CONTROVERSIAL TOPICS IN THE SCHOOL CURRICULUM: A CASE STUDY ON THE TEACHING OF EVOLUTION IN SOUTH AFRICA

Submitted by

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DECLARATION

I (Gumani Enos Mukatuni) declare:

Controversial topics in the school curriculum: a case study on the teaching of evolution in South Africa

Is my own independent work, that the work contained in this research proposal is my own and all the sources. I have used or quoted have been indicated and acknowledged by means of references. I also declare that I have not previously submitted this research proposal or any part of it to any university in order to obtain a degree.

Gumani Enos Mukatuni

Signature: *GEMukatuni* Date: **15/06/2022**

DEDICATION

Firstly, I would like to dedicate this dissertation to my late father and closest friend, Sampson Ndalammbi Mukatuni and my late aunt Nyamukamadi Maranda, who passed away just when I had completed my Secondary Teachers' Diploma, and who, although no longer on this earth, played an important role during my lifetime when they taught me about life in its entirety, humility, strength, integrity, and compassion.

Secondly, the dissertation is dedicated to my late grandmother, Ms Nyamukamadi Lugisani, who is also no longer with us. The role she played was evident when she realised that I was not keen on hard labour and therefore motivated me to go for the work of the pen through hard work in school. To show that she understood the importance of education, she insisted that i receive a good education. Her reputation as an illiterate and hardworking old lady for her big family at that time, outlived her. She is still remembered for her personal contribution to many people's lives even today.

Thirdly, the thesis is dedicated to the unqualified support of my portable family, my wife Girly Mukatuni and our three children: Fhulufhedzani Collen, Vhuthuhawe Carol, and Zwothe Conrad; they are my joy. To them, I say, "Dear children, real life has always proved to be tough, particularly to those who are lazy. It needs hard work, hard work and more hard work if one is to survive in it, so work very hard and do not rest until you have achieved what you want in life, no matter how and what impatient people say!"

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ABSTRACT

This study sought to explore how Life Science teachers in South Africa deal with challenges of teaching evolution in a country where Christianity remains dominant and is celebrated through public and/or national holidays. The theoretical framework underpinning this study is a cognitive framework of implementation, enabling the exploration of how teachers can construct understandings of the policy message; construct an interpretation of their own practice and how they integrated the policy signals in their practice. A qualitative approach was employed using an in-depth case study design in order to explore how three Life Sciences teachers in South Africa negotiate controversial topics like evolution within the Curriculum and Assessment Policy Statement, and what the challenges and opportunities are for teaching about evolution. Data were collected using semi-structured interviews and classroom observations.

Five major findings emerged from this cross-case analysis. First, it could be observed that two of the teachers did not study evolution when they trained to become teachers, whilst the topic of evolution was part of the third teacher's training programme. The second finding speaks to the influence of teachers' beliefs and perspectives on evolution during the lesson. The third finding shows that teachers demonstrated that they could use both teacher-centred and learner-centred approaches when teaching evolution. However, teacher-centred instructional strategies were dominant. The fourth major finding indicates that the teachers experienced challenges that stood in the way of teaching the topic of evolution effectively, which includes the notion that evolution stands as a competing worldview to the learners' and teachers' beliefs on the origins of the earth and its people. The fifth major finding shows that the teaching and learning of evolution exposed learners to critical thinking. The study recommends that decision makers, policy makers and educational authorities responsible for the education system in Gauteng and similar school contexts provide clear policy guidelines on the teaching and learning of evolution as a controversial topic and, where possible, provide continuous professional development programmes at various educational levels to equip teachers' pedagogical practices.

Key words: evolution, creation, life sciences, natural selection, religious beliefs, opinions

LIST OF ABBREVIATIONS AND ACRONYMS

CAPS	:	Curriculum and Assessment Policy Statement
NES	:	National Education System
BES	:	Bantu Education System
CNE	:	Christian National Education
OBE	:	Outcomes Based Education
RNCS	:	Revised National Curriculum Statement
NCS	:	National Curriculum statement
CAPS	:	Curriculum and Assessment policy statement
DoE	:	Department of Education
FET	:	Further Education and Training
NSC	:	National Senior Certificate
NSTA	;	National Science Teachers' Association
GDE	:	Gauteng Department of Education
OBE	:	Outcomes-Based Education
NOS	:	Nature of Science
BSC	:	Bachelor of Science
STD	:	Secondary Teachers' Diploma
GET:		General Education and Training
ATP	:	Annual Teaching Plan
HDE	:	Higher Diploma in Education
BoE	:	Bachelor of Education
PCK	:	Pedagogical Content Knowledge

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CHAPTER 1: SYNOPSIS OF THE STUDY

This chapter provides an overview, justification, and purpose of the study, with a summary of the theoretical framework and research questions used in the study. The research explores the teaching of controversial topics in the life sciences science curriculum and in particular how teachers teach the topic of evolution. The chapter further introduces the literature and the theoretical background; methodology; and concludes with an outline of the order of the chapters.

1.1 INTRODUCTION

The topic of evolution in the school curriculum is seen as a challenge because it touches on some of the most sensitive issues such as beliefs, religion, and culture (Sutherland & L'Abbé, 2019; Sanders, 2018; Abrie, 2010). The overview of the Curriculum and Assessment Policy Statement (CAPS) in South Africa requires schools to cover all sections of evolution in the Life Sciences curriculum for secondary schools. However, in most cases, teachers may have different beliefs and cultural backgrounds from those of the learners and their parents (Long, 2012). Some parents might view such teachings of evolution as misleading, confusing, and blasphemous, and emotions might cloud the learning process during the lesson (Hahn, Brem & Semken, 2005). It is these considerations about the challenges in the teaching of evolution that have propelled me to explore the topic of controversial topics in the context of a didactical stance on evolution in South African schools' Life Sciences curriculum.

A research report by Sanders (2010) shows that there are many international studies on perceptions and challenges of teaching and learning evolution. Some of the international studies were conducted by Bilica (2012), Knippels, Waarlo & Boersma (2005), Neubrand and Harms (2017), Scharmann (2018) and Sutherland (2019). Furthermore, some international studies report that teaching of evolution creates tension among stakeholders due to their religious and social positions and was rejected in some countries (Abrie, 2010; Sanders, 2018). Some studies on evolution have also been conducted in South Africa,

i.e. by Sanders (2008; 2009; 2010; 2018), Abrie (2010), Van der Mark (2012), Yalvac (2012) and Reddy (2012), and Sutherland and L'Abbé (2019). One of the international studies by Knippels *et al.* (2005) has found that Dutch teachers are usually challenged by the terminology in evolution, which is often not used consistently and explicitly in curriculum materials. The complex nature of the concept of evolution requires of teachers to think deeper about molecular, cellular, organism, and population levels of understanding, among other things that may be partly blamed. According to the literature, other factors that contribute to the difficulties in teaching evolution in the Life Sciences curriculum include learners' prior knowledge, which either provides a context for their understanding of the concepts or is a source of confusion in the learning of the topic (Tsui & Treagust, 2007; Scharmann, 2018). Traditional methods of teaching often rely on textbooks; yet textbooks tend to focus more on theory than the conceptual understanding about evolution (Reddy, 2012) and the abstract nature of the concept, with a limited area of focus for examinations, which make other aspects of the topic look useless, yet are important for conceptual understanding (Sanders, 2010).

The teaching of evolution was seen to be a challenge in various countries (Sanders, 2010). A report conducted in America by Bilica (2012) shows that teachers regularly fail to deal with arguments when teaching natural evolution because teachers tend not to allow learners to think and share their understanding about evolution. The study notes that if learners are given time to think effectively around new controversial topics, they will have the knowledge and understand the theory of evolution

Some seminal research by Sutherland (2019) and Menton (1991) on teaching the origin of species in schools indicates that there are differences in religious and professional understanding concerning evolution and creationism in different US open schools. Robins, Rountree & Rountree (2003) argues that teachers' religions make it problematic for them to communicate the teaching of evolution effectively and efficiently. Sutherland's (2019) report shows that public education suggests that study on the origin of life should be excluded from the school science classroom and that evolutionism only ought to be communicated as a logically reasonable concept or hypothesis of roots.

A study by Long (2012) investigated the politics and laws of teaching evolution, school science education benchmarks, and what it implies to be a creationist. The study discovered that there is a challenge to manage the academic stance of evolution and creation in American science classrooms. This is supported by Glaze and Goldston (2019), who discovered that there is a challenge in understanding the language used in evolution and creation in some American science classrooms. As a result, the study concluded that several high school Life Sciences teachers do not teach the section of evolution for learners to understand (Glaze & Goldston, 2019).

Similarly, South Africa introduced subject matter on evolution in secondary schools in 2008, and some teachers were not prepared to teach the content as they were facing evolution content for the first time (De Beer & Henning, 2010). For this reason, the Department of Basic Education (DBE) organised workshops and trainings to prepare all Life Sciences teachers (De Beer & Henning, 2010; Sutherland & L'Abbe, 2019). However, some educators and pupils continue to find evolution problematic to teach and learn respectively (Sanders, 2010). Reddy (2012) adds that this difficulty in teaching evolution exists at both theoretical and linguistic levels, and he blames the lack of satisfactory teacher development by the DBE.

Research by Holtman (2000) and Neubrand and Harms (2017) on the teaching of evolution reveals that some teachers do not usually use the word 'evolution' in their teaching, citing religious issues, even while the syllabus covers theories that are meant to deliver a concrete foundation for learning about evolution. Dempster and Hugo (2006) report that evolution remains a controversial topic in the schools' science curriculum. Holtman (2000) further argues that evolution is the merging source to accept the associations among the living, the history, and reliance of lifespan on the biosphere. The study suggests that scientific literacy, a primary aim of the current Life Sciences curriculum, may not be achieved without an understanding of the topic of biological evolution (Holtman, 2000; Neubrand & Harms 2017).

Hahn *et al*. (2005) explored the influence of societal, ethical, and temporal abilities of teachers' narratives of evolution, while Kyriacou (2013) undertook a study that looked at

teachers' conceptual understanding of evolution. Both studies argue that high school teachers experience discomfort when teaching evolution, in part due to poor teacher knowledge. The study recommends that workshops with longer learning programs for teachers should be conducted to assist them to gain more knowledge and understanding. The report shows that the link between common issues, evolution, and difficulties may assist teachers' conceptualizations of human evolution. Similarly, Van der Mark (2012) looked at the use of concept cartoons to encourage higher thinking skills about geological time. The results provide an exciting way forward for future teacher programs and a strategy for overcoming some of the cognitive and affective barriers hampering the teaching of evolution.

Reports by Yalvac (2011) and Reddy (2012) discuss the teaching of evolution by Muslim and Hindu educators in South African Muslim and Hindu schools. Yalvac (2011)'s study focuses on the challenges of teaching evolution while Reddy studied Hindu teachers teaching evolution in secondary schools. The findings by Yalvac show that the pedagogy of evolution demands a theoretical alteration, since evolution is frequently understood to be in direct contrast with some religious beliefs, while Reddy (2012) discovered that there is no conflict regarding evolution amongst Hindu teachers and learners, as they are ignorant of their religion (Reddy, 2012).

A study by Sanders (2008) reports on several difficulties that South African school teachers come across when teaching evolution, such as poor Pedagogical Content Knowledge; lack of adequate training and controversy in evolution; misconceptions held by teachers; and poor consideration of the nature of science. A study by Abrie (2010) on attitudes and willingness to teach the content on evolution by teachers found that some teachers reject the theory of evolution, citing religious and Christian beliefs.

Considering all the various studies that have been conducted and areas recommended for future study by various researchers outlined above, I noted that most of the studies conducted focus on teacher and learner beliefs, and teacher training, and do not examine how teachers provide instruction to learners to understand evolution in the classroom. This study explores how teachers teach controversial topics such as evolution during

classroom instruction. The study also seeks to explore how Life Sciences teachers in South Africa deal with the challenge of teaching evolution in a country where Christianity remains dominant and is celebrated even through public and/or national holidays.

1.2 BACKGROUND TO THE STUDY

To create a clear picture of the introduction of evolution in the South African school curriculum, one needs to make a distinction between apartheid South Africa (before 1994) and post-apartheid South Africa (after 1994).

1.2.1 The Education System before Democracy, before 1994

During this period, the curriculum was isolated into the National Instruction Framework (based on Christian National Instruction, 1967–1994) and the Bantu Education System (initiated in 1952). The South African education system was mostly Christian-based and overlooked evolution, because it conflicted with the widely accepted Christian National Education values and religious beliefs of the government. Science instruction was neglected in the Bantu Instruction program (Dempster & Hugo, 2006; Sanders, 2018).

When science instruction was permitted as part of Christian National Education (Van Eeden & Vermeulen, 2005), the science of evolution was disregarded. Dempster and Hugo (2006:106) explain this education practices as being “based on Calvinism, which has as its cornerstone the absolute sovereignty of God”. Creationism was seen as the only belief of how life on Earth came to be. As a result, the Department of Education promoted creationism, loyalty, race associations, and religion as part of the everyday school experience. The promotion of Creationism caused that South African government schools rarely mentioned evolution in their classrooms because the laws of the country promoted the absolute sovereignty of the Christian god (Dempster & Hugo, 2006; Sanders, 2018).

