, p. 64) describe purposive sampling as the “sampling where the people selected as research participants are deliberately chosen because of their suitability in advancing the purpose of the research”. In this study, purposive sampling was used deliberately for accessibility of data collection sites and ease of data collection from the participants (Welman, Kruger, & Mitchell, 2006). The participants were also selected “for their relevant knowledge and interest in the phenomenon under study” (Rule & John, 2011, p. 64). As a result, only Life Sciences educators were selected as participants of this study.

Convenience sampling is described as “choosing a sample which is easy for the researcher to reach” (Christiansen, Bertram, & Land, 2010, p. 43). Sampling was convenient because the researcher chose educators from three out of fifteen schools from circuit 3. The educators were easily and conveniently accessible and available because the researcher taught with them in the same cluster. In the case where there were more than two educators in a school, the researcher selected those who were willingly and easily available to be participants, taking into consideration variation in teaching experience as well. Since the educators were filtered because of their willingness and eagerness to reflect on their enactment of RBT, the researcher anticipated that they were mature and were less likely to be resistant to the research and would not leave the study because they were committed.

The schools that were selected for this study were conveniently located for easy access by the researcher. This type of sampling does not represent any group apart from selected participants (Cohen et al., 2011); therefore, this type of sampling does not seek to generalize findings. Six educators who taught Life Sciences from three secondary schools were chosen because they were easily accessible during and after school hours. Travelling to these schools and making appointments with educators was easy.

3.11 Data analysis

The researcher adopted content analysis. Cohen et al. (2011) describe content analysis as the process of summarizing and reporting the main content and messages of written data. Krippendorff (2013) and Wilkinson and Birmingham (2003) agree that content analysis attaches meaning or significance to information collected through the categorization of verbal or behavioural data for the purpose of classification, summarization and tabulation. Furthermore, repeated themes and other meaningful traits within the collected data may be identified for the purpose of interpretation. The analysis of content can be accomplished through the interpretation of the content, establishing frequencies, and coding to develop themes (Krippendorff, 2013). The data include interview transcripts, questionnaire narratives, field notes, and the analysis from documents (Wilkinson & Birmingham, 2003).

3.12 Validity and Trustworthiness

Effective research is anchored in solid grounds of validity. If validity is not there, the research is rendered invalid and worthless (Cohen et al., 2011). Validity is defined as the "degree of congruence between the explanations of the phenomenon and the realities of the world" (McMillan & Schumacher, 2010, p. 330). Validity is used to measure aspects of the study such as the rigor and trustworthiness of the findings (Cohen et al., 2011).

According to Jerkins (2010, p. 1), reliability in qualitative research "is challenging to demonstrate because data is based on interviews, personal accounts, real life experiences and face encounters". Thus, credibility, transferability, dependability, confirmability, honesty, fidelity to participants, rigour, trustworthiness, richness, scope of the data collected and its uniqueness is the criteria cited by Guba and Lincoln (1994) to determine reliability in a qualitative study. In addition, Creswell (2009) expands Guba and Lincoln’s sentiments and says that credibility and accuracy of the research are achieved by way of triangulation and through validation techniques such as member checking and multiple data collection methods.

In this study, triangulation was achieved through the use of different data collection methods, namely, a questionnaire, document analysis, lesson observation and one-on-one interviews. Cohen et al. (2011) and Merrian (2009) agree that member checking entails availing transcripts to participants so that they can check their accuracy and to ensure that their views were captures accurately. The researcher re-visited the participants to allow them to read the transcripts so that they could elaborate, clarify, confirm or refute certain aspects of the interview (Rule & John, 2011). Validity is important in research(Rule & John, 2011) because if one section is neglected, then the whole study is rendered irrelevant and may be unacceptable (Christiansen et al., 2010; Cohen et al., 2011).

The interview and observation schedules were pilot tested to eliminate any form of ambiguity. This way, the researcher ensured there was clarity in individual interview questions. Furthermore, the researcher spent three months observing participants in their day-to-day teaching activities. As a result, carefully crafted research questions, meticulous data analysis and a thick description of the phenomenon enhanced the validity of the study.

3.13 Ethical considerations

In every research, it is very important to ponder ethical behaviour. Ethical considerations in research are concerned with minimizing harm while in turn increasing benefits (Flick, 2009). In this study, the researcher sought permission to conduct the study from relevant authorities. Application letters to conduct the study were written and sent to the DoE (Osbeck, Franck, Lilja, & Sporre, 2018). Other application letters were sent to the sampled schools to ask permission to conduct the study. Throughout the data collection period, the researcher respected the rights of all participants by only asking them questions dependent on their consent. No research participant was coerced to participate in this study (Mouton, 2001). The researcher did not falsify the results, as data was analysed as objectively as possible. Confidentiality was maintained to the extent that the information uncovered reflected anonymity. The names of the schools, their location, and the names of research participants are not disclosed in this study and only pseudonyms are used (Creswell, 2014). The data that were collected are stored safely in a locked storage in my supervisor's office where only the two of us have access (McGinn, 2018).

3.14 Limitations of the study

No research method is innocent than the other, and no study is perfectly done without limitations (Marshall & Rossman, 2011). Due to the fact that the researcher is also a high school Life Sciences educator in the same circuit, bias might have been unavoidable in some instances. The fact that the researcher personally knew all the participant educators, and that they all worked in the same circuit, raised a possibility of bias and persuasive attempts to encourage them to give information based on the researcher's personal interest. So, in order to overcome this challenge, the researcher gave particiants a questionnaire to complete at home during their free time (Cohen et al., 2011).

It is further acknowledged that this study, like any other qualitative study, is limited in breadth but signficant in depth (Rowe & Oltmann, 2016). Thus, the findings are contextual and therefore cannot be generalised but may be transferred to similar contexts. Ovarally, the strength of the results lies in the triangulation of data collection methods, which ensured that the data collection process was near exhaustive.

3.15 Conclusion

In this chapter, the researcher elaborated on all the details of the research design and methodology, ranging from the research paradigm, research approach, sampling, data collection, analysis, ethical considerations and limitations of the study. All the above-mentioned research methods outline how this study was conducted and how it intends to answer the research questions and attain the aim of the study, which is to explore Life Sciences educators' enactment of RBT. In the next chapter, the researcher presents data collected from the four data collection instruments guided by the three research questions of this study.

CHAPTER 4
PRESENTATION OF DATA

4.1 Introduction

In the preceding chapter, the researcher outlined the research methods used to generate data for this study. The data generation instruments were the questionnaires (Appendix D), lesson observations (Appendix F), semi-structured interviews (Appendix G), and the analysis of documents (Appendix E) which were crafted using the constructs of the theory of curriculum implementation by Rogan and Grayson (2003). To maintain confidentiality, the participants and the schools were assigned pseudonyms. Denise and Patrick belonged to School A, Michael and Nelson belonged to School B, whereas Nikita and Zane were educators in School C.

This chapter provides a presentation of raw data. The context in which the study was carried out is presented first. This is followed by the presentation of data for each case (participant) as guided by the three research questions for this study which are;1) What are Life Sciences educators' understandings of RBT? 2) How do Life Sciences educators enact RBT? 3) Why do Life Sciences educators enact RBT the way they do?

4.2 Natural and material resources available to Life Sciences educators and learners

There is a wide range of resources that can be used to teach Life Sciences. The ORTCD of education, in particular, has a variety of natural and material resources for teaching Life Sciences. In chapter 2 of this study, a resource was defined as anyone or anything that facilitates learning (Khoza, 2012).

Figure 4 shows the geographical location of the ORTCD. In this district, natural resources are easily accessible as the three selected schools are located in the rural outskirts of the district and are in close proximity to a variety of terrestrial and aquatic plants and animals.

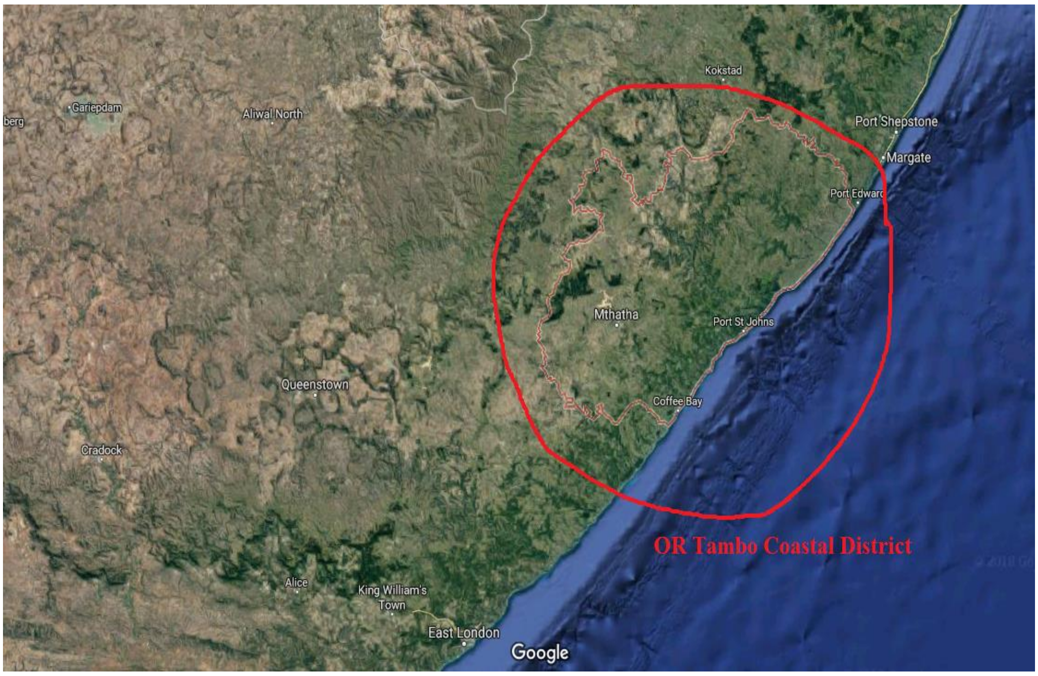

Figure 4. A geographical map of the O.R Tambo Coastal District. Accessed from https://www.google.com/maps/search/OR+TAMBO+COASTAL+DISTRICT/@-31.6471027,28.3215957,348511m/data=!3m1!1e3

The ORTCD is largely composed of rural villages and is close to the Indian Ocean. Figure 5 shows Ocean view (pseudonym for the area marked in red), where the three selected schools are located within the ORTCD. As depicted in Figure 5, Ocean view is a largely rural area located on the southern east coast of South Africa and is characterized by green vegetation of flora and fauna species. In Ocean view, communal households are densely located in one place and the livestock feeding field is purposively demarcated from homestead.

Figure 5. A geographical map of Ocean view, showing available resources.

*(*Accessed from https://www.google.com/maps/place[redacted],+5140/@-31.6673666,29.0403343,5298m/data=!3m1!1e3!4m5!3m4!1s0x1e5fca89244f1553:0x8e9e1f3b62b1c001!8m2!3d-31.6683629!4d29.0275432)

4.3 School A

School A is in a deep remote area in Ocean view under the jurisdiction of Nyandeni Local Municipality. In the community where the school is located, the majority of the people practice subsistence farming for a living. The extremes of this village are that some learners travel a consolidated distance of 90 kilometres to and from the school every day.

South African schools are either categorized as section 20 or section 21 schools in terms of norms and funding (Mestry & Ndhlovu, 2014). All section 20 schools solely rely on the government to buy resources. It is the schools' responsibilities to then sustain the resources provided by the DoE. For example, those schools that fall under the section 20 category might need to make requisitions to the DoE and wait authorization and delivery by the department (Mestry, 2014). Section 21 schools are regarded as long-serving schools with more experienced staff and administrative personnel to handle school finances. Section 21 schools enjoy the privilege of having funds as per the allocation of the state, deposited directly into the school's bank account (Mestry, 2014).

School A is categorized under section 21 and is a quintile one school. Like all quintile one schools, the school benefits from a government funded scholar transport. However, because of the small carrying capacity, the transport does not cater for all children from the surrounding villages. Road infrastructure for motorists is poor and the terrains are dangerously sloped such that motorists struggle to drive by. The principal of this school reported to the researcher that during the summer season, learner attendance drops significantly as the summer rains fill up rivers that learners cross when they are going to school. Learner attendance in summer, according to the school principal, is also influenced by the rise in illnesses due to outbreak of contagious diseases in the area.

Ntsunguzi (pseudonym) administrative area, a village where the school is located, is close to a forest characterized by green vegetation such as trees, shrubs, and long grass. The Nkanini clinic (pseudonym) is situated about 520 metres from the school. About 3.5 kilometers from the school there is the Thathani river (pseudonym). Figure 6 shows the geographical location of School A. In the areas where the school is located, there is a variety of natural resources that the Life Sciences educator can take advantage of to teach the subject.

Figure 6. A map showing School A and its surroundings. Accessed from [https://www.google.com/maps/place[redacted]/@-31.7617559,29.2083248,1269m/data=!3m1!1e3!4m5!3m4!1s0x1e5e4fcc63271c09:0x4d0ccde012a5f44a!8m2!3d-31.76182!4d29.21543]

The schools' science and computer laboratories (Figure 7 and 8) were used as staffrooms for educators after they were damaged during a violent learners' protest in 2016 (Zane, interview, May 2017).

Figure 7. School A's laboratory that is used as a staffroom

Figure 8. School A’s computer laboratory

The school did not have running water. Therefore, two large water tanks (Figure 9) were used by the school for drinking and gardening activities such as irrigation. According to the principal of this school, learners fetch water from the Thathani river using wheel barrows to fill the tanks in the absence of the rain.

Figure 9. Tanks between the senior and junior blocks at School A.

There were 567 learners enrolled in different streams across Grade 10-12 in this school. The available streams were the Science stream which was composed of Mathematics, Physical Sciences, Life Sciences, and Agricultural Sciences; the Commercials stream which was composed of Accounting, Economics, and Business Studies, and finally the Humanities stream which had IsiXhosa home language (HL), English first additional language (FAL), History, Geography, and Life Orientation (LO). From the 567 learners in this school, 227of them were registered in the Humanities stream followed by the Science stream which had 171 learners and at the bottom is the Commercials stream with 104 learners.

4.4 School B

This school is located in a village called Red location (pseudonym). The village has a high population of elderly people who benefit from social grants. School B is situated 1.5 km away from the Emanzini River (pseudonym). Surrounding the school are natural resources that are ideal for teaching Life Sciences. North east to the school there is a forest with mountain escarpments. The principal of this school reported that children were punished by their parents when they visited the forest because parents claim that there are dangerous animals living in the forest. Community members who lived in Red location mostly practice subsistence crop farming.

School B is categorized under section 21 schools and is a quintile one school. Due to the socio-economic conditions of the households in the village surrounding the school, School B is a no-fee paying school. The two buses that are used for the scholar transport services pick up learners from nearby villages in the mornings and send them back to their homes in the afternoons daily. The road infrastructure leading to the school is dilapidated. In less than 2 km north of the school, there is a natural ecosystem consisting of mountains, fountains, water pools, indigenous trees, bird and insects (Figure 10).

Figure 10. A map of School B and surrounding areas. Accessed from https://www.google.com/maps/place/[redacted]l/@-31.6791168,29.2185149,4209m/data=!3m1!1e3!4m5!3m4!1s0x1e5e4da9f1a76fa1:0x4df75e4301199e89!8m2!3d-31.6825!4d29.19194

Figure 10 shows the geographical location of School B within the OR Tambo district. There is a forest about 5.7 km east of the school.

School B had a computer laboratory (Figure 11) that was apparently not used for teaching and learning because Denise informed the researcher that the computers needed to be fixed while others were damaged or stolen. The keyboards were packed in stack and all the computers were not connected to electricity. According to the principal of the school, this room did not have electricity and was not used for teaching and learning. He reported that the computer laboratory was used as a storage of old computers and gadgets.

Figure 11. School B’s computer laboratory

During the data collection period, the school had a population of 592 learners across Grades 10-12. The learners were registered in two streams only and the available streams were the Sciences stream which comprised of Mathematics, Physical Sciences, and Life Sciences, the Humanities stream which was made up of IsiXhosa HL, English FAL, History, and LO. The majority of the learners in this school were registered in the Humanities classes. The school principal reported that the Commercial stream was cut out because it had few enrolments in previous years. As a result, 24% of the learners were registered in the Sciences stream because there were 143 learners in the Science class.

4.5 School C

The school is located in Ntlaka (pseudonym), a small town that is situated about 13 kilometers from Libode. A busy highway (R61 national road) runs next to the school. A taxi rank is about 750m away from the school, whereas Luncedo hospital (pseudonym) is about 500 m from the school (Figure 12). The Luleka nature reserve (pseudonym) is situated at about 48km from the school, and the school is situated at about 43.7 km from Walter Sisulu University (WSU) medical school.

School C is categorized as a section 21 and is a quintile one school. For that reason, parents do not pay school fees for the education of their children. The school benefits from the government's initiative of scholar transport. Three taxis and one mini-bus collect learners from nearby villages to and from the school daily. According to the principal, discipline and learner attendance at this school are serious problems. The principal of school C told the researcher that learners were involved in drug and substance abuse. The biggest influence to this problem is the taxi rank that is nearby the school.

Figure 12. School C and surrounding areas. Acessed from https://www.google.com/maps/dir[redacted]a//@-31.5621551,29.113089,1458m/data=!3m1!1e3!4m9!4m8!1m5!1m1!1s0x1e5fb697108df7a5:0x2f9d5e701b64b265!2m2!1d29.11194!2d-31.56417!1m0!3e0

The school is located about 500m from the forest and about 780m from the Ngonyama river (Figure 12). Life Sciences educators from the school could make use of the natural ecosystem surrounding the school and the material resources such as the Lusizo hospital, the Luleka nature researve, and the WSU Medical school.

Both male and female educators in the school shared one staffroom (Figure 13), and the staffroom adequately accomodated them.

Figure 13: School C's science laboratory.

According to the principal of this school, the science laboratory was vandalized and the apparatus were stolen because of ongoing violence in the school. The school principal suspected that violence was caused by extreme levels of drug and substance abuse in the area. The science laboratory was then converted to a staffroom. The science laboratory (Figure 13) has a chalkboard and an educator's table to conduct science practical work. The design of the room is typical of any science laboratory found in schools.

School C's computer laboratory (Figure 14) was not functional during the researcher's visit to the school. The principal reported that it was also vandalized by people who broke into the school and stole valuable gadgets such as computers, printers, and tablets that were kept there. It was then used as a staffroom for educators since there were few staffrooms in the school. According to the principal of this school, the staffroom was also used to store textbooks and stationery since there was no store room and it was not safe to keep teaching and learning material in the classroom since they did not have locked doors.

Figure 14: Schools C's computer laboratory

Figure 15 shows a Grade 10 block where the classrooms do not have doors and windows. According to the principal of this school, it was not safe to keep teaching and learning resources in these classrooms.

Figure 15: School C's Grade 10 block with broken doors and windows.

There was one water tank that catered for 500 learners and 19 educators in this school (Figure 16). Learners fetched water from the nearby hospital with buckets to fill the tank after every two days.

Figure 16: Satellite dishes for DSTV and the internet connection at School C

Although School C had dilapidated buildings and lacked resources, it had internet connection. The school also had a DSTV, which could be used to teach Life Sciences by allowing learners to watch the learning channel (Figure 16).

There were three subject streams that learners were registered under. The available subject streams of the school were the Sciences stream which was composed of Mathematics, Physical Sciences, Agricultural Sciences, and Life Sciences; the Humanities stream which had subjects such as IsiXhosa HL, English FAL, History, and LO. The last stream was the Commercial stream which comprised of Accounting, Business studies, and Economics. The highest enrolled stream in this school was the humanities stream which was composed of 277 learners adding to a total of 55.4% of the schools' learner population. The grade 12 enrolment was 222 learners. From this enrolment, 119 learners were registered in the Science stream, 55 learners were in the Humanities, and only 48 learners were in the Commercial stream.

4.6 The cases

In this section, a thick description of the cases is presented. In the description, the demographic information of each case is highlighted. Raw data from the four data collection instruments as described in Chapter 3 are presented under each case in an attempt to answer the three research questions of the study which are:

1. What are the Life Sciences educators' understandings of resource-based teaching?
2. How do the Life Sciences educators enact resource-based teaching?
3. Why do Life Sciences educators enact resource-based teaching the way they do?

An understanding of how the participants enacted RBT was achieved using data obtained from the questionnaire, interview responses, the analysis of documents, and the lessons that were observed by the researcher. Lesson observations were planned and arranged over telephone calls between the participants and the researcher. In the subsequent sections, data from the interviews and questionnaires is presented first, followed by data obtained from the lesson observations.

4.6.1 Case 1: Denise

Denise was a 55-year-old native isiXhosa-speaking female educator who had a senior teachers' diploma and more than 20 years Life Sciences teaching experience in Grades 10-12. Over the years, Denise had taught Life Sciences, IsiXhosa, and Life Orientation (LO). At the time of doing this study, Denise was teaching Life Sciences and LO in School B.

4.6.1.1 Denise's understanding of resource-based teaching

To get the full import of the participants' understanding of RBT, it is important to first describe their understandings of a resource as it might have a bearing on their understanding of RBT. Additionally, a description of the resources used by the participants may give context to their understanding of RBT. Therefore, in this section and subsequent similar sections for each participant, the researcher describes participants' understanding of a resource and the resources they used to teach Life Sciences, and eventually each participant understanding of RBT is documented.

Denise understood a resource as a teaching material. During the interview she said, "a resource is a tool that is used when you teach" (Denise, interview, May 15, 2017). Her questionnaire response to the same question indicates that she knew a variety of educational resources that belong to both the hardware and the software resources categories. She, however, did not show knowledge of ideological-ware as a group of resources that can be used in the teaching and learning of Life Sciences. Denise wrote, "The resources are charts, overhead projectors, chalkboard, textbooks, and models" (Denise, questionnaire, May 15, 2017). Denise's understanding of a resource is consistent with literature (Hill & Hannafin, 2001). A resource is a teaching material that has a potential to support learning (Hill & Hannafin, 2001).

To teach Life Sciences, Denise used hardware resources. During the interview, she told the researcher that, “In our school we have resources such as textbooks, chalkboards, charts, and models. So, I teach using them” (Denise, interview, May 15, 2017). Denise further indicated that she used the stated resources because they are not time-wasting and are helpful to summarize lessons. During the interview she told the researcher that, “I mostly use textbooks, chalkboard, and also the charts. It’s because they are not time-consuming. The textbook is not time consuming. I use the chalkboard when I summarize my lessons” (Denise, interview, May 15, 2017).

Denise understood RBT as a teaching strategy. During the interview, she said, “resource-based teaching is a teaching strategy to teach by using the resources” (Denise, interview, May 15, 2017). In the questionnaire, she indicated, “resource-based teaching is a teaching strategy whereby an educator teaches using resources as much as possible” (Denise, questionnaire, May 15, 2017). Denise’s understanding of RBT was consistent with Beach and Willows (2014) description of RBT. The authors argued that RBT is an instructional strategy that takes into consideration learners’ abilities.

4.6.1.2 Denise’s enactment of RBT

Denise used the available resources as sources of information to which she constantly referred. The reason for using resources this way might possibly be because they save on time and are good for summarizing lessons because Denise said; “I mostly use textbooks, chalkboard, and also the charts. It’s because they are not time-consuming. The textbook is not time consuming. I use the chalkboard when I summarize my lessons" (Denise, interview, May 15, 2017).

Another possible reason Denise might have opted to rely heavily on the textbook as a source of reference may be that other resources are unavailable. She said, "we do not have other resources" (Denise, questionnaire, May 15, 2017). Denise also used a textbook because she seemed to be the least technically competent in designing and using PowerPoint presentations. She told the researcher that, "resources like power point are time consuming" (Denise, questionnaire, May 15, 2017). Lastly, Denise probably lacked exposure to laboratory apparatus and training to use the apparatus. She reported that, "I was not trained to use laboratory apparatus" (Denise, questionnaire, May 15, 2017), and that may be the reason why she was least technical competent.

Denise used the available resources in her lessons but she did not exhaust all the prescribed resources for the topics she taught during her lessons. For instance, during the first observed lesson, the recommended resources for use were the textbook, charts, microscope slides/micrographs, microscopes, and reference books (Education, 2011), but only the textbook, and reference book were used during this lesson. This might possibly be because resources such as micrographs and microscopes were not available in her school because during the interview, she did not mention them.

When asked how she used resources to teach LifeSciences, Denise said, "I use these resources to teach Life Sciences by engaging the children to make charts" (Denise, interview, May 15, 2017). This means that Denise creates an interactive teaching environment because when learners design charts, they are coerced to engage cooperatively with one another so that their chart could be a result of a collective effort (Yeboah et al., 2016).

To conduct Science practical work, Denise indicated that she used the textbook, chalkboard, and the reference book. During the interview she said: “It causes my lessons to be clearer and the teaching and learning environment becomes more conducive when I use those resources” (Denise, interview, May 15, 2017). Denise probably used resources this way because she believed that RBT enhances conceptual understanding and facilitates knowledge transfer to learners. She said, “It helps the lesson to be clear. It helps them to grab the reason for the lesson. To grab everything**”** (Denise, interview, May 15, 2017).

Denise’s best experience in using a resource to teach Life Sciences was when she used a model to show the human brain. She reported that the model ‘brought reality into the classroom’ because learners could touch the brain and see its different sections. She said,

> It was when I was using a model of the brain in my class. It was an exercise that brought reality into the classroom because learners were able to touch and identify the different parts of the brain while reading more information about it in the textbook (Denise, questionnaire, May 15, 2017).

Denise believed that the enactment of RBT was beneficial to both learners and educators on a number of aspects such as instructional strategies used, collaboration, life-long learning, assessment tasks, critical thinking, and learning environment. She exposed that the enactment of RBT results in simplicity of teaching. Thus, educators do not have to struggle in executing lessons by incorporating difficult instructional techniques. She said, “It makes teaching easy for me and when I use these resources the learners grasp the content well” (Denise, interview, May 15, 2017). She argued that the enactment of RBT makes the learning environment conducive because learners begin to show interest in the lesson. Hence, that may be the reason ‘learners grasp well’ because she said, “The learning gets very conducive and the learners become so excited” (Denise, interview, May 15, 2017).

Denise argued that effective enactment of RBT increases collaboration amongst learners. She said that, “The learners develop that thing of working together, they develop that” (Denise, interview, May 15, 2017). Denise added that RBT is a foundation to life-long learning. When learners are exposed to RBT in their Life Sciences classrooms, they may be motivated to interrogate and discover more knowledge on their own and in their free time. During the interview, she said, “In terms of life-long learning, it motivates them to learn on their own beyond the classroom (Denise, interview, May 15, 2017).

Denise argued that the enactment of RBT in Life Sciences lesson encourages learner’s creativity. She said, “It enhances their critical thinking and also they become more creative” (Denise, interview, May 15, 2017). She also argued that the enactment of RBT enables her to design good assessment tasks that take less time to prepare. She said, “In assessment it is very easy for me. And also, I am assessing them very easily and I can’t prepare too much**”** (Denise, interview, May 15, 2017).

Denise claimed that she did not have challenges in enacting RBT. She said, “No, I do not have any challenges**”** (Denise, interview, May 15, 2017), but the description of her worst experiences in using a specific resource indicated that she had a challenge. In the questionnaire, she wrote;

> I was trying to set up a PowerPoint presentation that we were given by the subject committee in the cluster. It became a disaster because the screen was not showing the slides and that ate on the period. I was eventually assisted by learners to make it work and the time of the period remaining was very small. It was such a disaster! (Denise, questionnaire, May 15, 2017).

During the same interview, Denise indicated that she had a challenge of shortage of time when using a computer because it is time consuming to set it up. Denise said, “other resources are time-consuming e.g. when you use PowerPoint, it is time-consuming and the connection of computers is very difficult to me**"** (Denise, interview, May 15, 2017). In dealing with the challenges experienced, Denise reverts to using her usual resources such as textbooks, charts, and models. She said, "I just go back to my easier resource like textbooks, and my charts and my models" (Denise, interview, May 15, 2017).

As part of insight into Denise's enactment of RBT, lesson observations were done to collect first-hand information on how she enacted RBT in her classroom to enable the researcher to draw an understanding on and why she enacted it the way she did. There was a total of seven lesson observations that were made when Denise was teaching in her classroom.

During the first lesson observed, Denise introduced a new unit in her Grade 10 classroom. The topic of the lesson observed was *Animal Tissues.* Inside the class, there were 58 learners who were seated on wooden desks which accommodated five learners each desk. The classroom was full and there were no spaces for movement in-between the desks. The researcher was seated at the back-left corner of the classroom sharing a bench with three learners.

The classroom had no door and eleven windows were broken. As a result, it was cold inside. The classroom was also not electrified. The walls of the classroom did not have any Life Sciences-related learning material. A list of classroom rules and a duty roster for cleaning were the only things that were pasted on the noticeboard. The available resources in the classroom were a chalkboard, textbook, chalk, and a reference book (Denise, lesson observation 1, May 15, 2017).

During the lesson, Denise asked the learners to look at the structures of epithelial, connective, muscle, and nerve tissues in the textbook. The focus throughout the lesson was on epithelial tissues. It was noticed that learners did not have enough textbooks as about five learners shared one textbook throughout the lesson. Denise used the chalkboard to draw epithelial tissues which were the squamous, columnar, and cuboidal tissues. She sourced the drawings from her reference book that she had brought to the classroom. She then asked the learners to go upfront to the chalkboard and name the tissues. Siyabonga (pseudonym for one of the learners) went to the chalkboard to identify the tissues and explained their functions to the rest of the class. Learners were then instructed to use their cell phones to google pictures of the connective, muscle, and the nerve tissues and draw and label them during the period. During this time, Denise supervised if they were doing what she had instructed them to do (Denise, lesson observation 1, May 15, 2017).

In her second lesson observed in Grade 10, Denise went to class with magazines, newspapers, scissors, colour pens, and A3 size drawing papers. She instructed learners to use the material to cut out pictures and design educational posters of food webs that involve producers, consumers, and decomposers. Seated in groups, learners shared the material amongst them and started to do the work. During the lesson, Denise moved around the groups and monitored what was happening. She was always helpful to pass glue stickers from one group to the other since there was a shortage of scissors and glue stickers. Learners spent the whole period doing the activity in groups (Denise, lesson observation 2, May 16, 2017).

During the third lesson observed in Grade 12, Denise combined two classes to form a large group of 94 learners who were seated in rows parallel to each other. The classroom had a door and six windows. Inside the classroom there were no Life Sciences related teaching and learning material. Only one light bulb was functional in this classroom, two were very dim while one was broken. Consequently, the lighting inside the classroom was very poor. The lesson was about the human eye. Denise used a textbook to teach learners during this lesson. She drew sketches of the human eye on the chalkboard from her textbook, which the learners also had. She also gave each group a photograph of the human eye (Figure17). During the lesson, learners discussed the eye and its functions using the picture provided and a list of questions to guide their discussion (Denise, lesson observation 3, May 16, 2017).

Figure 17: Picture of the human eye

During the fourth lesson observed, Denise summed up the previous day's work on the human eye and told the learners to write an assignment on visual defects. The focus of the assignment was on the causes and ways to limit or redress visual defects. Learners were required to use their textbooks, libraries and find books, and the internet to search for myopia, hyperopia, and astigmatism. Learners were required to complete the assignment in one week with a list of references. After Denise had finished explaining what was required from the learners, she instructed them to use their cell phones to search for information to complete the assignment. Learners started organizing themselves into groups immediately after Denise have spoken (Denise, lesson observation 4, May 17, 2017)

During the fifth lesson observed, Denise invited a nurse from Lusizo hospital (which is 21.8km away) to her classroom to explain birth abnormalities and sexually transmitted diseases (STDs). The nurse seemingly had prepared everything that she sought to talk about. The session was not necessarily a presentation, it was more interactive. Pamphlets with a summary of the presentation and contact details (cell phone numbers) of the nurse were distributed to the learners at the end of the lesson (Denise, lesson observation 5, May18, 2017).