1.2.2 The Education System during Democracy, after 1994

After 1994, the new democratic South African government began to change instruction to provide all South Africans with access to quality learning. Social transformation is now foregrounded in the new curriculum, as is the production of internationally competitive, literate, creative, and critical citizens (Dempster & Hugo, 2006). The education curriculum was changed several times to improve the South African education system. Previously, the education system was segregated, based on racial lines where Black people received Bantu Education and was implemented before 1994. After 1994, the new curriculum in the name of Outcomes-Based Education (OBE) was implemented, and over the years was changed to the Revised National Curriculum Statement (RNCS), the National Curriculum Statement (NCS), and finally to the Curriculum and Assessment Policy Statement (CAPS). The change of curriculum was the mandate of the government in 1994 to change instruction to create a globally competitive, proficient, inventive curriculum that will enable individuals to cope with the needs of the country (DoE, 2011). To improve the curriculum, the reorganization of the curriculum addressed three issues:

- Racist and sexist language, including controversial subjects, were banished from syllabi.
- Curriculum plans were modelled according to an OBE model called Curriculum 2005, which was intended to alter the education system so that that learner could acquire skills to use the knowledge to reach certain outcomes (DoE, 2011); and
- Curriculum 2005 was revised before it was practised, resulting in the RNCS: Natural Sciences for Grades R–9 and the NCS for Grades 10–12. These curricula were implemented gradually: Grades 1–3 in 2004, Grade 6 in 2005, Grades 7 and 10 in 2006, Grades 8 and 11 in 2007, and Grades 9 and 12 in 2008. In 2010, the NCS was amended to become CAPS (DoE, 2010).

During the curriculum change, in the Grade 12 Life Sciences syllabus there was an introduction of different Knowledge Areas, such as the topic on evolution and natural selection. In 2010, we saw the start of the CAPS preparation, which was a new curriculum document (DoE, 2010), and was implemented in 2012 in Grade 10.

1.2.3 Curriculum and Assessment Policy Statement (CAPS)

The Republic of South Africa announced the CAPS curriculum for all the grades in 2010 (DoE, 2010), providing teachers with detailed guidelines on what to teach and assess in all grades. The CAPS are based on several values, and one of the principles is that of providing learners with the necessary information that can support them to participate in the real world (DoE, 2010). The CAPS encourages teachers to support and guide learners during the lessons.

The school system in South Africa is comprised of two phases, with the Further Education and Training (FET) band as one of the two phases, spanning from Grades 10–12. In the FET Phase, Life Sciences is one of the subjects for the National Senior Certificate (DoE, 2010), and comprising of four Knowledge Areas in Grades 10, 11, and 12, i.e. life at molecular, cellular, and tissue level; life processes in plants and animals; diversity, change, and continuity, and environmental studies. The topic of evolution belongs to the diversity, change, and continuity' knowledge area.

1.2.4 Inclusion of evolution in the Life Sciences curriculum

The year 2008 saw the implementation of the NCS in South African schools. One of the previously excluded topics within the Life Sciences educational modules was evolution. Some of the topics included in the Life Sciences CAPS document are Lamarck and Erasmus Darwin's theories; natural selection; human evolution; and alternative theories to evolution (DoE, 2011:10).

Even though evolution is not a completely new theme in South African schools, it did not appear to produce many concerns or contention among teachers and guardians of the learners. This may have caused teachers not to pay special attention to the topic, probably since it comprised only a few percentage marks of the final examinations (Yalvac, 2011). In 2008, the area of evolution was included as a portion of an externally examinable educational module, where it comprised 25% of the ultimate registration examination, and concerns about lack of knowledge and beliefs started to emerge (Sanders & Ngxola, 2009).

Despite the development made in South Africa by including evolution in the syllabus, understanding and acknowledgment of the topic are still lacking in the country (Sanders & Ngxola, 2009). Research has shown that these days people react to the theory of evolution much as they did in Darwin's time – they worry about and doubt it and are greatly resistant to change (Yalvac, 2011). As a result, numerous teachers, schools, and school frameworks in South Africa either maintain a strategic distance from teaching evolution even though it is included in the set curriculum, or they do not teach it as it should be done (Sanders & Ngxola, 2009; Yalvac, 2011). This issue is compounded by the notion that evolution is an intrinsically troublesome concept to instruct and to learn (Sanders, 2016). The history of evolution has, regrettably, fuelled the growth of misconceptions and distrust on the reality of evolution (De Beer & Henning, 2010).

1.2.5 The importance of teaching evolution

The teaching of evolution leads to learners becoming mindful of the “powerful modern problem-solving tool”, organic evolution (Scharmann, 2005:13). Teaching learners evolutionary theory will moreover permit learners to understand the scientific principles and processes underpinning the nature of science (NOS), enabling them to analyse scientific evidence insightfully (Cavallo & McCall, 2008; Sutherland & L’Abbé 2019). There are three reasons why evolution is vital in science:

- Evolution is a unifying concept

The logic communities around the world have acknowledged that evolution is one of the foremost connective concepts in science (Rutledge & Warden, 2000; Rutledge & Mitchell, 2002; National Science Teachers Association, 2013). The concept of moderate changes in populaces over time is a "golden thread" (Scharmann, 2018) that joins science disciplines such as fossil science, biogeography, physiology, biology, efficiency, embryology, hereditary qualities, and cytology (Scharmann, 2018). Many textbook creators do not treat evolution as a separate topic, but utilize it as a topic in several topics and disciplines, as is the case in a few present-day tertiary courses such as the biology textbook by Raven *et al.* (2005). From a report by the National Science Teachers Association (2013), it appears that evolution could be a connective concept in science

since disciplines like material science, space science, topography, human studies, and geochronology all support the premise that change occurs over time.

- Evolution could be an effective illustrative apparatus

As an informative concept, evolution can be utilized to reply to the "why", "what" and "how" inquiries concerning the assortment of life. The National Science Teachers Association (2013) clarifies that understanding organic evolution permits one to understand other things. The differences of life have come into existence due to organisms adapting to environments because of natural selection. The environment does not cause living beings to advance, but provides challenges that living beings will react to by adjusting, because of the genetic variations they possess (Dobzhansky, 1973; Sutherland & L'Abbé 2019). Adjusting to diverse natural conditions, the accessibility of diverse nourishment sorts, and creating distinctive components for survival have resulted in a wide diversity of different types of living organisms.

- Evolution could be a modern problem-solving device

Researchers use the components of evolution to explain some of the abstract and complex formations on earth (Pigliucci, 2005). The hypothesis of evolution has become "the establishment of malady following and the recognizable proof of species in therapeutic, pharmacological, or preservation settings" (Bull & Wichman, 2001:1). The likenesses between life forms are utilized in present-day biomedical investigations to study organisms to understand "biological forms basic to humankind" (National Science Teachers Association, 2013:31), which can be utilized to illuminate issues that people need to understand. By applying their understanding of hereditary qualities, characteristic determination, and common parentage, well-being analysts can create immunizations and can bargain with anti-microbial resistance of microbes and HIV resistance (Scharmann, 2005). The National Academy of Sciences (2008) shows that to solve the severe acute respiratory syndrome (SARS) pandemic, researchers needed an understanding of evolution, i.e. that living things change over time.

1.2.6 Teaching and learning evolution

Life Sciences is required if the public is to be involved in an informed, expressive way on social issues such as Human and Plant evolution (Haga, 2006). The main source of Life Sciences knowledge is through biology education. However, some teachers and learners find evolution a controversial topic to teach and learn, respectively (Sanders, 2010; Reddy, 2012; Neubrand & Harms, 2017). Tsui and Treagust (2007) add that this difficulty is at both theoretical and semantic levels, promoted by a lack of adequate training on evolution by the DBE.

The other contributing factors to the difficulties on the teaching evolution in schools include learners' prior knowledge, which either provides context for their understanding of the concepts or is a source of confusion in studying the topic (Tsui & Treagust, 2007; Neubrand & Harms, 2017). Traditional methods of teaching often rely on textbooks; yet textbooks tend to focus more on theory than the conceptual understanding of evolution (Reddy, 2012). The abstract nature of the concept and limited area of focus for examinations make other aspects of the topic look useless, yet important in conceptual understanding (Sanders, 2010).

1.3 PROBLEM STATEMENT

The topic of evolution is a controversial subject in many parts of the world where Christianity and other religions that subscribe to the idea of creation are dominant. Sanders and Ngxola (2009) report that when evolution somehow finds its way into the school curriculum, it can be expected that teachers will face a constant challenge on how to approach the subject in a way that is sensitive enough to some of the stakeholder concerns, while doing justice to the curriculum requirements (Sanders & Ngxola, 2009). This study seeks to explore how teachers in South Africa deal with this challenge of teaching evolution in a country where Christianity remains dominant and is celebrated through public and/or national holidays. Various issues on pedagogical practices of evolution have been recorded in other nations, particularly in the United States of America, and provide data on how one might understand instruction on evolution. For

example, in the USA people (51%) and UK (54%) support teaching of evolution in schools (Shepherd, 2009).

A major difficulty in the science education system in South Africa is one of justice. If learners are denied access to higher-order thinking skills such as the consilience of inductions (combining multiple disparate avenues of evidence into a coherent theory), and a correct understanding of subjects like evolution, the social justice imperative that frames the Curriculum and Assessment Policy Statement is undermined. Moreover, misconceptions around evolution (Okoth, 2016; Govender**,** 2018) may often result in further teaching problems when scientifically incorrect prior knowledge is committed to long-term memory and functions as the basis for further learning.

In this study, the researcher explored how teachers teach controversial topics in the school science curriculum and explore the perspectives*,* practices and challenges of teachers about evolution in the classroom. In CAPS, teachers are expected to support learners during the pedagogic process. During teaching and learning, teachers lead, support, simplify and provide the way, while learners become dynamic participants, deliberate in groups, and complete activities (Schreuder, 1998; Govender**,** 2018).

The CAPS outlines the necessity to consider other ways of knowing, i.e. faith-based and indigenous knowledge systems (DoE, 2010). The recommendation of the use of faith-based and indigenous knowledge systems places a weight on the teachers in dealing with multicultural classes with different faiths. However, the DoE (2010) does not allow schools to value, judge, and criticize various religious issues in the school science classroom in respect of religious rights as set by the Constitution of South Africa. This is because schools accommodate learners and stakeholders from various religious positions. As a result, learners' views and perceptions of their beliefs should be protected in schools.

A study by Reddy (2012) reveals that at certain schools, learners were not interested in studying evolution, due to their spiritual philosophies, and they are not open to evolution because of their beliefs. As a result, it is difficult for learners to make an intellectual effort to understand evolution, even though there is a reason for learning about evolution.

During the lesson, teachers worry more about teaching the practical work of Life Sciences than thinking of learners' understanding of science, because practical work makes learners understand their lessons. Dempster and Hugo (2006) indicate that evolution is one of the questionable points within the science curriculum that require the use of practical work to enhance understanding, due to the abstract nature of the concepts of the curriculum.

Against a history of enormous educational disparities and Christian National Education, South African teachers now face the task of teaching a revised and updated science curriculum. Diverse and complex topics such as evolutionary biology pose an enormous challenge. According to Cronje (2011), a proper understanding of evolutionary processes requires a solid graduate education embedded in evolutionary thinking and explanation – an education that was not available to many practising teachers. A study by De Beer and Henning (2010) indicates that the DoE organized workshops in the form of in-service training, and short learning programs over weekends or after school. Some of the training was offered by the various provincial Departments of Education, and by designated service providers such as the universities.

In addition, since evolution was presented in the school Life Sciences educational modules, information has been documented in South Africa on the problems that teachers encounter when teaching evolution; understanding of the topic; their conflicts; and those of the learners and communities in which they teach. This study intended to explore how perceptions, beliefs, and other challenges affect Life Sciences teachers' approaches in the classroom.

1.4 RESEARCH QUESTIONS

The leading research problem addressed by the study was:

> *How do Life Sciences teachers in South Africa teach the topic of evolution within the school science curriculum?*

To answer this major research question, the following sub-questions were proposed:

- What are the Life Sciences teachers' perspectives and beliefs about evolution as a topic in the curriculum?
- How do selected teachers' perspectives and beliefs influence the approach to the teaching of evolution in their classrooms?
- What are the challenges and opportunities for teaching evolution in the Life Sciences curriculum?
- How can South African teachers' perspectives and practices on evolution be understood and/or explained?

1.5 AIMS AND OBJECTIVES

The main question of this report was to explore how Life Sciences teachers in South Africa engage with controversial topics like evolution in the Curriculum and Assessment Policy Statements in their classroom teaching.

The objectives of this study were to:

- Describe Life Sciences teachers' perspectives and beliefs about evolution as a topic in the South African curriculum
- Determine how Life Sciences teachers' perspectives and beliefs influence the approach to the teaching of evolution in their classrooms
- Identify the challenges and opportunities for teaching about evolution in the Life Sciences curriculum
- Develop an understanding of South African Life Sciences teachers' perspectives and practices on evolution

1.6 SIGNIFICANCE OF THE STUDY

This case study is important in numerous ways. Firstly, I was a professional Life Sciences teacher teaching at secondary schools and had an interest in the Life Sciences

curriculum. This study would assist me and other researchers with the necessary knowledge and understanding of evolution as a controversial topic in the science curriculum. Through this study, I also sought to develop my capacity to become a critical and reflective education specialist educationist after observing teachers using a variety of teaching approaches, as prescribed by CAPS.

Reports by Sanders (2010; 2016) indicate that certain studies on evolution were conducted in South Africa on teaching and learning. It is anticipated that this research will add to the current body of academic literature and scholarship on the teaching of evolution. Considering that most studies on evolution are conducted internationally, this report endeavours to provide a perspective of what is happening in South Africa, which may guide other researchers in terms of what has to be done to move forward when teaching evolution.

The research report by Neubrand and Harms (2017) reveals that some teachers do not use the word 'evolution' in their teaching, citing religious issues. All through my career as a school Life Sciences teacher and analyst inside the DoE, I can relate to the teachers' battles, not as it were with the teaching of Life Sciences only, but with the implementation of the numerous changes within the CAPS. This research report will further assist other FET Life Sciences teachers at different schools on how to deal with different controversial topics in the classroom.

According to the literature, other factors that contribute to the difficulties in teaching evolution in the Life Sciences curriculum include teachers' prior knowledge, which provides a context for understanding (Scharmann, 2018). This research will possibly also inform the DoE about the need for a curriculum implementation policy to guide teachers and help them to understand the origin of ideas on evolution specifically. It will also contribute by offering suggestions for policy and reform, which will enhance improved teaching and learning of evolution.

1.7 THEORETICAL BACKGROUND

A theoretical framework explains the main areas that need to be considered when conducting a study, i.e. the key reasons, variables, and the alleged relationship amongst them (Bell, 2005). A theoretical framework helps to draw and summarise results to make information meaningful to those who would wish to use the findings for further studies (Coburn, Hill & Spillane, 2016; Spillane *et al.*, 2018). The study adopted the cognitive framework of curriculum implementation as explained by Spillane, Reiser, and Reimer (2002). Spillane *et al.* (2002) emphasize that the cognitive framework takes into consideration how information is processed, such as the problems and influences involved in the handling of information about academic ideas (Alkahtani, 2017; Blackman, 2016; Dao, 2018).

In other words, the cognitive framework outlines the ways that social context and social interaction affect sense-making. According to Lefstein (2008), the cognitive perspective is an important dimension of the implementation practices and enables teachers to come to understand their practices during teaching and learning within the classroom. Spillane *et al.* (2002) and Coburn *et al.* (2016) suggest that the cognitive framework is characterized by sense-making within the execution process of the curriculum, and draws on basic intellectual processes, societal reasoning, and positioned awareness. This suggests that a teacher should understand the policy information; build an explanation of his/her practice; and form a conclusion about the potential changes in the everyday practice informed by how prior knowledge, beliefs, and involvements impact the building of new understandings.

A study by Cotton (2006) supports this idea that teachers' beliefs, values, and emotions influence the pedagogy during the lesson. Spillane *et al.* (2002) further illustrate that situated cognition complicates the human sense-making process by arguing that context is critical in understanding the implementing agent's sense-making. This suggests that the teaching and learning community may influence teaching in the classroom because of a particular community's culture and beliefs. Coburn *et al.* (2016) show that individual cognition explores the local implementing agent considering how individuals notice and

understand the changes, and how prior knowledge, beliefs, and involvements impact the building of new understandings. Coburn *et al.* (2016) further indicate how conditions affect the application of understanding from and about the program because a situation is a constituent element in teaching and learning (Kirk & MacDonald, 2001). The cognitive perspective emphasizes developmental change, which has a fundamental cognitive component. As a result, teacher challenge involves representing the abstract and the concrete ideas about teaching in understandable ways (Spillane *et al.,* 2018).

The cognitive framework was the focal point through which I conducted and analysed the findings of the study for all the four subsidiary research questions of this study. I found this theoretical framework to be useful because it outlines the curriculum implementation process that was required to transform the subject content effectively and it helped me to analyse how teachers made sense of the curriculum.

The cognitive framework tenets framing the study are individual cognition, situated cognition, and role of representation. These stages are important during teaching and learning in the classroom, because during individual cognition, the teacher pays special attention to how individuals receive information, understand change, and how opinions and capabilities impact the formation of new understanding. Situated cognition, on the other hand, is important in understanding how teachers create knowledge and understanding. Lastly, the role of representations places more emphasis on the role of policy implementation, focusing on the growth of illustrations of thoughts about varying practices in the classroom. In Chapter 2, more literature findings on curriculum implementation and on evolution as controversial topics in the curriculum will be discussed in greater detail**.**

1.8 RESEARCH METHODOLOGY

The drive of this section clarifies the research design that this research report followed and substantiates the approaches that were applied to collect the information.

1.8.1 Research paradigm

According to Babbie (2011) and Creswell (2009), a research study should lead to a systemic description of reality. This section represents how I moved from a worldview and assumption into research methodology. The journey started with the paradigm that was the fundamental frame of reference or worldview that underlies social theories and inquiry, referred to as a method that underlines the significant nature of the public's involvement in social and cultural life (Creswell, 2009). In this study, the paradigm is viewed as a worldview that provides ways of looking into the theories and provides a logical framework. For this study the Constructivist paradigm was selected from the four that are outlined by Creswell, namely: Positivist, Constructivist/Interpretive, Participatory, and Pragmatist. The reason for this selection is because this study seeks to explore how Life Sciences teachers in Gauteng teach controversial topics like evolution within the Curriculum and Assessment Policy Statement. Therefore, it was expected that teachers in this study would have different reasons for their experiences in teaching evolution, and they use different techniques for different reasons in dealing with the challenges.

1.8.2 Research approach

Creswell (2014) states that there are three recognised research approaches for the procedures to conduct research: Quantitative, Qualitative, and Mixed Methods. This study used a qualitative research approach. According to Creswell (2014), during the qualitative approach, a researcher gathers data in a confrontational state of affairs and interact with nominated persons in their setting. In support of the explanation by Creswell (2014), according to Opie (2004), this approach strives to recognize incidences in particular settings. The qualitative research approach enabled me to observe a set of material and practices in the classroom.

1.8.3 Research design

Creswell (2014) explains research design as a process of understanding what is developed during the study when analysing words, developing detailed reports about the views of participants, and recognizing incidences in particular settings. The qualitative

research design enabled me to observe a set of material and measurable practices. Qualitative research design is pertinent to my study, since it offered me the opportunity to understand the material conditions of teachers and the classroom realities. Ormrod and Leedy (2013) show that a design exposes an approach of how the researcher intends to do the research and bridges the gap between the research questions and the implementation process. This also leads to the procedure and techniques of circumstances for the collection and analysis of data. Yin (2014) and Cohen, Manion and Morrison (2011) concur with the aforementioned explanations and outline five traditions that could be practised in qualitative research. Considering the different traditions as outlined by Creswell (2014) and others, in qualitative research, i.e. case studies, ethnographies, grounded theories, and biographies, the study adopted a case study approach of teachers from different schools using semi-structured interviews and classroom observations.

This study took a descriptive qualitative case study approach (Yin, 2018), and used three teachers teaching Grade 12 learners from different schools and districts in Johannesburg, South Africa. As study sites, the schools were selected through purposive sampling. The three teachers in three schools represented a bounded case of teaching evolution, from which thick and in-depth data were generated through semi-structured interviews and classroom observation (Creswell, 2014). Each case was unique in that professional and academic qualifications; the physical resources in their local environment; and backgrounds of the students they teach were different. Therefore, each school has its own context.

1.8.4 Sampling

Sampling encompasses an action, process, and/or technique of selecting an appropriate sample from people to provide research material and stipulates how members are nominated in a study (McMillan & Schumacher, 2010). A purposive sampling strategy was used to guide data collection. According to Creswell (2014), purposive sampling is a strategy that involves selecting information-rich cases and participants that assist the researcher to understand the problem as well as the research question. Three different

secondary school teachers teaching Life Sciences from Grade 10–12 were purposively sampled for the study, looking at their minimum qualification of Secondary Teacher's Diplomas, who attended CAPS and NCS training and workshops, and used the same resources for the teaching and learning of evolution. These three cases of teaching evolution involved teachers from different schools, racial, cultural, and/or religious groups.

1.8.5 Data collection techniques

Data in this study were gathered from the participants who had experience and knowledge of the subject. Data were gathered through observations, documents, and semi-structured interviews. The interviews were audio-recorded as part of the qualitative methods of assembling data (Creswell, 2014). Lesson observation involves a person observing other individuals from the outside, inspecting as a bystander without participating in the activities (Myers, 2010). An observation schedule was the main method to collect the data and was designed based on how teachers negotiate controversial topics like evolution during teaching and learning. A total of six lessons were observed and three lessons per teacher were audio recorded. This was followed by two semi-structured interviews per teacher, which helped me to document teachers' vocal interactions in lessons, perceptive and societal processes (Denscombe, 2007). This further enabled the researcher (me) to look at teacher-learner interaction activities during the lessons. The observation was not a holistic approach, because teachers can change their normal practice; however, to overcome these limitations, during the lesson teachers were not aware of what I observed during the lesson. Some of the teachers and learners' interactions, background information, and observation were documented and taken into account.

1.8.6 Qualitative data analysis

A study by Hatch (2002) describes the process of analysing data and information as a way that entails a logical quest for implication and sense from the information. During this period, the researcher works with data, classifying and synthesising information into controllable components, finding patterns, and categorising what is significant so that the researcher can account for others in the research fields (Creswell, 2014). Cohen *et al*.

(2011) explain data interpretation as a procedure of creating direction and developing implications for the collected information and data. According to Nieuwenhuis (2011) and Creswell (2014), the process assists in considerations about the data collected, requesting reasoned questions, and writing memorandums. In this study, analysis of data was based on a constructive model that seeks to find significant and meaningful content from qualitative data gathered (Nieuwenhuis, 2011). Information from the observation guide and in the transcripts of the audio recordings was coded under tentative headings, and these headings were adapted, as the weight of additional data helps to clarify the headings into more definite patterns and clusters of patterns (Myers, 2010). In this study, predetermined categories were used to save time, as suggested by Hatch (2002). Categories were teachers' perspectives, religious views, and professional beliefs about evolution as a topic in the curriculum. A further discussion on the analysis and interpretation of the data will take place in Chapter 5.

1.8.7 Validity and reliability

To safeguard the element of validity and reliability in this study, I prepared the observation guide, interview schedule, piloting sample, and selected the teachers that would represent the cases (Scaife, 2004). The transcripts of interviews were discussed with the participating teachers. This was done so that teachers could add to or subtract from what they had said previously. This was following Griffiths (1998), who indicates that respondent validity can be applied by relaying analysed data back to the participants in the study for them to acknowledge if the data were presented correctly and, if possible, they can discard or improve their understanding. This was done by discussing the data that were collected, analysed, and interpreted from three classroom observations with the three teachers as a way to improve the reliability of the results,

1.8.8 Trustworthiness and credibility

Trustworthiness was attained through a course of thought-provoking evidence breakdown, results, and deductions (Nieuwenhuis, 2011). The trustworthiness of the findings of my research largely depends on the coherence of the four basic elements of research (Creswell, 2014), namely methods, methodologies, theoretical perspectives,

and epistemology, which have been discussed in the research design section of this proposal. It was when these four elements were in resonance with one another that the trustworthiness of research could be ascertained. In this research, therefore, I have, based on the research problem, selected methods, methodologies, theoretical perspectives, and epistemology that are known to be compatible. Hence the trustworthiness of the findings rested on the strength of these four elements. This was further guaranteed by doing participant checks, confirming findings, and avoiding generalization. This was done by searching for participants' perspectives, selecting quotations carefully, upholding disclosure and privacy, and affirming the boundaries of the study truthfully, as suggested by (Nieuwenhuis, 2011).

1.9 ETHICAL ISSUES

Ethical considerations are viewed as the most significant part of the research, particularly when it involves human and social matters (Opie, 2004). As a result, Strydom (2011) indicates that the data collection process in a study should always protect human beings. The researcher agrees to that and complies with the ethical considerations by requesting participants to agree to informed consent, voluntary contribution, and confidentiality.

Therefore, it was important for the researcher to request ethical clearance to conduct this study. The purpose of ethical clearing is to prevent harming others. The principles of conducting the research were well thought out by following the three features of piloting the research in schools, as outlined by Setati (2005). I sent research request letters to the University of the Free State, the Gauteng Department of Education, and to the principals of the schools that were involved in the research. Ethical approval and clearance from all the stakeholders in the study were received. A meeting was requested with the teachers to update them about the research report and to request them to become part of the study. Letters with subject information about the study were sent to the participating teachers, assuring through the consent form that the information collected in the study would be used for research purposes only and would be held safely for a period of three to five years.

1.10 DELIMITATIONS OF THE STUDY

The research report only identified secondary schools in Gauteng, South Africa, and no primary schools. The research focused on three secondary Life Sciences teachers in Gauteng Province: one each in Soweto, Alexandra, and Ekurhuleni. Teachers from independent schools, the Tshwane region, and the Sedibeng region were excluded from this study. The group was small and manageable. These teachers teach at secondary schools that all have more than 1 500 learners from different backgrounds. Learners were not part of the research report, because the focus was on the teachers. Lastly, the study was limited to secondary schools in the province of Gauteng that offer Life Sciences as part of the school curriculum, considering that other secondary schools do not offer Life Sciences as a subject. As a case study, the findings were not generalized (Denscombe, 2007).

1.11 LIMITATIONS OF THE STUDY

The research study focused on how FET Life Sciences teachers teach the controversial topics in the Life Sciences curriculum and the perceptions and practices of teachers about evolution. To avoid a large-scale study that will take time to complete, the study was, however, limited to three competent and qualified Life Sciences teachers located in different areas of Gauteng. This was not a big sample to manage, but small and manageable. Learners were not part of the research report, because the focus was on teachers.

During the data collection process, it was important to ensure the trustworthiness and sincerity of the participants. I realised that it is necessary to have a good working relation with all the participants so that it can be easier to collect data. This made the participants to talk easily about whatsoever requested from them, despite the ethos of the schools. It was expected that the contribution would promote ownership and transparency. It was important for me to ensure that no bias occurred during the data collection process due to my interest in the study as a former departmental official. However, this was analysed

carefully so that it did not influence the outcomes of the study. The process of collecting of data was thoroughly realised to limit any ambiguity in the interpretations.

Lastly, the findings of the study generated were not generalised. This study was a qualitative case study investigation, since it only represents the selected participants and their working environment.

1.12 THESIS OUTLINE

This research report comprises five chapters, references, and appendices containing all material relevant to the research.

Chapter One

Chapter 1 announced the background, rationale, purpose, research questions, methodology, and ethical issues of the study, and concludes with an overview of the chapters to follow.

Chapter Two

Chapter 2 contains a comprehensive overview of works related to the study, including the aspects of a cognitive framework on curriculum implementation as the hypothetical system for this study. Research conducted on teaching of evolution in South Africa and globally, are also analysed and form part of the literature.

Chapter Three

This chapter displays the methodology of the study, as well as a theoretical analysis of the research design. The whole process also involves data collection instruments used, analysis of information and the ways used to create meaning of data.