The sixth lesson observed was about the application of Indigenous Knowledge Systems (IKS) and Biotechnology. There were 56 learners in the classroom. During the lesson, Denise had invited a village elder to the classroom to present about traditional beer making. According to Denise, the objective of the lesson was to show that there is a link between Indigenous Knowledge and Science. Thus, Denise started the lesson by reading information about traditional beer and fermentation. She then asked Mrs Msomi (pseudonym) to describe the traditional beer making process to the learners. As Mrs Msomi was presenting, learners were listening and simultaneously taking notes. Mrs Msomi described that during beer brewing, she used yeast to ferment the mixture so that it becomes alcoholic. She also explained that if there is no yeast added to the beer, it will not be intoxicative.

Seemingly, learners had basic understanding of the beer brewing process prior to Mrs Msomi's presentation. Judging from their engagement in the classroom and the questions that they asked (particularly girls) showed that they have been involved in traditional beer brewing in their homes. For instance, during question and clarity time, Nomsa (pseudonym), asked whether Mrs Msomi used very hot or mildly hot water to mix the five ingredients (maize (corn), maize malt, sorghum malt, yeast, and water) of brewing traditional beer. She referred her question based on the fact that, 'my grandmother taught me to use very hot water for quick fermentation' (Denise, lesson observation 6, May19, 2017).

The seventh lesson observed for Denise was in Grade 10 in the afternoon of the same Friday. Denise took learners to the nearest forest to learn about flora and fauna. The fieldwork was attended by all 153 Grade 10 learners. The forest (Figure 18) was a walking distance from the school (900m).

Figure 18: Route from School B to the forest. Accessed from

https://www.google.com/maps/dir[redacted]/-31.6765678,29.1910089/@-31.6800257,29.1934119,1380m/data=!3m1!1e3!4m9!4m8!1m5!1m1!1s0x1e5e4da9f1a76fa1:0x4df75e4301199e89!2m2!1d29.19194!2d-31.6825!1m0!3e2

In the forest, learners were taught about the different types of plant and animal species that were available. Denise showed the learners a variety of trees and shrubs that were the sweet thorn tree, coastal silver oak, the big num-num, and the stinky ebony according to Denise’s description. Animal (fauna) species were however rare to find in that part of the forest. It was evident that learners were inquisitive during this lesson judging from the questions they asked. For instance, Simfumene (pseudonym) told Denise that he noticed that the trees available in the forest were all green and herbaceous and he wondered about the properties of the soil in that region. He was interested in learning more about soil properties that influence plant growth between vegetated and desert soils.

To conclude the lesson, Denise asked learners to compile a report of the trip and describe their experiences and what they had learnt during their visit to the forest. Learners were also required to use their study materials to write the relationship between the living organisms they learnt about in the forest (Denise, lesson observation 7, May 19, 2017).

Although Denise reported that she was technically incompetent to use technologies during her teaching of Life Sciences, she used the available natural ecosystem in a way that was beneficial to the learners and was consistent with the Life Sciences policy document. Learners were given opportunities to interact with the natural, physical, and human resources and learn independently on their own throughout all the lesson observed for Denise.

4.6.2 Case 2: Patrick

Patrick was a 30-year-old male educator who was teaching in School B. He had a Bachelor of Education (B.Ed.) degree and majored in Agricultural Sciences. He obtained his qualification in the year 2015. By the time of conducting this study, he had two years of experience in teaching Life Sciences in Grade 11 and 12.

4.6.2.1 Patricks' understanding of resource-based teaching

Patrick understood a resource as a tool that is used to support the transfer of knowledge from the educator to the learners. In the questionnaire, he wrote, "a resource is anything that a person uses to implement or to augment his content, to make it easier for his learners to understand" (Patrick, questionnaire, May 15, 2017). He added that, "it is a tool such as past examination papers, chalkboard, chalk, computers, laptops, cellphones, data projectors, videos, as well as microscopes that are used to supplement the textbooks used by learners in class" (Patrick, questionnaire, May 15, 2017). This description was consistent with the description he gave during the interview with the researcher where he elucidated that; "a resource is anything that you use to enhance something (teaching) or to achieve a goal in the classroom**”** (Patrick, interview, May 15, 2017).

The available resources in Patrick’s school were both hardware (textbooks, study guides, and question papers) and software resources (overhead data projector, and computers). During the interview, Patrick did not show knowledge of the ideological-ware resources. He only told the researcher about the available physical resources and said, “here at school we have the normal resources such as textbooks, study guides, question papers. We also have a data projector and two computers that are used by educators when they are teaching” (Patrick, interview, May 15, 2017).

When Patrick was asked about the resources, he was using to teach Life Sciences and the reasons he used those resources he indicated that he was using a textbook and YouTube videos. He argued that the latter resources brought visual representation of scientific concepts to learners in the classroom. He further claimed that the resources help to capture learner’s attention and improve their understanding of the overall lesson. Patrick said;

> I use data projector as well as the textbook so that learners may understand what I am saying. I have seen that learners are more interested when they see something than when it is said by an educator. So, I use the data projector to show some videos (Patrick, interview, May 15, 2017).

In his questionnaire narrative, when Patrick was asked to identify the resources, he used to teach Life Sciences, he selected rivers, dams, lakes, PowerPoint presentation, the internet, and a reference book (Patrick, questionnaire, May 15, 2017). Patrick indicated that he would love to use a microscope to teach Life Sciences in his lessons because it makes teaching easy. He said;

> I would like to use the microscope simply because it makes things better. To study a cell through the textbook is not like studying it through a microscope because learners are interested to see things than hearing and seeing on the textbook. And also, the stethoscope, I would like to use it some other time during my lessons (Patrick, interview, May 15, 2017).

Patrick understood RBT as a teaching strategy whereby a variety of resources are used by educators to improve learners' understanding. Patrick said, "resource-based teaching is a strategy whereby a teacher uses projectors, computers, textbooks, study guides, question papers, and many other things to enhance learning" (Patrick, interview, May 15, 2017). Similarly, he indicated that, "resource-based teaching is a strategy where the educator uses the various resources to enhance the understanding of learners" (Patrick, questionnaire, May 15, 2017).

Patrick's understanding of RBT is consistent with the literature as reviewed in Chapter 2 of this study. Studies revealed that RBT is a learner-centered instructional strategy that gives learners an opportunity to study independently through the use of resources (Beach & Willows, 2014; Hill & Hannafin, 2001).

4.6.2.2 Patrick's enactment of RBT

Patrick claimed to use hardware and soft-ware resources to teach Life Sciences. The hardware resources that Patrick said he used in the teaching of Life Sciences were the data projector, interactive whiteboard (IWB), cell phone, television, forest, computer, textbook, and past examination papers. The software resources were social networks, the internet, videos, PowerPoint slides, and simulations (Patrick, questionnaire, May 15, 2017).

Some of the possible reasons for Patrick's use of the stated resources might be that a textbook was the only source of rich information at his disposal at that time, and that he used his creativity to incorporate the use of PowerPoint slides, and videos to advance learning. During the interview, Patrick said, "these are scarce resources as this is a poor school that is not yet built by the department of education" (Patrick, interview, May 15, 2017). He further elucidated that, "here at school we only have basic resources such as textbooks, study guides, and past examination papers" (Patrick, interview, May 15, 2017).

Another possible reason for using the stated resources might be due to his personal classroom experiences. During the interview Patrick said, "I have seen that learners are more interested when they see something than when a teacher says it" (Patrick, interview, May 15, 2017).

Patrick indicated that in the classroom he first teaches learners about a particular topic and then download videos of that specific topic on YouTube and use a computer and a data projector to play the video for the learners. He said;

> I download YouTube videos that are relevant to the topic. Then I play the videos to the learners so that they may understand the content better. Sometimes I start by playing the videos and then ask learners to summarise them (Patrick, interview, May 15, 2017).

Patrick often borrowed some resources from a neighbouring school. He explained that;

> "We do not have adequate resources in our school so I demonstrate the practical experiments. In the neighbouring school they have a microscope and other Science laboratory practical apparatus. So, I borrow the resources that I do not have depending on the demands of the practical activity and select few learners at a time to watch because they cannot all see at the same time. I then select another group of learners to watch the experiment the following day until all of the learners have observed me demonstrating the experiment (Patrick, interview, May 15, 2017).

In addition, Patrick could perhaps be opting to demonstrate a practical experiment because of the fact that "learners are more interested when they see something than when it is being said by the educator" (Patrick, interview, May 15, 2017). It is important to respond to learners' preferences and learning styles to avoid boring the learners during teaching and learning.

Patrick believed that the enactment of RBT was beneficial to both learners and educators on a number of aspects such as the instructional techniques, collaboration, life-long learning, assessment tasks, critical thinking, and the learning environment. He argued that the instructional techniques used by educators in RBT environments (RBTE) promoted classroom engagement and reflective activities because learners get an opportunity to think broadly and reflect on the lesson. He said;

> If I play a video in the classroom, learners are then able to discuss after that. They can account to me what they have seen and how the process happens. They even make classroom presentations after what they have seen (Patrick, interview, May 15, 2017).

Patrick claimed that the RBTE is a space of positivity where learners actively discuss the lesson and ask questions based on what they have seen in the lesson. He further compared a RBTE to a live experience of a practical activity. He said, "the learning experience becomes positive. Learners become actively involved in the discussion of what they have actually seen. It's like they have just experienced it. So, that is why it becomes positive" (Patrick, interview, May 15, 2017).

Patrick claimed that the enactment of RBT guarantees collaboration amongst learners in the Life Sciences classroom. He stated that, "the learning becomes more collaborative. The learners start to work together more successfully than when resources are not used" (Patrick, interview, May 15, 2017). Patrick then put it into context and said, "for instance, you organise the learners into groups and then after watching the video they discuss what they have seen" (Patrick, interview, May 15, 2017).

Patrick described the benefits of enacting RBT in terms of life-long learning. Firstly, the educator learns from the resource while teaching, and secondly, learners experience a different way of learning. He said that;

> As an educator, I learn from those YouTube videos first. Learners also learn from those videos as well. For instance, I usually take them out of the classroom and send them to the laboratory where they watch the videos repeatedly. From watching the videos, they gain more information because the videos are not boring. This guarantees that they learn more and more on the topics that I have taught in the classroom (Patrick, interview, May 15, 2017).

Patrick used his computer to design assessment tasks. He said that computers enable him to assess learners with ease. He said, "I use my computer to type the question papers. I also use the computer to show past examination questions. Therefore, I can use them to assess learners in class" (Patrick, interview, May 15, 2017). Patricks' understanding of assessment in a RBTE was very shallow based on this statement because assessment in RBT cannot be judged based on one's ability to type an examination paper.

The benefit of enacting RBT according to Patrick is that RBT arouses critical thinking. He said, "critical thinking is provoked during the classes that I usually conduct" (Patrick, interview, May 15, 2017). Patrick reported that his learners have improved their academic performance because of the enactment of RBT in his lessons. He said, "It has helped me because I have seen improvement in the results. The learners are getting better marks during examinations" (Patrick, interview, May 15, 2017).

Patrick claimed that he used YouTube videos to enhance his teaching of Life Sciences. He said, “most of the topics are there on YouTube. Environmental studies, digestion, and the endocrine system are there on YouTube” (Patrick, interview, May 15, 2017). Patrick faced a challenge of having a few computers and only one data projector in his school. Sometimes when he wants to use the data projector, it would be used by another educator. As the staff, they have resolved to design a timetable for using the data projector to avoid clashing or having to “wait or cancel a lesson because the projector is not available”. He said, “the challenge is that there are few computers. Sometimes I would want to use the data projector but then it won’t be available. It would be used by another educator” (Patrick, interview, May 15, 2017).

Patrick thought that “resource-based teaching is very awesome” and he suggested that the DoE should provide in-service training workshops to up skill educators and enable them to enact RBT effectively. He also reported that educators lack experience in using RBT as an instructional strategy. He said, “we need to have workshops on resource-based teaching to enable us to enact it properly. We also need more Life Sciences teaching resources in our schools” (Patrick, interview, May 15, 2017).

A total of eight lessons were observed where Patrick taught Life Sciences. The lesson observations were done over a period of two weeks. Each lesson observed lasted 60 minutes except for field and practical activities which exceeded the 60 minutes timeframe.

During the first lesson observed, Patrick was teaching his Grade 12 class about genetic disorders caused by mutations. There were 68 learners present in the classroom. Similar to Denise’s classroom, 3-4 learners shared a bench in a desk. There was sufficient lighting in the classroom. On the walls of the classroom, there were no Life Sciences learning material as suggested in the Life Sciences policy document that;

> The Life Sciences classroom or laboratory should be equipped with charts, Bunsen burners or spirit lamps, hand lenses, bio viewers and relevant bio strips, microscopes, a set of prepared slides, glass slides and cover slips, reference books, blades or scalpels, models, field guides, identification keys, thermometers, glass beakers, test tubes and chemicals, and, if at all possible, access to appropriate DVDs and a DVD player (Education, 2011, p. 19).

During the lesson, the researcher was seated at the back sharing a bench with two learners. Patrick brought A4 size printed pictures of children with Down syndrome, a girl with albinism (Figure 19), a picture of a human nose that is excessively bleeding to show haemophilia (Figure 20 and Figure 21), and pictures of sickle-cell-anaemia. He introduced the lesson by writing the topic on the chalkboard and asked the learners to refer to page 89 of their books. Eighty-four learners took out their books while only five learners did not have the textbooks (Patrick, lesson observation 1, May 15, 2017).

Patrick started the lesson by explaining the causes, symptoms, treatment, and ways to screen the genetic disorders. During his teaching, Patrick read from his textbook and wrote notes on the chalkboard. After covering all the four disorders in the textbook, he issued printed images of the disorders to the learners who were seated in groups of eight learners in each group. Patrick then told the learners to identify the disorders and discuss their related social problems.

Figure 19: Learners looking at a picture of a person with albinism

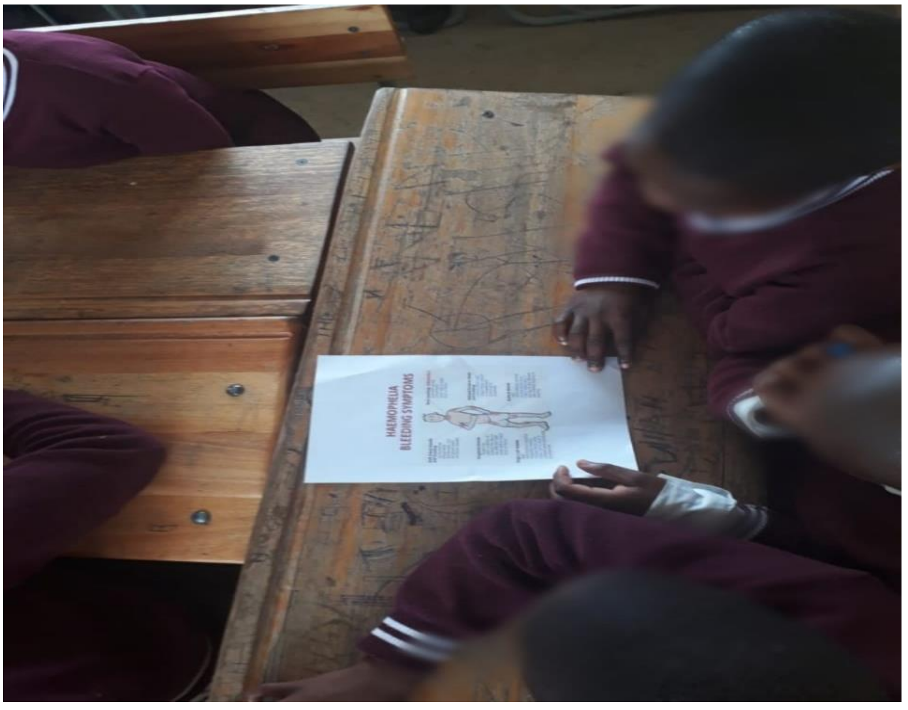

Figure 20: An image illustrating haemophilia

Figure 21: Learners working with an image of a bleeding nose

It was noticed that all the pairs were talking to each other as guided by the pictures in front of them. Patrick then asked the learners to present their findings to the class. Only two groups were able to give feedback due to time constraint. The first group reported on societal attitude towards people with albinism. During the feedback, the pair demonstrated an improved practical understanding of albinism. The second pair which presented on societal attitudes towards people with Down syndrome also articulated symptoms of Downs syndrome satisfactorily. The presentation was good on the basis that it incited further classroom engagement. Learners showed interest to express their views to an extent that Wendy (pseudonym of a learner) confessed that she once ill-treated her friend with Down syndrome because she was not aware of it (Patrick, lesson observation 1, May 15, 2017).

During the second lesson observed, Patrick was using the natural ecosystem around the school with the Grade 10 class (Figure 22 and figure 23). Patrick took learners outside the school to a forest across the road and instructed them to dig a hole on the damp soil (Figure 22). As the learners were digging deep, they came across a variety of small living organisms. Among the organisms collected were the earthworm, spring nails, mites, nematodes, ants, and rodents. Patrick then instructed the learners to collect the organisms and classify them. Learners were observed classifying the organisms and writing some notes into their fieldwork books. They handed their books to the educator for marking (Patrick, lesson observation 2, May 17, 2017). There were no pictures of the collected organisms that were taken because the researchers' camera had fallen and fractured. It was, therefore, not working.

Figure 22: learners standing around a hole in the natural ecosystem

Figure 23: Learners working with the soil from the hole

During the third lesson observed, Patrick demonstrated a science practical activity to test the presence of starch in green leaves for the Grade 11 classroom (Figure 24). There were 68 learners in the classroom. The available resources in the classroom were a potted green plant with leaves, methylated spirits, water, tin, saucer, test tube, wire gauze, and a two-banner stove (Patrick, lesson observation 3, May 18, 2017).

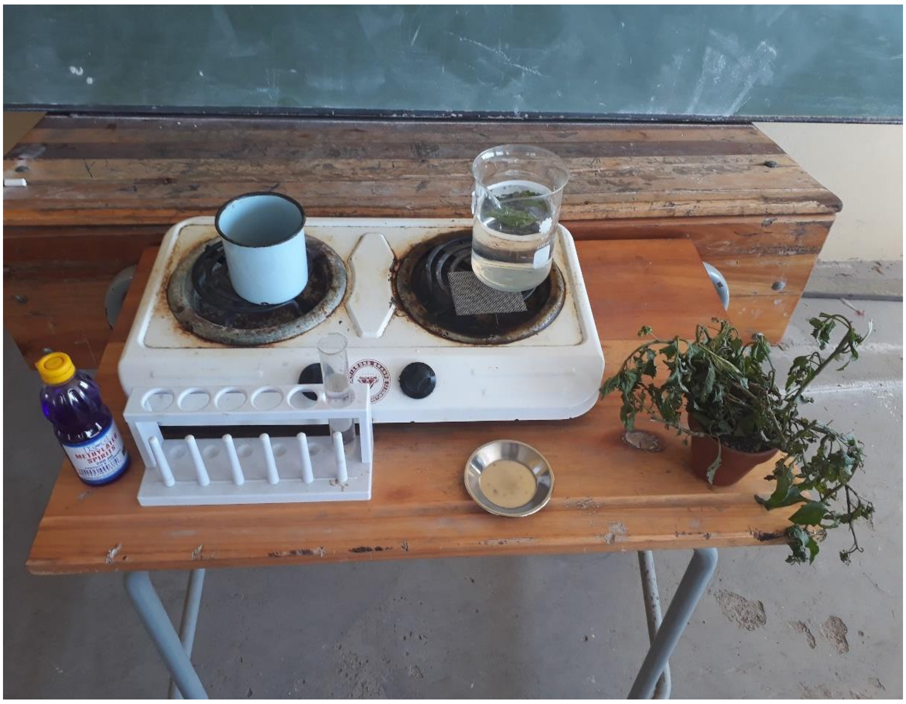

Figure 24: Patricks' apparatus before demonstrating the practical investigation.

Before the practical commenced, Patrick dressed the table as shown in figure 24. Figure 25 shows Patrick while demonstrating the practical to the first group of learners. Patrick explained to the learners that he would demonstrate the practical to small groups because there was only one set of apparatus available. He then requested that three groups at a time should come upfront where he had placed the apparatus for the practical. During the practical demonstration, he asked learners to read out the procedure while others actually performed what was instructed. The groups that were seated were instructed to analyse the procedure of the practical and understand it before their turn to watch the practical demonstration come. After the demonstration, Patrick asked the groups to answer the questions that were in the practical manual (Patrick, lesson observation 3, May 18, 2017).

Figure 25: Patrick demonstrating a practical

Patrick also used a research project during his enactment of RBT. During his fourth lesson observed, he instructed Grade 10 learners to research about missing links between dinosaurs and birds. He gave an example of Archaeopteryx Coelacanth, which is a living fossil that was found in the coasts of South Africa. Learners were required to use their textbooks, libraries, the internet, and other resources to source information and write a research report with a list of references for assessment (Patrick, lesson observation 4, May 18, 2017).

The fifth lesson observed was in Grade 11 and there were 65 learners present. Patrick was teaching about transpiration and photosynthesis. He used simulations to teach the lesson. There were only two computers for the entire school so Patrick used his personal tablet to access the simulation videos on the process of photosynthesis and transpiration. He then turned on his mobile hotspot and instructed learners to connect to the Wi-Fi signal and play the simulation from their cell phones. The simulation video was sourced from YouTube and it is accessible from https://www.youtube.com/results?search_query=simulation+of+ranspiration+and+photosynthesis. Only 30 learners had cell phones during the lessons. Patrick asked them to work in pairs. As learners were connected to Patricks' Wi-Fi signal, they watched the simulation in total quietness and attention while simultaneously taking down notes (Patrick, lesson observation 5, May 22, 2017). After everyone had watched the simulation, Patrick turned off his Wi-Fi signal and instructed learners to reflect on the simulation.

The sixth lesson that was observed was on genetic engineering in a Grade 12 class. There were 67 learners in the classroom during the lesson. The researcher was seated in the corner sharing a bench with three learners. Patrick came into the classroom carrying a textbook, a study guide, and a reference book that he used to copy the notes onto the chalkboard.

Patrick gave the learners five minutes to study the diagram on their textbooks which showed the production of insulin using bacteria. He then referred them to connect to this website https://www.youtube.com/watch?v=OYvav8aDGCc using their cell phones. Learners connected and played the video. Again, Patrick used his mobile hotspot and the learners used their cell phones. Learners connected and watched the simulation that showed the production of insulin from bacteria. After everyone had watched, the Wi-Fi connection was switched off and learners were assigned work on the advantages and disadvantages of cloning. They were advised to use the internet and libraries books and reference the source of information in a bibliography (Patrick, lesson observation 6, May 22, 2017).

During his seventh lesson observed, Patrick demonstrated a practical activity to small groups since there was only one set of borrowed apparatus (Figure 26). According to Patrick, the apparatus was borrowed from Vuyani Senior Secondary School (pseudonym) which was located 17.5 km away from School B. The practical aimed to investigate whether chlorophyll is essential for photosynthesis or not. The available apparatus was a potted green plant with leaves, methylated spirits, water, tin, saucer, test tube, wire gauze, and a two-banner plate stove. During the practical, small groups came to the front of the class where the apparatus was placed (Figure 26). Patrick read out the procedure to the learners and begun carrying out the practical activity about testing availability of starch in green plant leaves. When he was done with the first group of learners, he called others to come until he was done with all of the groups (Patrick, lesson observation 7, May 23, 2017).

Figure 26. Patrick demonstrating a practical activity about testing starch in plant leaves.

During the eighth lesson observed, Patrick walked with his Grade 11 learners to Emanzini (pseudonym of a valley that is about 1.5 km away from the school) to study aquatic biodiversity (Figure 27). Patrick was accompanied by another Life Sciences educator when he went to the valley with learners. On arrival, learners learnt about different aquatic plants and their adaptation to the environment. Learners were also taught about animals that live in water and their importance in the food web. Learners did not only listen to the educators, but they also touched the plants and saw animals and other small living organisms that live on moist soils such as crabs and dragonflies. Safety precautions were taken by both educators with learners as the learners were excited to touch the organisms and even took samples of the organisms with them for further analysis. No pictures were taken during the trip because educators feared that they might be attacked by gangs who allegedly hijack people in the forest. As much as there were no resources in School B, Patrick did his best to improve the learning experiences of the learners.

Figure 27: Map of the Emanzini (pseudonym) valley and School B. Accessed from https://www.google.com/maps/dir[redacted]/-31.665386, 29.1947698/@-31.6736995,29.1932009,2350m/data=!3m1!1e3! 4m9!4m8! 1m5!1m1! 1s0x1e5e4da9f1a76fa1:0x4df75e4301199e89!2m2!1d29.19194!2d-31.6825!1m0!3e2

4.6.3 Case 3: Nelson

Nelson was a 33-year-old male educator who had taught Life Sciences in Grade 10 – 12 for 12 years in school C. His highest academic qualification was a Master of Commerce degree (Mcom) which he obtained in 2009. During the time when this study was conducted, Nelson was completing his Post Graduate Certificate in Education (PGCE).

4.6.3.1 Nelson understanding of resource-based teaching

Nelson understood a resource as a teaching material used to scaffold learners. He said, “a resource is a teaching material used by educators to overcome learners’ difficulties” (Nelson, questionnaire, 5 May, 2017). He added that, “in general terms resources are materials that are used in schools to optimize the teaching and learning of a particular subject” (Nelson, questionnaire, 5 May 2017). Nelson emphasised that resources “are materials used by educators to deliver instruction in order to support and assist learners” (Nelson, questionnaire, 5 May, 2017). He further added that resources facilitate knowledge transfer between the educator and learners and “it plays a large role in making knowledge accessible to learners” (Nelson, questionnaire, 5 May, 2017).

Nelson also understood a resource as a material which can be used to support educators to meet teaching goals. During the interview, he said, “it can be used as a teacher companion in the classroom” (Nelson, interview, 8 May, 2017). This means therefore that during the enactment of RBT, an educator employs multiple resources to be used by learners for learning.

The available resources in Nelson’s school were hardware resources such as textbooks, models, and study guides. He said, “we have a very few resources such as textbooks and models. I think we also have a few study guides” (Nelson, interview, 8 May, 2017). This is contrary to the field notes I recorded when I was taken to the store room where Life Sciences material is kept, I did not see models that Nelson claimed to have, I saw a microscope instead (Figure 28).

Figure 28: A microscope in Nelsons' school

Data from the interview and questionnaire show that Nelson understood RBT as a teaching strategy that heavily relies on using resources to achieve educational outcomes. During the interview with the researcher Nelson said, "it is a form of teaching where you need adequate resources to be provided in order to achieve the stated outcomes for such teaching" (Nelson, interview, 8 May, 2017). The questionnaire response to the same question suggests a similar insight into Nelson's understanding of RBT. It shows that Nelson understood RBT as "a teaching strategy used by educators to transfer knowledge or subject content to the learners" (Nelson, questionnaire, 5 May, 2017).

4.6.3.2 Nelson's enactment of RBT

An understanding of how Nelson enacted RBT was reached using data obtained from the questionnaire, interview responses, and the five lessons that were observed by the researcher. In this section, data from the questionnaires and interview are presented first, followed by data obtained from the lesson observations in a view to discover Nelson's enactment of RBT.

Nelson claimed that he mostly used print resources to teach Life Sciences. He said, "I use textbooks, study guides, past examination question papers and some models" (Nelson, interview, 8 May, 2017). Nelson's justification for using the stated resources was that they are available in the school. During the interview, Nelson told the researcher that, "they are the ones at the moment I can lay my hands on and which are available in our staff room" (Nelson, interview, 8 May, 2017). However, this was not accurate because when I went to the store room, I did not see any kind of a model.

Nelson indicated that he used textbooks, PowerPoint presentations, DVDs and DVD players and the internet (Nelson, questionnaire, 5 May, 2017). Nelson also claimed that he used the stated resources because they were available in the school. He said, "I am using textbooks, PowerPoint presentations, DVDs and the internet because they are the resources that we have at the school and all learners can access them" (Nelson, questionnaire, 5 May, 2017).

Nelson used textbook for lesson planning and preparation. During the interview he said, "I use textbooks to prepare notes and to guide the learners when carrying out the process of teaching so that they follow my lesson (Nelson, interview, 8 May, 2017). Nelson also used study guides to guide learners on using their textbooks effectively. Nelson believed that study guides specify what learners need to study and pay attention to when preparing for examinations. He said, "the study guides also serve as an additional resource to guide learners on how to use the textbook and what to pay particular attention to" (Nelson, interview, 8 May, 2017). Nelson used past examination question papers to prepare learners for examination. He said, “question papers give ideas of how they are going to be assessed in the matric examination” (Nelson, interview, 8 May, 2017).

Nelson believed that the enactment of RBT exposes learners to the practicality of Life Sciences. He said, “my belief is that when you expose learners to a variety of resources, that capacitates them with the knowledge of the resource and procedure to use them” (Nelson, interview, 8 May, 2017). He also added that the enactment of RBT was critical in preparing learners for tertiary education. He said, “the enactment of RBT gives learners opportunities to use a range of resources. When they go to the university, they will adapt well there” (Nelson, interview, 8 May, 2017).

Due to the fact that school C had limited resources, Nelson argued that learners were deprived practical experiences of Life Sciences. He said “I believe my learners are being limited especially when it comes to practical work in Life Sciences” (Nelson, interview, 8 May, 2017). However, Nelson opined that RBT enhances learners’ collaboration in the classroom. He said, “in terms of teaching, learners can collaborate with each other.” (Nelson, interview, 8 May, 2017).

Nelson opined that successful enactment of RBT in the classroom creates a conducive learning environment that positively influences learners’ attitude towards Life Sciences. He said, “I think using a range of resources increases learners’ interest in the subject. We may also be able to attract more learners to this school” (Nelson, interview, 8 May, 2017).

Nelson reported that RBT cultivates higher order thinking skills amongst Life Sciences learners. He said, “when learners are interacting with certain resources, they develop critical and creative thinking. It also helps them to be resourceful especially when we use non-conventional material sourced from our environment” (Nelson, interview, 8 May, 2017).

According to Nelson, Evolution is a topic which is appropriate to be taught using resources. He said, “I prefer using resources in teaching evolution”. He substantiated his choice of the topic and said that the topic required a lot of comparison to do. He believes in using PowerPoint slides to illustrate the differences between organisms so that learners can understand. Nelson said “teaching evolution requires a lot of comparative analysis where we need to compare some of the ancient life forms with the modern life forms. Visual aids make it easier for the learners to do the comparative analysis” (Nelson, interview, 8 May, 2017).

Nelson faced “financial challenges, which impedes buying the required resources” (Nelson, interview, 8 May, 2017). Nelson sometimes found himself helpless because “there are certain things that are above my control. When they say there is no finance, then there is nothing I can do” (Nelson, interview, 8 May, 2017).The curriculum implementation theory by Rogan and Grayson (2003) is clear on the effects of financial resources to the implementation of curriculum (RBT). According to Rogan and Grayson (2003), if the managers of the school are reluctant to use the school budget to buy teaching resources, the subject (Life Sciences) will be compromised.

Nelson was observed teaching in class for six lessons. All the lessons observed were in Grade 11 and 12. The first lesson observed for Nelson was in Grade 12, and was a continuation of the previous day’s lesson on reproduction in vertebrates. There were 49 learners in the classroom. The learners were sharing seats in seats in the classroom while seven were sitting on the floor. The desks were arranged in rows and were facing north in the direction of the chalkboard. In between the desks, there was a space wide enough for a person to move. There were no Life Sciences charts that were hanged on the walls of the classroom as prescribed in the Life Sciences policy document (Nelson, lesson observation1, May 09, 2017).

During the lesson, Nelson played the learning channel on the DSTV (Figure 29). Learners were quietly watching the TV while simultaneously taking notes into their books. In the TV there was a tutor who taught about reproduction in vertebrates. The graphics on the TV were concise and the TV program showed various examples of reproduction in vertebrates.

Figure 29: Nelson’s classroom with a television above the chalkboard

During the second lesson observed, Nelson gave Grade 11 learners photographs of the cross sections of the human kidney (Figure 30). Learners were requested to discuss the position of the kidney and its significance in the functions of the kidney. Learners were arranged to seat in pairs. Using their study guides, school Wi-Fi, and the textbooks, they discussed questions and wrote on their answer books. The structure of the kidney was the topic of the lesson. Nelson asked the learners to read from their textbooks. It was noted however that not all learners had textbooks during the lesson. The textbook-learner ratio was 1:4.

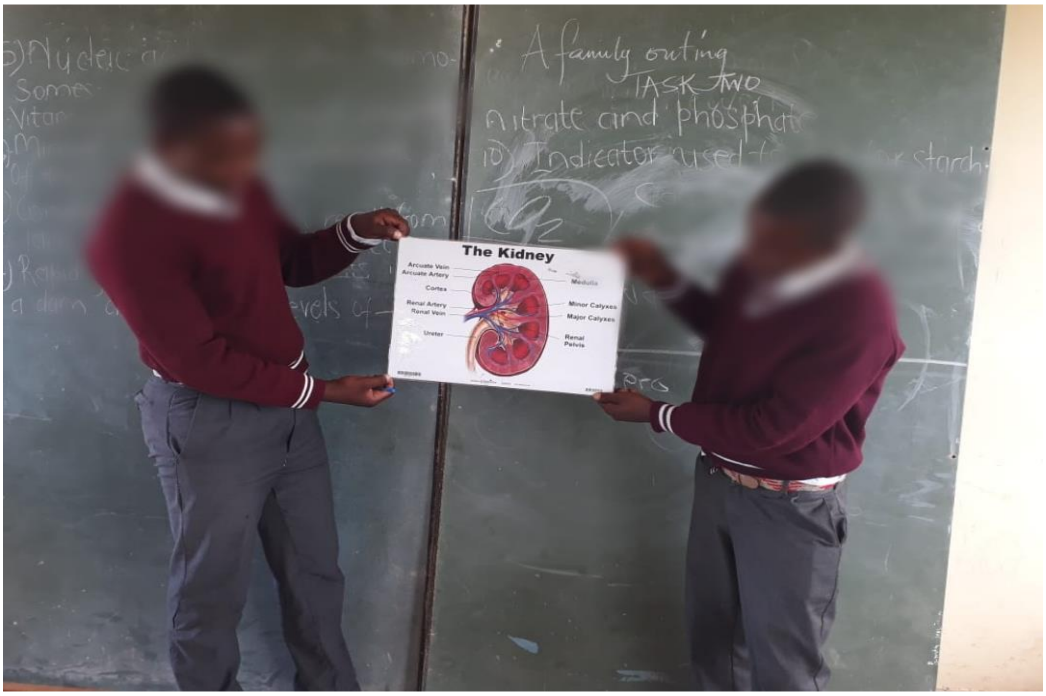

Figure 30: Learners holding a chart showing a cross section of the human kidney

During the lesson, two learners presented a poster of the structure of the human kidney in the chalkboard. The educator explicitly explained its (kidney) functionality and its adaptation to perform its function. A home activity was given to learners at the end of the lesson.

During the third lesson observed there were 66 learners in the classroom. Precocial and artificial development was the topic of the lesson. The lesson was aimed at making learners understand reproductive development in birds. The researcher noticed that there was an acute shortage of textbooks in this class as

Nelson instructed learners to refer to their textbooks as he taught and explained concepts by writing sketch notes on the chalkboard. During the lesson, Nelson threw some questions to check if learners followed him. Learners complied to the instruction of the educator. The preferred teaching resources according to the Life Sciences policy document were a textbook, charts, reference book, and appropriate DVDs. DVDs were however optional (Education, 2011). The resources used by Nelson during the lesson were a textbook, the internet, and a video. According to Nelson, he used the video to prepare for the lesson.

During the lesson, Nelson instructed the learners to use their cell phones and connect to the school's Wi-Fi by searching for the link: https://www.youtube.com/watch?v=ApP2c6uwxVw and watching the video simulation on precocial and artificial development in birds. Only six out of the 66 learners did not have cell phones to connect to the Wi-Fi. The six learners joined others to make pairs. This segment of the lesson excited the learners as they were curious of the development of chicks and their how they hatch from an egg. To conclude the lesson, Nelson instructed learners to monitor chickens at their homes during their mating and record their observations. At the end of the lesson, Nelson collected the learners' work for marking (Nelson, lesson observation 3, May 10, 2017).

The fourth lesson observed was attended by 70 learners. Nelson was introducing a new topic on human reproduction. Nelson used a PowerPoint presentation to present about the male and female reproductive system. The structures and functions of the male and female reproductive systems were displayed on the slides during the presentation. As Nelson was explaining, learners copied down summary notes into their books. During this segment of the lesson, Nelson referred learners to compare and contrast the reproductive system observed on the display screen simultaneously with those available in their textbooks. He also told them to write about sexually transmitted diseases (STDs) and reproductive problems affecting humans. This kept the learners actively involved and interested in the lesson (Nelson, lesson observation 4, May 11, 2017).

During the lesson, Nelson merely answered questions and guided learners' discussions to make sure they were doing the right thing. Only twenty-five minutes was allocated for this. They were then given five minutes for each group to present their findings from the pictures. Presentations were done and presenters demonstrated good understandings of sexual diseases and reproductive problems.

The fifth lesson observed was attended by 59 learners. During this lesson, Nelson and the learners walked to Luncedo hospital (Figure 31) to learn about sexual diseases affecting the human reproductive system. The lesson was seemingly meant to strengthen learners' knowledge base of STDs as they had learnt about them in the previous lesson observed. The hospital was a walking distance from the school (500m) and it took them only 6 minutes to arrive (Figure 31).

Figure 31: The route from School C to Luncedo hospital. Accessed from

https://www.google.com/maps/dir/[redacted]/@-31.5651814,29.1142425,686m/data=!3m1!1e3!4m14!4m13!1m5!1m1!1s0x1e5fb697108df7a5:0x2f9d5e701b64b265!2m2!1d29.11194!2d-31.56417!1m5!1m1!1s0x1e5fc80b6f1b78cb:0x14bc41eefc91386d!2m2!1d29.1175178!2d-31.5649067!3e2

On arrival, Nelson and the learners were welcomed by two staff nurses who were seemingly waiting for them. They were then taken to a hall where the nurses had hanged educational posters displaying sexual diseases on the wall. No photographs were taken during the hospital visit because the nurses did not give their consent. The nurses began their presentations on various sexually transmitted diseases such as HIV/AIDS, hepatitis B, pubic lice, genital herpes, chlamylia, and chancroid. During both sessions of presentations, learners took notes. During question time, learners asked a variety of questions on the causes of the diseases and how best people could keep safe from getting them. For instance, Achumile (pseudonym) asked the nurses to tell her which STI causing bacteria are transferrable in toilet seats and how best one can avoid infection? (Nelson, lesson observation 5, May 12, 2017).

The sixth lesson observed for Nelson was on a Saturday morning. Nelson had combined his two Grade 12 Life Sciences classes. The lesson was conducted in the schools' hall. The hall was big enough to accommodate all Life Sciences learners. Nelson played a video in the schools' TV during this lesson. The video was about the structures of the male and female reproductive systems and the main changes that occur during puberty in both boys and girls. When Nelson was asked where he got the video from, he indicated that he had downloaded it from YouTube using his laptop. Nelson indicated that he had accessed the video from the link,

https://www.youtube.com/results?search_query=puberty+changes+in+boys+and+girls.

During the lesson, Nelson had enough time to play the video which was 5 minutes and 14 seconds long. The learners were also listening attentively and writing down some notes as the video was playing. Some learners complained that the volume of the TV was too low and that they could not hear well. The problem was that the sound connection system in the hall was not working. As a result, Nelson only relied to the sound of the TV. After the lesson, learners were requested to use their textbooks to complete an activity in pairs. During the activity, Nelson moved around the desks marking learners' work and explaining to them when necessary (Nelson, lesson observation 6, May 13, 2017).

Nelson concluded the lesson by going over the classroom activity together with the learners. He did this by asking questions to the learners and giving them opportunities to respond and discuss responses before they could be accepted as correct.

4.6.4 Case 4: Michael

Michael was a 28-year-old male educator who was in his second year of teaching during the time when this study was done. He had a Diploma in Agriculture and a PGCE. Michael taught Life Sciences to Grade 10 and 11 in School C.

4.6.4.1 Michaels' understanding of resource-based teaching

Michael understood a resource as a teaching material used by educators to enhance learners' understanding in order to achieve educational outcomes. During the interview Michael said, "a resource is a material that one uses with the aim of assisting learners to understand the topic" (Michael, interview, May 08, 2017). In the questionnaire, Michael wrote, "a resource is a tool that is used by educators and learners in Life Sciences. If used correctly, it will result in achieved lesson outcomes" (Michael, questionnaire, May 05, 2017).

The available resources in Michael's school were the models and charts. During the interview, Michael said, "there are models. I have not used any resources except the charts" (Michael, interview, May 08, 2017). This information was consistent with the data reflected in the researcher's field notes. The researcher saw three new smart boards that were not yet installed in the schools' store room. In addition, there were a variety of textbooks and past examination papers that were seen in the store room of the school.

Michael understood RBT as a teaching strategy where learners learnt from interacting with the available resources during a lesson. Michael said, “resource-based teaching is a form of teaching which is based on using resources as much as possible” (Michael, interview, May 08, 2017). In the questionnaire, Michael said, “It is a way of teaching where learners learn with resources”. He added that, “educators plan lessons by using the resources such as textbooks. These resources help learners to learn better and more efficiently” (Michael, questionnaire, May 05, 2017).

4.6.4.2 Michael’s enactment of RBT

An understanding of how Michael enacted RBT was gathered using data obtained from the questionnaire, interview responses, and the six lessons that were observed by the researcher. In this section, data from the questionnaires and interviews is presented first, followed by data obtained from the lesson observations with a view to understanding Nelson’s enactment of RBT.

Michael mostly used a textbook and the internet to teach Life Sciences to his learners. During the interview, he said, “I am using the textbook and also the internet” (Michael, interview, May 08, 2017). The reason for using the internet was to “supplement the information because textbooks are not exhaustive” (Michael, interview, May 08, 2017).

Michael indicated that he used other resources too. In the questionnaire he stated that he used educational charts once a term, resource people every month, and a textbooks and reference book in every lesson (Michael, questionnaire, May 05, 2017). Michael said the reason he used these resources was that other resources were unavailable in the school. The laboratory was vandalized, while other resources such as the museums and fossil sites were located far from the school. The school did not have money to fund the educational trips. He said;

> Some of the resources are not available in the school because we are told that there is no money to buy them. A laboratory was available here but it was vandalized and chemicals were stolen from it. Other resources are far away, we do not have money to finance trips to see resources such as game reserves, museums and fossil sites (Michael, questionnaire, May 05, 2017).

When using the available resources to teach Life Sciences, Michael said that he summarizes the textbook and adds internet information while making that summary. He also draws diagrams on the chalkboard to enhance learner's understanding. During the interview, he said, "I summarize the textbook and add information sourced from the internet and come up with consolidated information. I also use diagrams to enhance learners' understanding" (Michael, interview, May 08, 2017).

When doing a Science practical investigation, Michael indicated, he used unconventional materials. He said, "the school is under-resourced so, I improvise. For example, if I need a Bunsen burner, I use a stove. I use cans or plastic bottles in place of beakers" (Michael, interview, May 08, 2017). Michael identified unavailability of resources as a challenge he faced when enacting RBT. He told the researcher that "there can be a challenge. For example, if I don't have models for some topics such as the digestive system" (Michael, interview, May 08, 2017).

Michael's worst experience in the enactment of RBT was when he was using the internet for teaching but learners used it for fun. He said;

> I once asked learners to connect to the Wi-Fi using my phone's hotspot so that they conduct research in Grade 10. Instead of doing the research, one learner told me that some learners were watching pornography while others were on WhatsApp and Facebook (Michael, interview, May 08, 2017).

Michael wished he could do a PowerPoint presentation to teach Life Sciences. He said that the PowerPoint presentations were ideal because they give good visual representations thereby catering for all types of learning. He believed that PowerPoint presentations captured learners' attention.

Michael claimed that a textbook can be used as a supplementary resource for information that is not covered during lessons. During the interview, Michael told the researcher that "I would like to use an overhead projector because it minimizes time when writing notes and it is something that is visual to everyone. Everyone will concentrate on that visual aid rather than when using a textbook" (Michael, interview, May 08, 2017).

Michael believed that the enactment of RBT in Life Sciences classes is necessary for lifelong learning. He indicated that RBT capacitates learners with knowledge that they can use in life after school. During the interview, he told the researcher that,

> "it can be of good use even in the working environment. Learners will be better exposed to such resources compared to other people who were never exposed to them in high school. For instance, they can be able to make PowerPoint presentations in a meeting" (Michael, interview, May 08, 2017).

Michael argued that the enactment of RBT is appropriate for the assessment of learning. During the interview, he told the researcher that, "it is good for assessment tasks. After using a video simulation to teach a topic, an educator can ask questions to diagnose whether the actual learning have taken place" (Michael, interview, May 08, 2017).

The enactment of RBT improves higher order thinking skills. During the interview, Michael said, "the resources can help learners to think critically. Meaning they will use their mind. It will broaden their mindset" (Michael, interview, May 08, 2017).

The resources that Michael used the most to achieve the aims of his lessons were the textbooks, the internet, and charts. Michael believed that it was easy to deliver lessons using the stated resources. During the interview, he told the researcher that, “I use notes from the textbook together with the internet and some charts. I feel it is easy for me to stress information that way” (Michael, interview, May 08, 2017).

The least used resources were the DVD’s and Science laboratories. Michael used the stated resources the least because the Science laboratory was dilapidated. During the interview, he told the researcher that, “the resources that I use the least are the DVD’s, and laboratories. Our laboratory is not in good condition to enact RBT” (Michael, interview, May 08, 2017).

Limited resources at the school were a challenge identified as a barrier to successful enactment of RBT. Michael said, “in the school the resources are scarce” (Michael, interview, May 08, 2017). To deal with this challenge, Michael said,

> “I try to research a lot and try to come up with additional information so that the learners can have extra study material. I do copies of diagrams and design posters so that the learners can have a mind picture of something (Michael, interview, May 2017).

Michael opined that Life Sciences is a pure Science subject that is practical. He also added that there was a need to resource rural public schools with Science material to optimize learning. He said, “Life Sciences is a subject that requires learners to do practical work. Resources are scarce here. We need more” (Michael, interview, May 08, 2017).

Six lessons were observed for Michael. The inner and outer appearance of the classroom where the first observed lesson took place was dilapidated. The windows were broken and there was no door. There was no roof ceiling. The classroom did not have electrical connections and the learners were seated in rows facing the educator. The researcher was seated in a chair at the back of the classroom. The chalkboard was available but had been detached from the wall of the classroom. It was placed to stand in front of the learners. There were 61 learners in attendance during this lesson.

The first lesson observed for Michael was on the structure and functioning of the human kidney. Michael had brought an educational poster of the human kidney to the classroom so that everyone can see it and its labels. Michael used the poster of the human kidney to teach learners about the nephron. During the lesson, Michael held the poster and pointed at specific labels. The poster was then circulated amongst learners in class for viewing. Michael then asked the learners to play a computer-based simulation of the urinary system. Learners connected to the school Wi-Fi using their cell phones in this website https://www.youtube.com/watch?v=lfGYd1wrTgE. After watching the simulation of urine formation in the nephron, Nelson instructed the learners to do an assignment on disorders associated with kidney failure and how they can be corrected (Michael, lesson observation 1, May 10, 2017).

During the second lesson observed for Michael, he organised learners into group and instructed them to use the A3 size white papers he had brought to the classroom and design educational posters by drawing (and labelling) the structure of a nephron. Each educational poster was supposed to have a description of all the renal processes in sequential order (Figure 32). The educational posters were to be hanged in the classroom notice board. Learners used their cell phones to search for information in the internet; they used their textbooks, study guides, pencils, rulers, and colour pens to complete the activity. The educational posters were submitted on the following day (Michael, lesson observation 2, May 11, 2017).

Figure 32: Learners using a chart showing a nephron

During the third lesson observed, Michael used his personal computer to teach his learners how to process experimental data from a cross pollination of a pea plant with wrinkled seeds and a pea plant with round seeds using excel spreadsheet. He started the lesson by demonstrating how to enter the data on the spreadsheet. The excel spread sheet automatically calculated the values on its own (Michael, lesson observation 3, May 11, 2017).

Michael then allowed learners in groups of five to use his computer to process their own experimental data. Each group had a different set of data. When they were finished, they saved the activities in their files and Michael told learners to compile a write up on the results they had generated from the processing of experimental data.

During the fourth lesson observed, Michael took his Grade 10 learners to the forest to learn about the natural ecosystem. The same forest also serves as a junction of the Ngonyama river. Due to this, the forest was rich in a biodiversity of plant, animal, and bird species. The forest was a 10-minute walk from the school (Figure 33). On arrival at the forest, Michael told the learners to identify, count, sort, and classify the different trees and animals they could find in the ecosystem (Michael, lesson observation 4, May 12, 2017).

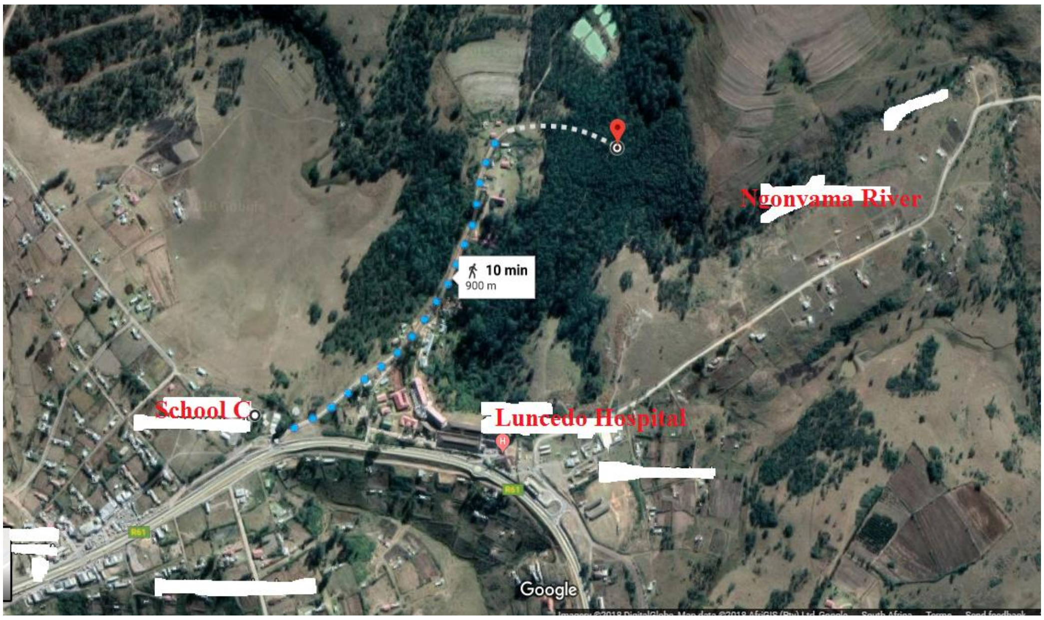

Figure 33: The route from the School C to the forest. Accessed from https://www.google.com/maps/dir/[redacted]/-31.559357,29.1204257/@-31.5615603,29.1165821,1187m/data=!3m1!1e3!4m9!4m8!1m5!1m1!1s0x1e5fb697108df7a5:0x2f9d5e701b64b265!2m2!1d29.11194!2d-31.56417!1m0!3e2

During the fifth lesson observed, Michael instructed learners to do a project in groups of four and design a model of a human skeleton using recyclable material (Figure 34). Michael informed the learners that when they were done with their projects, he would organise a science exhibition in the school where each group would present their projects to other learners (Michael, lesson observation 5, May 13, 2017).

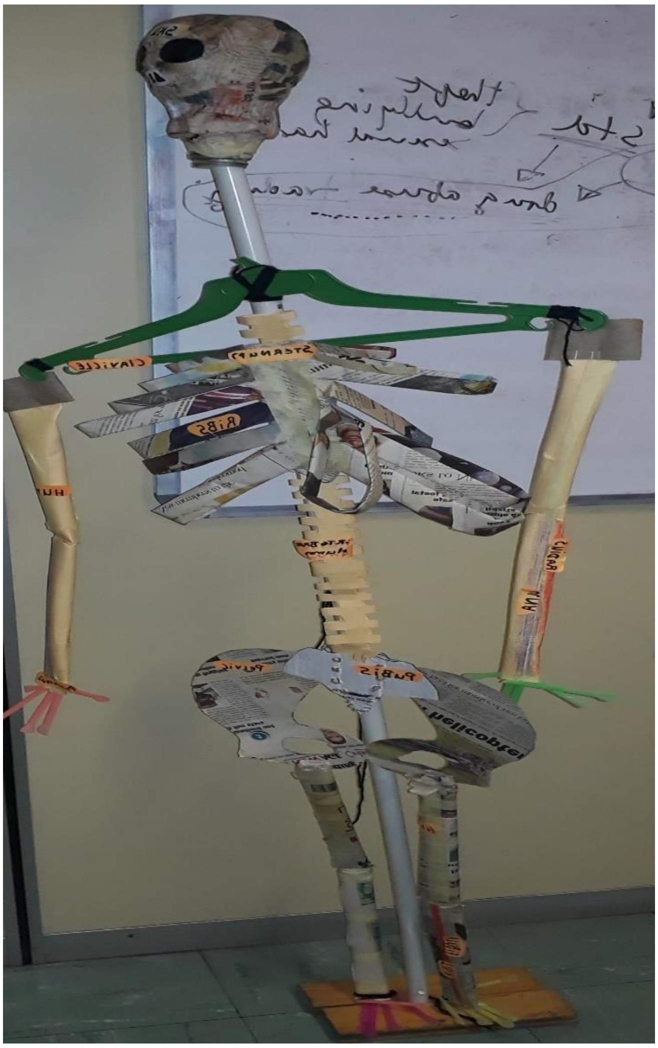

Figure 34: A model of the human skeleton

During the sixth lesson observed, Michael was teaching about the human heart in his class. Learners were seated in groups. Michael used labelled photographs depicting the internal structures of the heart. During the lesson, learners were tasked to discuss the photographs as guided by a list of questions provided. Michael then told them to design wall posters describing the atrial systoles in each group. Michael advised the learners to use their libraries, internet, and other relevant material to search for the functioning of the human heart and how each part is essential in the survival of the human being. During the lesson, the learners were observed talking to each other and using their books to take out papers in the middle and combining them with glue stick until it was one big wall paper (Michael, lesson observation 5, May 13, 2017).

I noticed collaboration between learners during the lesson because while others were reading the procedure, others were using pencils, pens and coloured pens to sketch the heart into their posters. In conclusion, all lessons observed for Michael were well-planned and well-coordinated. The use of resources for learning was effective as I saw learners using them on their own.

4.6.5 Case 5: Nikita

Nikita was a 29-year-old female educator who taught at School A. Nikita had three years of teaching experience. She taught Life Sciences in Grade 10 -12. She had a B.Ed. degree and majored in Agricultural Sciences.

4.6.5.1 Nikita's understanding of resource-based teaching

Nikita understood a resource in two different ways. First, she understood it as a teaching and learning material that can be used by educators to teach effectively and the learners to learn successfully. She said, "a resource is any material that can be used by both teachers and learners in order to enhance teaching and learning" (Nikita, questionnaire, May 22, 2017). Nikita also understood a resource as a material that can be used to enact teaching and learning. During the interview, she said, "a resource is any material or tool that is used to implement the learning and the teaching" (Nikita, interview, May 22, 2017).

Nikita told the researcher that the available resources in her school were the textbooks, chalkboards, charts, and a data projector. Nikita said, "in our school we have textbooks, chalkboards, charts, and an overhead projector" (Nikita, interview, May 22, 2017).

Nikita understood RBT in two different ways. First, Nikita understood RBT as "any material or tool that can be used now in order to facilitate and to enhance learning" (Nikita, interview, May 22, 2017). Second, she understood RBT as "a way of teaching whereby an educator uses or relies on teaching material to deliver a lesson. It involves using ICT, indigenous knowledge and human beings as resources" (Nikita, questionnaire, May 22, 2017).

4.6.5.2 Nikita's enactment of RBT

Nikita used "textbooks, charts, models, and the chalkboard because they are the only resources that are easily available in our school" (Nikita, questionnaire, May 22, 2017). Nikita indicated that she used a forest, rivers, dams, lakes, and the internet once a term. She described that she used charts and models once a week. Nikita also used a resource person once a month (Nikita, questionnaire, May 22, 2017). Nikita does not use other resources to teach Life Sciences because "we do not have them in my school" (Nikita, questionnaire, May 22, 2017).

During lessons that require the use of the resources that Nikita "does not have, she improvises". She said, "I improvise. For an example, if I do not have sodium bicarbonate, I use baking powder" (Nikita, questionnaire, May 22, 2017).

Nikita uses the teacher's copy of the prescribed textbook to prepare her lessons. She also uses the textbooks for assessment of learners (Nikita, interview, May 22, 2017). She also used the internet to download videos about photosynthesis on YouTube. As a result, "there was maximum attention and learner participation in the class. They were also positively engaged in that lesson as compared to others" (Nikita, questionnaire, May 22, 2017).

Nikita's worst experience in using a resource was when she took learners to the forest to study insects. She said, "I took my learners to the forest to study insects but we did not find the insects in the area because it was cold. Learners were terrified because they saw big snakes while overturning rocks" (Nikita, questionnaire, May 22, 2017).

Nikita encountered some challenges when using resources. She said, "when I am using the chalkboard, some of the learners do not write notes. When I am using videos, some of the learners get too excited and make a lot of noise" (Nikita, interview, May 22, 2017).

Nikita asserts that the enactment of RBT "encourages learners to use self-regulated learning strategies and learn independently of the educator". She also believed that RBT "creates a positive atmosphere as learners are engaged in a lesson. Learners get excited and are motivated to learn" (Nikita, interview, May 22, 2017).

The enactment of RBT has helped Nikita to improvise. For instance, instead of performing practical investigations, learners usually watch them on YouTube videos. Nikita said,

> They (YouTube videos) help to show all the processes, for example, the process of photosynthesis. In our school, we do not have money to buy Science equipment therefore it helps the teacher and the learners to learn better as they watch those videos" (Nikita, interview, May 22, 2017).

Nikita used the internet the least number of times because about 221 learners did not have cell phones and the school policy stipulates that learners should not bring them into the school premises. Furthermore, the school did not have computers to enable use of the internet. During the interview, Nikita said, “I use the internet the least because we do not have computers and learners are not allowed to bring cell phones into the school” (Nikita, interview, May 22, 2017).

During the first lesson observed, there were 66 learners in the classroom. All learners were seated sharing desks. There was little space between the desks in the classroom. The researcher was seated at the back row in a position that enabled him to have a full view of the entire classroom floor.

Only 15 learners in the classroom had textbooks. Nikita instructed the learners to share the textbooks amongst themselves. She was teaching about the importance of indigenous knowledge in science. She had invited a resource person to the classroom. Tata Mkhize (pseudonym), a traditional healer from the village did a presentation in front of the learners about traditional medicine. In his presentation, Tata Mkhize highlighted the need to preserve endangered plant species that are of cultural importance to the IsiXhosa speaking people (Nikita, lesson observation 1, May 23, 2017).

Embedded in his presentation, Tata Mkhize described how he grew up with his parents using traditional herbs to heal diseases. Tata Mkhize explained that modern medication such as pills and dosages are manufactured using a knowledge base and understandings of the healing powers of traditional herbs. Some people in the remote rural areas of the Eastern Cape still use traditional medicine to treat ailments related to witchcraft (Nikita, lesson observation 1, May 23, 2017).

During the second lesson observed, Nikita told the learners to observe and collect information (by means of taking pictures) and write a research project about the positive and negative human activities on the natural ecosystem that is surrounding their school. She told the learners to use the internet, libraries, resource people, newspapers, magazines, and other sources they could find to add more on their reports. The research project was required to contain a list of human impacts (both negative and positive), pictures of the impacts, and thick descriptions for each human impact on the natural ecosystem. Learners were given three weeks to complete the project (Nikita, lesson observation 2, May 24, 2017).

Nikita also used laboratory-based practical activities during her enactment of RBT. During the third lesson observed, she instructed learners to bring bread slices to the school (Figure 35). She had planned to do a practical investigation about the anaerobic microbial fermentation in bread. The practical activity was to be carried over a period of seven days. The learners placed the bread in the cupboard for 5 days. Learners were in control of this long-term practical investigation (Nikita, lesson observation 3, May 25, 2017).

Figure 35: Decomposing bread with fungus

In her fourth lesson observed, Nikita taught about photosynthesis and respiration using samples of leaves. During the lesson, all 55 learners individually had a plant leaf. The leaves were of different types, shapes, and sizes. According to Nikita, she instructed the learners on the previous day to bring the leaves in class during the lesson observed. Nikita told the learners to study the leaves and describe their suitability for photosynthesis and transpiration. They were also tasked to draw the leaves in their classwork books.

During the activity, Nikita monitored the learners as they were drawing. Nikita reported that learners' attention was enhanced and they participated fully in the proceedings of the lesson from the beginning to the end. She said, "there was maximum attention given by learners and their participation was surprisingly good too. They were also positively engaged in that lesson as compared to others" (Nikita, questionnaire, May 25, 2017).

Nikita's fifth lesson was observed in the schools' garden. During the lesson, Nikita took Life Sciences learners to the school garden to dig and observe plant roots. As learners were observed digging, they came across potatoes that were seemingly not fully harvested during the previous seasons' harvesting period. Learners also unearthed various soil microorganisms such as the earthworm (Figure 36). Learners learnt using the microorganisms found in the soil and their roles in the soil food chain (Nikita, lesson observation 5, May 25, 2017).

Figure 36: An earthworm from School A's garden

The sixth lesson observed was attended by 66 learners. The classroom was well-spaced and poorly equipped because the desks were old and few chairs were available. Learners were seated in groups. Only 23 learners had textbooks in the classroom.

When the lesson started, notes were already written on the chalkboard. Nikita read the notes and the learners followed after her. As the learners were reading the notes on the chalkboard, she constantly pointed at the arrows on the images of the heart to explain how those parts function to pump blood. Nikita then distributed labelled images of the internal structure of the heart (Nikita, lesson observation 6, May 25, 2017).

To conclude, Nikita gave the learners a work sheet to fill missing gaps and match columns based on the functioning of the human heart. Learners were given enough time to do the activity individually using their textbooks and notes to cross-reference their answers. During this time, Nikita explained questions to learners who called her.

4.6.6 Case 6: Zane

Zane was a 38-year-old male educator with less than 10 years of teaching experience. He had a BEd (Natural Sciences) degree and was teaching Life Sciences in Grade 12 at School A.

4.6.6.1 Zane understanding of resource-based teaching

Zane understood resources as “all the teaching and learning material and technologies that are used by educators to enhance the interest of learners for effective learning to occur” (Zane, interview, May 22, 2017). In the questionnaire Zane said, “videos, charts, textbooks, and study guides are used to teach Life Sciences. Other resources are those that attract the learners’ interest such as technology” (Zane, questionnaire, May 23, 2017).

The available resources in Zane’s school were the Life Sciences CAPS policy document, programme of assessment, textbooks, chalks, chalkboard, duster, computer, data projector, and charts. Zane said, “we have the policy document, work schedules or subject guidelines, textbooks, chalkboards, and chalks. We also use computers, projectors, videos, as well as charts” (Zane, interview, May 22, 2017). During my visit to School A to observe Zane teaching, I noticed other resources not mentioned by Zane. There was a garden, study guides, past examination papers, as well as microscopes (Field Notes for School A, May 25, 2017).