Chapter Four

This chapter covers evidence from the cases and an analysis of the outcome that was attained. A record of the information scrutiny of the data received is provided.

Chapter Five

In this chapter, I discuss a cross-case analysis, findings, discussion, and the conclusion. This chapter also provides the recommendations, implications, restrictions, and areas that can be considered for future study.

1.13 CONCLUSION

In this chapter, an account of all the sections included in the study was briefly described, including the introduction, background, literature and theoretical review, and the limitations encountered during the study. This chapter also outlined the research questions and the objectives, as well as the research methodology used that guided the study. The limitations and delimitations of the research report were also highlighted. The next chapter provides the theoretical framework suitable for my research topic on controversial topics in the school science curriculum, and a review of the literature on teaching and learning of evolution, i.e. the teachers' use of perceptions, skills, beliefs, understanding, challenges, and difficulties that Life Sciences teachers face when teaching evolution in South Africa.

CHAPTER TWO: THEORETICAL BACKGROUND

2.1 INTRODUCTION

This chapter discusses the literature reviewed and the theoretical framework that guided the study. The literature reviewed includes teachers' use of knowledge, skills, beliefs, understanding, challenges, and difficulties that Life Sciences teachers face when teaching evolution in South Africa. According to Tsaparlis, (2001), what separates the writing of academic research from that of newspaper writing is the organization of information and the use of a theoretical framework when creating and supporting arguments. A study by Abd-El-Khalick (2006) points out that there is no precise explanation of a theoretical framework in the field of science education, but LeCompte and Preissle (1993) explain it as a way of gathering associated ideas that direct research to the purpose of the research. In educational research, the theoretical framework has several roles and functions that increase the value of research (Tsaparlis, 2001). According to Molefe (2013), and Abd-El Khalick and Akerson (2009), a theoretical framework serves to unite the researcher to current literature, offers conventions that direct the inquiry, helps the analyst to choose fitting questions, guarantees the reader of the appropriateness of the report, leads the selection of research design, leads the researcher towards proper data gathering methods, and supports the analyst to form likelihoods of the results and translate it based on the current literature.

In this chapter, I firstly theorise about the controversial issues around the topic, then reflect on and adopt a cognitive framework of curriculum implementation as a basic hypothetical system to direct my study on controversial topics in the school science curriculum and review some literature related to the study so that I can answer the questions outlined next:

- What are the Life Sciences teachers' perspectives and beliefs about evolution as a topic in the curriculum?
- How do selected teachers' perspectives and beliefs influence the approach to the teaching of evolution in their classrooms?

- What are the challenges and opportunities for teaching evolution in the Life Sciences curriculum?
- How can the South African teachers' perspectives and practices on evolution be understood and/or explained?

2.2 CONTROVERSY AND CONTROVERSIAL ISSUES AROUND TEACHING OF EVOLUTION

2.2 1 Meaning of the word 'controversial'

Controversial issues refer to conflicts of value and interest, which are often coupled with disputed claims about underlying facts and tend to be complex, with no easy answers (Brookfield & Preskill, 2005; Cashin, 2010). According to Brookfield and Preskill (2005), controversial issues arouse strong feelings and tend to create divisions between people engendering suspicion and mistrust. During teaching and learning, controversial issues in the curriculum are thought to raise difficult pedagogical questions such as how to protect the sensitivities of learners from different backgrounds and cultures, how to prevent friction in the classroom, how to teach contentious material, and avoiding criticisms of bias (Brookfield & Preskill, 2005; Kustra & Potter, 2008). It also raises questions about academic freedom and the role of the teacher's own beliefs and values. The study focused on the promotion of an open and collaborative approach to teaching and learning, with a special emphasis on self-reflection and thoughtful, and informed action. During the lesson, teachers may reflect on the way their personal beliefs and values affect their professional attitudes towards and handling contentious material.

2.2.2 Controversial issues challenging teaching

According to Brookfield and Preskill (2005), controversial issues express major conflicts of value and interest, often coupled with disputed claims about underlying facts. They tend to be complex with no easy answers. This is supported by Cashin (2010) who states that controversial issues may provoke strong feelings and also have a tendency to create divisions between people, which may lead mistrust (Kustra & Potter, 2008). In this study,

evolution content is seen as challenging religion, on the basis that some teachers and learners have strong religious beliefs.

The impact of controversial issues in the curriculum may raise difficult pedagogical questions (Cashin, 2010), such as how to protect the sensitivities of students from different backgrounds and cultures, how to prevent friction in the classroom, and how to teach contentious material even-handedly, avoiding criticisms of bias. Brookfield and Preskill (2005) indicate that it raises questions about academic freedom and the role of a teacher's own beliefs and values, which may raise questions of policy, such as how to support classroom teachers in their teaching of controversial issues like evolution, how to provide additional opportunities for dialogue within the school community, how to promote a supportive school ethos, how to monitor the overall quality of provision, and how to address the anxieties of parents and others outside the school.

Furthermore, I surveyed four bodies of writing that to form and conduct my thoughts about, to be specific:

- Life Sciences teachers' perspectives and beliefs about evolution
- Teachers' approach to the teaching of evolution in their classrooms
- The challenges and opportunities for teaching about evolution
- Understanding of evolution

2.3 THE THEORETICAL FRAMEWORK FOR THE STUDY

The section of the theoretical framework covers a description and explanation of the theoretical framework; the cognitive framework of implementation and the stages of the cognitive framework of implementation; how one can sketch a cognitive framework of implementation; and the core elements of the basic cognitive framework, as explained by Spillane *et al.* (2002).

As explained above, that theoretical framework explains and clarifies the main aspects to be studied in the research, i.e. the key variables, constructs, factors, and the assumed

relationship between them (Bell, 2005; Wilcox & Lawson, 2018). It helps with drawing up and summarising findings of the study to make the information meaningful for those who would wish to use the findings for further studies (Spillane *et al.*, 2002). Spillane *et al.* (2018) highlight that the cognitive framework takes into consideration basic information processing such as the difficulties, complications, and inspirations that are elaborated upon during the handling of data about intellectual ideas. This further includes the effect of inspiration and influences and how community background and interaction affect knowledge and understanding (Wilcox & Lawson, 2018).

According to Lefstein (2008), the cognitive perspective covers the implementation process, and enables implementing mediators to come to know and understand their practice and potential to change agents' beliefs and attitudes during teaching and learning in the classroom (Lefstein, 2008; Coburn *et al.*, 2016). Spillane *et al.* (2002) suggest that the cognitive framework is characterized by sense-making in the implementation process of the curriculum, and draws on essential cognitive forms, social cognition, and arranged cognition. In his earlier paper, Spillane (1999) shows that individual cognition explores the teacher as an individual sense maker, looking at how individuals notice, understand changes, and the influence of previous experience on the formation of new knowledge and understandings. An investigation by Cotton (2006) also indicates that a cognitive framework of the implementation model considers how the implementer's perceptions influence the sense-making process. Coburn *et al.* (2016) indicate that situated cognition complicates how individuals process information by indicating that context is critical in understanding the implementing process by the teachers.

According to Spillane *et al.* (2018), a cognitive framework model shows how teachers form their understanding of the policy and come up with their practice and conclusions about ways to change in their practice (Spillane *et al.*, 2002). The cognitive framework was the lens to analyse the outcomes of the study for all four research questions on the teaching of evolution.

2.3.1 Cognitive framework of the implementation

The policy on curriculum implementation shows that the implementing agents – in this case, teachers – are set up in contact with learners' existing cognitive structures such as awareness, philosophies and attitudes, their conditions and position, and the policy motions (Spillane *et al.*, 2002). Spillane *et al.* (2018) further indicate that a cognitive framework involves taking into account the basic information processing, the difficulties, and effects that are part of the processing of information about non-concrete ideas, i.e. these change thoughts such as a student-centred classroom, science, and mathematics talk (Spillane *et al.*, 2018; Cotton, 2006). The influence of social context and interaction is considered when applying a cognitive framework of curriculum implementation (Spillane *et al.*, 2002). According to Spillane *et al.* (2018), the implementing agents are confined to interacting and interrelating within three dimensions of the cognitive framework, namely individual cognition, situated cognition, and role of representation. This study is mainly embedded in the individual cognition of curriculum implementation and partly situated cognition because the situation has a great influence on teaching and learning.

2.3.2 Stages of the cognitive framework of the implementation

According to Spillane *et al.* (2002), the three stages of a cognitive framework of implementation are individual cognition, situated cognition, and role of representation. During individual cognition, educators pay special attention to how individuals receive information, understand change, and how individual perspectives impact the formation of new understanding (Coburn *et al.,* 2016). Therefore, Spillane *et al.* (2018) suggest that during teaching and learning more consideration should be on how the implementer's viewpoints influence the understanding of information.

Situated cognition, on the other hand, argues that situation and context are important in understanding how the teachers create knowledge and understanding. Spillane *et al.* (2002) also suggest that the positioned reasoning view is a constituting element of the teaching and learning process, and not just a condition for the teacher to develop knowledge (Alkahtani, 2017; Blackman, 2016). Lastly, the role of representations places

more emphasis on the change of the implementing agents' sense-making, focusing on the character of social context in the understanding of information. According to Zhao, Mok and Cao (2019), Okoth (2016), and Dao (2018), this covers the development of illustrations in policy about new practice so that they can help the actualizing agent's sense-making within the classroom. In short, the implementation process involves mutual understanding among members concerning the beliefs, values, and assumptions that originate from the program, and how they understand the program in terms of the school, community and course circumstance (Coburn *et al.*, 2016; Blackman, 2016; Alkahtani, 2017).

2.3.3 Sketching a cognitive framework of the implementation

The cognitive framework emphasizes the need to take into consideration the position of the teachers and how they understand the policy. Spillane *et al.* (2002) show how teachers build knowledge and an understanding of the program, interpret their practice, and make inferences about possible alterations in their work practices. A cognitive perspective shows that social changes are an intellectual element in the classroom during teaching and learning and focus much on how teachers build the meaning of policy information and their behaviour, which may lead to alterations in both knowledge and understanding.

Various studies such as those by Coburn *et al.* (2016), Dao (2018), and Zhao *et al.* (2019) on policy implementation in education have used the cognitive frames (Spillane *et al.*, 2002; 2018). Some policy implementation rubrics are part of cognitive frames, which include amongst others understanding, reasoning, culture, and interpretation. Academics maintain that the notion that teachers come to appreciate and read the policy forms a necessary and unexplored component of the execution handle and other agents' prior knowledge, actualizing agents' draw between modern thoughts and their existing contemplations (Spillane, 2000). The professional expertise (Spillane, 1999), dialogue, and formal and informal linkages (Cotton, 2006) influence the implementing agents' sense-making.

According to Okoth (2016) and Alkahtani (2017), this will help to construct this work and arrange it within the writing on essential cognitive forms and social cognition (Okoth, 2016). The cognitive framework has three fundamental elements, namely the individual agents, the situation where learning happens, and the policy indicators (Coburn *et al.*, (2016; Alkahtani, 2017; Dao, 2018; Zhao *et al.*, 2019). Cognitive scholarship proposes that what informs individuals' building of new information depends on prior knowledge, beliefs, and experiences. During the lesson, teachers are encouraged to simplify subject content by using their experiences and what they already know. The study will explore how prior knowledge, perspectives, and beliefs, experiences influence the approach to the teaching of evolution in their classrooms.

2.3.4 Core elements of basic cognitive framework

The cognitive framework of implementation involves relating the devices of knowledge, understanding, and analysing rules and the applications (Cotton, 2006; Spillane *et al.*, 2018). Professionals in the field of sociology and psychology claim that more attention should be paid to the social and situated dimensions of cognition when applying a cognitive framework. The sense-making process during curriculum implementation is said to have been situated in particular communities, like professions, nations, political parties, religions, and organizations (Spillane, 2000; Coburn *et al.*, 2016). One of the core elements of a basic cognitive framework on curriculum implementation is implementing agents as sense makers. Below is the discussion of elements of the basic cognitive framework.

2.3.4.1 Teachers in the classroom create meaning of the content learned and influence learner understanding

According to Spillane *et al.* (2002), teachers as agents integrate experiences and information through existing knowledge building. This means that the implementing agents depend on the amount of existing knowledge and experience. According to Tikkanen *et al.* (2019), cognitive processes are included in making sense of troublesome exercises amid education and learning and consider how the forms are influenced by policy on practice (Spillane *et al.*, 2018; Tikkanen *et al.*, 2019). The implementing agent

as a sense maker is best explained by considering how prior knowledge impacts the sense-making; how different interpretations arise from the same message; how agents can misunderstand new ideas as familiar; and how the understanding may centre on shallow highlights (Spillane *et al.,* 2002). This element of the basic cognitive framework is important in my study because teachers are expected to explain difficult terminology during the lesson on evolution as a topic in the Life Sciences syllabus to simplify the subject matter for the learners to understand.

2.3.4.2 Teachers' use of prior knowledge influences learner understanding

A report by Spillane *et al.* (2018) suggests that teachers' prior knowledge, beliefs, and understanding play a major role during lesson planning, which makes teachers hesitant to alter the course of the approach (Spillane *et al.*, 2002). This is supported by Okoth (2016) and Govender (2018), who further indicate that understanding provides the teacher with the skills to apply the change in ways that are compatible with the policy objectives (Cotton, 2006; Govender, 2018). The role of individual understanding in implementing policy takes note of unexpected disappointments of implementation, while still tolerating careful misconception. Therefore, teachers implement the change in the policy when they understand what is expected of them. Teachers utilize earlier information and involvement to interpret (Spillane *et al.*, 2002) and respond to incoming changes in the policy.