Zane understood RBT as “a teaching strategy where an educator extensively prepares a lesson by searching for various resources and then use the resources in a lesson where learners actively interact with them on their (learners) own” (Zane, interview, May 22, 2017).

4.6.6.2 Zane’s enactment of RBT

Zane used a textbook to teach Life Sciences because it is a rich source of information. During the interview, Zane reported that, “the resource that I usually use is the textbook. I use the textbook because it is the resource that has everything that I need to teach" (Zane, interview, May 2017). Other resources used by Zane were charts, PowerPoint presentations, DVDs and DVD players, the internet, and social networks. The frequency of use of each selected resource was as follows: the charts, DVDs, DVD players, and social networks were used once a week. PowerPoint presentations and the internet were used once a term while the textbook was used in every lesson (Zane, questionnaire, May 23, 2017). Zane reported that some resources were destroyed during the learners' protest at the school. He added that it is expensive to have trips for educational excursions. In the questionnaire, he explained that, 'the laboratory was destroyed. It is expensive to visit some resources such as biological gardens and fossil sites" (Zane, questionnaire, May 23, 2017).

Zane used the resources to plan his lessons. When planning a lesson, he used the work schedule as a guide on what to teach and then use the textbook to prepare the content to teach as per the guidance of the work schedule. After lesson planning, Zane uses past examination papers to assess the learners accordingly. During the interview, he reported,

> I take the work schedule which tells me what to teach and then take the textbook and prepare my lessons according to the work schedule. After finishing the lesson planning, I take the past examination papers and choose questions that are covered in my lessons and give them to the learners after my presentations (Zane, interview, May 22, 2017).

Zane did not do practical work with his learners because there was no laboratory in his school. He said, "since we do not have a functional science laboratory, we often find and use videos just for the learners to watch the practical and observe the results" (Zane, interview, May 22, 2017). When Zane used the videos and PowerPoint presentations, learners' attention and participation during the lesson was enhanced. Zane said, "videos and

PowerPoint presentations are the best in terms of capturing learner's attention. Every time I use these resources, the learners participate positively" (Zane, interview, May 22, 2017).

Zane said, "It is wise to bring different resources into the classroom in order to draw learner's attention to the lesson if you want your lessons to be interesting" (Zane, questionnaire, May 23, 2017). Zane used WhatsApp to communicate with his learners and to share Life Sciences related information. However, the learners abused that platform and posted disturbing content while others had conversations that were not relevant to Life Sciences. Zane said, "I created a WhatsApp group where I would easily communicate with learners and give them working material like prepared notes, but the learners posted irrelevant staff to the group and I decided to stop using the group" (Zane, questionnaire, May 23, 2017).

Zane pointed out that there were technical challenges in operating the data projector. During the interview, Zane said;

> You have to check if all the resources that you are going to use are working properly before the lesson begins. For instance, you have to check and test your computer and data projector before the lesson. If you bring an unfamiliar resource to the classroom, it draws learners' attention to learn. If it suddenly stops working, they (learners) lose focus and this draws away their attention from the lesson (Zane, interview, May 22, 2017).

Zane said that "it's easy to teach using resources because you can demonstrate a Science phenomenon through the use of resources" (Zane, interview, May 22, 2017). Zane opined that the enactment of RBT "guarantees that one has taught in different ways that accommodate all learners with different learning abilities" (Zane, internet, May 22, 2017).

Zane also reported that the enactment of RBT has helped his learners to assimilate Life Sciences content. He reported that he noticed that from the assessment results of the learners. He claimed that “after using different resources, I noticed an improvement in the learners’ performance (Zane, interview, May 22, 2017). As a result of using different resources in teaching Life Sciences, Zane believed that learners’ creativity and critical thinking were challenged.

Zane highlighted that “Life Sciences deals with many complicated structures of which are very difficult and time-consuming to draw. It is very important to have different resources to make sure that every learner understands” (Zane, interview, May 22, 2017).

During the first lesson observed, 98 learners were in the classroom. The learners were congested in the back rows. There were about four to five learners seated per bench. There was hardly any space for movement in between the rows as they were filled with chairs where learners sat. There was also very little space in front of the chalkboard because the desks were occupying the space that was meant for movement. The researcher was seated next to the door because that was the only position he could sit on. Classroom lighting was sufficient. The classroom did not have any Life Sciences related teaching material on the walls. The educational poster that was on the notice board was a Physical Sciences formula sheet. All the classroom windows were broken and there was cold air blowing into the classroom.

Teaching resources available in the classroom were a textbook, a chalk, and a duster. Zane begun the lesson by describing the topic on the chalkboard taking notes from his preparation book. Zane asked the learners to do an activity on page 195 of their textbooks where they were required to analyse evidence of comparative embryology. There were embryos for different vertebrates such as fish, chicken, pig, and human beings (Zane, lesson observation 1, May 22, 2017).

Zane then distributed pictures of primates' heads, wings, and limbs showing more different types of evidence of comparative embryology (Figure 37 and Figure 38). He instructed the learners to carefully study the images.

Figure 37: Learners working on comparative embryology at School A

Figure 38: Learners working on comparative embryology at School A

During the second lesson observed, Zane invited a game ranger from the Luleka nature reserve to explain animal biodiversity and environmental awareness. The ranger also explained about marine careers in the Grade 12 class. The game ranger had travelled 15.1 km to School A (Figure 39).

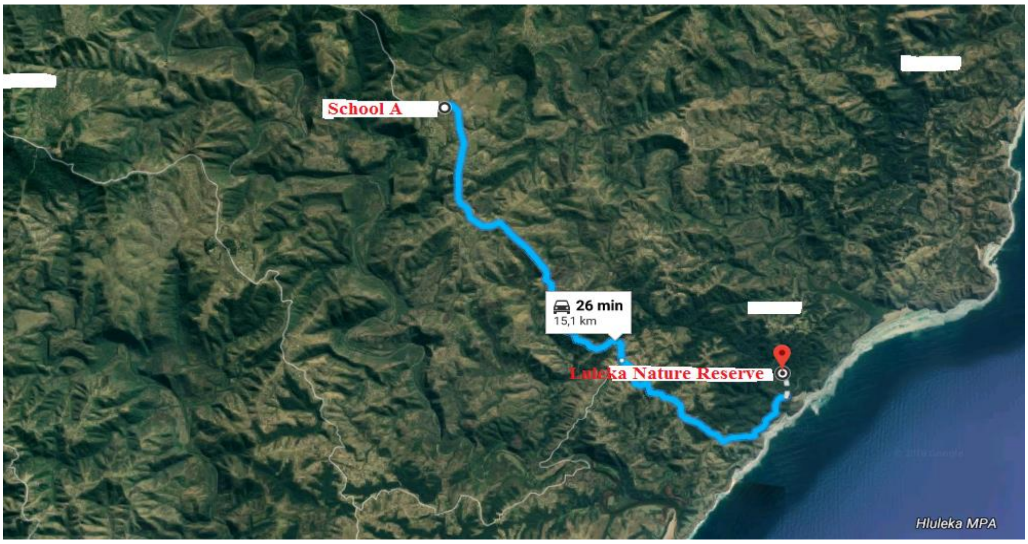

Figure 39: Route and distance from School A to the Luleka Nature Reserve. Accessed from https://www.google.com/maps/dir/[redacted]/@-31.7988257,29.2225378,10821m/data=!3m2!1e3!4b1!4m14!4m13!1m5!1m1!1s0x1e5e4fcc63271c09:0x4d0ccde012a5f44a!2m2!1d29.21543!2d-31.76182!1m5!1m1!1s0x1e5e5a4b2b3ec673:0x45f5f9c36ecb65db!2m2!1d29.29864!2d-31.82132!3e

In a nutshell, the lesson was highly interactive. It aroused curiosity in learners and awakened their awareness of aquatic life and the necessity for people to conserve it (Zane, lesson observation 2, May 23, 2017).

During the third lesson observed, Zane taught a large group of learners in the school hall. He used a PowerPoint presentation to show the similarities between apes and humans. The chalkboard was also used by learners to write notes. Learners were required to indicate the observable differences in the pictures. They were also required to substantiate the reasons for those differences to illustrate how humans evolved.

Jerry (pseudonym), the class prefect who was writing on the chalkboard during the period, summed all the contributions on the chalkboard. This lesson was considerably different to others because learners seemed to be hands-on and in control of their learning (Zane, lesson observation 3, May 24, 2017).

During the fourth lesson observed, Zane was teaching on gaseous exchange in humans. He told learners to construct a model of the human breathing system using recyclable material (Figure 40) and outline the limitations of the model. Learners were expected to manage their own time. They were expected to plan and design the model on their own (Zane, lesson observation 4, May 24, 2017). Learners made the human breathing model using plastic bottles and balloons as illustrated in Figure 40.

Figure 40: Model of the human breathing system

During the fifth lesson observed, Zane took the learners to a mountain nearby the school to learn about the effect of altitude, slope factor, and the direction of the slope to the sun in plants. Zane identified a mountain. According to Zane, a mountain was ideal to visit because 'the plants that grows in the higher parts of the mountain are different from those growing at the bottom'. The mountain was a walking distance (650m) from the school (Figure 41) hence the learners enjoyed going there (Zane, lesson observation 5, May 25, 2017).

Figure 41: Distance between School A and the mountain. Accessed from https://www.google.com/maps/dir/[redacted]/-31.7599626, 29.2016833/@-31.757922,29.2052658,1917m/data=!3m1!1e3!4m9!4m8!1m5!1m1!1s0x1 e5e4fcc63271c09:0x4d0ccde012a5f44a!2m2!1d29.21543!2d-31.76182!1m0!3e

Interesting observations were made in the mountain in relation to Zane's claims. Indeed, the plants that were growing on top of the mountain were not of the same height and maturity like those which grew on the bottom. According to Zane, this was caused by the exposure of the sides of the mountain to the sun and the amount of rainfall received on the mountain top and that of the bottom.

The sixth and last lesson observed for Zane was when he invited a plant breeder (Figure 42) to the school to explain the importance of plant breeding systems. The plant breeder described and demonstrated a breeding technique to learners. She also showed and explained to learners the variated seeds of breeding crops for commercial use.

Figure 42: A plant breeder explaining breeding techniques to learners at School A

Throughout the lesson, learners were listening to the expert as she explained plant breeding in depth

4.7 Chapter summary

In this chapter, data that emerged from the participants' responses were presented. The data presented in this chapter were generated through the triangulation of four data collection instruments, namely, structures interviews, lesson observations, questionnaire, and document analysis. The participants reported on their understanding of a resource, resource-based teaching and their enactment of resource-based teaching. The participants indicated that they used various ways to enact RBT including through interactive teaching aids and science practical work. Reasons as to why the participants enacted RBT the way they did were also advanced. This included but not limited to contextual factors such as financial resources and physical resources. In the next chapter, the researcher explicates the details of the findings, discussions and analysis of the data which was obtained during the data collection period of this study.

CHAPTER 5
FINDINGS AND DISCUSSION

5.1 Introduction

In the preceding chapter, data on educators' understandings of RBT, the way they enacted it, and the reasons they enacted it the way they did was presented. The data presented in Chapter 4 was then subjected to content analysis which enabled the researcher to carefully sort and code similar responses until they formed themes. Some themes were modified while others were removed until three major themes emerged as the findings of this study. The three major themes addressed the three critical research questions that underpinned this study. The three critical research questions were:

1. What is the Life Sciences educators' understanding of resource-based teaching?
2. How do the Life Sciences educators enact resource-based teaching?
3. Why do the educators enact resource-based teaching the way they do?

5.2 Participants' understanding of resource-based teaching

The critical research question sought to be answered here is: What is the Life Sciences educators' understanding of resource-based teaching? To answer this critical research question, themes, subthemes, and categories that emerged from the analysis of the data were considered.

Theme 1: Participants understood RBT as a teaching strategy and a resource as a teaching material

The data that is presented in the preceding chapter shows that the research participants of this study understood RBT as a teaching strategy. In this study, there is a view that the participants' understandings of a resource inform their understandings of RBT. In chapter 4, data on the participants' understandings of RBT was presented. In this section, participants' understandings of a resource are highlighted first as a prelude to the first theme of this study. Table 5 shows a summary of the participants' understandings of a resource.

Table 5

A summary of participants' understanding of a resource

Understanding of a resource	**Frequency**		**Total**
	Questionnaire	**interviews**	
Teaching material	3	4	7
Teaching and learning material	1	2	3

From the six participants, four of them, Denise, Patrick, Nelson, and Michael understood a resource as a teaching material. Nelson for instance wrote in his questionnaire narrative that "a resource is a teaching material used by educators to overcome learners' difficulties" (Nelson, questionnaire, May 05, 2017).

While four participants, Denise, Patrick, Nelson, and Michael, seemed to understand a resource in a way that has a deliberate focus on them using resources, Nikita and Zane presented a deeper understanding of a resource. They described a resource as not just a teaching material, but as a material that can also be utilized by the learners for learning during teaching and learning. Zane said resources are "the teaching materials and technologies that are used by educators to enhance the interest of learners for effective learning to occur" (Zane, interview, May 22, 2017). In her narrative, Nikita said, "a resource is any material that can be used by both educators and learners in order to enhance teaching and learning" (Nikita, questionnaire, May 22, 2017).

The participants' understandings of RBT stems from their understanding of a resource. As a result, the participants generally understood RBT as a teaching strategy. Zane described RBT as a teaching strategy that enables the educator to “provide learners with different resources to learn and guide them while they look for the relevant information on their own” (Zane, questionnaire, May 23, 2017). During the interview, Zane said during resource-based teaching, an educator facilitates the use of resources by learners for learning. These were his words, “RBT is a teaching strategy where an educator extensively prepares a lesson by searching for various resources and then using them in a lesson where learners actively interact with the resources on their (learners) own” (Zane, interview, May 22, 2017).

In conclusion, the participants’ understandings of a resource inform their understandings of RBT. Their understandings of RBT ultimately influence the way they enact RBT in their classes. The next section describes how the participants of this study enacted RBT in their classrooms. The next section must be read with an understanding that the participants; understandings of RBT will have a bearing on what they actually do in the classroom when they enact RBT with the learners.

5.3 How Life Sciences educators enacted RBT

In the previous section, Life Sciences educators’ understandings of RBT were described. In this section, the second critical research question of this study is addressed. The second critical research question sought to reveal how the participants of this study enacted RBT in their lessons. The critical components of scrutiny in this question were the actions of the participants during teaching, the specific resources used by learners, and the way the resources were used. That information was sufficient to reach a finding into how the participants have enacted RBT in their lessons. It emerged from the analysed data that there were many factors that shaped the way Life Sciences educators enacted RBT in their classrooms. The factors were reorganised, consolidated, and presented as one broad theme with four subthemes.

Theme 2: Life Sciences educators mainly enacted RBT through interactive teaching aids, practical work, use of technology, and resource persons.

The participants used interactive teaching aids to enact RBT. In this study, the use of interactive teaching aids refers to the use of resources that encourages learners to brainstorm, think, count, analyse, interpret, discuss, and listen to one another in the learning process (Education, 2011). Interactive teaching aids are teaching materials such as, but not limited to, posters, resource persons, and models (Chen, 2017). Practical work is another approach used by the participants of the current study to enact RBT. Fieldwork, investigations, demonstrations, simulations, and modelling were the five types of practical work that were used by the participants to enact RBT in their lessons.

The participants also used technology to enact RBT. Technology teaching materials that were mostly used by the participants were computers, DSTV, and the internet. In this study, computers were conceptualised as a category that entailed tools such as PowerPoint presentations, cell phones, tablets, desktops, and laptops. DSTV was a category that encompassed satellite decoders, CD's, DVD players, and videos. Lastly, the participants of this study also used resource persons to teach Life Sciences. In this study, resource persons are categorized into two. First, they refer to experts such as professional nurses, agronomists, and game rangers; and village elders such as traditional healers and experienced women of the village. Resource persons were instrumental in teaching Life Sciences phenomenon that learners could relate to. Table 6 shows a summary of teaching strategies used by the six participants to enact RBT and their frequencies of use.

Table 6

Teaching strategies and frequency of use during lesson observation

Teaching strategies	Frequency of use during lesson observations						
	Denise	**Patrick**	**Michael**	**Nelson**	**Nikita**	**Zane**	**Totals**
Interactive teaching aids	02	01	01	01	01	01	07
Technology	01	00	03	03	00	01	08
Experts	02	00	00	01	01	02	06
Fieldwork	01	02	01	00	01	01	06
Simulations	00	02	01	01	00	00	04
Demonstrations	00	02	00	00	01	01	04
Research projects	00	01	00	00	00	01	02
Modelling	00	00	01	00	00	01	02
Assignments	01	00	00	00	00	00	01

Table 7 shows a summary of the interactive teaching aids used by the participants during their lessons observed. The table also shows the frequency of use of each interactive teaching aid by each participant. The interactive teaching aids used by participants were models, resource persons, and educational posters (Table 7)

Interactive teaching aids

Table 7 A summary of interactive teaching aids used by the participants

Participants	**Questionnaire**			**Observations**			**Interviews**		
	Educational posters	**Resource persons**	**Models**	**Educational posters**	**Resource persons**	**Models**	**Educational posters**	**Resource persons**	**Models**
Denise	✗	✓	✓	✓	✓	✗	✓	✗	✓
Patrick	✗	✓	✗	✗	✗	✗	✗	✗	✗
Nelson	✗	✗	✗	✗	✓	✗	✗	✗	✓
Michael	✓	✓	✗	✓	✗	✗	✓	✗	✓
Nikita	✓	✓	✓	✗	✓	✗	✓	✗	✗
Zane	✓	✓	✗	✗	✓	✗	✓	✗	✗

Key: ✓- Used ✗ - Not used

It emerged from the questionnaires and the interviews that were done that the participants used a variety of teaching aids but educational posters, resource people, and models were the most frequently used. In this study, educational posters refer to drawings, charts, banners, and wall posters. Resource persons refers to experts (nurses, agronomists) and village elders (traditional healers,) utilised in the teaching and learning of Life Sciences.

The participants mostly used interactive teaching aids to enact RBT. All the six participants reported that they used interactive teaching aids to teach Life Sciences. They were also observed in their classrooms during their teaching making use of the interactive teaching aids. According to Table 7, predominantly used interactive teaching aids were resource persons which were used by four participants, Denise, Nelson, Nikita and Zane.

Educational posters were used by two participants, Denise and Michael whereas none of the participants used a model to teach Life Sciences.

Four participants, Denise, Nelson, Nikita, and Zane enacted RBT through the use of resource persons. Denise and Zane were observed using resource persons in two of their lessons observed. Denise used a nurse and a village during her fifth and sixth lesson observed respectively whereas Zane's second and sixth lessons observed were respectively facilitated by a game ranger and an agronomist. During her sixth lesson observed for instance, Denise had invited Mrs. Msomi, a village elder to teach learners about traditional beer brewing (Denise, lesson observation 6, May 19, 2017). Mrs. Msomi created an interactive RBTE through her flexible presentation and demonstration skills as she articulated the beer making process to the learners. Learners discussed with her during the lesson and were seemingly making inferences of what she spoke about

Denise's lesson was consistent to her questionnaire narrative which suggested that she used resource persons at least once a month (Denise, questionnaire, May 15, 2017. Moreover, it was interesting to discover that Denise seemingly became more committed in her work to an extent that she invited resource people in two of her lessons observed in the same month. Just like Denise, Zane also claimed that he used a resource person during his teaching of Life Sciences. In his questionnaire narrative he indicated that he used a resource person once a month (Zane, questionnaire, May 23, 2017). He affirmed his claims during his sixth lesson observed. During the lesson, Zane invited an agronomist to explain breeding methods such as pure-line, backcross, and bulk breeding method (Zane, lesson observation 6, May 26, 2017).

Out of the six participants, only two, Denise and Michael enacted RBT using educational posters. Denise used educational posters during her second and third lessons observed while Michael only used educational posters during his first lesson observed. In his first lesson observed, Michael for instance used a poster of the human kidney to teach about the cortex (Michael, lesson observation 1, May 08, 2017). This was consistent with his interview narrative. When Michael was asked of the resources, he used the most during teaching, he said, “I use charts, a textbook, and the internet because it is easy for me to teach that way” (Michael, interview, May 08, 2017).

According to Table 7, four participants, Nikita, Denise, Nelson, and Michael claimed to use a model to teach Life Sciences whereas none of them actually used it during their observed lessons. In her questionnaire narrative, Nikita said she used a model once a week (Nikita, questionnaire, May 22, 2017). During the interview, Nelson also said he used a model. He said, “I use some models” (Nelson, interview, May 08, 2017). However, in all the lessons observed for all six participants, a model was not used to teach Life Sciences instead Michael and Zane were observed giving learners tasks to design models.

During Zane’s fourth lesson observed for instance, learners were requested to design a model of the human breathing system using recyclable material and submit it for assessment (Zane, lesson observation 4, May 24, 2017).

The educators also enacted RBT using different types of science practical work. Table 8 shows the different practical work that were used by the participants during their enactment of RBT in their lessons.

Practical work

Table 8

Practical work used by the participants from the lesson observations.

	Participants					
Type of practical	**Denise**	**Patrick**	**Nelson**	**Michael**	**Nikita**	**Zane**
Fieldwork	✓	✓	✗	✓	✓	✓
Investigation	✗	✗	✗	✗	✓	✗
Demonstration	✗	✓	✗	✗	✗	✓
Simulation	✗	✓	✓	✓	✗	✗
Modelling	✗	✗	✗	✓	✗	✓

Key: ✓ Used ✗ Not used

All the six participants enacted RBT through practical work. There were five types of practical work that were mostly used by the participants (Table 8). In this study, fieldwork refers to educational visits to artificial and natural ecosystems around the participants' school. From the six participants, five of them, Denise, Patrick, Michael, Nikita, and Zane used fieldwork whereas only Nikita used an investigation as a type of science practical work to teach Life Sciences.

In her seventh lesson observed, Denise for instance walked with learners to a nearby forest and taught them about flora and fauna. During the fieldwork, learners studied various plant and animal species (Denise, lesson observation 7, May 20, 2017). Similar to Denise's seventh lesson observed, during her fifth lesson observed, Nikita took learners to the school garden where she taught them about microorganisms that live in the soil (Nikita, lesson observation 5, May 26, 2017).

Nikita's enactment of RBT through fieldwork was consistent with her questionnaire narrative. Nikita selected natural ecosystems such as forests, rivers, and lakes as resources she used to teach Life Sciences. Nikita also claimed that she visited the forests once a term (Nikita, questionnaire, May 22, 2017) because of what she described as ‘a worst experience in using a forest’. In her questionnaire narrative, Nikita said, “I took my learners to the forest to study insects but we did not find insects in the area because it was cold. Learners were terrified because they saw a big snake while overturning rocks and ran away” (Nikita, questionnaire, May 22, 2017).

The fact that there was internet in Nelson’s and Michael’s school seemingly enabled them to teach learners using simulations. Nelson was observed using simulations during his third and sixth lessons whereas Michael used simulations only in his first lesson observed. During the third lesson observed, Nelson used simulations to teach learners about precocial and artificial development in birds. Learners used their cell phones to connect to the school Wi-Fi and play the video (Nelson, Lesson observation 3, May 10, 2017). Cell phones were used because only study guides, question papers, and models were “the ones at the moment I can lay my hands on and are available in the staffroom” (Nelson, interview, May 08, 2017). Nelson’s use of internet was consistent to his questionnaire narrative that, “I am using textbooks, PowerPoint presentations, DVDs and the internet because they are the resources that we have at the school and all learners can access them (Nelson, questionnaire, May 05, 2017).

Although there was no internet in Patrick’s school, he used simulations to teach his learners about photosynthesis and transpiration, and the production of insulin from bacteria during his fifth and sixth lessons observed respectively. During the fifth lesson for instance, Patrick was observed instructing learners to use their cell phones to connect to his tablet’s Wi-Fi hotspot signal to access a website where they played the video simulation from (Patrick, lesson observation 5, May 22, 2017).

This is consistent to his questionnaire narratives where he claimed that he used cell phones, television, forests, social networks, the internet and simulations to teach Life Sciences (Patrick, questionnaire, May 15, 2017). However, the reality is that Patrick's school was underprivileged as it was not refurbished by the government at that time. It was therefore apparent from the lessons observed that Patrick improvised to create effective RBTE because of scarcity of resources in his school. During the interview, Patrick said, **"**here at school we only have basic resources such as textbooks, study guides, and past examination papers**"** (Patrick, interview, May 15, 2017).

Although other types of practical work were used by two or more participants, investigations were used by only one participant, Nikita. During her third lesson observed, Nikita instructed learners to do a practical investigation of fungal bacteria in bread. Learners brought bread to the school. It was stored in a cupboard for about a week. After a week it had accumulated fungi (Nikita, lesson observation 3, May 25, 2017).

Use of technology

Technology was also used during the enactment of RBT in Life Sciences lessons (Table 9). The technologies used by participants were social media, DSTV, computers, and the internet. All the six participants enacted RBT through the use of technology. Four technology devices and tools that were mostly used by the participants to teach Life Sciences (Table 9).

In their questionnaire narratives, all six participants reported that they used the internet to teach Life Sciences. For instance, Nelson said that he used the internet once a week (Nelson, questionnaire, May 05, 2017). During the interviews only Patrick and Michael said they used the internet. Michael said, "I use the textbook and the internet to supplement the information…" (Michael, interview, May 05, 2017). From the six participants, four of them, Denise, Patrick, Michael, and Nelson actually used the internet to teach Life Sciences.

Table 9

A summary of technologies used by the participants.

	Questionnaire				**Observation**				**Interview**			
Participant	**Computer**	**DSTV**	**Internet**	**Social media**	**Computer**	**DSTV**	**Internet**	**Social media**	**Computer**	**DSTV**	**Internet**	**Social media**
Denise	✗	✗	✓	✗	✓	✗	✓	✗	✗	✗	✗	✗
Patrick	✓	✓	✓	✗	✓	✓	✓	✗	✓	✓	✓	✗
Nelson	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗
Michael	✓	✗	✓	✓	✓	✗	✓	✗	✗	✗	✓	✗
Nikita	✗	✗	✓	✗	✗	✗	✗	✗	✓	✗	✗	✗
Zane	✓	✓	✓	✓	✓	✗	✗	✗	✓	✓	✗	✗

Key: ✓ Used ✗ Not used

However, a surprising finding was noted during lesson observations. Despite Denise's questionnaire and interview narratives that suggested that she did not use the internet to teach Life Sciences, she was actually observed using the internet in two of her lessons. During the first lesson observed for instance, Denise instructed learners to use their cell phones and google pictures of epithelial cells in the classroom (Denise, lesson observation 1, May 15, 2017).

In a RBTE, the internet is commonly used complementarily with a computer. Khoza (2012) describes a computer as a hardware resource that operates through a software resource (internet) Perhaps that may justify the reason why exactly the same participants (Denise, Patrick, Nelson, and Michael) who were observed using the internet were also observed using a computer to teach Life Sciences. During his fifth lesson observed, Patrick for instance taught transpiration and photosynthesis. Learners used their cell phones to access an online simulation video (Patrick, lesson observation 5, May 22, 2017). This was despite the fact that Patrick told the researcher that there were only two computers in the entire school (Patrick, interview, May 15, 2017). It is therefore apparent that Patrick was an innovative educator who was able to utilize available resources efficiently.

Denise was apparently the worst technologically incompetent participant out of the six participants. She did not know how to use PowerPoint presentations and the laboratory apparatus (Denise, questionnaire, May 15, 2017). However, she managed to use cell phones (computers) during her first lesson observed (Denise, lesson observation 1, May 15, 2017). Creativity and experience were apparent during the lesson as she allowed the learners to make use of the resources on their own by using their cell phones to google epithelial tissues. Denise knew that she would face technical challenges if she were to use the resource on her own because she was technically incompetent. In her questionnaire narrative, Denise said;

> I was trying to set up a PowerPoint presentation that we were given by the subject committee in the cluster. It became a disaster because the screen was not showing the slides and that ate on the period. I was eventually assisted by learners to make it work and the time of the period remaining was very small. It was such a disaster (Denise, questionnaire, May 15, 2017).

Denise reported that she was technically incompetent to use resources such as PowerPoint slides and laboratory apparatus (Denise, questionnaire, May 15, 2017). However, she was aware that learners are not incompetent in using technology. Perhaps that is why during her first lesson observed she instructed the learners to use their cell phones to google about animal tissues (Denise, lesson observation 1, May 15, 2017).

Nikita was apparently the only participant who was not observed using any technology device during her teaching of Life Sciences. The reason she did not use them was probably because they were not available in her school. When she was asked the reason, she did not select other resources presented in the questionnaire, she said, “we do not have them in my school” (Nikita, questionnaire, May 22, 2017). Another possible reason might be that she avoided chaos during her lesson because she told the researcher that learners tend to be uncontrollable when she uses teaching technologies in her classroom. She said, “When I am using videos, some of the learners get overexcited and make a lot of noise” (Nikita, interview, May 22, 2017).

Out of the six participants, only two, Michael and Zane, claimed to have used social media to teach Life Sciences. Michael’s questionnaire narrative suggests that he used social media once a month (Michael, questionnaire, May 05, 2017). However, Zane describes his use of social media as his worst experience in using a resource to teach Life Sciences. He holds the view that the use of social media for teaching leads to chaos in the classroom of it is not used well. Zane said “I created a WhatsApp group where I planned to communicate with learners and give them working material like prepared notes, but the learners posted irrelevant things to the group. That is when I decided to stop using WhatsApp” (Zane, questionnaire, May 23, 2017).

Resource persons

Five participants, Denise, Nelson, Michael, Nikita, and Zane used resource persons to enact RBT in teaching Life Sciences (Table 10). While Michael was not observed using a resource person, in his questionnaire response he stated that he used a resource person once a month (Michael, questionnaire, May 05, 2017). Denise invited resource persons (expert and village elder) in her fifth and sixth lessons observed respectively. Nelson was observed using a professional nurse in his fifth lesson observed whereas Nikita invited a traditional healer in her first lesson observed. Lastly, Zane made use of a game ranger and an agronomist during his second and sixth lesson observed respectively.

Table 10

Use of resource persons by the participants.

Participant	Questionnaire	Observation	Interview
Denise	✓	✓	✗
Patrick	✓	✗	✗
Nelson	✗	✓	✗
Michael	✓	✗	✗
Nikita	✓	✓	✗
Zane	✓	✓	✗

Key: ✓ Used ✗ Not used

During Nelson's fifth lesson observed, for instance, learners were taken to Lusizo hospital where they were taught by professional nurses on sexually transmitted diseases. (Nelson, lesson observation 5, May 12, 2017). During her first lesson observed, Nikita invited a village elder to the classroom to teach learners about traditional medicine and the need to preserve endangered plants. Tata Mkhize was a traditional healer who grew up harvesting medicinal plants and using them to heal people. He was vested with the knowledge of medicinal plants. The lesson was interactive between Tata Mkhize and the learners (Nikita, lesson observation 1, May 2017). The lesson also authenticated Nikita's questionnaire narrative where she claimed that she used a resource person once a month to teach Life Sciences to the learners (Nikita, lesson observation, May 23, 2017).

Similarly, during his second lesson observed, Zane had invited a game ranger to teach learners about marine biodiversity. The game ranger displayed advanced knowledge of game and wild animals and satisfactorily replied to all questions from the learners (Zane, lesson observation 2, May 2017). Zane's enactment of RBT in this lesson was consistent with his questionnaire narrative where he said that he used a resource person once a month (Zane, questionnaire, May 23, 2017).

Despite Denise and Nelson making use of resource persons during their teaching of Life Sciences, their colleagues Patrick and Michael respectively did not make use of resource persons. In his questionnaire narrative, Michael claimed to be using a resource person once a month but in all his lessons observed he did not use a resource person (Michael, questionnaire, May 05, 2017). The distance from School C to the nearest resource centre (Lusizo hospital) was not a factor that could have resulted in Michael not utilizing experts in his teaching because Nelson who is in the same school walked to the hospital with his learners.

The reason that might have resulted in Patrick not using a resource person is probably that he did not deem them necessary to use because he did not mention using them in his questionnaire and interview narratives. Additionally, it might be because of the fact that in all of his lessons observed, a resource person was not recommended for use according to the Life Sciences policy document. It also cannot be the proximity of his school (School B) to resource persons because Lusizo hospital was a 30-minute drive away. Moreover, the school was situated in a rural village so he could easily invite a village elder to come to his classroom and teach learners.

5.4 Why the participants enacted RBT the way they did?

The third critical research question of this study sought to unveil the reasons why Life Sciences educators enacted RBT the way they did. It was revealed that there were many factors that were the reasons for educators to enact RBT the way they did in this study.

Theme 3: The participants enacted RBT the way they did because of contextual factors, their understandings of RBT, and their levels of technical competence

Contextual factors

Participants' enactment of RBT was influenced by various contextual factors such as financial resources and availability of physical resources.

Financial resources

The schools' finances are an integral part for resource provision and subsequently the enactment of RBT. The Life Sciences policy document encourages educators to improvise in situations where the school does not have resources because of financial limitations. The policy document stipulates that;

> While it is acknowledged that it is not ideal to use improvised equipment, teachers should remember that it is more important for learners to have the experience of carrying out a variety of investigations than to depend on the availability of standard laboratory equipment. If equipment is limited, teachers should be encouraged to improvise. The same skills can be developed using improvised equipment. Moreover, if there are no alternatives, it is more effective for teachers to demonstrate an investigation than to not do investigations at all due to a lack of equipment. Secure storage for equipment and chemicals must be provided by the school (Education, 2011, p. 19).

Thus, adequate resources are a prerequisite to successful implementation of RBT. The findings in this section reveal that instead of complaining about lack of resources due to financial constraints, rational educators improvised and enacted RBT as suggested in the Life Sciences policy document. Table 11 summarises the participants' responses where they indicated that they encountered financial limitations that inhibited them from enacting RBT.

Table 11

Financial limitations to participants' enactment of RBT

Participant	Questionnaire	Observation	Interview
Denise	✗	✗	✗
Patrick	✗	✓	✓
Nelson	✗	✗	✓
Michael	✓	✗	✓
Nikita	✗	✗	✓
Zane	✗	✗	✗

Key: ✓ Indicated ✗ Not indicated

Four (Patrick, Nelson, Michael, and Nikita) out of the six participants mentioned financial limitations as an obstacle in their enactment of RBT. Michael was resolute in expressing financial limitations that impeded him from successfully enacting RBT. In his questionnaire narrative, he said;

> Some of them are not available in the school because we are told that there is no money to buy them. Other resources are far away, we do not have money to finance trips to see them such as the museums and fossil sites" (Michael, questionnaire, May 05, 2017).

During the interview, Michael was asked the barriers he experienced while enacting RBT. He said, "the barrier is that in this school, resources are scarce. There is no money to buy them" (Michael, interview, May 08, 2017). Scarce resources are associated with lack of finances in a school because if finances were available, the resources would possibly be purchased.

The participants of this study were observed enacting RBT in their classrooms. To teach the subject, the participants used a variety of improvised resources due to the fact that they had “financial challenges which impedes buying the required resources” (Nelson, interview, May 08, 2017). Michael for instance told the researcher that he used unconventional teaching materials to teach Life Sciences. He said, “the school is under-resourced so, I improvise. For example, if I need a Bunsen burner, I use a stove. I use cans or plastic bottles in place of beakers” (Michael, interview, May 08, 2017).

Similarly, Nikita also improvised when she had to use resources that are not available at the school. She said, “I improvise. For an example, if I do not have sodium bicarbonate, I use baking powder” (Nikita, questionnaire, May 22, 2017). As part of improvising, Nikita used YouTube videos to replace practical experiments (Nikita, interview, May 22, 2017) because according to Nelson, “there are certain things that are above my control. When they say there is no finance, then there is nothing I can do” (Nelson, interview, May 08, 2017).

Finances affected the way Nelson and Zane enacted RBT in their classrooms. When the researcher asked Nelson about his barrier in enacting RBT, he said it was ‘financial challenge’. Nelson explained that the SMT controls the finances of the school and that if they are not willing to buy the resources he needs, he usually succumbs. During the interview, Nelson said, “mine is to tell my HOD, the principal, or the management team that I need some resources. I make a list of them and hand it in. I then wait for them to act, if they do not act, that means I cannot get them” (Nelson, interview, May 08, 2017).

Zane expressed similar sentiments to Nelsons’. When he explained the reasons, he did not use some of the resources at his disposal to teach Life Sciences, he said, “It is expensive to visit some resources such as biological gardens and fossil sites” (Zane, questionnaire, May 23, 2017). Patrick was also observed using improvised material in two of his lessons. During his third lesson observed, Patrick used a two-banner stove instead of a Bunsen burner. He also used a tin instead of a beaker (Patrick, lesson observation 3, May 18, 2017). Similarly, in his seventh lesson observed, Patrick used a two-banner stove and a tin instead of using a Bunsen burner and a beaker respectively (Patrick, lesson observation 6, May 22, 2017).

Finance is one of the major barriers to the successful enactment of RBT in Life Sciences classes. Although other participants did not mention finances as a barrier to their enactment of RBT, it was evident from the lack of resources in their schools that finances were a problem. When the researcher was in School C, he had a conversation with the principal after noticing that there was only one computer and one small printer for the whole school. The researcher asked the cause because he had knowledge that School C was a section 21 school. The principal explained that they were waiting for money from the District Department of Education (DDoE) for Norms and Standards so that they can buy a photocopying machine.

The principal also revealed that the school was under the departmental administration for funds and that they received money from the department in the School Account quarterly and were mentored on how to use the money. The central control of school funds are likely to compromise enactment of RBT by Life Sciences educators

Physical resources

In this study, pictures refer to drawings, images, charts, and posters that were used by the learners to learn Life Sciences. Educational technology refers to devices such as cell phones, DVDs, DVD players, and televisions. All the six participants used physical resources to enact RBT. However, the physical resources were used in varying frequencies. A frequently used physical resource, amongst all the six participants, was the pictures. Table 12 shows that pictures were used by all participants in the different lessons observed. Pictures were also used in varying frequencies by the participants. For instance, Michael used pictures in three of his lessons. He used them in the second, sixth, and seventh lesson observed whereas Patrick used pictures only in his first lesson observed.

Table 12

A summary of physical resources used by the participants

Participant	Questionnaire					Observation					Interview				
	Pictures	Ecosystem	Laboratory apparatus	Educational technology	Resource person	Pictures	Ecosystem	Laboratory apparatus	Educational technology	Resource person	Pictures	Ecosystem	Laboratory apparatus	Educational technology	Resource person
Denise	✓	✗	✗	✓	X	✓	✓	✗	✓	✓	✓	✗	✗	✓	✗
Patrick	✗	✓	✓	✗	✓	✓	✓	✓	✓	✗	✓	✗	✗	✓	✗
Nelson	✗	✗	✗	✓	✗	✓	✗	✗	✓	✓	✗	✗	✗	✓	✗
Michael	✓	✗	✗	✓	✓	✓	✓	✗	✓	✗	✓	✗	✗	✓	✗
Nikita	✓	✓	✗	✓	✓	✓	✓	✓	✗	✓	✗	✗	✗	✓	✓
Zane	✓	✗	✗	✓	✓	✓	✓	✗	✗	✓	✓	✗	✗	✓	✗

Key: ✓ Used ✗ Not used

In his sixth lesson observed, Michael for instance instructed the learners to use A3 size papers and draw a picture of a nephron. The posters were to be hanged in the classroom notice board for display (Michael, lesson observation 2, May 2017). In his first lesson observed, Patrick distributed pictures containing descriptions and illustrations of Downs' syndrome, sickle-cell-anaemia, albinism, and haemophilia to the learners in his first lesson observed (Patrick, lesson observation 1, May 11, 2017).

Pictures were commonly used because they were available in the participants' schools and therefore were easily accessible to them. During the interview, Denise for instance said, "in our school we have resources such as textbooks, chalkboards, charts, and models" (Denise, interview, May 15, 2017).

Nelson and Nikita seemed to share Denise's sentiments. Nelson reported that he used the textbook, a study guide, question papers, charts, and a model because "they are the ones at the moment I can lay my hands on and which are available in our staffroom" (Nelson, interview, May 2017), while Nikita said, "I always use textbooks, charts and chalkboards because they are the only resources that are available in my school" (Nikita, interview, May 08, 2017). This therefore means that the availability of resources in a school had an influence the reasons as to why Life Sciences educators enacted RBT the way they did in their classrooms.

The least used physical resources amongst the three participants were laboratory apparatus. Out of the six participants, only one, Patrick used them. Patrick used the laboratory apparatus in two of his lessons observed, lesson three and seven. During the third lesson observed, Patrick used the test tube and wire gauze. Other resources used during the practical were conventional as a result to compromising. The conventional resources used were the two-banner stove and a tin (Patrick, lesson observation 3, May 18, 2017). While Patrick was not observed using laboratory apparatus, his questionnaire response suggests that he used the laboratory apparatus once a term (Patrick, questionnaire, May 15, 2017). Probably the reason he did not use laboratory apparatus during the lessons observed it's because they were not prescribed for use in the Life Sciences policy document for use in the observed lessons.

Understanding of RBT

Participants' understandings of RBT affected the way they enacted RBT in their classrooms. Four participants, Denise, Patrick, Nelson, and Michael, understood RBT as a teaching strategy hence their enactment of RBT was largely focusing on them using the resources. Participants' understandings of RBT were limited and that is why they enacted RBT narrowly as they did. Seems like, they did not fully understand what RBT entails.

As highlighted in chapter 4, Denise, Patrick, Michael, and Nelson understood a resource as a teaching material. Their understandings of RBT were therefore largely based on their understandings of a resource. The participants' classroom teaching practices were indicative of their narrow understandings because they were observed using the resources on their own instead of allowing the learners to use them. In his fourth lesson observed, Nelson for instance used a computer to do a PowerPoint presentation about the male and female reproductive systems in class (Nelson, lesson observation 4, May 11, 2017). Instead of him using a learner centred approach in the classroom, Nelson used a teacher centred approach where he was the one who interacted with the resource.

Patrick thought that "learners are more interested when they see something than when it is being said by the educator" (Patrick, interview, May 15, 2017). Maybe that is why he enacted RBT as narrowly as he had done. In addition, Patrick said "I use my computer to type the question papers. I also use the computer to show past examination questions. Therefore, I can use them to assess learners in class" (Patrick, interview, May 15, 2017). It is apparent that Patrick's understanding of RBT was shallow and narrow because assessment in a RBTE cannot be judged based on a person's ability to type a question paper on a computer

Zane and Nikita's understanding of a resource was different from the other four participants. The two participants, Zane and Nikita, understood a resource as a teaching and learning material. Their understanding of a resource was deeper and more relevant to how a resource is defined in this study. This was not surprising because in Nikita's narrative for instance, she understood RBT as an instructional material. During the interview, she said, "RBT is any material that can be used to facilitate and enhance learning" (Nikita, interview, May 22, 2017).

Her understanding of a resource has contributed to building her deeper understanding of RBT and that informed her classroom teaching practice. For instance, I observed Nikita during her fifth lesson using a garden. During the lesson, learners interacted with the artificial ecosystem by digging up soil microorganisms (Nikita, lesson observation 5, May 26, 2017). During the lesson, learners were in charge because they were the ones who were digging the soul and analysing the earthworm that they found in the soil during the lesson.

The other reason the participants probably enacted RBT the way they did is because of the benefits associated with the enactment of RBT. During the interviews, participants described various benefits of RBT for them and for their learners. Denise for instance said she enacted RBT because "it helps learners to be clearer and that teaching and learning becomes more conducive when I use resources" (Denise, interview, May 15, 2017). Patrick described his personal experiences on enacting RBT and said that learners tend to develop passion for the subject when RBT is enacted. These were his words;

> On my experience in the field I have a belief that when you are using various resources in your teaching, it is likely that your learners will like the subject more and more than when you are just verbally teaching them. Learners enjoy seeing things than listening to an educator and reading a textbook (Patrick, interview, May 15, 2017).

Denise reported that the use of RBT in the classroom excite learners and make the process of teaching and learning conducive for both the educator and learners. She said, "Learning becomes very conducive and the learners become excited" (Denise, interview, May 15, 2017).

Other participants, Michael, Nelson, Zane, Nikita, and Patrick all seemed to agree that the enactment of RBT encourages collaboration amongst learners in the classroom. Michael and Nelson reported on collaboration in a similar way. Michael said grouping learners and assigning them a task enables them to engage on the task, and in that way, they are collaborating. He said,

> You can divide your learners into groups and tell them that this group is going to learn using this model and the other will use another model. By grouping them, that can create a good scene of collaboration. They will be coerced to talk to each other and discuss. That way they are learning to do group work (Michael, interview, May 08, 2017).

Similarly, Nelson described the benefits of enacting RBT as enhancing collaboration between classroom participants. He said;

> In terms of teaching, learners can collaborate. For example, if you are projecting a particular topic, some learners will be fast to understand just by observing a lesson. Some may not understand very fast. They can sit down in groups and discuss trying to dismantle that information amongst them. They will help each other to try to recall some of those images they have seen from the lesson that was projected (Nelson, interview, May 08, 2017).

Nelson argued that the enactment of RBT prepared learners to cope with life after high school. During the interview, he said;

> It gives learners a wider scope to know how to use available resources in preparation for a later stage in life when they are going to the university or to work. They are not going to be surprised or be embarrassed when they are required to use them in a professional platform like doing a business presentation for instance (Nelson, interview, May 08, 2017).

Zane was of the belief that RBT draws learners' attention. When he was describing his best experience in using a specific resource he said,

> Videos and PowerPoint presentations are the best for inviting learners' attention. Every time I used those resources, learners participated positively. So, it's wise to bring different resources in the classroom to draw learners' attention to the lesson if you want your lessons to be interesting (Zane, questionnaire, May 23, 2017)

Zane also pointed out that the enactment of RBT prepares learners for learning. During the interview, he said, "it makes learners to be ready to learn and cooperate in the learning process. The learning environment becomes conducive to learn as well" (Zane, interview, May 22, 2017).

Nikita described that the enactment of RBT was beneficial in her lesson after using the internet to download and play videos of Photosynthesis to her Grade 11 class. She said;

> I used the internet to download videos of photosynthesis on YouTube and then I projected them so that all Grade 11 learners can observe and learn since we did not have the required apparatus to do the practical activity. As a result, there was maximum participation of learners in the lesson. They were asking questions. They were also positively engaged in that particular lesson as compared to other lessons (Nikita, questionnaire, May 22, 2017).

Nikita added that RBT caters for a variety of learning styles. During the interview, she told the researcher that, “RBT accommodate different learning styles. For example, if I use the overhead projector and the videos, some of the learners who are good in visual learning learn the best” (Nikita, interview, May 22, 2017).

Zane, Nikita, and Patrick concurred that the benefits of working together in a resource-based teaching and learning space encourages learners to work together. Zane mentioned that the enactment of RBT is ideal for learners to work in groups and exchange ideas. He said, “Learners get a chance to work together. For example, you can assign a number of learners to one chart to identify structures” (Zane, interview, May 22, 2017).

Nikita was in agreement with Zane when she described that collaboration enables learners to verbally engage with one another and share ideas. Nikita said, “Learners enjoy working in pairs and in groups which improve participation and sharing of ideas” (Nikita, interview, May 22, 2017).

Patrick believed that the introduction of RBT in the classroom results in improved learners’ participation and cooperation in the learning process. During the interview, he said “the learning becomes more collaborative. When resource-based teaching is introduced at school, learning becomes more collaborative. Learners start to work together more successfully as compared to when resources are not used” (Patrick, interview, May 15, 2017).

In conclusion, clearly, the participants’ understanding of RBT influenced the way the practiced it in their classrooms.

Technical competence

The participants’ technical competencies in using a particular resource influenced on how they enacted RBT in their classrooms. It emerged in this study that the participants had varying degrees of technical incompetency

Five participants, Patrick, Nelson, Michael, Nikita, and Zane out of the six were moderately competent in their use of technological resources such as the internet, computers, overhead projectors, and PowerPoint presentations. The participants were observed using these resources to teach Life Sciences. It became apparent that they used them in a very basic way that did not exhibit profound knowledge of their use in a RBTE. In his fourth lesson observed, for instance, Nelson used a computer to do a PowerPoint presentation in the classroom (Nelson, lesson observation 4, May 11, 2017). The lesson was very basic in a sense that learners were not fully involved in their learning. All they did was to sit and watch Nelson as he delivered the presentation while passively taking notes.

Michael, Nelson, and Zane for instance all claimed to use the internet during their teaching of Life Sciences. Michael claimed that he used the internet to enrich learners' knowledge. He told the researcher that, "I use a textbook and the internet to deepen learners' knowledge" (Michael, interview, May 2017). He added that, "I summarize the textbook and add the internet information to come up with consolidated information" (Michael, interview, May 08, 2017). However, Michael did not use the internet or any technical resource in all of his observed lessons.

Similarly, Zane indicated that he used the internet to download videos for the learners. When he was asked how he used resources to conduct science practical work, he said, "I often use the internet to download videos for the learners to watch the practical and observe the results" (Zane, interview, May 22, 2017). Not everyone can use the internet. This demonstrates that Zane had a skill but his skill was not used to the benefit of Life Sciences learners.

Nikita and Patrick reported that they used videos to teach Life Sciences. During the interview, Nikita told the researcher that, "when I am using videos, some of the learners get too excited…”. Nikita also indicated that using videos in her teaching helped her a lot because “learners learn better as they watch those videos projected on a screen” (Nikita, interview, May 22, 2017). Patrick described how he used the internet in his classroom and said “I take the topic and use my computer to go to YouTube and type the topic. After finding the videos that are relevant to my topic, I will then play them for the learners as additional information” (Patrick, interview, May 15, 2017).

However, during lesson observation, Patrick’s claims did not translate into benefits for the learners.

While the five participants were moderate in their technical competence, Denise was highly incompetent because she said, “the connectivity of computers is very difficult to me” (Denise, interview, May 15, 2017). She also reported a lack of skill to use science laboratory apparatus. Denise said, “I was not trained to use laboratory apparatus” (Denise, questionnaire, May 15, 2017). As a result, in all her observed lessons, she never attempted to use any technical resource such as a computer or PowerPoint presentations. However, during her first lesson observed, she instructed learners to use their cell phones to google epithelial tissues (Denise, lesson observation1, May 15, 2017). This means that she was aware that learners were not necessarily technical incompetent as she was hence, she told them to using their cell phones for learning Life Sciences.

In conclusion, all the participants were technically incompetent with varying degrees hence their enactment of RBT was shallow. It can be noted that younger participants, Zane, Nikita, Michael, Patrick, and Nelson, were all capable of using the internet and computers in their teaching while Denise was unable to do so.

5.5 Discussion of findings

In the previous sections, the findings were presented. In this section, the findings are discussed under three headings, which are participants' understanding of RBT, how the participants enacted RBT, and why the participants enacted RBT in the way they did. In the discussion, literature is used to highlight points of convergence and divergence of views pertaining the findings of the current study. Succeeding this section is a section that provides a discussion of findings in light of the Framework of Curriculum Implementation that was proposed by Rogan and Grayson (2003)

5.5.1 Participants' understanding of RBT

It was mentioned in the preceding chapter that the participants' understanding of RBT were influenced by their understanding of a resource. This is in line with the constructivist view of learning which postulate that current experiences and ideas of a phenomenon influences future understandings of that phenomenon (Afify, 2018). Brown (2017) holds the view that the recognition of prior informal learning of a phenomenon is likely to have a transformative potential to the understanding of broader aspects of that phenomenon. Thus, in the current study, the participants' understandings of a resource were correlated with their understandings of RBT.

It emerged as a finding of this study that the participants held two understandings of a resource, which ultimately influenced their understanding of RBT. This resonates with the findings of Chandra (1987) who investigated educator's views of teaching and their use of teaching resources. The findings showed that the participants held different views about their use of teaching resources.

In the current study a resource is mainly understood as a teaching material. The participants' understanding of a resource were similar to the understanding of Öztürk and Dagistanlioglu (2018) who defined teaching materials as "the contents of course presentations performed using tools to achieve the objectives" of the lesson (812). The contents of course presentation or lesson presentation in this case are resources because no lesson can be carried out without the relevant teaching material or resources (Jones et al., 2015).

Although four participants, Patrick, Denise, Michael, and Nelson, shared the same understanding of a resource, Nikita and Zane expressed a more complex understanding of the concept. Nikita and Zane understood resources as referring to more than just a teaching material, but as a learning material too (Table 6). This means that Nikita and Zane recognised that in a RBTE resources should be used extensively by the learners. This is in line with the findings of Okongo et al. (2015) who emphasised the importance of both the teaching and learning material for the enactment of inclusive education in Kenyan pre-school centres.

Participants understood RBT as a teaching strategy. The finding in this section is in line with Sitepu (2010)who defined RBT as a teaching strategy which can enable learners to construct meaning through their interaction with a wide-range of resources. Butler adds that learners should be given ample opportunities to learn with resources up to a point where they will get used to them. In this study, learners were observed using a variety of resources to learn Life Sciences.

5.5.2 How participants enacted RBT.

The findings in this section reveal that the participants enacted RBT through the use of interactive teaching aids (ITA), resource persons, practical work, and the use of technology.

Use of the interactive teaching aids

The use of interactive teaching aids has gained momentum in science and technology education as there is an international outcry that calls for educators to employ RBT as a teaching strategy to use in their teaching practices, particularly in teaching of science subjects like Life Sciences (Butler, 2012; Hill & Hannafin, 2001).The findings of this study revealed that the participants used ITA as tools that helped them to enact RBT in their lessons. It emerged as a finding that the participants' use of the ITA was to a huge extent focusing on educational posters, resource persons, and models which were mostly used to teach Life Sciences. These ITA were used because they were available to the participants. They were also selected for use depending on the demands of the lessons taught as per the suggestions of the Life Sciences policy document (Education, 2011).

Trigueros et al. (2007) refer to interactive teaching aids as material devices that are considered to be mediators of human activity. This means that in a RBTE, the ITA play a role of knowledge transfer between the educator and the learners whereby the learners use them (ITA) to learn on their own. The ITA form an integral part of learning because their use in a Life Sciences lesson shapes the processes of learners' knowledge constructions (DuŢĂ, 2017). The use of ITA in Life Sciences lessons is consistent with the study by Gillen et al. (2008) who examined the way educators used an interactive whiteboard to teach primary school learners. The latter study revealed that educators used the interactive whiteboard for teaching and learning, and that learners were curious of their learning. In their study, Jančaříková and Jančařík (2017) classified the types of models used in sciences education based on their differences and the realities they present and proposed possible systematic ways of including models in teaching.

Only two participants, Denise and Michael actually used educational posters to enact RBT. Michael told the researcher that he used educational posters because they enabled him to teach easily. This is in line with a study by Kewaza and Welch (2013) who investigated the challenges encountered with reading practices, teaching materials, and educator's attitudes towards teaching overcrowded classes of primary school learners. Keweza and Welch discovered that traditional teaching material such as wall charts and posters were effective for use because the learners practiced crowd reading. They noted that the lessons were not strenuous to the educator and the wall posters used during the lesson indirectly enabled the educator to have a better classroom control (Kewaza & Welch, 2013). Michael was always in control of learners' behaviour throughout the lesson, because he used a poster of the human kidney for learners to interact with.

Like Michael, Denise was observed using educational posters. During her first lesson observed, Denise drew epithelial cells on the chalkboard. When probed why she used drawings to teach epithelial cells, Denise said resources were scarce in her school. This resonates with Maebuta and Phan (2011) whose findings revealed that resource scarcity in rural schools have a likelihood of delaying educational reform. In addition, in her questionnaire narrative, Denise told the researcher she did not use other resources because she was technically incompetent. This finding tallies with Gulbahar and Guven (2008) who indicated that lack of in-service training opportunities of teachers constrains them from successfully enacting RBT. The same authors concluded that technically incompetent educators should be sent for in-service training because technical competency and environmental awareness are a prerequisite for the successful enactment of RBT, especially for Life Sciences (Gulbahar & Guven, 2008).

It emerged as a finding that the participants used models to enact RBT. Although Nikita, Denise, Nelson, and Michael were not observed using a model, they all indicated in their questionnaire and interview narratives that they used models in their lessons. The scarcity of resources could explain why the participants did not use models during their observed lessons (Maebuta & Phan, 2011). It could also be the fact that, in all the four participants' lessons observed, a model was not recommended for use in the Life Sciences policy document (Education, 2011)

The ITA used by the participants of this study are physical resources that supports the enactment of RBT in Life Sciences lessons. Two constructs (outside influences and capacity to innovate) of Rogan and Grayson's theory of curriculum implementation are in support of the findings of this study that the enactment of RBT heavily relies on the availability of physical resources like educational posters, resource persons, and models. According to Rogan and Grayson (2003), ITA can be donated by organizations and they influence the capacity of the school and the educator to enact RBT. Therefore, ITA is a fundamental aspect of the successful enactment of RBT in Life Sciences lessons. Without proper resources, no enactment of RBT can be possible (Rogan & Grayson, 2003).

Use of resource persons

Denise, Nelson, Nikita, and Zane used resource persons to teach Life Sciences. This finding resonates with Smith (1980) who investigated the use of community elders in teaching middle level science in community schools. In the current study, both Denise and Nikita were observed using village elders in their lessons. They used them because village elders had vast knowledge of traditional and cultural aspects that informed children's view of Life Sciences as a subject and science in general (Smith, 1980).

Although Patrick and Michael were not observed using resource persons, they indicated having used them in their questionnaire and interview narratives. Perhaps the reason why both educators did not use resource persons in their lessons observed was because they had misconceptions about resource persons because Michael for instance told the researcher teachers from other schools usually influence learners in a bad way. This is in line with the findings of (Duru, 2015) who discovered that elementary student teachers were not confident in inviting other people to assist them in teaching because they thought that they will lose learners' respect.

Use of practical work

Use of practical work also emerged as a finding of this study. It emerged that the participants used five types of practical work namely; fieldwork, investigations, demonstrations, simulations, and modelling to enact RBT in their lessons. The commonly used type of practical work in this study was the fieldwork which was used by five participants, Denise, Patrick, Michael, Nikita, and Zane. Studies view fieldwork as an integral part of Life Sciences teaching in secondary and higher education (Lock, 2010). Wandersee and Clary (2006) also reported about the importance of fieldwork in informal science education settings. Wandersee and Clary (2006) posit that field experiences in Life Sciences education are important for motivating learners to learn and for driving knowledge application and integration. Without exposing learners to proper field experiences, they would not be able to effectively make meaning of Life Sciences concepts and processes (Wandersee & Clary, 2006).

Denise, Patrick, Michael, and Zane all used a forest to teach their learners. The proximity of the forests to their schools was one of the reasons they opted to use the forests. For instance, Zane's school was eight minutes' walk away to the nearest forest, whereas Michael's school was ten minutes' walk from the forest. This is in line with the findings of a study by McCabe et al. (2014) who found that a short walking distance to the forest is likely to encourage the use of field trip whereas a long walking distance discourages the use of field trips. In the current study, all the three schools were in close proximity to a forest.

It also emerged that two participants, Zane and Patrick, demonstrated science practical work to teach certain Life Sciences topics (lesson 6 and lesson 3 respectively). There is evidence that practical demonstrations in Life Sciences teaching generally spark interest in the learners' mind (Sunassee et al., 2012). This resonates well with Patricks' interview narrative when he told the researcher that learners' interests are often sparked when they see something happening in front of them than when it is narrated. Patrick told the researcher that he often borrowed the apparatus to conduct science demonstrations because resources were scarce in his school. This is in line with the mandate stipulated in the Life Sciences policy document that "if there are no alternatives, it is more imperative for educators to demonstrate a practical activity" (Education, 2011, p. 19). There is an advantage of enjoyment and evidence of higher order thinking after a practical demonstration. In their study, Sunassee et al. (2012) investigated the likelihood of climate change awareness in South African schools through practical chemistry demonstrations. The result was that learners' attitudes changed and they became more aware of the effects of climate change on the environment.

Nikita used a science investigation to teach learners (Figure 5.7). According to Partridge (2006, p. 44), a Life Sciences research investigation "offers an opportunity for learners to develop and apply understandings and skills in literacy, numeracy, ICT, and thinking". Partridge (2006) elaborates that the use of science investigation promotes inquiry and hands-on opportunities of group work that motivate learners.

Use of technology

Computer simulations in Life Sciences have a potential to provide a virtual laboratory experience as an adjunct to conventional teaching approaches (Shegog et al., 2012). Three participants, Patrick, Nelson, and Michael used simulations to teach Life Sciences in their lessons. Some Life Sciences phenomena are difficult to explain to learners hence a simulation is necessary. During his sixth lesson observed, Patrick used computer-based simulations to teach learners about the production of insulin from bacteria. This resonates with Shegog et al. (2012) who in their study used a simulation to show the preparation of a gene construct in a molecular Life Sciences laboratory. Similarly, scholars like Mutch-Jones et al. (2018) agree that a computer-based simulation model brings positive learning opportunities to the learners.

The participants' use of simulations was influenced by contextual factors such as the availability and the scarcity of teaching resources in their schools. In Nelson's third and sixth lessons observed, learners used computer simulations on YouTube because of the availability of Wi-Fi connection in the school whereas in Patrick's lesson five and six observed, learners connected to Patrick's mobile hotspot to access the simulations YouTube., Wekesa et al. (2006) report that learners exposed to computer based instruction simulations significantly gained knowledge and had a better perception towards the topic of cell division. However, if resources are scarce, educators should be innovative and use unconventional materials to give learners vivid learning experiences (Education, 2011).

The use of technology was another finding of this study. It emerged as a finding that the participants used a variety of technology tools to enact RBT namely; computers, DSTVs, social media, and the internet (Table 10). The participants of the current study used the internet to teach Life Sciences. Hargis (2001) discovered that internet learning was not straightforward. Hargis argues that younger learners required more supervision than older learners due to the fact that the younger ones are likely to divert focus when they use the internet on their own (Hargis, 2001). As opposed to this study, the use of internet was monitored by the educator who guided learners throughout lessons where internet was used.

It emerged from the lessons observed that computers were used to teach Life Sciences. Learners used their cell phones to access video simulations from the internet. In some instances (Michael and Nelson's lessons), the learners connected to the school Wi-Fi signal whereas in other instances (Patrick's lesson), learners connected to the signal coming from the participants' tablet. These findings are in agreement with Vanderbeck (2017) who discovered that the more time learners spend using a computer for learning, the better they performed in mathematics. Therefore, if educators can expose learners to using cell phones to learn about Life Sciences processes and phenomenon, learners might improve on their academic performances (Vanderbeck, 2017). However, learners need to be psychologically conditioned to use the internet because they can be easily distracted. During the interview, Zane reported that he once told learners to connect to his cell phone signal and use the internet to research Life Sciences work, but they watched pornography instead.

The findings of this study also resonate with the findings of Gerber, Shuell, and Harlos (1998) who explored the use of the internet to study mathematics and found that the proper use of internet for learning enhances learners mathematics achievement. Although the participants were not observed preparing learners for using the internet, it emerged from the actions of the learners during the lessons observed that they were familiar to using the school's Wi-Fi for learning purposes. In addition, Patrick, during his lesson observed, gave learners a link to connect to and he monitored whether the learners were doing as they were instructed by going around the groups.

Evidence provided in the current study indicates that the participants' use of technology was largely very basic. This finding is the same as that of (Özer, 2018) who found that pre-service English language teachers mostly used computers for sending emails and doing presentations only.