A study by Cohen (1990) and Okoth (2016) notes that when research is applied during policy formation, it is encouraged through the users' previous understanding, enhancing rather than relocating teachers' prior knowledge, understanding and practice. Teachers will then build new a understanding of the policy on present understanding and interchanging the existing knowledge. Therefore, the sense-making process is quite important to simplify the interpretation of information and focus on one's past to construct meaning of the changes (Spillane *et al.*, 2018). Understanding requires gaining access to former knowledge and applying it to guide and connect to the unused thoughts and occasions that are as of now prearranged in memory. Typically, a dynamic prepares to encode data (Von Glasersfeld, 1989; Okoth, 2016).

A report by Spillane (2000) shows that accessing the known to note the new change is a fixed focus in cognitive work and draws on the ideas when constructing information (Coburn *et al*., 2016). An individual's prior knowledge influences what the individual notices in the surroundings and how they are intentional and get interpreted (Coburn *et al.*, 2016; Spillane *et al.*, 2018). Representations assist in the coding of information and understanding about the societal world, as it creates relationship and opportunities between the individuals and social circumstances.

A study by Spillane (2000) reveals that the use of schema during learning further leads to the processing and handling of the social evidence, and helps to focus on information handling, enabling the individual to use pre-knowledge to see outlines in data (Blackman, 2016; Zhao *et al.*, 2019). Blackman (2016) suggests that getting to a pattern from memory impacts the comprehension by sanctioning collections of needs that are utilized to fill the gaps in what is observed, driving the top-down nature of comprehension, so that much of what is caught on is in truth accumulated from input that is only partially explicit (Spillane, 2000; Govender, 2018). The understanding accounts include getting to and utilizing patterns to develop an organ of clear objectives and filling the holes between the objectives and occasions (Spillane *et al.*, 2018).

The understanding of information also involves the mechanisms of retrieving and applying knowledge structures (Coburn *et al*., 2016; Spillane *et al.*, 2018), and concrete structures of a location are outstanding. People often depend on shallow similarities and affiliations when recalling associated data from memory, specifically when the knowledge arrangements connected through the moralities may be relevant. The factor in the tool used to develop knowledge is the level of knowledge that one constructs that includes more cases that are controlled around deeper values.

In this study on the teaching of evolution, the teachers are expected to use existing structures to simplify complex information that influences learners' development of new knowledge. This suggests that teachers will have to construct natural models from their experience, and use these models to envision a situation, build natural copies of the physical world, and the world of social interactions (Okoth, 2016). On the other hand,

teachers may build their intuitive models and explanations about how people think and teach (Spillane *et al.,* 2002). Intuitive models also impact the new ideas that are translated on the premise of agents' existing knowledge of the teacher, experience, and thoughts. The understanding of new meaning is influenced by the knowledge that one as of now has, and this implies more than basically recognizing (Spillane *et al.*, 2002). Therefore, teachers construct their meaning from what they perceive, know and understand; what we see is influenced and inclined by what we expect to see.

2.3.4.3 Teachers' interpretation of the subject content contributes to learner understanding

A study by Spillane *et al.* (2018) indicates that a teacher may interpret the same message differently, depending on prior knowledge or experience about the situation. In a classroom situation, a teacher may develop learning materials based on a particular understanding of the learning environment (Spillane *et al.*, 2002), while other teachers might see it as an unruly, chaotic classroom requiring an understanding of certain ideas and experiences. This means that educators may translate a thought such as examination in exceptionally distinctive ways in line with the policy. Later studies have emphasized the significance of contrasts in elucidations of transformations and improvements (Spillane *et al.*, 2002).

Research by Spillane *et al.* (2018) and Tikkanen *et al. (*2019) show that previous knowledge and practice influence the changing of instructional practice; teachers who exercise the same language and reading strategies do not always have the same ideas customizing their teaching practices (Coburn, 2001). Some of the various challenges teachers experience is because teachers have varying opportunities to memorize approximate policy writings, proficient improvement, and direction and bolstering from the schools. Teachers' beliefs and understanding are influential in what they interpret during their practice (Spillane *et al.*, 2002). Therefore, this research on the teaching of evolution will illuminate the significance of differences in the interpretation of previous experiences in manipulating the application of policy.

2.3.4.4 Teachers' misunderstanding of new ideas leads to learner confusion

Studies by Okoth (2016) and Govender (2018) show that thoughts may be seen as more recognizable and familiar than they are, influence individual perception, and guide the interpretation to unclear and confusing events. When the teacher recognizes an instructional idea in policy, the impression may be understood as fundamentally similar to the confidence and training that the teachers already embrace (Okoth 2016; Govender**,** 2018). The impact of opportunities from existing information structures helps the implementing agents to centre on understanding, which may lead to the dismissal of knowledge suitable to the prospects (Spillane *et al.,* 2002). Understanding includes retrieving related configurations in applying them to create knowledge of what is presented, and this procedure often causes contradictions to be overlooked. Individuals interpret new evidence by familiarizing themselves with to they already know, and this may lead to unreliable understanding (Coburn *et al*., 2016). In this study, teachers' understanding of evolution is important for learners to understand the content and create new knowledge. The study will look at the impact of teachers' misunderstanding of new ideas using existing knowledge as to whether there is learner fusion during the learning process.

2.3.4.5 Teachers' focus on superficial features influences understanding

The implementing agents' understanding may centre on shallow highlights and/or lost more profound relationships (Spillane *et al.,* 2002; Dao 2018). As a result, there is a need for an implementing agent to have a great deal of expertise and capability, as this affects the utilization of the shallow highlights and more profound standards to get to and utilize data structures in making sense of circumstances and ideas. Individuals can be deceived by shallow likenesses in circumstances. Coburn (2001) indicates that the individual's understanding may centre on the shallow highlights in comparison and analogical thinking; as a result, operators may differentiate a classroom usage with an objective state and see vital similitudes, which may be as it were shallow (Coburn *et al*., 2016). On the other hand, the implementation process may be perceived to be anticipated by policymakers (Coburn, 2001); indeed, on the off chance that more profound and more

theoretical standards such as changes in students' epistemological position towards science are not reflected. In this study, the teachers are expected to implement CAPS, even though the enactment of policy may press changes in existing behaviour. It is expected that teachers will use their perceptions, beliefs, and experience to teach evolution to the latter and make learners understand during the lesson. The study will then look at how teachers' perspectives, beliefs, and experiences influence the approach to the teaching of evolution in their classrooms.

2.3.4.6 The implementing agent as social sense-maker

Research by Spillane *et al. (*2018) shows that situated cognition is essential in understanding human cognition and perception. They explored how depictions of knowledge about societal conditions influence perception and representations for understanding new knowledge (Spillane *et al.,* 2002). Situated cognition demonstrates situations as a constituting component in creating understanding, moving individuals' knowledge organization to the activity structure. Understanding and action are dispersed in the collaborative net of on-screen characters, artifacts, and circumstances, and this becomes the reasonable level of analysis (Coburn *et al*., 2016). In this study, it is believed that the learning environment is important in understanding how the teachers create knowledge and understanding. Teachers' curriculum meetings, preparations, and teamwork play a role during teaching and learning and lead to the development of new knowledge and understanding. During the lesson, teachers are expected to use the knowledge gained from other teachers that may assist teachers in promoting teacher-learner interaction in the classroom.

2.3.4.7 Learners' understanding occurs in a learning environment

Considering how individuals' previous experience impacts how individuals make meaning of strategy and interpret that knowledge into action, in this study I note how social context affects sense-making. Research suggests that knowledge that is rooted in societal settings influences an understanding of curriculum enactment (Spillane *et al.,* 2002; Gudyanga & Jita, 2018). As indicated earlier, the implementing agents come from a multifaceted net of organizational structures, proficient affiliations, social systems, and

conventions (Coburn, 2001). The way one categorizes the world we live in impacts how we describe and create meaning of things; hence individuals construct a sole set of experiences and expectations from their own experience.

The institutional perspective of teachers is located in areas that offer norms, rules, and definitions of the environment (Spillane *et al.,* 2018). Individual understanding is controlled by the regions in which they are positioned and illuminates different sectors of work practices, advances, and the operation process. Institutional theory assists the implementing agent to account for large-scale designs of usage inside a regulated division (Spillane *et al.,* 2002) and is confined to accounting for differences in implementation within any one sector.

The social context in a workplace describes how teachers develop an understanding of new practices and settings (Coburn, 2001). Social means is a very important aspect for teachers to work and to create meaning of the policy so that the implementation process becomes easier (Gudyanga & Jita, 2018). During this period, people draw on existing information and collect knowledge to determine the meaning of the policies and make recommendations. Social and group interactions enable individuals to learn and allow them to be exposed to alternative interpretations of mutual changes (Spillane *et al.,* 2018). In this study, during lesson observations, teacher-learner interactions may be through discussion, debate, and negotiations. During the lesson, teachers are expected to use knowledge from the communities and local actors to mediate the confusing situations when learners interact in the classroom, receiving the information that is found within a set of social connections.

2.3.4.8 Dialogue and debate in the learning environment shape learner understanding

Research studies on implementation emphasize the need for social interaction and dialogue during the lesson. A study on the mediating role of teachers' proficient communities shows the significance of communally simplified understanding within the application practices (Spillane *et al.,* 2002). When the public interrelates with new information over time, individuals develop an understanding of what they need to do well in their work (Coburn *et al.*, 2016) and filter ideas about existing practices. According to

Coburn (2001), teachers' sense-making within the same school can be orchestrated in a few formal and casual bunches, and teachers interpret and make sense of the same policy differently. In this study, experienced teachers may support other teachers who are inexperienced during the lessons, which can, in turn, assist teachers in incorporating their perceptions, beliefs, and experiences about evolution into their lessons in different ways. The study understands that teachers use the same textbooks in schools; however, their interpretation of curriculum content may be different. This suggests that patterns of formal and informal teacher interaction influenced what teachers noticed, how they noticed it, and how they interpreted reform initiatives. Teachers in different formal and informal groups understand the reading reforms differently (Coburn *et al.*, 2016). This is supported by Gudyanga and Jita (2018) in a study on teachers' implementation of laboratory practicals in South Africa.

In conclusion, the study adopted the cognitive framework of curriculum implementation as the theoretical framework. The theoretical framework was adopted because it outlines the stages and core elements that a teacher can consider when teaching controversial topics like evolution in the classroom. The three stages of a cognitive framework of curriculum implementation are individual cognition, situated cognition, and role of representation. The researcher understands that during individual cognition, educators pay special attention to how individuals receive information, understand change, and how individual perspectives impact the formation of new understanding, while situated cognition explains how situations and contexts are important in understanding how the teachers create knowledge and understanding. The cognitive framework on curriculum implementation was the key in this study, because I was able to observe teachers making meaning of the content for learners to learn and influence learner understanding, using prior knowledge, and interpreting the same subject content. The framework further enables me to observe how teachers' misunderstanding of new ideas leads to learner confusion and how teachers' focus on superficial features influences understanding in the classroom. Learners' understanding and social interactions such as dialogue and discussions shape learner understanding during the lesson. The framework outlined will assist in analysing the data collected.

In the next section, literature on curriculum implementation and teaching of evolution is discussed.

2.4 LITERATURE REVIEW

In this section, literature pertinent to the present study are reviewed. These include studies that were conducted on curriculum implementation and on teaching evolution in the classroom internationally and in Africa (particularly in South Africa) including the gaps that this study addresses.

2.4.1 Curriculum implementation in the classroom

This study concerns the pedagogics of evolution as a controversial topic in the school science curriculum. The implementation of curriculum differs from one country to another, based on the needs of the curriculum. Many studies reported on in the literature examine the curriculum implementation in the classroom. This study focuses specifically on how teachers manage the controversy of the topic of evolution when implementing the curriculum in the classroom.

2.4.1.1 International studies on curriculum implementation

In most countries, curriculum change had a significant influence on education and was affected by several interrelated factors that influence the success of the practices (Fullan, 2001; Priestley & Philippou, 2018; Gleeson, Klenowski & Looney, 2020). Studies conducted by Hill (2001), Drake and Reid (2018), and Harris and Graham (2019) have found that teachers may accept the teaching and learning materials to support the policy reform ideas, only to find that the available material does not match the expectations of the curriculum. Teachers may see their position of teaching better than the new curriculum and/or think that a traditional curriculum is adequate to implement the policy.

The article on the challenges faced in the implementation of the new curriculum in Zimbabwe (Dube & Jita, 2018), due to lack of resources and poor teacher planning, found that solid school relations are imperative for the success of any curriculum implementation

process. The study proposed a need for educational module organizers, school heads, teachers, and learners to invest in healthy relations supported by social equity, liberation, and change of school conditions to enhance curriculum implementation.

A study by Chimbi and Jita (2020) on how teachers in Zimbabwe choose their teaching strategies in reaction to a modern educational program change approach finds that policymakers put academic change arrangements before the teacher. The study demonstrates that for compliance with the change approach, it is fundamental for in-service teachers to utilize imaginative teaching approaches. The study further suggests that teachers' capacity building on innovative instructional strategies and creating learning communities may reduce the gap between policy demands and classroom practice. The research report by Chimbi and Jita (2020) on teachers translating the new curriculum policy, discovered that the teachers are naturally resistant to change and suggests that teachers have to be engaged with how to actualize the conceived changes.

A study conducted by Haug (1999) on mathematics curriculum implementation in four Colorado school districts reveals that individual interpretations influence the implementation process. The result shows that the four districts have been implementing the same curriculum for several years, but the teachers' understandings were different. This means that there was a difference in interpreting the curricular specification and the understanding as it plays a vital change in classroom practice. A study by Spillane (2000) on school districts' reactions to science policies recommends that district leaders should attend to familiar policy ideas and come up with newer ideas to support teachers (Spillane, 2000). From a case study by Cohen (1990) on teachers' responses to new content, it transpires that now and then teachers miss the new and more fundamental transformation in substance and pedagogy required by the curriculum. The study shows that teachers attend to familiar ideas, i.e. groupwork and the use of manipulatives, but lack of a mental framework to associate and clarify unfamiliar ideas (Cohen, 1990).

Some curriculum implementation studies show that some teachers tend to assimilate new information into their present basis for understanding (Cohen, 1990; Priestley & Philippou 2018). A study by Hill (2001) highlights the conservative nature of teachers' sense-making

concerning state benchmarks, i.e. the California teachers' understanding of that state's science systems contains old and new ideas of curriculum instruction. Cohen (1990) further indicates that teachers construct knowledge and an understanding of the thoughts that fit within their existing instruction, which then lead to differences between the intended policy and teachers' understanding.

Spillane and Zeuli (1999) also determine that teachers are willing to participate in change of practices that emanate from the intent of the curriculum. The results of the study by Spillane and Zeuli (1999) show that few teachers were familiar with the curriculum and implement the required standards. This implies that few teachers understand the core ideas of the reform (Priestley & Philippou 2018; Gleeson *et al.*, 2020), but emphasize procedural knowledge and understand the guidelines in ways that include no fundamental changes, i.e. mathematical knowledge. A study by Vesilind and Jones (1998) reports that teachers integrate forms of philosophies into their modern views, opinions, and beliefs of learning during implementation, and this challenges the change when teachers' thinking clashes with the intent of a policy. Teachers present understandings and interpret science changes from available information from textbooks and put emphasis on hands-on activities (Vesilind & Jones, 1998). This shows incorporating existing practice that enables students to play new roles in the classroom.

A report by Haug (1999) reveals that some of the teachers understand changes as involving rearranging the content covered in the traditional curriculum and ensuring that it fits the topics covered in the new curriculum. In this instance, Haug (1999) has found that few teachers had a partial understanding of the new curriculums, and implemented few isolated changes in existing practice, while other teachers understand the change as including fundamental changes for conventional instruction, and building on students' prior knowledge, which then made connections among topics and the content areas. Therefore, teachers' experiences will play an important role when teaching evolution as a controversial topic in the curriculum. A study by Spillane and Callahan (2000) on the patterns in teachers' understandings of scientists discovered that some teachers have their opinions, and they draw from prior experiences. The study highlights those teachers

who focus on external structures instead of the fundamental auxiliary thoughts of the curriculum (Spillane, 2000).

A study on implementation by agents illuminates how community setting impacts how teachers understand the policy and the requirement to improve applications (Priestley & Philippou, 2018). In this study, teachers' local settings of enactment served as facilitating functions between policy and practice (Priestley & Philippou, 2018). The study found that the implementation of policies was based on social activities and not individual understanding, and negotiations amongst teachers and alteration in teaching, and material resources influence teacher practices (Spillane & Zeuli, 1999). Teachers with enactment zones that extend beyond the individual classrooms include ongoing deliberations with fellow teachers and their implications for practice so that they can understand the ways that resonate with the policy. This may suggest that during the lessons on evolution, teachers should consider using existing examples like social and community understanding and knowledge of evolution to build the lesson for learners to understand.

A research report by Tshiredo (2013) shows that the repetitive improvement of science in England and Wales has created some challenges and impacted diverse ways of education. Numerous studies suggest that factors like teachers' knowledge, capacity, will, and expertise (Cohen, 1990; Harris & Graham 2019) have either a positive or negative impact on curriculum implication. Other factors include suitable teaching resources, unintended in-service training, and inequalities, according to places (Spillane *et al.,* 2018). Therefore, teachers should have all resources and the necessary expertise to teach evolution as a controversial topic and use relevant social and existing ideas and knowledge from the community to influence learners' understanding.

Research by Spillane *et al.* (2002) points out that opinion among teachers and curriculum managers on a school's preparedness to implement and deliver the new curriculum affects the implementation process. Therefore, the Department of Education should improve science teachers' subject knowledge through workshops and training to advance teaching in schools (Parker, 2006). To achieve this, the Department should place subject

knowledge in line with the curriculum area at the centre for effective learning (Parker, 2006). Spillane (1999) argues that the failure of curriculum managers to notice the problems associated with implementation accurately affects the success of the curriculum.

Rogan and Grayson (2003) report that the UK chose a distinguished approach to curriculum implementation to help schools to achieve some goals, assist them to advance in areas where they are already competent, and introduce class teaching and learning methods. According to Rogan and Grayson (2003), these approaches did not help to resolve the discrepancies in schools; instead, more schools are still faced with difficulties to implement the changes due to their will and capacity (Spillane, 1999; Cohen, 1990). Harris and Graham (2019) suggest that curriculum implementation should always take the background of a specific place and environment into account. However, Cohen (1990) indicates that the attention should focus on implementation flaws during curriculum monitoring.

A study by Tshiredo (2013) proposes that an effort is needed to empower mathematics teachers to attain new skills of the new curriculum to address the challenges. Cohen (1990) suggests that to safeguard the curriculum implementation process so that it can move efficiently, there should be curricular alignments to monitor the process so that the implemented curriculum attains the required goals and objectives. This suggests that subject specialist who monitors and support changes in curriculum implementation should be empowered (Priestley & Philippou 2018; Gleeson *et al.,* 2020). The curriculum changes from different countries outlined above show that change in the curriculum has a significant influence on classroom practices. The outline of the curriculum in South Africa in 2008 expected of teachers to come up with strategies that will enable them to negotiate controversial topics like evolution in the classroom. This study looks at how teachers teach the section on evolution in their classrooms.

2.4.1.2 South African studies on curriculum implementation

Research shows that curriculum change in South Africa, the National CAPS, intends to create a healthy, conducive learning environment in our schools (DoE, 2011), and has

some dynamics that influence the success of curriculum implementation. A study by Sanders (2010) has found that there is a lack of required skills for managers to monitor and support curriculum change. Spillane *et al.* (2002) indicate that the brilliance of teachers' and supervisors' knowledge, experiences, and open-mindedness can permit achievement in pedagogical practices. This suggests that more work should be done during the development of curriculum implementation theories so that the implementers, i.e. school-based specialists and in-service training providers, can be guided through the process when teaching evolution.

The current curricular change contains Indigenous Knowledge Systems and Nature of Science (NOS). This suggests that when teaching evolution there should be argumentation in the recent curriculum reform and careful articulation through teacher education. A report by Gudyanga and Jita (2019) on physical sciences teachers' perceptions and experiences indicates that while reform implementation is known to be a challenge, the significant changes in the practical components show the difficult nature of the process. A research report by Molapo (2018) suggests that CAPS implementation is hampered by inadequate training of educators, a lack of resources, and too much paperwork. In another study, Tsakeni, Munje and Jita (2020) show that schools can use sense-making to forge unique practices that culminate in effective instructional leadership, and they indicate that it is essential for districts to provide tools that support schools' effective sense-making of instructional leadership. Lastly, the study by Govender (2018) on teachers' perspectives on implementing reforms in schools reveals that teachers feel inadequately provided with sustainable professional development, and have minimal opportunities for classroom support, guidance and monitoring to assist in implementing the changes required.

The international and South African studies summarized above are important in my study, on the basis that they provide the success and challenges encountered during curriculum implication. They further give possible recommendations of what needs to be done in the classroom.

2.5 TEACHING AND LEARNING OF EVOLUTION

This section covers the presentation of evolution within the South African curriculum, international and African studies, teacher training, teachers' misunderstanding of evolution, managing controversy when teaching evolution, teachers' acceptance of evolution in the classroom, public knowledge, and views of evolution, teacher knowledge and views of evolution, religious views related to evolution ideas and opinions, and challenges experienced in the classroom.

2.5.1 The introduction of evolution in South Africa

Evolution was introduced in 2008 in secondary schools. During this period some teachers were not familiar the topic on evolution. This, therefore, resulted in the DBE offering training to prepare all Life Sciences teachers. Evolution could be a crucial perspective of Life Sciences and is exceptionally significant in existence. Life Sciences is required if the public is to understand social issues such as human and plant evolution (Haga, 2006). The main source of Life Sciences knowledge is through biology education. However, the origin of ideas about evolution is one of the themes most teachers and learners find troublesome to teach and learn (Sanders, 2010; Tsui & Treagust, 2007; Reddy, 2012) due to a lack of adequate training by the DBE.

According to the literature by Sanders (2010), Neubrand and Harms (2017), and Sutherland and L'Abbe (2019), other factors contributing to the difficulties in teaching/learning the Life Sciences concepts in schools include learners' prior knowledge, which either provides context for their understanding of the concepts or is a source of confusion (Tsui & Treagust, 2007). Traditional methods of teaching, which often rely on textbooks, tend to focus more on theory than a conceptual understanding of evolution (Sanders, 2010). The abstract nature of the evolution lets teachers focus on limited areas for examinations purposes, which make other aspects of the topic look useless, yet important in conceptual understanding (Sanders, 2010). Few of the literature reviewed so far explores the difficulties faced by Life Sciences teachers teaching the origin of idea(s) about evolution, considering the tenets of science.

The main source of Life Sciences knowledge is through biology education, but evolution is viewed as a challenge (Knippels *et al.*, 2005; Tshui & Treagust, 2007). Tshui and Treagust (2007), supported by Knippels *et al.* (2005), add that this struggle in teaching evolution is at both an abstract and language level. They have found that Dutch teachers are challenged by the terminology in genetics, which is often not used consistently and explicitly in curriculum material, and the complex nature of the genetics concept, which engages teachers and learners in to-and-fro thinking between molecular, cellular, organism, and population levels, among others.

In 2010, the Republic of South Africa announced CAPS for all grades to amend the NCS (DoE, 2010). The principles of OBE are one of many principles in the CAPS, which is planned to develop learners holistically (DoE, 2010). OBE underpins the basis of the curriculum in South Africa (DoE, 2011) and promotes a learner-centred teaching and learning approach to education (DoE, 2011). During the learning process, the focus is now on learners, which in part has grown out of teachers' discontent with old-fashioned strategies that give learners a fixed body of knowledge. The shift transmits an ambition to search for possible ways of creating reactive teaching to learner necessities and benefits and enables learners to be energetic in the learning processes (DoE, 2010).

The South African school system does not organize schoolteachers and children to benefit from the understandings of the evolution of life. The CAPS is a planned policy statement that intends to address inequalities of the past and to empower people with knowledge and skills for future use (DoE, 2011). The improvements in the curriculum focus on a learner-centred method and are incorporated across the syllabus at the lower grades. There was an inclusion of knowledge systems like evolution in the Life Sciences Curriculum (DoE, 2010).

The South Africa school system consists of different phases: the FET is one of the phases and includes Grades 10 to 12. In the FET phase, Life Sciences is a subject for the National Senior Certificate (DoE, 2010). The main contest confronting teachers has been to adapt to the new curriculum for which they were possibly not equipped to teach during their training. The training for the new curriculum implementation consisted of workshops for

different districts in Gauteng in 2010/11 during holidays, in preparation for the implementation. Reddy (2012) further reports that little support was employed by the DoE, i.e. district offices support teachers to assist them with implementation.

This study concerns teaching controversial topics like evolution in the science classroom. Therefore, it was important for the researcher to consider and look at how evolution is taught and learned in schools. The studies that were conducted globally are discussed in this section, as well as the highlights of the gap that this study addresses. A study by Sanders (2010) shows that many studies reported in literature examine the didactic part of evolution, but very little has been done on how teachers manage the controversy of the topic in the classroom.

2.5.2 International studies on the teaching and learning of evolution

Several headings were created to discuss international studies, and are discussed next:

2.5.2.1 Acceptance of teaching and learning evolution in schools

Hermann *et al.* (2020) reveal that 51% of the people in America and 54% in the UK indicated that evolution teaching was allowed in schools (Shepherd, 2009; Hermann *et al.*, 2020), which shows that most of the population are in favour of evolution lessons. Other studies that were conducted internationally investigated the teaching and acceptance of evolution by teachers, learners, and the public.

A study by Akyol *et al.* (2012) on pre-service science teachers' understanding, and acknowledgment of evolution has found that teachers' views on NOS were related to higher levels of convictions and understanding, and that influenced teacher acceptance of evolution. Besides the high levels of understanding and reception of the theory on NOS, the study found that there was a strong self-efficacy conviction for instructing evolution successfully. Šorgo *et al*. (2014) conducted a study to measure first-year university and high school students' level of knowledge about evolution. Šorgo *et al.* (2014) found that knowledge of the NOS at freshmen level was seriously weak and unsound and impacted seriously on the teaching of evolution. Non-scientific explanations were present in high

percentages and served as barriers towards scientific reasoning and acceptance of evolution, especially for students articulating religious beliefs (Šorgo *et al.*, 2014).

According to Baker (2013), public acceptance of evolution remains low in the United States when it gets to support for the teaching of creation, and the impact of teacher attitudes towards evolution and creationism depends upon religious uniqueness. Baker states that the misunderstandings about evolution and its place in education remain a challenge, because of the involvement of religious and political communities. A study by Hermann (2013) on high school teachers' teaching of biology provides an awareness of the clear characteristics of teaching evolution as seen by public high schools. This study made suggestions for science teacher educators to adjust the preparation to develop science teachers to deal with the challenges of teaching evolution.

Research by Robins, Rountree and Rountree (2003), and Menton (1991) on teaching the origin of species in schools shows that there is conflict about the teaching of evolution and creationism in US public schools, which makes lessons on evolution unsuccessful and inefficient, while Menton (1991) reports that there is a serious debate on creation evolution in public education that recommends the inclusion of evolution. The report suggests that creationism should be omitted from the science syllabus, while evolution is only taught as a theory of origins.

2.5.2.2 Approaches and strategies for teaching evolution

Romine *et al.* (2014) and Glaze and Goldston's (2019) research on professional development indicates that teachers' endeavours have progressed on acknowledgment related to the hypothesis of theory in school science education. This suggests that teachers require more understanding of evolution and its fundamental position. Debates by Diamond (2014) on the teaching of evolution and creationism in schools show that very few people seem to know the arguments opposing evolution in schools. The outcome of the debate shows that the thoughts on evolution and creationism do not have to be limited, but that there should be a proper time and place to teach evolution.