Two participants, namely Patrick and Nelson were observed using DSTV to enact RBT (see Table 10). Technology integration in conventional lessons was explored in-depth by Hockly (2016) who revealed that the use of DVD players was an integral part of learning in both regular schools. The participants' use of DSTV was in line with research findings and it shows that even in rural schools have some technogical resources that educators can make use of in their Life Sciences lessons.

5.5.3 Why did the educators use RBT the way they did

The findings in this section revealed that the participants used RBT in the way they did because of financial resources, physical resources, their understandings of RBT, and because of their technical competencies. These are discussed below.

Financial resources

The participants used improvised material to teach Life Sciences because of financial limitations that impeded them from getting resources. Nikita told the researcher that she improvised to do science practical work because the resources were scarce in her school. This is similar to the findings of Iji et al. (2014)who found out that due to financial limitations that had an impact on resource availability, improvised materials were used and successfully improved learner’s performances. They recommended that educators teaching in schools lacking resources should use improvised teaching materials.

There is evidence that participants like Nelson wanted to take their learners to museums and resource centres. However, financial limitations impeded them. Financial barriers, according to Rogan and Grayson (2003), affect the capacity of the school to support innovation, and consequently that affects resource availability in schools. South Africa is rich in fossils (Makhubela et al., 2017), but the fossil sites and museums, like Maropeng and Sterkfontein caves, are often far away from schools. The financial standings of the schools and parents often impedes educational excursions which could boost learning experiences and conceptual understandings of learners (Makhubela et al., 2017). Similarly, in this study, participants were impeded by lack of money in schools to attend educational excursions.

Physical resources

In addition to human resources, practical work, and technology, the participants also used picture animations as a RBT tool to assist them in the Life Sciences curriculum. In his review of literature, O'Day (2008) discovered that various scholars highlight seven benefits of using animations such as retention of memory, accurateness of knowledge assimilated, enhancing learners' achievement, interactivity, complexity, encourages classroom discussion, and a broad picture of the understanding of Life Sciences.

Understanding of RBT

Four of the participants' understanding of RBT was to a large extent superficial because they understood RBT as a teaching strategy. Denise, Patrick, Michael, and Nelson had a narrow view of RBT and apparently did not recognise its elements of learner centeredness, autonomy, and flexibility (Butler, 2012; Campbell et al., 2002; Fry et al., 2007). Seemingly, Denise, Patrick, Michael, and Nelson thought that RBT was about their teaching practices only and ignored that RBT is mainly centred on learners using the resources for their learning (Sitepu, 2010). That probably influenced the way they enacted RBT in their lessons observed.

Ideally, learners should take full ownership of resources in class by using them to learn while the educator monitors the learning process. For instance, the majority of Zane's and Nikita's lessons observed were more learner centred as it was the learners who made use of the resources. During her third lesson observed, Nikita instructed learners to bring bread to the class so as they can do a hands-on practical activity of fungus while Nelson in his first lesson observed, played a DSTV channel for learners to watch. Nelson's lesson was not highly RBT relevant as compared to Nikita's third lesson observed because the level of engagement with learning resources was different. Nikita's learners were highly interactive with the bread, while nelson's learners were passively watching the TV without any noticeable physical and intellectual involvement.

Technical competence

The participants' use of resources was at a very basic level. It became evident as a finding of the current study that they were not very technically skilled in using resources such as the internet, computers, and PowerPoint presentations. Denise for instance, told the researcher that she was not trained to use computers and the internet and therefore she needed training to use the resources. This finding is in line with a study by Niederhauser (1996) who suggests that educators needed training and support to revise their instructional practices in order to address their needs in a RBTE. Niederhauser (1996) urges district officials to equip educators with the necessary skills for operating technological infrastructure effectively.

Similarly, Nelson (1984) conducted a national survey of in-service educators' instructional material needs for using micro-computers in their lessons. They discovered that in-service educators were making little use of computers and micro-computers in their lessons. Nelson (1984) recommends that additional funding be injected and in-service and training be provided in colleges for use of a computer during lessons. The latter further suggests that educators be given technical assistance with specific difficulties encountered in preparing software and instructional material. This resonates with Denise's call for help during the interview when she said government must provide training to capacitate educators with computer-usage skills. Other participants, Zane and Nikita told the researcher that the barrier to their enactment of RBT was finances. As Nelson (1984) suggests, funding must be injected in schools to capacitate educators to successfully enact RBT.

Bekirogullari (2012) asserts that to integrate computers and technologies in schools required educators to understand their potential to help learners during teaching and learning.

Bekirogullari (2012) adds that educators need training and guidance in using computers and other related technologies and that educators' preparation programs need to include computers and ICT as essential components in the training of educators.

5.6 Reference to the theoretical Framework

In the previous section, the literature was used to discuss findings pertaining to participants' understanding of RBT, their enactment of RBT, and why they enacted it the way they did. In this section, the theory of curriculum implementation, as proposed by Rogan and Grayson (2003), is used to make sense of the findings that emerged in the current study.

5.6.1 Participants' understanding of resource-based teaching

As mentioned earlier, participants understood RBT as a teaching strategy and they were hugely influenced by their prior understanding of a resource. Teacher factors, the sub-construct of the major construct Capacity to Innovate describes that educators are surrounded by a range of external factors that influence the way they understand, interpret and enact curriculum. Educators understanding of RBT was influenced by their personal level and type of training, and their exposure to RBT during their teacher training programmes. Further, educators understanding of RBT is according to Rogan and Grayson (2003) dependant on how educators perceive their roles in the Life Sciences classroom. Probably that is why Nikita and Zane had a deeper and more meaningful understanding of a resource. They understood it in line with their teaching role in the classroom.

5.6.2 Participants enactment of resource-based teaching

Participants enacted RBT differently using a variety of interactive teaching aids, and as influenced by various contextual factors.

Interactive teaching aids

Participants' enactment of RBT was as mentioned earlier, mainly through interactive teaching aids. Most of the interactive teaching aids are according to the construct Capacity to Innovate, physical resources (Rogan & Grayson, 2003). The construct Outside Influences also describe that it is the responsibility of the government through the DoE to provide interactive teaching aids in schools. Physical resources are either tangible nor electronic (Rogan & Grayson, 2003). Through their proposed theory, Rogan and Grayson (2003) emphasised the necessity for the government through the DoE and NGOs to donate interactive teaching resources to enhance teaching and learning experiences of Life Sciences learners because without adequate resources, learning is in vain (Bantwini, 2009). It is also the responsibility of educators to outsource interactive teaching aids and more knowledgeable educators from other schools to come and teach learners. In this study, models were used by the participants in the teaching of Life Sciences. However, the findings of the current study show that instructional resources such as models and educational posters are inadequate, and that compromises the successful teaching and learning of Life Sciences as argued by Bantwini (2009).

Furthermore, the provisions of the sub-construct classroom interaction of the major construct Profile of Implementation correlates with the findings of this study because according to Davenport et al. (2017), models enhance classroom interaction. In this study, classroom interaction was enhanced when Zane asked learners to design a model of the human breathing system during his third lesson observed. This finding is similar to the findings of a study by De Voogd and Salbenblatt (1989) who introduced a model for teaching molecular biology. It was found in the study that the model enhanced learner participation.

In addition, models may also be used for the purpose of assessment for learning during the course of study. The Profile of Implementation explains this better that assessment should be a regular exercise in a Life sciences classroom because it is an integral part of teaching and learning. Different types of assessment exist, namely baseline, formative, and summative (Education, 2011). Science projects, investigations and demonstrations are forms of assessment that promote enquiry and they are highly recommended in science education (Pearlman et al., 2016).

During the undertaking of science projects and investigations, learners can design things or solve everyday problems by applying the knowledge learnt in the classroom. Scholars such as Edessa (2018) and De Voogd and Salbenblatt (1989) attest to this by asserting that science practical work is necessary to capacitate learners with skills that are applicable to their daily lives. Moreover, Rodríguez, Viña, and Montero (2013) also recommends this form of assessment and attests that any science topic can become a focus for an investigation. The latter further argue that when investigations are applied appropriately, they can encourage and strengthen learners' ability to explore and invent things on their own. Investigations according to Partridge (2006) can stimulate thinking and observational skills while strengthening analytical skills and the understanding of the relationship between science, technology, society and the environment. Perhaps that could explain why learners who are exposed to science projects and investigations tend to perform better in their studies.

Lastly, the construct Outside Influences emphasised the need for the provision of resources, especially in rural schools as a means of equalising educational conditions between urban and rural contexts (Rogan & Grayson, 2003). Zane for instance, practised formative assessment. However, no investigation activity was given, instead a research project was assigned to the learners.

According to Rogan and Grayson (2003), the availability of knowledgeable, active, and well-skilled human resource in a school optimises the enactment of RBT. It emerged as a finding of this study that when experts and village elders were used during this study, they were very instrumental in the enactment of RBT in Life Sciences lessons. This finding is supported by teacher factors and science in society, the sub-constructs of the Capacity to Innovate and the Profile of Implementation respectively in a sense that educators are viewed as a pre-requisite to RBT (Bantwini, 2009), and that the teaching of Life Sciences is not divorced to the society. In this study, educators invited village elders to explain science phenomena such as the beer brewing process to learners. The sub-construct physical resources under the major construct Outside Influences also describe human resource as a factor that have a big influence in the enactment of RBT because without knowledgeable educators as physical resources, the enactment of RBT would be in vain (Bantwini, 2009). That is perhaps why Rogan and Grayson (2003) stresses the need for science educators to practice team teaching so that the learners' learning experiences can be optimised.

It emerged as a finding of this study that participants enacted RBT through science practical work. Different types of practical work were used by participants, but fieldwork was the most frequently used type. The theory of curriculum implementation highlights that as much as science practical work is necessary, it cannot be successfully implemented when there are inadequate physical resources in a school to support such innovation (Rogan & Grayson, 2003). Therefore, NGOs should willingly donate science kits to schools to enable educators to conduct various types of science practical work. Drawing from the provisions of teacher factors, the sub-construct of the Capacity to Innovate, educators should be adequately skilled to facilitate science practical work. Demonstrations, for instance, need to be done by a competent, well-prepared and adequately trained educator who knows what he/she is doing to avoid collapsing the lesson (Sunassee et al., 2012). Therefore, professional development initiatives should be made available as per the proposal of Rogan and Grayson under the major construct, Outside Influences.

In addition, as part of a learner factor, learners themselves should be mentally and emotionally conditioned and prepared to engage in science practical work, because it is very demanding and requires dedication from both educators and learners. Therefore, support to learners is necessary and possible through scaffolding by the educator so that learners can exploit their zones of proximal development. Most importantly, the school ethos and management should be motivating enough to understand the demands of science so as to support science initiatives such as excursions(Rogan & Grayson, 2003).

The use of technology also emerged as a finding of the current study. With regards to the use of technology, Rogan and Grayson's theory of curriculum implementation highlights that technology should only be used when it is feasible to do so (Rogan & Grayson, 2003). For instance, educators in this study used simple technology that is easily accessible due to the fact that the three schools were under resourced and were located in deep rural areas where access to technology was not common. The use of social media, internet, DSTV, and computer by the participants is supported by the sub-construct physical resources under the major construct Capacity to Innovate because no technical part of curriculum implementation can happen if the school does not have the proper technologies to use during the teaching of Life Sciences topics such as evolution in Grade 12 which require a lot of comparative slides (Nelson, interview, May 2017).

However, it was evident that there is a need for professional development of educators in using technical gadgets as some of them struggled to use them. This is supported by the sub-construct, professional development. It is the responsibility of the DoE and the school to train educators and give them basic and advanced computer literacy skills.

5.6.3 Why participants enacted resource-based teaching the way they did

Participants advanced various reasons as to why the enacted RBT in the manner they did. The availability of financial and physical resources is amongst the factors that shaped educators' enactment of RBT in their lessons. They were also influenced by their understanding of RBT and technical competence

Financial resources

It emerged as a finding that contextual factors such as financial limitations and physical resources influenced participants' enactment of RBT during Life Sciences lessons. Availability of money would make all the three constructs of the curriculum implementation theory functional in any given case (Evoh, 2007). Therefore, nothing exists in avacuum. As a result, it emerged in the current study that educational excursions (field trips) were limited by lack of money in the schools. This has a direct effect on science practical work, a sub-construct of the Profile of Implementation. Science practical work requires a lot of time in planning and money to enact properly (De Villiers, 2007; Wei, Chen, & Chen, 2019). Scholars like Rogan and Grayson (2003) are of the view that, if science practical work is not done in science subjects, then that curriculum has not been adequately done. However, it is good that participants used unconditional teaching resources and compromised to enact RBT in their lessons.

As described through Outside Influences, financial resources also impede professional development needs of educators. Financial resources also have a direct bearing on physical resources as a sub-construct of Capacity to Innovate and Outside Influences because no physical resources such as textbooks can be brought without money (Bantwini, 2009; Rogan & Grayson, 2003). That is why during most lessons observed during the data collection process of this study, learners shared textbooks. Finances also create interpersonal conflicts in schools, and have the ability to affect the overall ethos of schools. Rogan and Grayson (2003) assert that school ethos and management influences innovation in schools. If working relations are not positive due to personal interests about money in schools, the enactment of RBT might negatively be influenced (Rogan & Aldous, 2005). That is why Nelson pointed out that his SMT is very reluctant to authorise trips because they always say there is no money.

Physical resources

As mentioned earlier, it emerged as a finding of this study that physical resources such as educational technology, laboratory apparatus and pictures in schools are scarce, and natural resources are far from the schools. Consequently, that impeded the enactment of RBT to a certain extent. The worrying lack of resources in the sampled schools according to Rogan and Grayson (2003)affects the Capacity of the school to Innovate and needs the intervention of Outside Influences. The lack of laboratory apparatus in schools leads to educators using unconventional teaching resource, and sometimes resorting to performing practical demonstrations to replace hands-on practical work.

According to (Rogan & Grayson, 2003), science practical work, the sub-construct of the Profile of Implementation emphasises the need for each learners to be involved in hands-on practical work to enhance their learning experience and stimulate their love for science. The Profile of Implementation further stresses that assessment activities in the laboratory are necessary for meaningful science learning. This calls for outside agencies to donate science laboratories to rural schools in order to provide meaningful learning opportunities to learners in rural schools (Rogan & Grayson, 2003). This is because the capacity of the school to innovate is measured by the availability and quality of laboratory apparatus as per the physical resources construct.

Science in society, a sub-construct of the Profile of Implementation, was embraced by the participants by inviting village elders and Sangomas to their schools to demonstrate traditional beer brewing to learners. By inviting village elders in schools, IKS is incorporated in science as per Rogan and Grayson's (2003) proposal.

Understanding of RBL

It emerged as a finding of this study that educators' understanding of RBT influenced the way they enacted RBT in their lessons observed. Educators who understood RBT as a teaching strategy enacted it through teaching while those who understood it as a learning strategy also involved learners in their teaching as per the constructivist learning theory. This finding resonates with the Profile of Implementation's construct, classroom interaction. There is likely to be more interaction when educators are involving learners actively in the lesson as compared to when they focus solely on using resources to give instructions (Wei et al., 2019).There is no guarantee that learner are learning when they are simply taught by educators and not actively involved in the learning process. It is necessary therefore that RBT be integrated with RBT during the teaching of Life Sciences to enhance learner's interaction in the classroom for meaningful learning to take place.

Technical competence

Lastly, it emerged that educators were technical incompetent in using basic resources such as laboratory apparatus owing to their initial teacher training programmes. Manifest to this, is the suggestion description the construct Outside Influences which argue that educators undergo professional development in areas where they need assistance in. This according to Rogan and Grayson's (2003) construct, Outside Influences – monitoring of educators during teaching to see if they enact RBT properly.

CHAPTER 6
SUMMARY, RECOMMENDATIONS AND CONCLUSIONS

6.1 Introduction

This chapter reviews the findings, recommendations and conclusions of this qualitative study carried out in three rural secondary schools in the Eastern Cape province of South African. This study, whose focus was on the exploration of Life Sciences educators' enactment of RBT, had three research questions. The study generated three themes and subthemes that aimed at addressing the research questions.

6.2 Summary of Findings

This section focuses on the summary of findings with regards to the literature review, the theoretical framework, and the data collected from the field. In addressing the research questions, data were generated from structures questionnaires, lesson observations, and in-depth, semi-structured interviews. The main findings were summarised according to the three research questions of the study.

Research Question One: What are Life Sciences educators' understanding of resource-based teaching?

In this study, participants' understanding of resource-based teaching was to a large extent based on their understanding of a resource. Thus, the participants understood a resource as a teaching material. As a result, a theme that emerged from the participants' responses indicated that educators understood resource-based teaching as a teaching strategy.

Research Question Two: How do Life Sciences educators enact resource-based teaching?

Research question 2 explored how participants enacted RBT in the teaching of secondary school Life Sciences. Four subthemes emerged from the four data collection instruments (questionnaire, lesson observation, interview, and document analysis). Findings show that participants enacted resource-based teaching through the use of interactive teaching aids, practical work, use of technology, and the use of resource persons.

Findings indicate that in this study educators taught Life Sciences using a variety of interactive teaching aids but educational posters, resource persons and models were the mostly used. Findings also show that fieldwork, investigation, demonstration, simulation, and modelling were the types of practical work that were also used by participants to teach Life Sciences in their lessons. The participants also used technology to enact RBT in their lessons. A computer, DSTV, the internet, and social networks such as Facebook and WhatsApp were technology tools that were mostly used by the participants to teach Life Sciences. Moreover, findings show that the participants also used resource persons to teach Life Sciences in their lessons. Experts such as an Agronomist and a nurse were invited to Life Sciences classrooms including village elders such as a traditional healer and an experienced woman to teach learners about Life Sciences phenomena.

Research Question Three: Why do Life Sciences educators enact resource-based teaching the way they do?

The focus on research question 3 was on why educators enacted RBT in the way they did in the teaching of secondary school Life Sciences. The research findings indicated that the participants' enactment of RBT was largely influenced by their context, understanding of RBT and by their technical competence.

Firstly, the findings showed that the contextual factors that were beyond the participants' control were financial constraints and physical resources. It emerged that lack of financial assistance in the schools constrained the participants from successfully enacting RBT because most of the occasions, participants complained that there was no money at school. As a result, they could not purchase relevant study material or resource educational excursions to museums and fossil sites to study about Life Sciences phenomena. Moreover, it was found that participants enacted RBT the way they did because of physical resources. In this study, readily available resources were found to be textbooks, chalkboards, a few computers, internet, pictures, and resource persons. It emerged from the findings that the available resources did not adequately enable participants to enact RBT fully in their lessons. Lack of physical resources handicapped some of the educators because in some classrooms there was no electricity to connect a socket. Most of the classrooms were small in size with few desks and learners were overcrowded in the classroom.

Secondly, the findings also showed that participants enacted RBT the way they did because of their understanding of RBT. Participants of this study understood RBT as a teaching strategy. Thus, their understanding of RBT implied that they did not fully understand what RBT entails. The participants of this study used resources for themselves instead of allowing learners to use them to construct knowledge independently.

Lastly, participants enacted RBT the way they did because of their technical competence. The participants had varying degrees of technical incompetence. Generally, participants' skills and understanding of using resources for learning was very basic. They did not adequately understand what RBT entails. Participants' technical incompetence ranged from moderate to poor (Cullen, 2008).

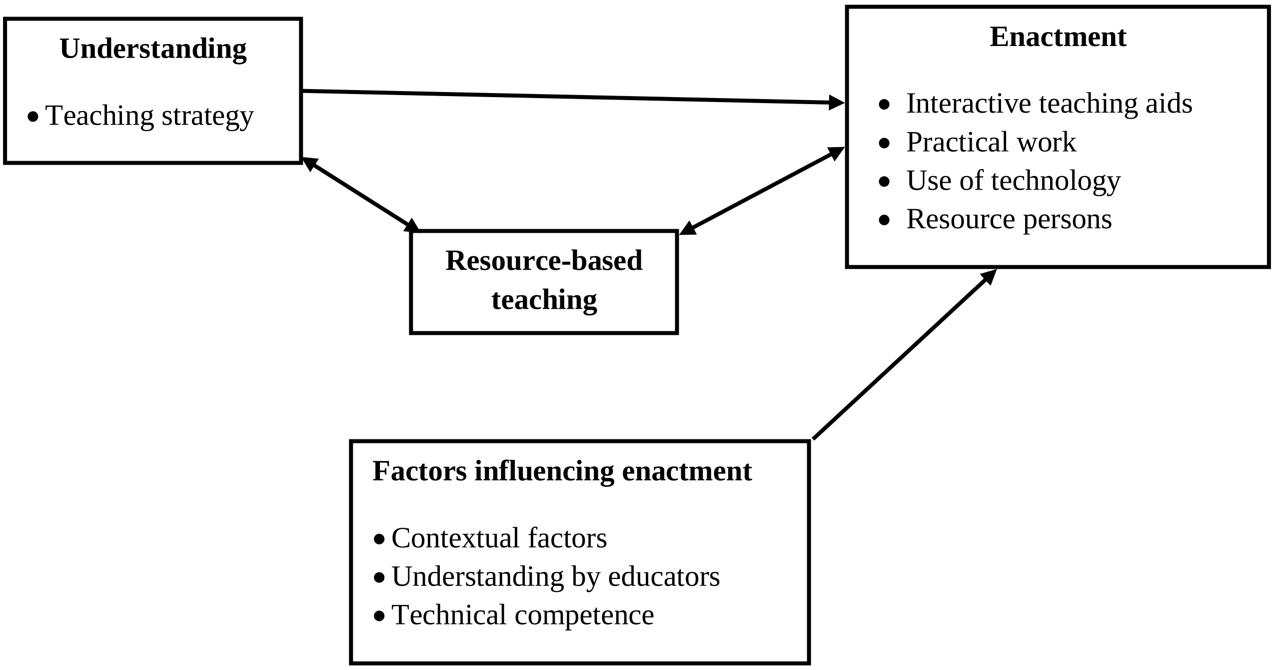

Figure 43: Summary of research findings

6.3 Significance of the study

This study has a significant value to policy-makers and implementers in the province at all levels to improve the standard of education. This study highlighted on some challenges and strengths that will help the DoE to improve the way they resource schools in the province. This study also outlines the significance of curriculum enactment in South Africa as a developing country based on Rogan and Grayson's theory of curriculum implementation.

6.4 Recommendations

This section presents recommendations made to various education stakeholders and education levels so as to enhance the enactment of RBT in rural schools as necessitated by the findings of this study.

6.4.1 Recommendations to the department of education

As a result of the findings that were outlined, the following recommendations to the Eastern Cape department of education are made:

6.4.1.1 Workshops and in-service training

The DoE in the Eastern Cape Province should hold regular workshops and seminars for all Life Sciences secondary school educators in schools especially Grade 12 educators because of the expected outcomes at the end of the year. The workshops and seminars should be based on the orientation of Life Sciences as a subject and the introduction of RBT to enhance their understanding of the teaching strategy. These workshops and seminars should be conducted at least twice a quarter. The workshops should focus on the challenges experienced by educators in their daily teaching roles, particularly when enacting RBT, and how to overcome those challenges.

In addition, it should be made compulsory for all secondary school Life Sciences educators to be entered into in-service training programmes by the DoE and also at the expense of the DoE. There should be some form of monetary incentives for successful completion of the course. This will guarantee that educators take part in the trainings and complete them. During the in-service training programmes, educators should be given opportunities to practice RBT micro-teaching in front of peers, get feedback and make reflections on the lessons presented. This will enable them to correct their mistakes and improve on their weakest points. This will in turn promote better-skilled Life Sciences educators who are up-to-date with new technical developments for teaching Life Sciences as a subject. Through in-service training, even educators perceived to be technical incompetent will get the necessary skill they need for a virtual RBT lesson.

There should also be targeted professional development of all Life Sciences educators in high school where they are taught teaching techniques and skills necessary to exploit their immediate natural environments for teaching and learning. Female Life Sciences educators should be targeted the most for such professional development workshops as they are the ones who usually complain about fears of insects and reptiles in the natural ecosystem. This initiative by the DoE will foster all Life Sciences educators to enact RBT in the natural ecosystem and give opportunities for experimental learning to take place as supported by the constructivist view of learning. In turn, this will produce environmentally aware learners who practice nature conversation measures in their lives. This could also see an increase of tertiary enrolments in scientific fields of study such as environmental sciences, Agriculture, Zoology and natural Sciences.

6.4.1.3 Resourcing schools

The DoE should resource schools with basic resources such as textbooks, study guides, computers, question papers, pictures, wall papers, etc. School infrastructure, as a barrier to successful enactment of RBT should also be provided to schools in the form of classrooms, electricity, the expansion of classroom sizes and provision of desks and chairs.

6.4.2 Recommendations for teacher education institutions and university lecturers

Findings of this study might be useful to tertiary institutions to include in their training of educators, the contemporary theories like the curriculum implementation theory by Rogan and Grayson (2003). This may equip prospective Life Sciences educators with techniques to employ when enacting RBT and be aware of common challenges so that they can avoid them.

Universities and all other teacher training institutions should design a curriculum that emphasises the practicing of resource-based teaching to all secondary school student teachers. Student teachers must be made familiar with resource-based teaching and be taught how to use different resources to teach not only Life Sciences, but all science subjects. Resource-based teaching is not intended to replace traditional teaching methods; thus, it is imperative for teacher training institutions to draft syllabi that places more emphasis on the use of different resources by educators in high school. Since Life Sciences is a practical subject and RBT is a cornerstone of teaching the subject, it should be explained in detail so that student teachers can understand the full import of the practices before leaving universities.

University lecturers should provide mentoring and demonstrations to ensure student teachers understand what RBT entails. Lecturers should ensure that student teachers are involved in micro-teaching by doing peer teaching in the classrooms to practice RBT before they even go to meet learners. Lecturers can also increase the number of assessments on RBT as a pedagogical concept to ensure that student teachers can demonstrate their understanding of the pedagogy. Teaching material and tools such as the internet, computers, tablets, smart boards, pictures, videos, audios, and slides can be made available to student teachers so that they are better equipped to tackle the demands of teaching in this way upon leaving training colleges or universities.

6.4.3 Recommendations for school heads and educators

School heads should also provide in-service trainings for staff development purposes to ensure that educators are abreast with latest RBT techniques in the teaching of Life Sciences. In-service training will also equip educators for using educational technologies in their teaching of Life Sciences. This will equip educators who are conceived as technical incompetent.

Heads of schools should make sure they recruit suitably qualifies educators and that Life Sciences is taught by educators who underwent university training specifically to teach it because there is a likelihood that they (well-trained educators) will understand it (Life Sciences) better than those who did not do it in university. Life Sciences educators should ensure that there are plots of gardens in their schools to enable learners to do fieldwork.

Educators should be able to design or acquire effective teaching resources and how the less frequently resources used can be optimised.

6.4.4 Recommendations for further studies

The findings show that the participants' understanding of RBT was not consistent with what the literature says. Therefore, similar studies on RBT can be conducted using larger samples of educators and schools. Educators from private well-resourced schools can also be used to compare results involving educators from both rural and urban settings in South Africa in order to provide insights to various educational institutions responsible for the training of educators. Consequently, this might enhance the enactment of RBT in the teaching of Life Sciences in South African secondary schools.

6.6 Conclusion

The aim of this study was to explore how secondary school Life Sciences educators enact RBT in their lessons. The researchers' concern was about Life Sciences educators' understanding of RBT and how they enact it in their lessons. The way Life Sciences educators understand RBT may lead to a failure or a successful enactment of RBT. If educators do not understand what RBT entails, they are likely not to enact it well. This was evident in the current study because majority (four) of the participants did not understand the concept RBT and what it entails, and thus could not enact it well in their lessons observed. Moreover, inadequate resources in schools, technical incompetence of educators, faulty electrical connections in classrooms and the unavailability of gardens in the schools inhibited the successful enactment of RBT. Life Sciences is a practical subject, and failure to actively expose learners to a variety of resources during the teaching and learning process may produce unskilled school leavers who do not qualify to be admitted to fields such as Medical studies, Agricultural studies, Marine studies, and other key career paths at university. It is therefore imperative for educators to enact RBT to enable them to grasp Life Sciences phenomena for lifelong learning.

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Appendices

Appendix A: Ethical Clearance, University of Kwazulu-Natal

UNIVERSITY OF KWAZULU-NATAL™
INYUVESI YAKWAZULU-NATALI

30 March 2017

Mr Sindile Mahambehlala 216057822
School of Education
Edgewood Campus

Dear Mr Mahambehlala

Protocol Reference Number: HSS/0255/017M
Project Title: Exploring Life Sciences Educators' Enactment of Resource-based Learning in three rural Secondary Schools in South Africa: A case study

Full Approval – Expedited Application

In response to your application received 9 March 2017, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **FULL APPROVAL**.

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

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

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

Dr Shenuka Singh (Chair)
Humanities & Social Sciences Research Ethics Committee

/pm

cc Supervisor: Tamirirofa Chirikure
cc. Academic Leader Research: Dr SB Khoza
cc. School Administrator: Ms Tyzer Khumalo

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 3587/8350/4557 **Facsimile:** +27 (0) 31 260 4609 **Email:** ximbap@ukzn.ac.za / snymanm@ukzn.ac.za / mohunp@ukzn.ac.za
Website: www.ukzn.ac.za

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Appendix B: Letter of permission from the ECDoE South Africa

Province of the
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EDUCATION

STRATEGIC PLANNING POLICY RESEARCH AND SECRETARIAT SERVICES
Steve Vukile Tshwete Complex • Zone 6 • Zwelitsha • Eastern Cape
Private Bag X0032 • Bhisho • 5605 • REPUBLIC OF SOUTH AFRICA
Tel: +27 (0)40 608 4773/4035/4537 • Fax: +27 (0)40 608 4574 • Website: www.ecdoe.gov.za

Enquiries: NY Kanjana   Email: nykanjana@live.co.za   Date: 28 February 2017

Mr. Sindile Mahambehlala

19 Sidumo Street

Kwa-Dwesi

Port Elizabeth

6201

Dear Mr. Mahambehlala

PERMISSION TO UNDERTAKE A MASTERS THESIS: EXPLORING LIFE SCIENCES EDUCATORS' ENACTMENT OF RESOURCE-BASED LEARNING IN THREE RURAL SECONDARY SCHOOLS IN SOUTH AFRICA – A CASE STUDY

1. Thank you for your application to conduct research.
2. Your application to conduct the above mentioned research at three Secondary Schools under the jurisdiction of Libode District of the Eastern Cape Department of Education (ECDoE) is hereby approved based on the following conditions:
   a. there will be no financial implications for the Department;
   b. institutions and respondents must not be identifiable in any way from the results of the investigation;
   c. you present a copy of the written approval letter of the Eastern Cape Department of Education (ECDoE) to the Cluster and District Directors before any research is undertaken at any institutions within that particular district;
   d. you will make all the arrangements concerning your research;
   e. the research may not be conducted during official contact time;
   f. should you wish to extend the period of research after approval has been granted, an application to do this must be directed to Chief Director: Strategic Management Monitoring and Evaluation;

building blocks for growth

PGDP EASTERN CAPE

Ilizwe eliqaqambileyo!

g. your research will be limited to those institutions for which approval has been granted, should changes be effected written permission must be obtained from the Chief Director: Strategic Management Monitoring and Evaluation;

h. you present the Department with a copy of your final paper/report/dissertation/thesis free of charge in hard copy and electronic format. This must be accompanied by a separate synopsis (maximum 2 – 3 typed pages) of the most important findings and recommendations if it does not already contain a synopsis.

i. you present the findings to the Research Committee and/or Senior Management of the Department when and/or where necessary.

j. you are requested to provide the above to the Chief Director: Strategic Management Monitoring and Evaluation upon completion of your research.

k. you comply with all the requirements as completed in the Terms and Conditions to conduct Research in the ECDoE document duly completed by you.

l. you comply with your ethical undertaking (commitment form).

m. You submit on a six monthly basis, from the date of permission of the research, concise reports to the Chief Director: Strategic Management Monitoring and Evaluation

3. The Department reserves a right to withdraw the permission should there not be compliance to the approval letter and contract signed in the Terms and Conditions to conduct Research in the ECDoE.