In America, Bilica (2012) discovered that teachers fail to contain learners in a lesson when teaching debatable topics like biological evolution because they allow learners to discuss the nature of science. The study notes that if learners are given time to think effectively around new controversial topics, they will learn to position their knowledge into the greater systematic perspective. Bilica (2012) indicates that thinking is helpful when learners are about to study contentious topics like human evolution, because they learn to position their learning in a precise background. By doing so, learners will be able to differentiate questions of science from questions that cannot be answered by science, further advising them not to study particular ideas in class that are outside the domain of science. These will in turn show respect for learners' philosophies while helping them to realize why the perceptions are not considered a part of science.

2.5.2.3 Challenges of teaching and learning evolution

A research report by Borgerding and Klein (2015) on the teaching of evolution shows that teachers of evolution are confronted by a few challenges, including limited content information, individual clashes with evolution, desires of resistance, concerns around students clashes with religion, and curricular imperatives. The study further shows that teaching can be especially challenging for new teachers who start to pick up educational information and educational substance information related to evolution. This, therefore, suggests that science teachers need to know how best to support one another.

A study by Hahn *et al.* (2005) on societal qualities of pre-service teachers' accounts for evolution has discovered that teachers encounter difficulties when teaching evolution. The research report shows that the individual understanding of evolution is the most debatable part of evolution notion and contributes to learner and teacher discomfort (Hahn *et al.*, 2005). Hahn *et al*. (2005) further examined teachers' theoretical illustrations of an evolutionary process and discovered that the narratives are closely parallel to human evolution, which then seemed to be difficult to understand. The report further shows that the association among social and moral issues provides important indications into pre-service teachers' conceptualizations of human evolution.

The National Science Teachers Association (2013) shows the position statement taken by teachers in schools, namely that evolution is an important notion in science education and should be included in a science education curriculum. The inclusion of evolution will boost students to achieve the level of scientific literacy required and prepare them for college and science-related careers. This position is similar to those of the National Institutes and numerous other logical and instructive organizations. Teachers are confronting challenges to present logical distortion and non-science substance into science classrooms (National Science Teachers Association, 2013).

A study by Tucker (2012) on the benefits of teaching the neo-Darwinian theory of evolution shows that teachers encounter challenges as to how to manage the teaching of evolution from a practical theological perspective. The study by Long (2012) examines the assumptions concerning biology teacher approaches towards evolution and discovers that there is a battle to control the instruction of evolution and creationism in America's classrooms. The study concludes that due to several teachers compromising evolution within the educational modules, the arrangement of teaching courses should prepare new teachers. Tucker (2012) suggests that teachers should only teach what the curriculum demands. In support of the above idea, Kampourakis and Zogza (2007) indicate that the relationship between students' thoughts and views on evolution ought to emphasize students' ideas and the role of change during the evolution process, given the contrasts within the cultural, historical, and social settings (Kampourakis & Zogza, 2007).

2.5.3 Studies on teaching and learning evolution in South Africa

The literature below is key to my study as it provides me with the gaps and pictures of the influence of teacher perceptions, beliefs, understanding when teaching evolution.

2.5.3.1 Teacher training on teaching of evolution

According to Sanders (2018), scanty teacher development may have influenced teachers' ability to teach some of the topics in Life Sciences and to implement OBE properly. The GDE offered teacher training for six days, preparing teachers about something that requires the formal training of a teacher at a college or university (Sanders, 2018). The

teacher development was on updating teachers of the NCS in 2006, and not teaching approaches. Teachers who were appointed to facilitate the process read the training manual with no interpretation of the content. From my observation, teaching the origin of ideas on evolution needs adequate time. Therefore, training and workshops on evolution should be organized to support the teachers (De Beer & Henning (2010).

According to Sanders (2010), the curriculum demands of teachers to have knowledge and an understanding of evolution so that they can cover ideas at the different levels in the structures. The study also shows that teachers lack support and training on the concepts of evolution (Sanders, 2010). The workshops conducted by the department of education did not make a major difference in terms of preparing teachers to teach Evolution and Indigenous Systems (Sanders, 2010). This means that teachers face the implementation process without sufficient training to teach the basic elements of evolution.

Research by Stears (2012) on learners' responses to a course in evolution shows that there is an inadequate enhancement in content knowledge in the understanding of the NOS. This study was on conceptual change, NOS, and religious conflict, as supported by Scharmann (2018). The report suggests that teacher education courses and workshops ought to centre on conceptual understanding, making strides towards understanding the NOS, and supporting teachers to develop an understanding of how to bargain with challenges that arise within the classrooms (Stears, 2012). An inquiry into a report by Sanders and Ngxola (2009) distinguishes the teachers' concerns in teaching evolution and discovered that teachers move through a predictable series of concerns. The concerns identified are around managing individuals' understanding of the theory of evolution (Sanders & Ngxola, 2009; Neubrand & Harms 2017).

Wiles and Alters (2011) investigated the impact of an educational experience and the factors influencing student reception of evolution. Their report states that the level of acceptance by various teachers differs, and is influenced by different philosophies, i.e. religious, political, and moral, etc. A report by Abrie (2010) recommends that new teachers who are not prepared to teach evolution should receive training. The study

further discovered that learners come to the science classroom with devout convictions that conflict with science, and that impacts negatively on their learning (Abrie, 2010). This study will also check on how the participating teachers' development and educational experiences help to negotiate evolution in the classroom where most learners belong to a particular religion.

Sanders (2008), and Sutherland and L'Abbé (2019) report several difficulties that South African school teachers face when teaching evolution. Among these are poor PCK; lack of adequate training in the topic; the controversy around this topic; and widespread misconstructions by teachers, learners, and the public in general (Neubrand & Harms, 2017; Glaze & Goldston, 2019; Probiner, 2016). To assist teachers who attend the courses she offers, Sanders provides them with an adapted table taken from the website of the University of California, Berkeley – for those teachers who do not have internet access. The author notes that one of the most common misconceptions she has encountered in her research is the notion that evolution contradicts the existence of God, and that a choice, therefore, has to be made. Sanders (2018) further notes that many of the misconceptions identified in the Berkeley table and her research arise from poor knowledge of the NOS, specifically the meaning of theory and evidence in science, and the development in which understanding is constructed, reviewed, and constantly re-evaluated (Glaze & Goldston, 2019; Probiner, 2016).

2.5.3.2 Teachers' misunderstanding of evolution

Research by Zuzovsky (1994) and Jimenez-Aleixandre (1994) on the knowledge and understanding of evolution reveals that the teaching of some teachers is subjective, due to confusion, misinterpretation, and misunderstandings related to evolution. The confusion is based on Darwin's theory of evolution, in which organisms best adjusted to a certain environment replicate and pass on their genetic factor to the coming generation, while some teachers possess knowledge, opinions, and an understanding of Lamarck's ideas (Zuzovsky, 1994). Research by Jimenez-Aleixandre (1994) discovered that some teachers use Lamarck's viewpoints to respond to questions like organisms that need to undergo modification and further reveal that pre-service teachers enter the course with

misconceptions. The research further reports that there is no difference between teachers about significant concepts about evolution in some situations. A report by Sutherland and L'Abbe (2019) also shows that the curriculum, support material, and textbooks designed to strengthen the teaching of evolution are often inaccurate. Religious views in the country, especially Christianity, become a stumbling block towards understanding and accepting evolution.

Rutledge and Warden's (2000) study reports that teachers understand questions related to environmental change and the importance of genetic variation in natural selection, but they are unable to understand natural selection. Rutledge and Warden (2000) and other various researchers reveal that there are some mistaken assumptions of the objectives of science and the dubious nature of logical information (Rutledge & Warden, 2000). Zuzovsky (1994) also emphasizes teachers' misunderstandings of scientific theories and their view of evolution. Neubrand and Harms (2017) also indicate that evolution is challenging due to the fundamental developmental concepts that are complex for learners, which then become a challenge during the lesson.

Chinsamy and Plagányi (2007) conducted a study with students to measure their knowledge and understanding as well as their attitudes towards learning about evolution. The study discovered that students have inadequate information about evolution, and they learn about it for the first time at college and higher institutions. Some students find it difficult to accept evolution, due to the complexity of evolutionary ideas and theories, and due to religious views (Chinsamy & Plagányi, 2007). The study shows that learning about evolution seems to have done very little to change students' views and opinions at the start of the study, due to religious ties (Chinsamy & Plagányi, 2007).

A study by Chinsamy and Plagányi (2007) also found that more religious students, who practised their religion, are likely to find evolution mismatched with their beliefs and therefore relinquish the philosophy of evolution (Abrie, 2010). This idea was similar to the one shared by Trani (2004), who offers that teacher with solid devout feelings are less likely to instruct evolution. He further states that teachers with religious opinions have a particular thinking about evolution and the NOS.

2.5.3.3 Managing controversy during teaching and learning

Various international studies recognize teachers' perceptions of the controversy connected to teaching evolution. A study by Cleaves and Toplis (2007) indicates that some teachers are not at ease with handling the controversial nature of teaching evolution due to learners' religious beliefs and opinions. Cleaves and Toplis (2007) and Schulteis' (2010) studies have found that pre-service teachers and some experienced teachers experience challenges from learners when teaching evolution, due to social pressure from parents (Fowler & Meisels 2010). A study by Dempster and Hugo (2006) on teachers' efforts to deal with the creation disagreement in evolution discovered that teachers keep a neutral stance to make themselves and students comfortable, even though there is a lack of the academic understanding vital to assist pre-service teachers considering the evolution of the lesson. The analysis reveals that students share ideas and opinions on evolution, but the teachers miss opportunities to manage the ideas (Dempster & Hugo, 2006).

Schulteis (2010) further reports that teachers experience extreme pressure from different stakeholders not to teach evolution and include creationism. Teachers are requested to develop information of and approach for including learners who oppose evolution education, and teachers should become aware of other bolsters for educating advancement, i.e. supporting reports such as position articulations that offer foundations for teaching evolution (Schulteis, 2010). This can help teachers to deal with troubled parents, administrators, and the community that is in denial. Brunner and Lewis (2007) suggest that when confronting someone angry, one should maintain eye contact and clarify the person's concerns and clarifications. This may assist teachers to involve parents in conferences and other interactions that are planned to justify the teaching of evolution using these approaches.

2.5.3.4 Teachers' acceptance of teaching and learning evolution in the classroom

Various research reports uncover that acknowledgment of evolution may be a crucial instrument for educating evolution. Most teachers in the world announce that they do not accept evolution (Abrie, 2010). Levesque and Guillaume's (2010) research discovered

that teachers who possess only one way of knowing the world are likely to dismiss evolution. Southerland (2000) invites teachers to admit that the interpretations that support evolution and beliefs in evolution ought not to be the essential objective of education (Southerland, 2000; Probiner, 2016). However, acknowledgment of evolution as a logical hypothesis is seen as the fitting goal for future science teachers.

Research by Moore and Kraemer (2005) and Glaze and Goldston (2019) reveals that some teachers accept evolution as a useful and valid theory within the science society and public. Science teachers and scientists should help one another so that everyone can accept evolution as useful in the science community. To simplify, teachers and learners should apprehend basic backgrounds and customs of various ways to deliberate religion and science, because religions may rely on an amalgamation of tenets from the Bible and beliefs, whereas science depends upon clarifications and understanding of concrete proof to build defences of the characteristic world.

A report by Hermann (2008) suggests that learners and teachers must have discussions and deliberations on advancement in such a way that they do not debilitate their claim to devout understanding and knowledge. This discussion will enable teachers who claim to be creationists to read about the different creationist viewpoints and may recognize that there is no interference if one accepts evolution as a scientific theory. Smith and Scharmann (2008) and Scharmann (2018) reveal that inviting teachers to place evolution on a scientific band after receiving knowledge claims could help teachers to view evolution as important within the science family. This will allow teachers to discover their views and opinions on evolution that will enable them to accept it as a theory, while still adhering to their convictions (Scharmann, 2018).

2.5.3.5 Knowledge of learners' understanding of evolution

Research by Schulteis (2010) on teachers' knowledge about students' knowledge, opinions, and understanding of evolution discovered that teachers consider students capable of understanding evolution. Jimenez-Aleixandre (1994) reveals that practising teachers experience challenges in recognizing the ultimate real difficulties in students' other conceptions, but teachers understand students' challenges of evolution. Veal and

Veal and Kubasko (2003) report that some science teachers were better at detecting students' misinterpretations when compared to geology teachers. Van Dijk (2009) found that the teachers identified learners' preconceptions, for example, failure to understand the intra-species difference, selection occurring on the individual level, and misunderstandings of descent from common ancestry, etc. Sutherland and L'Abbe (2019) show that there is a need for logical proficiency that permits the continuation of social Darwinism and racial generalizations, and as a result, denies learners' information and instruments of thought to counter Christian ideas.

An article by Reddy (2012) reports that some learners do not want to study evolution, citing religious beliefs, which creates a challenge for learners to understand ideas on evolution, due to both concrete and phonological levels, and blames the lack of acceptable preparation by the DoE. A study by Coleman, Stears and Dempster (2015) on student teachers' perceptions about the NOS reveals that students have a poorer understanding of evolution and NOS**.** Stears *et al.* (2016) further conducted a study on creationist and evolutionist views of South African teachers with diverse devout affiliations, showing that there are concerns that in the community of logical thinkers there are teachers who do not acknowledge evolution as a logical, testable phenomenon, and this can be apparent in their educating. The article by Stears *et al.* (2016) suggests that teachers who hold views that are both creationist and evolutionist find educating the subject of evolution less tricky than teachers who hold fundamentalist creationist views.