4. The Department will publish the completed Research on its website.

5. The Department wishes you well in your undertaking. You can contact the Director, Ms. NY Kanjana on the numbers indicated in the letterhead or email nykanjana@live.co.za should you need any assistance.

NY KANJANA
DIRECTOR: STRATEGIC PLANNING POLICY RESEARCH & SECRETARIAT SERVICES

FOR SUPERINTENDENT-GENERAL: EDUCATION

Appendix C: Informed consent for the participant educator

Dear Participant

RE: INFORMED CONSENT LETTER

I am a Master's student from the Science and mathematics Education Department, University of KwaZulu-Natal South Africa. I am conducting a research titled '**Exploring Life Sciences Educators' Enactment of Resource-based teaching in Three Rural Secondary Schools in South Africa-A Case Study'.**

Resource-based teaching is a key element of any teaching and learning endeavour. The aim of the study is to explore educators' enactment of RBT in the teaching of secondary school Life Sciences.

I am kindly requesting your participation in the study. I will be collecting data using a questionnaire, observations, a semi-structured interview and document analysis. The interview will be audio-recorded. This interview will take about 30 minutes to complete. I would appreciate being able to interview you at a time that is mutually convenient. If you agree to this, I will also be asking you to sign a consent form regarding this event.

You have the right to decline taking part in this research project. If you have agreed to participate in the study, you can withdraw at any point during the process. You can also refuse to answer any particular question at any point in time. An opportunity to check the transcripts and make corrections will be given at the end of the exercise. Your identity will be kept anonymous. Neither you nor the institution will be identified in the thesis.

Please note that:

- Your participation is voluntary

- Your confidentiality is guaranteed as your input will not be attributed to you or any person.
- Information you volunteer will not be used against you and the data collected will be used for the purposes of this research only.
- All the data collected will be stored in a secure place and destroyed after five (5) years.
- You have the choice to participate, not to participate or to stop participating in the research any anytime without the risk of incurring any penalty.
- Your involvement is purely for academic purposes only. There are no financial benefits involved.
- At the end of the data collection process copies of transcripts of the interviews and audio recordings will be made available to you for cross-checking.
- If you are willing to have your lessons observed, your books to be analysed and to be interviewed, (please indicate by ticking as applicable) whether or not you are willing to allow recording by the following equipment:

	Willing	Unwilling
Audio equipment		

Thank you

Yours faithfully

Mahambehlala S. (Mr)

Email: sindilemahambehlala@yahoo.comCell: +27719677076

If you need further information, please contact my supervisor Tamirirofa Chirikure who is a lecturer at the Science and mathematics Cluster, School of Education, College of Humanities, Edgewood Campus, University of KwaZulu-Natal.

His contact details are:

Cu 135 (Ground Floor), Main Tutorial Building, Science and Technology Education Cluster

Edgewood Campus, University of KwaZulu-Natal

Private Bag X03, Ashwood 3605

Email: chirikure@ukzn.ac.za; Telephone: +27 31 260 3470

You can also contact Research office at:

Research Office: HSSREC – Ethics

University of KwaZulu-Natal

Govan Mbeki Building

Private Bag X54001

Durban 4000

South Africa

Tel: +27 31 260 4557

Fax: +27 31 260 1609

Thank you so much. Your participation will be greatly appreciated.

DECLARATION BY PARTCIPANT

I ____ (full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project and I consent to participating in the research project.

I understand that:

- I will participate voluntarily and am at liberty to withdraw from the project at any time should I so desire with no negative consequences.
- I voluntarily give permission for the study's activities to be digitally recorded.
- I give permission for my Chemistry practical work books and scripts to be used as a source of data.
- My identity will not be disclosed and that a pseudonym will be used to protect my identity.

Signature of participant ______________________ Date ______________________

Appendix D: Questionnaire schedule

QUESTIONNAIRE

This questionnaire is designed to gather data for a thesis in fulfilment of the requirements of a Masters in Life Sciences Education degree course by a postgraduate student at University of KwaZulu-Natal in South Africa. Completion of this questionnaire is voluntary and the information you are going to provide remains anonymous throughout the study.

Please complete the questionnaire, seal it in the envelope provided (using a stapler) and leave it with the school administrator.

Section A	*Demographic Information*

Please complete the table below by ticking of writing where necessary

Age	20 – 30 years ( ) 31– 40 years ( ) 41 – 50 years ( ) Above 50 years ( )
Gender	Female ( ) Male ( )
Race	African ( ) Indian ( ) Coloured ( ) Other ( )
Home language	Isixhosa ( ) English ( ) Zulu ( ) Other ( )
Years of Teaching Experience	0 – 10 years ( ) 10 – 20 years ( ) 20 – 30 years ( )

	Above 30 years ( )
Subjects taught	…………………………………………
Grade taught	……………………………………………
Highest academic qualification e.g. Grade 12, ACE, ABET, BED/BA, BEd Hons, Bsc, Msc, etc.	………………………………………..
Year obtained	……………………………………

Section B

2. Educators use a wide range of resources to assist in their teaching of Life Sciences content. What do you understand by a resource?

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3. What is your understanding of Resource-based teaching?

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3. Complete the table below by indicating with an 'X' all the resources you use in the teaching of Life Sciences and state the frequency of use.

Resources	Mark with an '*X*' if you use the resource in each case.	Frequency of use Key (write only the number) (every lesson) (once a week) (once a term) (once a month)
Biological gardens		
Museum		
Forest		
Game reserve		
Botanical Gardens		
River/Dams/Lakes		
Visits to Fossil Sites		
Charts		
Models		
Textbooks		
PowerPoint Presentations/Slides		
Appropriate DVDs & DVD players		
Internet		

Social Networks		
***Laboratory Apparatus*: **Bunsen burners, spirit lamps, hand lenses, bio-viewers, biostrips, microscopes, prepared slides & cover slips, chemicals, thermometers		
Reference Books		
Resource people		

3. Please explain why you do not use the resources that you did not mark with an 'X' in the above table.

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4. Please describe one of your best experiences with using a specific resource.

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5. Please describe one of your worst experiences in using a specific resource.

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Thank you very much for your time!!!

Appendix E: Document analysis guide

Date…........................ Time………………………

Participant……........

Evaluation of lesson plan	✓ (Yes/Available) - ✗ (No/Nit Available) - **Write**
Contents Topic Subject Number of learners Grade Duration Date	 …….. ……. ……. …….. …….. ……..
Aims /objectives	
Resources to be used Hardware Software Human other	 …………………………………………………………… …………………………………………………………… …………………………………………………………… …………………………………………………………… …………………………………………………………..… …………………………………………………………… ……………………………………………………………..
Assessment task/technique	……………………………………………………… …………………………………………………….. ……………………………………………………. ……………………………………………………..
Extended learning	……………………………………………………… ………………………………………………………… …………………………………………………………
Is the lesson plan feasible	………………………………………………………… ………………………………………………………… ………………………………………………………… ………………………………………………………… …………………………………………………………….. …………………………………………………………... …………………………………………………………… …………………………………………………………… …………………………………………………………… ……………………………………………………………
Final remarks about all aspects of the lesson plan	………………………………………………… …………………………………………………… …………………………………………………….. …………………………………………….. ……………………………………………………..

Appendix F: Lesson observation schedule

LESSON OBSERVATION TEMPLATE

Name of participant……………………………………………...

Name of school………………………………………………….

Grade……………….………………………………………...

Date…………………………………………………………….

Topic………...

No. of learners……………………………………………...

Lesson Duration…………………………………………….

Description of the lesson venue and classroom organisation:

Resources available in the classroom	***Resources used by educator***	***How the educator used the resource***	***Learners' response***	***Was the use of the resource successful or not?***

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Resources and their use:

Appendix G: Interview schedule for educators

INTERVIEW SCHEDULE FOR LIFE SCIENCES EDUCATORS

Introduction

Firstly, I would like to thank you for accepting to be interviewed. This interview is intended to gain an understanding of your views on Resource-based teaching and how you practice it with your Life Sciences classes. Your views will be invaluable to me. The interview should take about 15 minutes. I will record your responses. You will not be directly quoted in the study and you shall remain anonymous. What you say here shall be treated as confidential.

Interview Questions

1. I had the opportunity to observe some of Life Sciences lessons where you used various resources. What is your understanding of a resource?
2. What is your understanding of RBT?
3. Which resources do you have in the school?
4. Which RBT tools do you predominantly use to teach Life Sciences? Why?
5. Please describe the way you are using the resources you have to teach Life Sciences?
    - Can you describe how you use resources to conduct science practical work.
6. Describe your beliefs about using RBT in teaching and learning.
7. Can you identify challenges in using RBT?
8. Of the resources that you are currently not using, which ones would you like to use and why?
9. What are the benefits of enacting RBT in Life Sciences in terms of:
    a) Instructional strategies used
    b) Learning environment
    c) Collaboration
    d) Lifelong learning
    e) Assessment tasks
    f) Critical thinking
10. To what extent has the enactment of RBT helped in your teaching of Life Sciences?

- In that, has the learner's creativity and critical thinking been challenged?

11. What teaching and learning resources did you use the most to engage in achieving the aims of the topics taught? Why?
12. What teaching and learning resources did you use the least to engage in achieving the aims of the topics taught? Why?
13. Which Life Sciences topics do you find the use of RBT most tightfitting or appropriate?
14. What challenges/barriers you experience, if any, when enacting RBT in Life Sciences?
15. How do you deal with these challenges?
16. Do you have anything else that you would like to say with to the use of resources in the teaching of Life Sciences?

Thank you very much for participating in this interview.

Appendix H: Interview transcripts

Transcriptions for Interviews

(Denise)

Sindile : Morning ma'am.

Denise : Morning Sir.

Sindile : Morning. Firstly, I would like to thank you for accepting to be interviewed. This interview is intended to gain an understanding of your views on Resource-based teaching and how you practice it in your Life Sciences classes.

Denise : Okay.

Sindile : You – your views will be invaluable to me, and of cause the interview should take about fifteen minutes to complete

Denise : Oh

Sindile : So, I will record your responses as I am doing now.

Denise : Okay

Sindile : And of cause you will not be directly quoted in the study and you shall remain anonymous

Denise : Yes

Sindile : And of cause what you are saying here shall be treated as confidential as possible.

Denise : Umm.

Sindile : So, the first question is – I had the opportunity to observe some of your Life Sciences lessons where you used various resources. What is your understanding of a resource?

Denise : A resource is a tool Sir that is used when you teach.

Sindile : Thank you. Eh, what is your understanding of resource-based teaching?

Denise : Resource-based teaching is a teaching strategy to teach by using the resources.

Sindile : Thank you very much. Eh, which resources do you have in the school?

Denise : In – in our school we have we have resources like textbooks, like chalkboard, like charts and also models.

Sindile : Thanks. Which Resource-based teaching tools do you predominantly use to teach Life Sciences?

Denise : I mostly use textbooks and chalkboard and also the charts.

Sindile : And why?

Denise : Is because they are not time consuming – the textbook is not time consuming and also the chalkboard I use it when I summarize with my lessons.

Sindile : Oh, thank you. Please describe the way you are using the resources you have to teach Life Sciences.

Denise : The way I'm using?

Sindile : The way you use these resources that you have to teach Life Sciences.

Denise : I use these resources to teach Life Sciences by engaging the children to make models in my classroom.

Sindile : Okay.

Denise : and in my topics.

Sindile : Thanks. Can you describe how you use resources to conduct science practical work?

Denise : Yes, I use it because it causes my lesson to be clearer and also the learning and teaching is more conducive when I use it.

Sindile : Thank you. Eh describe your beliefs about eh using Resource-based teaching in teaching and learning.

Denise : Okay Sir thank you. I believe that it helps them to be more clearly in my lesson. It helps them to grab the reason of this lesson. To grab everything.

Sindile : Thank you ma'am.

Denise : And be clearer.

Sindile : Thank you ma'am. Can you identify challenges in using Resource-based teaching?

Denise : No, I do not have any challenges.

Sindile : Thank you ma'am. Of the resources that you are currently not using, which one would you like to use and why would you prefer to use them?

Denise : Okay Sir, I want to use laboratory because our Life Sciences is more practical and the children will not forget my lesson easily if I can use the laboratories

Sindile : Thank you ma'am. What are the benefits of enacting Resource-based teaching in Life Sciences in terms of instructional strategies that are used?

Denise : It make teaching easy for me and when I use these resources – the learners grasp well.

Sindile : Thank you ma'am. So, what are the benefits of enacting Resource-based teaching in Life Sciences in terms of enviro eh learning environment as well?

Denise : The learning is very conducive and also the learners are so excited.

Sindile : Thank you ma'am. How about collaboration?

Denise : The learners develop that that thing of working together – they develop that.

Sindile : Okay. And then of cause in terms of life learning?

Denise : In terms of life learning, it motivates them to learn on their own beyond the classroom.

Sindile: Okay thank you, and also what are the benefits of enacting Resource-based teaching in terms of assessment tasks?

Denise : In assessment it is very easy for me and also I – I'm assessing them very easy and I can't prepare too much.

Sindile : Okay, and then what are the benefits in terms of critical thinking?

Denise : It enhances their critical thinking – the learners critical thinking and also, they become more creative.

Sindile : Thank you. So, to what extent has the environment sorry! sorry! To what extent has the enactment of Resource-based teaching helped in your teaching of Life Sciences?

Denise : Okay. In my teaching of Life Sciences, these resources make my lesson to be easier and to clear to the learners.

Sindile : In that, has the learner's creativity and critical thinking been challenged?

Denise : Yes, it challenged them.

Sindile : Thank you. Eh what teaching and learning resources did eh did you use the most to engage in achieving the aims of the topics taught and why?

Denise : Mostly I used the chalkboard and also use the textbooks because it is not time-consuming.

Sindile : Okay thank you. What teaching and learning resources did you use the least to engage in achieving the aims of topics taught and why?

Denise : Eh I used laboratory equipment because our Life Sciences is more practical

Sindile : Thank you ma'am. Which Life Sciences topic do you find the use of Resource-based teaching appropriate?

Denise : Is the cell division and also a reproduction in grade 12 learners and the cell division in grade ten and twelve.

Sindile : Thank you ma'am. Eh What challenges or barriers you experience, if you have any, eh when enacting Resource-based teaching in eh Life Sciences?

Denise : Other resources are time-consuming e.g. when you use a power point its time-consuming and that connectivity of computers is very difficult to me.

Sindile : Thank you ma'am. How do you deal with these challenges?

Denise : I just go back to my easier resources like my textbooks and my charts and my models.

Sindile : Thank you ma'am. Do you have anything else you would like to say to the use of Resource-based teaching in teaching of Life Sciences?

Denise : Yes.

Sindile : Alright.

Denise : Resources like laboratories are so important because Life Sciences you know well it is a practical subject so I can ask if I have a chance I can ask government to build laboratories in all schools and also train teachers to use those laboratories just because we are not trained to use them.

Sindile : Thank you very much for your time ma'am I appreciate it.

<u>(Michael)</u>

Sindile : (clearing throat) Eh Thank you very much Sir for accepting to be interviewed. Firstly, I would like to thank you for accepting this interview and this interview is intended to gain an understanding of your views on Resource-based teaching and how you practice it with your Life Sciences classes. Your views will be eh very important to me and of cause the interview should take about fifteen minutes to complete so I will record your responses and of cause you will be dire – you will not be directly quoted in the study and you shall remain anonymous. What you say here shall be treated confidential as possible. Alright, can we start?

Michael : Yes, we can start.

Sindile : Alright, I had the opportunity to observe some of your Life Sciences classes eh where you used various resources. What is your understanding of a resource?

Michael : Ok. (Clearing throat) a resource is a material that one uses in in in an aim to assist learners in better understanding with visual as in a sort of a visual aid.

Sindile : Alright. Thank you. What is your understanding of Resource-based teaching?

Michael : Okay. Resource-based teaching is a learning eh which is based on eh using resources as much as possible.

Sindile : Thank you. Eh which resources do you have in the school?

Michale : (Clearing throat) Eh for now since I'm new at school, I'm not sure of the exact resources but there are models, but eh with my teaching for now, the models which I've seen eh are not eh going with the topics I'm dealing with now. So, I haven't used any sort of resources except of charts.

Sindile : Thank you thank you. Eh which Resource-based teaching tool do you predominantly use to teach Life Sciences and why do you use that tool?

Michale : Okay for now I'm using textbook and also internet to supplement eh the information because the textbooks can eh summarise the information so I go extensive into trying to give learners a better information.

Sindile : Thank you Sir. Pleas describe – please describe the way you are using the resources you have to teach Life Sciences.

Michael : Can you come again?

Sindile : can you please describe how you use these resources that you have to teach Life Sciences?

Michael : Okay. (Clearing throat) Eh I summarise the textbook and also add this eh internet information and come up with one vivid information and also try to use diagrams eh to better understand the learners. I can say.

Sindile : Thank you Sir. Can you describe how you use resources to conduct science practical work?

Michael : Eh for now since our school has got a problem with eh our laboratory so eh during science eh activities, there are lot of hustles so you we ah for myself I use eh what you call eh the indigenous knowledge eh rather than for example if ever you do not have a Benson banner, you can use a stove. I can even if I don't have a container – those lab containers you can use a tin.

Sindile : Thank you very much sir. Describe your beliefs about using Resource-based teaching and learning.

Michael : Eh resource-based eh this resource-teaching it can be of a disadvantage sometimes because eh a learner eh when they at home they do not have this resource but eh while in class using this resource they understand better but when they are going to learn at home without this resource being there available for them so it can be a problem because you use it in class. At home it can be also become a problem.

Sindile : Alright. Thank you, Sir. Eh can you identify challenges in using Resource-based teaching?

Michael : Eh challenges…. Yes, there can be challenges eh for example, if ever you wanted to teach a particular for example the digestive tract you want the learners to see as in a sort of a model but the model is not around to do such to conduct such an eh teaching- Yes

Sindile : Thank you Sir. Of the resources that you are currently not using, which ones would you like to use and why?

Michael : I would like to use for example eh a head-over projector. Eh because it minimizes time for example when writing notes and it's something which is visual to everyone and everyone will concentrate on that eh visual aid rather than using a textbook because. So, i-textbook can be of a supplement to eh like to get eh at least eh another information which was not presented eh there at the by the projector.

Sindile : Okay thank you Sir. What are the benefits of enacting Resource-based teaching in Life Sciences in terms of instructional strategies used?

Michael : Um ok, instructional ok but uh- instructional-wise I can say for example eh management of the class- class management it can be of good use because eh when using a projector for example, everyone would be curious on that thing which is there at the board because eh if you check people's mind they like eh viewing things visually rather than being told without seeing- so they can be maximum in terms of instructional.

Sindile : Okay thanks. So, what are the benefits of using Resource-based teaching in Life Sciences in terms of learning environment?

Michael : Can you try to ….

Sindile : To break down?

Michael : Yes, to break down.

Sindile : Alright yes so eh in terms of learning environment, right? How does Resource-based teaching eh make the the environment of learning to be? In terms of the eh benefits?

Michael : The benefits of learning?

Sindile : Yes. In the learning environment maybe in the classroom or...

Michael : So how does this Resource-based teaching? ok – eh this Resource-based teaching it can be of a disadvantage in terms of learning environment eh (Pause) in such a way that for example, if ever I wanted to use a projector the electricity maybe is not around or the classroom does not have the electricity so it can be of a challenge. If ever I was prepared to using the projector for that particular lesson.

Sindile : Okay. So, can you also identify the benefits of using Resource-based teaching eh in Life Sciences in terms of collaboration.?

Michael : In terms of collaboration Yes it can be of good use. Eh you can divide learners eh you give them eh let's say the other group is going to do using such a model and the other group is going to do another model so by grouping them it can create eh - a good impression into collaboration so one can learn to eh to do group work I can say.

Sindile : Thank you. And of cause eh what are what are the benefits of using eh resource-based teaching in terms of eh life-long learning?

Michael : Yes, in life eh long learning eh it can be of good use even in the working environment. So, they will be exposed to such resources. Eh whilst other people which never eh were never into access eh of this Resource-based teaching. So, they will be advantageous for example, they can be able to present because there will be cases whereby eh groups will have eh turn to use projector and present to the class so the long-life learning it could be of an assistance.

Sindile : Okay can you also identify the benefits of using Resource-based teaching in terms of assessment tasks?

Michael : Okay, it can be – you can teach something eh I will stress with this projector it can stress something eh then you shut down. Then you ask questions so by trying to check whether people are-are concentrating and if ever they are concentrating how much are they concentrating? Do they understand or hear what you are trying to stress? So, it can be good in terms of assessment tasks.

Sindile : Thank you- and also can you identify the benefits of using Resource-based teaching in terms of critical thinking?

Michael : Okay. In terms of critical thinking. Yes, this Resource-based teaching it can also be good eh because you'll be maybe you be using eh different kinds of eh resources so one can… how can I put this thing (pause) so it will help learners to - these resources can help learners to think critically. Meaning that they will use their mind- it will broaden their mindset.

Sindile : Thank you Sir. To what extent has the enactment of Resource-based teaching assisted in your teaching of Life Sciences?

Michael : Okay Yes it makes teaching more conducive because eh other learners do not have textbooks. There is that problem in our schools whereby learners don't have there isn't sufficient textbooks. So, using resources eh makes everyone feels free because one can have a textbook while the others doesn't have so what I'm talking eh when I'm using the textbook, the other learner cannot see maybe a figure or diagram so resources are you see resources besides eh textbooks is eh.

Sindile : Right. With that said, has the learner's creativity and critical thinking been challenged?

Michael : Yes, it has been challenged because when you group them or you say they must make eh chats or can make models so they will make different models using different creativity. So, by engaging or grouping them makes them more creative because everyone will use his or her own creativity but come up with one creative idea.

Sindile : What teaching and learning resources do you use the most to engage in achieving the aims of the topics taught and why?

Michael : I can say eh I use eh let's say notes from the textbook together with the internet and also some charts. Why? Eh I feel its I feel it-it is easy for me to stress information that way.

Sindile : Thank you. What teaching and learning resources do you use the least to engage in achieving the aims of the topics taught and why?

Michael : (pause)

Sindile : Alright, let me repeat the question. What teaching and learning resources do you use the least or those that you don't use the most. Those you use the least to engage in achieving the aims if the topics you teach and why?

Michael : So why don't I use them?

Sindile : No! which ones do u. Which resources do you use the least?

Michael : Okay, while is the comfort not sure most of the resources which I use the least ah is things like DVD's, laboratories, eh I can say because our lab is not in a good standard to practice such things.

Sindile : So, thank you Sir. Which Life Sciences topic do you find the use of resource-based teaching most appropriate?

Michael : Eh with these resources I have at school. Eh I can say the nutritional the topic eh which is based on nutrition whereby eh and also the tissues and also the topics with the tissues Yes, we've got a little bit of models of such eh topics.

Sindile : Thank you Sir. What challenges or barriers eh you experience when enacting Resource-based teaching in Life Sciences?

Michael : The barriers if ever—eh the barriers is that uh in a school uh the resources are scarce. I can say it's a major barrier that I experience.

Sindile : Thank you sir. How do you deal with these challenges?

Michael : I try to research a lot and try to come up with eh information from aside by myself so that at least eh learners can have eh a mind-picture of something. So, in terms of eh I do copies for diagrams and I make posters so that eh learners can have a mind picture of something.

Sindile : Thank you. Do you have anything else you would like to say to the use of Resource-based teaching in teaching Life Sciences.

Michael : Yes, Life Science it's a subject of practical since it is science. So, resources are may essential in Life Sciences but eh since we are busy with public schools so these resources are scarce and we don't have enough access to these resources. Thank you.

Sindile : Thank you very much for participating in this interview. Thank you very much Sir.

Michael : Thank you too Sir.

(Nelson)

Sindile : Morning Sir.

Nelson : Good Morning.

Sindile : Yes firstly, I would like to thank you for accepting to be interviewed. Eh this interview is- this interview is intended to gain an understanding - an understanding of your views on Resource-based teaching and how you practice it with your Life Sciences classes. Your views will be invaluable to me. The interview should take about fifteen minutes. I will record your responses. You will not be directly quoted in the study and you shall remain anonymous. And what you say here shall be treated with confidentiality as possible.

I had the opportunity to observe some of your of your life sciences lessons where you used various resources. What is your understanding of a resource?

Nelson : (clearing throat) resource is a to me- one I can put into two dimensions. One, primarily it can be used for sustenance. Two, it can be used to assist. Sustenance or assist us to meet certain goals in which we can use them to achieve.

Sindile : Alright. Thank you, Sir. What is your understanding of Resource-based teaching?

Nelson : I think Resource-based teaching is eh can be termed let's say eh form of eh learning where you need adequate resource to be provided in order to achieve the stated outcomes for such learning.

Sindile : Oh, thank you Sir. Which resources do you have here at the school?

Nelson : (clearing throat) eh talking on Life Science first eh is a practical subject that require many resources but at the moment I think I can say we only have very few resources such as textbooks, a few models, uh I can't go too far out of that context. I think we also have few eh study guides. I think those are the available resource at the school for the subject at the moment.

Sindile : Thank you Sir. Which Resource-based teaching tools do you predominantly use to teach Life Sciences and why?

Nelson : I use textbooks. I use eh study guides. I use some models. I use uh question papers. Because they are the one at the moment, I can lay my hands on and which are available in our staff room.

Sindile : Thank you Sir. Please describe the way you are using the resources you have to teach Life Sciences.

Nelson : In terms of using my textbooks or the textbooks uh obviously this I can say it's the most it's the one eh the prescribed document for the Life Sciences. So use them to prepare notes and guide the learners when (clearing throat) carrying out the process of teaching so that they follow your lesson as it is and the study I mean the textbooks. The study guides also give an additional resource guiding them on how to use the textbook and what to study. What to focus on. And what to pay particular attention on. Then using the question papers. Question papers give them, highlight them. Try to give them a scope for them to understand how does the textbook- maybe the umm study guides how it can reduce or resource can be assessed in terms of the examination to get a structure of how at the end of the day what they are studying, how they are going to be expecting in terms of example assessment. Thank you.

Sindile : Can you describe how you use resources to conduct science practical work?

Nelson : (clearing throat) uh like science- Life Sciences is a pure science subjects which first of all need a practical laboratory. When talking about conducting science practical at the moment, using text- you can use a textbook to—textbook is a theoretical part of studies of science subjects so you can- the textbook can guide you maybe through a methodological approach for you to get on to conduct an experiment. But at the moment I can say we must conduct practical. So, the resource I have (clearing throat). I only use them to do uh I do uh use them the resource to take my learners to follow the practical- the procedures how do carry out that particular experiment in terms of a practical in case we were in a laboratory set up. But since we don't have a laboratory, I can develop or come up with alternative ways where we can still manage those resource uh those practicals in a class set up using the little material we can pick so we can still have a practical knowledge in case they were in the laboratory. So, I just try to put one on one in order for them to come a glimpse of what is the practicality of the subject I can say.

Sindile : Thank you sir. Describe your beliefs about using Resource-based teaching in teaching and learning.

Nelson : Yes I think my belief is firstly you expose a learner into variety of resources giving the practicality in which they can use this to – let me say the application and the practical application of using the resources and giving them a wider scope to know how to use these resources in case the medium at a later stage in life maybe in other or they are going into the university or other staff. They are not going to be surprised or be embarrassed or kind of become naïve in terms of what they are seeing which they never saw when growing. Now we don't have to use them. So, I think it's another form of developing the learners in other capacitating them in order to follow and also to master the modern technology on how things are moving in our day of today.

Sindile : Can you identify challenges in using Resource-based teaching?

Nelson : Yes, I can say Resource-based teaching particularly there are challengers anywhere. So, one of the challenges we face some of those things we only we may only have from the school that is fully resources and may only have those things at school. Which we have when the learners go to their homes, I don't think they are going to have that opportunity to interact with those resources so therefore they have to limit them in terms of doing or trying to do their work at their own time in their own space or their own free time. So, they are just going to be based at school. So, I think that is one of the greatest challenges that I think we face at resource-based otherwise it's just. I think it's a good approach in well resource. I don't think the selfless challenges. I think it is a good approach for schools to adapt in case.

Sindile : thank you sir. Of the resources that are that you are currently not using, which ones would you like to use and why?

Nelson : Yes I think eh to right now I may say I if I'm asked if you were the government asking me such questions from the department of education to provide I you know I would be very happy (laughs) because I may rely I am a scientist, I studied through when I was doing my own studies in the laboratory. I know what is practical I know what is theory. So, I believe my students my learners are being limited especially when it comes to the practicality or the practical part of life sciences. There is more the theoretical part than the practical so I think I may like a laboratory to be provided or to work or have a laboratory in order to carry out my research and practical investigations in the laboratory. Also need uh maybe an overhead projector, and other overhead projector, the computer or the CDs so that Some of the resource that I can take from the internet I can make it available for my learners they can use them for studies and other explanations so I think this one would need most.

Sindile : what are the benefits of enacting resource-based teaching in terms of instructional strategies used?

Nelson : The… come again. The benefit from?

Sindile : the benefits of enacting or using Resource-based teaching in terms of the instructional strategies that are used?

Nelson : I think benefit is to (silence) if I understand very well (clear throat). The benefit first like eh you may say I think it empowers the learners and also empowers the institution because if for example, let's say a school have or my school or my subject for example, Life Sciences performing poorly, a learner have the right to come and say I did not have adequate resource. I am not provided with an adequate resource in order for me to really get what I was supposed to get if the learner wants to make a case, though as the teacher also come to say no, I was teaching you theoretically. But then I think people have ears to listen so they can listen and say this was the problem for this learner. Other people understand different using different resources and understand best using best using a textbook. Another person understands best using eh something else. Another person may even understand best in another module. So, I think it add value to first the level achievement and outcome that is going to produce at the end of the day because we need quality not quantity so I think the more we have the more quality at the end of the day we going to come out with. So, I think that is what I think in my opinion.

Sindile : Okay thank you very much. Eh what are the benefits of using Resource-based teaching in life sciences in terms of eh the learning environment? The learning environment. How does Resource-based teaching influence the learning environment in terms of benefits?

Nelson : Firstly, in this environment, you can see that this first is a rural environment where most of our learners have not – some of them they have not been out of this place to even the nearest town where they can see other- how things are done. I think I cannot compare a learner from a school and a learner from a model C school let's say [redacted] and all that stuff so I think it's going to be advantageous for them I can say it's going to first- make them know what these thigs are in the physicality to come across them. To interact with them. To have such contact with them. To also know the benefits that they can derive from them. So, as he grow as they growing the people we are empowering to take power and to be COEs and things in future so they need to have that basic knowledge before they even fleece out from this eh this stage. So, I think is very important for life science to inculcate all this eh to inculcate most of those resources and some of our learners we teach. At the end of the day some of them they will become doctors some of them will become other great scientists. Now if they are not coming in contact they don't have, at the end of the day it's good to have another challenger in future for them even if they embrace in those careers that we think we are building them for. So, I think we need it in this life science department in order to at least develop the learner and empower them also as they growing in their career.

Sindile : So, thank you. What are the benefits of using Resource-based teaching in eh life sciences in terms of collaboration?

Nelson : (Clearing throat) I think resource-based teaching. Resource based in Life Sciences in terms of collaboration, I think is going to, make the learner, let me say in terms of teaching , learners can collaborate in other let's say for example you are overhead projecting a particular topic, some learners are fast to understand thereby at the end of the day even if you are out of the class, they can still sit down and put the group in order and try to devolve some learners through better by observing so some of them understand when they observe regarding information - some may not understand very fast, so they can sit down, collaborate that information by trying to dismantle that information within themselves. And trying to even recall some of those pictures that are seen. Some of those images. Those lessons that they were projected. So, I think is going to give them that signage where the book on the learners or this group themselves and come up with a single understanding of what has been taught or what was being explained or what they observed during the teaching time using a particular resource. So, I think it's an advantage for the learners.

Sindile : Thank you sir. What are the benefits of using Resource-based teaching in life sciences in terms of life-long learning?

Nelson : in terms of lifelong learning using resource based uh I think uh in terms of to me (Clearing throat) like I said is going to make teaching easier first. Teaching without resources is a challenge. Because you even as a teacher you need to train to use resources. Like now the practicals I need to do I have not done them

I don’t have particular chemicals that I need. I have been going up and down I can’t have it. So its straining my life and the learners we can we are not progressing we are regressing so uh in a number I think is going to make the teaching environment the better place for even the learners who want to come here and you will see its going to sell then name of the school to other learners from different areas where you are going to say that in future most learners will even be coming from town schools to come and study here because they have all the resources that are really needed to equip them and to build their life - develop them in one way or another.so I think that is what I believe can happen.

Sindile : Thank you. What are the benefits of enacting Resource-based teaching in Life Sciences in terms of assessment tasks?

Nelson : Like I said if we have adequate resources- life science eh developing tasks will be easier like I said from my previous explanation because Life Science is a practical subject and practical is part of the assessment of the subject. Now If we don’t have resource like I said we are lugging back for those tasks- practical tasks right now because of lack of resources that we don’t have to carry out these practicals. I got practicals but I cannot carry out those tasks and they are going to be assessed on those tasks so bear for if those resources are do not the dear for me there’s a huge challenge eh in terms of carrying out the adequate tasks that are required in life science so it’s going to have a problem with those tasks so we can only be small on theoretical tasks than the practical so the both are not going much each other so there will always be that problem. So, I think with adequate resources is going to create an atmosphere where the all the tasks that are supposed to be carried out are going to be performed adequately.

Sindile : What are the benefits of enacting resource-based teaching in life sciences in term of critical thinking now?

Nelson : Yes (clear throat) I think it also help is going to have when we have adequate resources , life sciences I think is going to also be in the mind of the learners when they are interacting with certain let’s say eh certain eh resources is going to give them a scientific Knowledge. mind where these learners also be thinking scientifically and also be having to think that they can also become resourceful in future and they can also be resourceful in that subject at this particular time.

Now, for example if we only doing the theoretical without putting all necessary resources together in order to bring the full content or context of life sciences in both the practical and theory, most of our learners will not have that mind to think very deep. But if you put everything in order where these learners …as well as practical because of the little resource, I think its gong to develop them scientifically where they are going to think more scientific and trying to have this critical thinking where they can also know that you know at times like in my days when I was a student or learner I always – the fact that I was doing science I always feel that I am the scientist. There are things I can develop on my own even if – you know. So, I think that was a critical way of thinking. So, I think if these learners if they are put in that setting, they can also have that type of understanding. So that's what I think about the… (Clearing throat)

Sindile : Thank you sir. To what extent has the enactment of Resource-based teaching helped in your teaching of Life Sciences?

Nelson : I can say at the moment, putting having the few resources that remain I can say it has really made life teaching life sciences a difficult situation to me as a teacher. Because at times I'm not happy with the performance of my stud my learners because I partly I can feel that lack of resource to me I can say may be a situation affecting some of the performance in life sciences so I think it creates an impact as a teacher because not having or it makes me strain so it's giving me stress on that area. I can say.

Sindile : Thank you. With that said, has the learner's creativity and critical thinking been challenged?

Nelson : Very challenged. Very year because now they don't even know that life sciences is practical or is a life science is a scarce subject which is purely practical. They don't know what they think is an ordinary subject like English or Xhosa or any other subject.

Sindile : Thank you. What teaching and learning resources did you use the most to engage in achieving the aims of the topics taught and why?

Nelson : I use the… like I said I used mostly the textbooks, the study guides, and question. Like I said the textbook is the prescribed I can say it's like the bible of the subject at the moment where whatever we say we must – they must refer to that textbook so at least with that, then we're achieving the learning outcome to that. And the study guide also guides the learners how to move around the textbook. What is mostly important. What is to be stressed if you are adequate importance. And the question papers and some material downloaded from the internet help the learner to also understand how maybe an assessment can be done. What they should be thinking of a question can be asked during assessment and all that stuff so this is how I implement them (Clear Throat).

Sindile : Thank you. What teaching and learning resources did you use the least to engage in achieving the aims of the topics taught and why?

Nelson : I use less PowerPoint presentation because uh like I said challenges of eh having an overhead projector is not around at times maybe our classrooms are being designed or build in a way where times in a socket to put the charger, I men eh the charger system or the plug system for the overhead projector, the laptop are not available. And even the school have not even empowered their teachers with setting of this resources which were necessary for teaching and learning to see as resources to make teaching and learning easier so those are the challenges and that is the reason why (Clear Throat).

Sindile : Which life sciences topic do you find the use of resource-based teaching most appropriate.

Nelson : I think I like mostly I prefer using mostly evolution you know- teaching evolution require lot of comparative slides where we need to compare some of the slides the slides then we mean the modern world trying to analyse those slides uh I think eh its mostly required when doing I am doing evolution.

Sindile : Thank you. What challenges or barriers you experience when enacting resource-based teaching in life sciences?

Nelson : I can say financial challenge. One of the problems and like I'm not I cannot overshadow the finance ah -whosoever control finance. Mine is to state I need AB and C maybe to the management team, maybe to the principal or whosoever is my boss or my HOD. I come and sit down, they listen that they cannot act so I can only get them when they act on so if they don't act on becomes a challenge to me which it is already the case they will come with one or two reason which I also understand I'm also on the system I understand that finance is a problem and other stuff so I think finance Is one of those challenges we facing.

Sindile : Thank you. How do you deal with these challenges?

Nelson : There are certain things that are above my control – I can't, when they say there is no finance, there is no way I can go and source finance where I cannot get so I just seat and also watch how the thing is money while money struggle to lay hands in my own way what I can have to say come vent that issue of my challenge that's how I go about it.

Sindile : do you have anything else that you would like to say with regards to using Resource-based teaching in teaching life sciences as a subject.

Nelson : I think I have not much to say but then I thinks it's a practice where if it is being implemented at school level where adequate resource - relevant and necessary resources are available at schools for teaching life sciences I think uh the life science or the subject life sciences I think is going to become a good career for the students. So, I think I may just say as you are doing research, I think you should be recommending and one of your recommendation should be that schools should try and the department of education should endeavour the seed to schools with adequate resources that are needed. They should be on the look a particular resource or department that is not necessary or it has been done like this in the old, it should be done even today. So, some of those change needs to be affected. I think that's all I have to say.

Sindile : Thank you very much Sir for participating in this interview. I appreciate it

Nelson : thank you thank you

<u>(Zane)</u>

Sindile : Good afternoon sir

Zane : Yes, it is a very good afternoon and, how are you?

Sindile : I'm fine thank you Sir. Firstly, I would like to take this opportunity and thank you very much for accepting to be interviewed. This interview is intended to gain an understanding of your views on Resource-based teaching and how you practice it with your Life Sciences classes. Your views will be valuable to me. The interview should take about fifteen minutes. I will record your responses. You will not be directly quoted in the study and you shall remain anonymous. What you say shall be shall be treated as confidential as possible. Once again, thank you very much Sir for accepting to be interviewed.

Zane : Okay thank you.

Sindile : I have had the opportunity to observe some of your lessons in Life Sciences where you used various resources. What is your understanding of a resource?

Zane : Oh, everything that you need for quality teaching and learning is a – a resource.

Sindile : What is your understanding of Resource-based teaching?

Zane : Well Resource-based teaching means searching for every resource that you think can make your lesson effective and interesting to learners like the use of chats and videos.

Sindile : Which resources do you have here in the school?

Zane : Resources starts with the policy documents like we do have the policy document CAPS. We have work schedules or subject guidelines. We use textbooks. We use chalkboards, and chalks as well as dusters. We also use computers and projectors, videos, as well as charts.

Sindile : Which Resource-based teaching tools do you predominantly use to teach Life Sciences and why?

Zane : The most resource that is eh commonly used is the textbook. I also use the textbook most the times because it is actually the resource that has everything that I have to teach.

Sindile : Please describe the way you are using the resources you have to teach Life Sciences

Zane : Okay I take the work schedule which tells me what to teach and then take the textbook and prepare my lessons according to the work schedule. After finishing the lesson planning, I take the previous question papers and choose questions that are covered in my lessons and give them to the learners after my presentations.

Sindile : Can you describe how you use resources to conduct science practical work?

Zane : Okay well since we do not have a functional laboratory, we often find and use videos just for the learners to watch the practicals and observe the results.

Sindile : Describe your beliefs about using Resource-based teaching in teaching and learning.

Zane : Okay I believe that eh if you have all the resources needed, you can teach the learners in many different ways and make the lesson effective to accommodate both slow learners and fast learners.

Sindile : Can you identify challenges in using Resource-based teaching?

Zane : Well you have to check and test if all your resources that you are going to use are working properly before the lesson begins. For instance, you have to check your computers and projectors if you are going to use them. If you have brought an unpopular resource to the le to learners it draws their attention to learn. But if all of a sudden it stops working, they lose focus and draw away their attention from the lesson.

Sindile : Of the resources that you are currently not using. Which ones would you like to use and why would you liked to use them?

Zane : Well I think the visit of I-fossil sites and museums uh are the two resources that I believe can help me because its where the learners can see clearly that what you are teaching is alive and most learners relate better to the things that they saw with their naked eyes than what we are just explaining.

Sindile : What are the benefits of resource of enacting resource-based teaching in Life Sciences in terms of instructional strategies that are used?

Zane : Okay it’s easy to teach using resources because you can’t just demonstrate – you can just demonstrate a scientific phenomenon using through I mean using through the use of resource

Sindile : What are the benefits of enacting Resource-based teaching in Life Sciences in terms of the learning environment?

Zane : It makes eh it makes learners ready to learn and cooperate. Thus the learning environment becomes conducive to learn.

Sindile : What are the benefits of enacting Resource-based teaching in Life Sciences in terms of collaboration?

Zane : Okay uh learners get a chance to work together for an example you can assign a number of learners to one chat to identify structures for instance.

Sindile : What are the benefits of enacting Resource-based teaching in life sciences in terms of life-long learning?

Zane : It enables learners to be independent thinkers and researchers.

Sindile : Also, what are the benefits of enacting Resource-based teaching in Life Sciences in terms of assessment tasks?

Zane : It's easy to assess learners if you have used various resources because it guarantees that you have taught in many different ways that accommodate all the learners with different IQ levels.

Sindile : Okay. What are the benefits of enacting Resource-based teaching in terms of critical thinking?

Zane : Eh come again with your question?

Sindile : Eh what are the benefits of enacting Resource-based teaching in Life Sciences in terms of critical thinking?

Zane : Okay uh by engaging with the resources, learners start to have questions and concerns about the phenomena under study. That therefore sharpens their critical thinking.

Sindile : To what extent has the enactment of Resource-based teaching helped in your teaching of Life Sciences?

Zane : Okay well when assessing learners, I can see that most learners has grasped what I have taught. After using different resources.

Sindile : In that, has the learner's creativity and critical thinking been challenged?

Zane : Yes. It is.

Sindile : What teaching and learning resources did you use eh the most to engage in achieving the aims of the topics taught and why?

Zane : It's the textbook because it has everything that I have to teach.

Sindile : What teaching and learning resources did you use the least to engage in achieving the aims of the topics taught and why?

Zane : Okay. Its videos. Because I used them at the end of a chapter just to summarize the chapter.

Sindile : Which Life Sciences topics did you - do you find the use of Resource-based teaching most appropriate?

Zane : (laughs) its human reproduction because for instance, we cannot see a woman or force someone to give birth just uh just to see how it happens. We need more resources like chats and videos to show such things.

Sindile : What challenges or barriers do you experience if any when enacting Resource-based teaching in Life Sciences?

Zane : Okay no sometimes the learners get overexcited and lose focus if they are very unpopular to a particular resource.

Sindile : How do you deal with these challenges?

Zane : Umm (pause) I clearly give instructions and tell the learners what to focus on for the lesson before the lesson starts.

Sindile : Do you have anything to say with regards the use of Resource-based teaching in life sciences in general?

Zane : Jha what is very important is that life Sciences deals with many complicated structures of which are very difficult and time-consuming to draw. So, it is very important to have different resources to make sure that every learner understands

Sindile : That brings us to the end of our interview session. Thank you very much once again Sir your participation is appreciated by me. Thank you very much

Zane : Thank you

Sindile : Okay thanks Sir.

<u>(Nikita)</u>

Sindile : Good morning ma'am.

Nikita : Morning sir.

Sindile : How are you?

Nikita : I'm fine Sir thanks. How are you?

Sindile : I'm fine. Eh firstly, I would like to take this opportunity and say thank you very much for accepting to be interviewed today. This interview is actually intended to gain an understanding of your views on Resource-based teaching and how you actually practice it with your Life Sciences classes. So, your views would be invaluable to me. And of cause the interview should take about fifteen minutes to complete. I will therefore record your responses. You will not be directly quoted in the study and you shall remain anonymous. What you say here shall be treated as confidential. Once again, thank you very much ma'am for accepting this interview.

Nikita : Okay Sir.

Sindile : Alright. I had eh the opportunity to go to your life sciences classes and observe you while you were teaching using various resources. What is your understanding of a resource?

Nikita : Uh according to my understanding Sir, a resource is any material or tool that is used to implement the learning and the teaching.

Sindile : What is your understanding of Resource-based teaching?

Nikita : Resource-based teaching is any material or tool that can be used now in order to facilitate and to enhance only the learning.

Sindile : Which resources do you have in the school?

Nikita : In our school we have textbooks, chalkboards, chats, and one overhead projector.

Sindile : Which Resource-based teaching tools do you predominantly use to teach Life Sciences and why?

Nikita : I usually or I almost I always use uh textbooks, chalkboards because they are the only resources that are mostly available in our school

Sindile : Can you please describe the way you are using these resources that you have here in the school for to teach life sciences?

Nikita : As I said that I use textbooks, I use uh learner's textbooks in order to refer them for certain activities that are there in their books. I also use teacher's book for my preparation.

Sindile : Please describe how you use resources to conduct science practical work.

Nikita : When we are doing practical for example a practical of photosynthesis, I used to improvise by using umm bicarbonate instead of using the baking powder. I mean I usually use the baking powder instead of using bicarbonate in photosynthesis in order to improvise because we do not have enough resources at our school.

Sindile : Describe your beliefs about using Resource-based teaching in teaching and learning.

Nikita : First of all, the Resource-based teaching umm they accommodate different learning styles. For example, if I use the overhead projectors and the videos, some of the learners who are good in visual learning they learn the best.

Sindile : Can you identify challenges in using Resource-based teaching?

Nikita : Oh, when I'm using chalkboard, some of the learners do not write notes so I have a challenge on that because I have to monitor, I have to make sure that all the learners are writing notes. And when I'm using videos, some of the learners get too excited and they make lot of noise.

Sindile : Of the resources that you are currently not using, which ones would you actually like to use and why?

Nikita : I would like to use uh botanic gardens so that learners can see everything that we are talking about in class especially when we are doing or we are talking about the plants they do not know the greenhouse. They don't know the bryophytes and pteridophyte plants. So, if we can go to botanic gardens, they can get opportunity to see all these things that we are talking about in class.

Sindile : What are the benefits of enacting Resource-based teaching in Life Sciences in terms of instructional strategies that are used?

Nikita : In terms of instructional strategies it simplifies the teaching and the learning. Learners learn to learn on their own. They do not um need uh teacher. They learn on their own. So, it simplifies the teaching and the learning.

Sindile : What are the benefits of eh implementing Resource-based teaching in Life Sciences in terms of eh the learning environment?

Nikita : Uh it creates a positive atmosphere as all learners are being engaged in a lesson and learners get excited and motivated to learn.

Sindile : What are the benefits of enacting Resource-based teaching in Life Sciences in terms eh collaboration?

Nikita : Learners like working in pairs and in groups which improve participation and sharing of ideas.

Sindile : What are the benefits of enacting Resource-based teaching in Life Sciences in terms of eh life-long learning?

Nikita : Uh in terms of life-long learning, it increases curiosity among the learners. It motivates them to study further and to do research.

Sindile : What are the benefits of enacting Resource-based teaching in terms of the assessment tasks?

Nikita : Umm I think it create competition as learners they know what is required and they know better so it creates the competition among them. Everyone wants to succeed.

Sindile : What are the benefits of enacting Resource-based teaching in Life Sciences eh in terms of critical thinking?

Nikita : Learners understand better and eh it makes the lessons to be easy for them and its easy for the learners to follow in a lesson.

Sindile : To what extent has the enactment of Resource-based teaching helped eh in your teaching of Life Sciences?

Nikita : Uh for example we have chats, overhead projectors. They show all the processes. For example, the process of the photosynthesis. In our school, we do not have money to buy those practical apparatus so it helps with the teacher and the learners to learn better as they watch those videos on the overhead projectors.

Sindile : In all of that, has the learners' creativity and critical thinking been challenged?

Nikita : yes! Yes.

Sindile : What teaching and learning resources did you use the most to engage in achieving the aims of the topics taught and why?

Nikita : Can I can you repeat the question Sir?

Sindile : Alright. Eh I just what to know eh the teaching and learning resources that you used the most when you were teaching Life Sciences as I have been observing you to engage eh learners in terms of eh achieving the aims of the topics that you have taught and why did you use those teaching resources?

Nikita : Oh ok. I used textbooks and the chalkboard. I used textbooks because they are the only resources that are mostly available in school. Every learner has the learner's book. And I also used uh the chalkboard in order to explain further and in order to draw and simplify things that are on the textbook. So, I used both textbook and the chalkboard.

Sindile : What teaching and learning resources eh did you use the least to engage in achieving the aims of the topics taught and why?

Nikita : The internet. Not all the learners in our school have the cell phones. And besides that, they are not allowed to bring the cell phones in the school. We also do not have computers. So, I don't use internet. I just use it. When I'm using it I use it for my own?

Sindile : Which life sciences topic do you think eh eh which life sciences topic do you find the use of Resource-based teaching most appropriate?

Nikita : Its photosynthesis topic. Because umm when we are using those Resource-based teaching, it's easy for us when we are doing practical to be accurate. And our practical is being reliable and valid when we are using eh for example videos. So, it's better when we are using videos than when we are doing practical on our own because sometimes the apparatus that we ar using are not reliable and the results might not be valid. But when we are using the videos from the internet, they are always valid and reliable.

Sindile : What challenges or barriers do you experience if you have any when you are enacting Resource-based teaching in Life Sciences?

Nikita : Learners get too excited especially when they are watching videos. This led to chaos is class.

Sindile : How do you deal with these challenges?

Nikita : Umm I ask uh for assistance from other teachers to monitor the learners because it's hard when I'm alone. So, I ask the assistance from other teachers to help me in monitoring the chaos.

Sindile : Um. Do you have anything to say in regards with the use of Resource-based teaching in life sciences in general?

Nikita : No. I do not have.

Sindile : Okay. Eh thank you very much ma'am for participating in this eh interview. Your participation is appreciated. Thank you.

Nikita : Thank you very much sir.

(Patrick)

Sindile : Good morning Sir

Patrick : Morning

Sindile : How are you?

Patrick : I'm good thanks and you?

Sindie : I'm fine thank you very much. Eh, firstly I would like to take this opportunity and say thank you very much for accepting to be interviewed today. This interview is actually intended to gain an understanding of your views on Resource-based teaching and how you practice it with your Life Sciences classes. Your views will be invaluable to me. The interview should take about fifteen minutes to complete. I will record your responses. You will not be directly quoted in the study and you shall remain anonymous. What you say here shall be treated as confidential as possible.

I had the opportunity to observe some of your Life Sciences lessons where you used a variety of resources. What is your understanding of a resource?

Patrick : Eh a resource is anything that you use eh to enhance something or to achieve a goal. For instance, if you are talking about a resource in eh in terms of school eh environment, you are talking about the chalk, you are talking about the textbook, you are talking about the study guide, you are talking about the computers. That is my understanding of a resource and many other things.

Sindile : What is your understanding of Resource-based teaching?

Patrick : Eh a Resource-based teaching um is a learning whereby a teacher uses uh projectors, uses eh computers, uses uh textbook, study guides, question papers and many other things to enhance learning.

Sindile : Which resources do you have in the school?

Patrick : Okay here at school eh we're having eh the the normal resources eh such as um textbooks, study guides, question papers eh to help learners. And we've got the data projector and only two computers that are used by teachers when they are teaching.

Sindile : which Resource-based teaching tools do you predominantly use to teach Life Sciences and why?

Patrick : Okay uhm as for me I use um data projector as well as the textbook so that learners may understand what I'm saying and also refer it to their textbook. I also use computer with data projector to make learners you see I have seen that learners are more interested when they see something than when it's sad by the teacher. So, I also use that data projector to show them some videos you see.

Sindile : Please describe the way you are using the resources that you have to teach Life Sciences.

Patrick : Okay hence I've said that I'm using data projector my lessons I take the topic and then go to YouTube on my computer eh and then google that topic. And then find some videos that are relevant to that topic. And then I will show them to the learner's um so that they may understand you see but I teach before. And then to summarise it I then give them the video to watch. They will be watching in the lab. That's all

Sindile : Can you describe how you use resources to conduct science practical work?

Patrick : Okay umm (Clearing Throat) on how I conduct the practical work – eh there we uh we do not have eh so many resources but we do demonstrate for instance in the neighbouring school they are having the microscope. So, what I do is I select few learners to watch because we do borrow that microscope so eh not all of them can eh be able to see. Then I select few learners each week I take other ones in another week and then take others in another week so that they may complete the practical maybe on a cell more special the cell.

Sindile : Describe your beliefs about using Resource-based teaching in teaching and learning.

Patrick : Yes on my experience in the field I have a belief that when you are uh the these resources in your learning, it is likely that your learners will like the subject more and more than when you are talking to them giving them a general staff you see. They like seeing something than eh being told by the textbook and by the teacher.

Sindile : Can you identify challenges in using Resource-based teaching?

Patrick : Yes the challenges that I and other teachers are currently experiencing are that we do not have too much knowledge on these resources such as computer, For instance I learnt this from another young teacher who just arrived here at school eh so I learnt this from him so we have that challenge because we've been here and we were not taught these things at the university.

Sindile : of the resources you are currently not using, which ones would you like to use and why?

Patrick : Eh the resources that not using oh alright I would like to use eh much of uhm more of the microscope simply because um the microscope makes things better eh. To study a cell eh through the textbook it's not like studying a cell through a microscope because learners are interested to see things in see things than in hearing and seeing on the textbook. So, I think it can be best for Life Sciences it can be best. And also, the tools for testing heart beats and whatsoever I would like to use them in another time.

Sindile : What are the benefits of enacting Resource-based teaching in Life Sciences in terms of the instructional strategies that are used?

Patrick : Okay umm the instructional strategy becomes more um advantageous to the side of the teacher. For instance, if I am giving them a video, then they are able then to discuss after that. To tell me what they have eh seen and uh how the process happens, and uh also they even uh present after that what they have seen.

Sindile : What are the benefits of enacting Resource-based teaching in terms of the learning environment?

Patrick : Okay the learning environment becomes uh positive. And learners are actively involved in the discussion of what they have actually seen. It's like they have just experienced that so that is why it becomes positive.

Sindile : What are the benefits of enacting Resource-based teaching in Life Sciences in terms of collaboration?

Patrick : Okay Uh in terms of collaboration uh we can talk more uh on collaboration but then uh one thing that I can say in terms of collaboration is that uh the learning becomes more collaborative. Like when these uh Resource-based teaching are introduced at school so it's more collaborative. And the learners can work together more successfully than ever when these are used.

Sindile : Can you give me an example perhaps of a learning whereby it is collaborative?

Patrick : Okay. For instance, you group the learners into groups and then after the video and then they discuss what they have seen and what are the advantages of what they have seen. And what is the difference between one topic and another topic you see in terms of gaining the knowledge. And then uh they discuss there you know being interested and whatsoever.

Sindile : What are the benefits of enacting Resource-based teaching in Life Sciences in terms of lifelong learning?

Patrick : Okay the learners for instance in terms of eh being the teacher, I as a teacher I learn from those YouTube videos first you see. And then the learners as well when they are exposed to those videos for instance, I usually take them out of the class into the lab where they will be watching the videos during the extra time. They will watch those videos and then they gain more information because they are not bored when these resources are used therefore, they learn more and more the topics that I've taught in class.

Sindile : What are the benefits of enacting Resource-based teaching in Life Sciences in terms of the assessment tasks?

Patrick : Okay um using the computer – for instance I use the computer to type the question papers. I also use the question papers the computer to show them the previous question papers that are not downloaded. For instance, we do not have eh many printers in this school therefore we depend on this uh on this computer the few computers that we have. Therefore, I can use these ones to assess them in class. for instance, to project the questions on the projector so that they write.

Sindile : What are the benefits of enacting Resource-based teaching in Life Sciences in terms of critical thinking?

Patrick : Okay uh the critical thinking is provoked during the classes that I usually conduct. For instance, I will show them a cell sometimes and then in the cell there would be other organelles that won't be there, then I would ask them what cell is this? Then they will tell me it's a plant cell because of this and that and that you see. Yes, that is an example.

Sindile : to what extent has the enactment of Resource-based teaching helped in your teaching of Life Sciences?

Patrick : Umm it has helped me because I've seen that (bleeping sound) in the production of eh the results. The learners are getting more results when it comes to when it comes to the eh the examination time, they get more results.

Sindile : So, in all of that, has the learner's creativity and critical thinking been challenged?

Patrick : Jha it has been challenged because I do also some debates using the computer and I will put the topic there and then they debate the topic or else the pictures. They debate the pictures based on Life Sciences you see. I show them the pictures and then they critically uh discuss about the pictures there Yes. For instance, in the stage of meiosis and mitosis you see, they will tell me this is an interphase this is eh anaphase that is eh something.

Sindile : What teaching and learning resources did you use the most to engage learners in achieving the aims of the topics that you taught and why?

Patrick : Jha I use the pictures. Because if I use the pictures then I am able to give learners that opportunity to discuss you see, then in that discussion they now uh provoke I now provoke their critical thinking you see. Hence, I have said that I used the topics such as meiosis and mitosis for them to discuss each stage each phase you see. Then if they are saying its anaphase then they will discuss okay this is anaphase because of this and that, this in interphase because of that and that.

Sindile : What teaching and learning resources did you use the least to engage your learners in achieving the aims of the topics that you taught and why?

Patrick : Jha eh hence I've said in the beginning the microscope is not there in the school. Then I used it eh less than the others. Because it's not there at school so I borrow it so that I can conduct that particular lesson. But when it is needed tomorrow it won't be there because it's not ours.

Sindile : Which Life Sciences topic eh do you find the use of Resource-based teaching most appropriate?

Patrick : Okay um environmental studies. Most of the topics there they are there on YouTube. Environmental studies, um the digestion, eh the endocrine system is there on YouTube you see. And it appears more and more and more as time goes by because there are many teachers there who are teaching on YouTube. There are many experiments that are done there and even when talking about the chemicals – the chemicals that are used. When you go on YouTube – you find them the mixture of those chemicals and the reactions.

Sindile : What challenges or barriers do you experience if you do, when enacting Resource-based teaching in Life Science?

Patrick : Jha the challenges is that uh there are few computers sometimes I would want to use uh the projector the data projector but then it won't be there. It would be used by another teacher then I would have to wait and cancel the lesson for another for another time because the projector is not there.

Sindile : How do you deal with these challenges?

Patrick : Yes, to deal with these challenges we have talked as science teachers that uh eh we must have a timetable whereby I will be using the projector on this day at this time. He will be using the data projector on this day at that time to make things easy for us.

Sindile : Do you have anything else you would like to add on the use of Resource-based teaching by Life Sciences teachers?

Patrick : Yes, eh on this part I think we have to…. we need to have maybe some workshops on these resource-based eh learnings. Because we do not have eh too much experience on them. So, I think if we can be granted this favour maybe by the government and be provisioned with the extra materials eh that we can use on Life Sciences. And the videos from the department of education. I think this can be good because this Resource-based teaching is very awesome.

Sindile : Thank you very much. That brings us to the last eh leg of the question, thanks very much once again.

Appendix I: Lesson plan samples

Michael's Lesson 1 plan

Topic : Kidney (Nephron) Date : 19/05/17
Class : Grade 10 Duration : 1HR
Subject : Life Sciences
Material / teaching Aids : Poster of the kidney, textbook, note book.

Lesson Aims/Objective : ① To know the labels of a nephron.
② - To be able to explain the process of filtration, reabsorption and secretion in the nephron
③ - To understand how a nephron regulates water reabsorption

Lesson presentation / progression : Introduce the lesson by asking learners / recapping on yesterday's work. Talk about the cortex and explain its function in urine formation. Use the kidney to explain parts of the cortex, especially nephron. Show learners the poster of the nephron and the photographs and drawings in the textbook. Can also use my computer to play video on functioning of the nephron showing all processes taking place. Ask questions to check if children are on track. Use quizzes and question & answer method.

Extended learning : Give out assignment 1.

Evaluation : Lesson objective 1 & 2 were met, lesson objective ③ was not met due to time. Next time, I need to start lesson earlier not to delay arranging and silencing children. If early on time.

Appendix J: Field notes

Date visited: 8 May '17

FIELD NOTES TAKEN IN SCHOOL C

Pseudonym of participants: Nelson & Michael.
Location of School: Ntlaka
Surrounding possible teaching & learning resources: WSU, Lunwedu hospital, forest, ngqunyana river

The school has 500 learners and 19 educators.
3 subject streams are available.

① * Science → mathematics, maths L7. → physical sciences → Agriculture & Life Sciences
② * Humanities → IsiXhosa HL & English → History → Life Orientation
3. * Commerce → Economics → Business studies → Accounting.

I spoke to principal & he told me all the info: NB

Grade 12 enrolment: 222 learners
48 (commerce) · 119 (Sciences) · 55 (humanities).

The school is Quintile 1 & has 3 buses are scholar trans. In summer, children dont come to school when rivers are full, they also get sick. A high incidence of drug & substance abuse by learners. Discipline is a problem in learners. They smoke drugs. Teachers are having a staff room because it was vandalized. Science Lab and Computer Lab vandalised and broken — tablets, computers & printers stolen & sold.

Classroom dont have windows & doors due to theft & vandalism. Few classes & many learners. Temporal classes available. Water is a problem. There is one tank. Store room have an ~~[illegible]~~ unused IWB, soccer kit, computer set & printer & netball kit. Teaching resources available here in store room: Microscope, IWB, data projector, Study guides
Taxi rank contributes to ill-disciplined learners
- Overcrowded classrooms is evident
- Educators arrive late to work & depart early
- Teenage pregnancy is prevalent in this school

Appendix K: Professional editing letter

B S
C C

BE STILL COMMUNICATIONS
For effective communication solutions

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Professional EDITORS Guild

CERTIFICATE OF EDITING

This document certifies that a copy of the thesis whose title appears below was edited for proper English language usage, grammar, punctuation, spelling, and overall style by Dr Nhlanhla Landa whose academic qualifications appear in the footer of this document. The research content and the author's intentions were not altered during the editing process.

TITLE: **EXPLORING LIFE SCIENCES EDUCATORS' ENACTMENT OF RESOURCE-BASED TEACHING IN THREE RURAL SECONDARY SCHOOLS IN SOUTH AFRICA-A CASE STUDY**

AUTHORS: SINDILE MAHAMBEHLALA (STUDENT NUMBER 216057822)

Note: The edited work described here may not be identical to that submitted. The author, at their sole discretion, has the prerogative to accept, delete, or change amendments made by the editor before submission.

DATE: 16 **JUNE 2019**

EDITOR'S COMMENT

The author was advised to effect suggested corrections in regards to clarity of terms, structure of literature review chapter, consistency in structure and logic in general, and expression.

Signature

PhD Applied Linguistics (UFH), MA Applied Linguistics (MSU), BA (Honours) English and Communication (MSU)
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