2.5.3.6 Approaches and strategies for teaching evolution

Several teaching and learning strategies can influence teachers' knowledge and understanding of the content within the classroom. Research shows that there is a need for discussion or debate when teaching evolution (Weld & McNew, 1999), but no indication of whether teachers apply such approaches. A study by Marcelos and Nagem (2011) shows that some teachers build some contrasts between advancement and a tree of life in their instruction, but require data on educating the analogical highlights of the tree of life illustration. Neubrand and Harms (2017) also indicate that lack of a well-defined instructing and learning approach of evolution is challenging and leads to poor

understanding of evolutionary concepts by learners, as well as prevents a meaningful understanding of evolutionary concepts during teaching and learning.

Veal and Kubasko (2003) examined how teachers combine their knowledge of teaching approaches and assessment for teaching evolution and discovered that different teachers implement different methods during the lesson. As mentioned above, Van Dijk's (2009), study on teachers' knowledge of students' presumptions of evolution discovered that teachers recognize precise approaches for teaching evolution but their demonstrations are not related to students' misinterpretations and misunderstandings. A study by Sanders and Ngxola (2009) indicates that teacher preparation to teach evolution is poor and they propose that the department should employ advanced professional development to assist teachers, while Griffith and Brem (2004) suggest that teachers' desire for detailed lesson plans to can teach the section on evolution.

In 2005, Hahn *et al.* explored the moral inclinations of pre-service teachers' narratives of evolution, while in 2013, Kyriacou undertook a study that looked at teachers' conceptual understanding of evolution. Both studies argue that basic, centre and auxiliary schoolteachers encounter impressive uneasiness when teaching evolution due to poor teacher knowledge. The study recommends that workshops with longer learning programs for teachers be conducted to assist teachers to gain more knowledge and understanding. The report shows that the association among social and ethical issues, evolution, and challenges may assist teachers' conceptualizations of human evolution. Similarly, Van der Mark (2012) looked at the use of stories and concept cartoons to encourage higher order thinking skills about geological time. The results provide an exciting way forward for future teacher programs and a strategy for overcoming some of the cognitive and affective barriers hampering the teaching of evolution.

The Department of Education recommends that Life Sciences teachers should consider other ways of getting new knowledge when teaching evolution in the classroom such as religious and indigenous knowledge systems (DoE, 2010). As a result, there is added pressure on the teacher in a class with different faiths (Reddy, 2012). In some cases, the DoE controls what kind of exposure and experience teachers get to assist learners in the

classroom. The Department of Education's policy discourages schools from placing more emphasis on religious matters in the classroom, as it can be understood as undermining religious freedom. A study by Sanders (2010) shows that the introduction of evolution raised genuine concerns among teachers concerning the conceivable discussion seen to clash with religious beliefs and evolutionary theory. An examination of how teachers manage the contention shows that a few approaches likely advance the controversy. The investigation by Sanders also uncovered the unacceptability of teachers and their approach to teaching evolution. This suggests that teachers teaching evolution should consider using simple activities when planning and presenting a lesson, to avoid discussions that challenge religion and/or science. This will allow learners to explore their ideas about origins as a springboard for exposing myths and misconceptions.

The teaching of evolution demands that teachers must have information and an understanding of the social setting in which they work (Anderson, 2007). The most vital contextual factor relates to the predetermined ideas that learners bring to class during the learning of evolution. Therefore, teachers must understand these presumptions as they may obstruct the learning process in the classroom. A respectable Life Sciences teacher should possess enough content knowledge and understand the contextual backgrounds of the learners, their misconceptions and know the approaches of dealing with misunderstandings (Shulman, 1986).

Lastly, Scharmann (2018) recommends that it is critical when teaching science subjects such as evolution to set up NOS standards such as allowing learner’s involvement in learning process, earlier to the presentation of evolutionary concepts; and to integrate the theme throughout an introductory biology course. Scharmann (2018) further suggests that teaching evolution should engage learners in dynamic learning that improves openings for basic understanding, peer-to-peer intelligence, and student-to-teacher intelligence as they ponder developmental concepts.

2.5.3.7 Public knowledge and views about evolution

A study conducted in Britain, China, Russia, Argentina, and South Africa by Austerberry (2000) shows that most people surveyed know something about Darwin as well as his

theory of evolution. In particular, 42% of the people from South Africa who participated accepted the theory of evolution. The highest level of knowledge was recorded in countries like Great Britain, the USA, China, Russia, and Argentina. However, South Africa has the highest percentage of people (73%) who have never heard of Charles Darwin (British Council, 2009). This implies that the scientific literacy of most South Africans is low, even though the theory of evolution is essential to science. Low levels of acceptance imply low levels of motivation from parents to pursue science.

Research by Lelliott (2016) on visitors who visited the Cradle of Humankind in South Africa to find their knowledge of and acceptance of evolution shows that 58% of visitors accept human evolution. The visitors who rejected evolution mentioned their religious beliefs as the reason, while those who agreed with the idea of evolution cited fossils and comparative anatomy as reasons for their support of evolution (Lelliott, 2016). The acceptance of evolution by the visitors to the Cradle of Humankind in South Africa cannot be generalized to the South African population, since people who visit might already be interested in learning about evolution. Research shows that evolution is accepted by the scientific community, but the evolutionary theory has not been accepted by the public in America (Rutledge & Warden, 2000; Trani, 2004). The gap between the science community and the public causes the public community not to understand science; however, the public requires science to deal with some of the problems faced by different communities and societies.

A study by Mpeta (2014) investigates and portrays the convictions of teachers and learners about the concept of natural headway and how those feelings impact the guideline and the learning of the concept. The results show that the background of the participants, such as religion and from whom they first heard of evolution have a strong influence on their beliefs about evolution. Most of the learners in South African schools and the three teachers hold Christian convictions and a few of them see the evolution to conflict with those convictions (Mpeta, 2014). There was a direct acknowledgment of evolution by learners. In teaching evolution, all the teachers engaged learners in discussions and debates and encouraged them to separate their beliefs from evolution. Despite their Christian convictions and the discord between this and evolution, learners

were spurred on to memorize evolution. They felt that evolution give clarity to a few of the questions they had themselves, and therefore they wanted to understand it better. The study encourages an investigation of learners' and teachers' convictions and assistance of teachers like science (Mpeta, 2014), to gain a better understanding of the concept of evolution.

2.5.3.8 Teachers' knowledge and views about evolution

A study by Trani (2004) further affirms that teachers believe that teaching evolution is against their religious knowledge and understanding and is an idea that is against some teachers' religion (Train, 2004). There are claims against the teaching of evolutionary ideas and this may be one in several claims by teachers, particularly in secondary school biology classes around the world. The teachers' position makes the teaching of evolution concepts difficult. Rutledge and Mitchell (2002) indicate that the presence of teachers in the classroom determines the quality and value of learning that must take place within the classroom. Rutledge and Mitchell (2002) discovered in their study that teachers in America show low levels of information and understanding and constrained gathering of the evolutionary ideas, even though during learning teachers must ensure that learners develop an understanding of the evolution ideas, concepts, and theory. This is also indicated in reports from the general community. Trani (2004) suggests that it is important to appoint qualified Life Sciences teachers with the necessary knowledge, skills, and understanding of science in evolution.

A study was also conducted in South Africa on teachers' lack of knowledge and understanding evolution, investigating the concerns and needs of secondary school teachers (Sanders & Nqxola, 2009). The results from this study discovered that teachers are very worried about the controversial nature of evolution. Teachers' lack of knowledge influences learners' thinking, as the teachers can spread delusions and have an impact on the quality of people produced by South African Life Sciences education. Therefore, teaching evolution is seen as a challenge in most countries, including South Africa.

Sanders and Nqxola (2009) also report that some schools fail to answer questions on evolution, which suggests that some teachers do not teach the section, affecting many of

the learners. The reasons for learners skipping questions on evolution are not known, but further research is suggested to establish the reasons. A study conducted on Life Sciences teachers and scientists who are Christians shows that teachers from different educational experiences also encounter internal conflict between evolution and their philosophical views and beliefs (Meadows, Dorster & Jackson, 2002). Due to different educational experiences, teachers are found trying to resolve their religious issues about evolution as they are requested to deliver quality teaching to learners' knowledge, skills, and understanding about evolution.

Research by Reddy (2012) indicates that there are teachers who disregard the theory of evolution due to their religious beliefs, while certain learners are not open to evolution because of their beliefs. As a result, this creates a challenge for them to understand ideas on evolution. The science curriculum comprises ideas that offer a base for learning about evolution, but some teachers focus on teaching evolution at the level of imaginative natural science (Dempster & Hugo, 2006). The study by Reddy (2012) further shows that Hindu teachers do not struggle with the subject of evolution. They are uninformed of their religion and sacred texts and remain tolerant of the hypothesis of evolution.

2.5.3.9 Religious views related to evolution ideas and opinions

The studies conducted in South Africa pronounced diverse outcomes about evolution syllabus content in the classroom. Dempster and Hugo's (2006) conducted a study on the significant of having evolution as part of the school curricula. Chinsamy and Plagányi (2007), as well as Abrie (2010), examined learners' attitudes on the topic of evolution, while Sanders and Ngxola (2009) focused on teachers challenges while teaching the topic for the first time. All the studies show the influence of the learners' religious position during the lesson in the classroom.

A research report by Sanders and Ngxola (2009) shows that the source of conflict emanates from poor knowledge of and misconceptions about religion and evolution. The study also shows that certain number of teachers don't know that religions do not see developmental hypotheses as clashing with their convictions. As a result, individual religious beliefs seem to be a challenge for teachers to can be able to effectively share

information on evolution. The South African curriculum on evolution seems to bring comparable concerns articulated by teachers in other countries, i.e. in America, and predominantly of a religious nature and directed to the Christian idea of creation.

A study conducted amongst teachers and learners by De Beer and Henning (2010) shows that some teachers and learners do not accept evolution due to their religious positions. However, they believe that there is a need for bringing religious views when teaching evolutionary theory because this would allow learners to understand (De Beer & Henning, 2010). A similar study by Naudé (2013) shows that some Christians have their views and opinions and reject evolution. It has been noted that the integration of religion with the science is not clear on the CAPS document. Lovely and Kondrick (2008) further comes to the same conclusion that, even if evidence of evolution processes were provided to students, the evidence did not move teachers' and learners' views to any scientific point, opinions, and understanding of evolution.

2.5.3.10 Challenges to teaching and learning of evolution

In this study, the researcher proposed to explore how teachers teach controversial topics in the school science curriculum and also examine the perceptions and practices of teachers about evolution. In the CAPS, the some of the roles of the teachers are to guide, support, facilitate and provide direction during the learning process, while learners learn actively and perform activities (DoE, 2010). The CAPS considers other ways of knowing, i.e. faith-based and indigenous knowledge systems (DoE, 2010). This places weight on the teacher in managing with a multicultural class, with different faiths (Reddy, 2012; Neubrand & Harms, 2017). The policy of the DoE limits schools from deliberating religious issues in the school science classroom in respect of religious rights as set by the Constitution of South Africa.

Teaching evolution is seen as a challenge because it touches on the most sensitive issues such as beliefs, religion, and culture (Abrie, 2010). The CAPS in South Africa requires schools to cover all sections of evolution in the Life Sciences curriculum for secondary school. However, in most cases, teachers may have different beliefs and cultural backgrounds than those of the learners and their parents (Long, 2012). Some parents

might view such teachings of evolution as misleading and blasphemous, and emotions might cloud the learning platform (Hahn *et al.*, 2005). It is these considerations about the challenges in the teaching of evolution that propelled me to explore the topic of difficult dialogues in schools.

A study by De Villiers (2011) on the investigation of what learners reflected to be difficult and interesting in Life Sciences discovered that the four strands were interesting in Grade 12. In terms of challenges, the study reflects that the Grade 10 educational program's topics are more difficult, compared to the Grade 11 and the Grade 12 curriculum content. According to De Villiers (2011), most of the teachers found that the subjects in the substance zone diversity, alter and progression (Grades 10–12) are more difficult to memorize than the other three substance zones and the emphasis should be on what learners are interested in. The difficulties are viewed to be caused by a lack of enough knowledge and understanding of the evolution content of diversity, change, and continuity strand.

Research by Menton (1991), on teaching the origin of species in South African schools, indicates that teachers experience challenges concerning evolution, and creationism in various countries. Menton (1991) suggests that the study of the origin of life ought to be prohibited in the school science classroom, while Long (2012) investigated the politics and laws of teaching evolution, school science education standards, and what it means to be a creationist. The research study discovered that there is a challenge to manage the academic stance of evolution and creation in the classrooms. As a result, the study concludes that a large percentage of secondary school Life Sciences teachers compromise the section on evolution in the curriculum. Therefore, the Department of Education should organize and arrange detailed courses and specific programs on evolution for biology teachers.

The research conducted by Holtman (2000) on the teaching of evolution focuses on challenges and opportunities of teaching evolution. The study reveals that teachers do not usually use the word *evolution* in their teaching, citing religious issues. However, the curriculum contains theories that can deliver a concrete base for learning about evolution.

Dempster and Hugo (2006) report that evolution remains a controversial topic in schools' science curriculum. Holtman further argues that evolution is seen as the merging source to accept the associations among living things, the history of life, and the reliance of lifespan on the biosphere. The study indicates that it is the principal goal of present science education development within biology, and it cannot be attained without an understanding of biological evolution (Holtman, 2000).

A report by Yalvac (2011) discusses the obstacles in the teaching evolution among Muslim teachers and learners in South African Muslim schools, while Reddy (2012) examined the practices of Hindu teachers and learners in secondary schools. Yalvac (2011) discovered that the teaching of evolution requires a radical conceptual understanding, while Reddy discovered that Hindu teachers and learners are ignorant of their religion and sacred writings and acknowledge the hypothesis of evolution. Reddy further indicates that the acceptance is attributed to the links of evolutionary concepts by the Hindus. A study by Sanders (2008) on some difficulties that South African school teachers face in the teaching of evolution shows that challenges on approach to teaching evolution are influenced by religious views, practices, and understandings. The studies indicate that there is a requirement for learners to be allowed to learn; however, controversy in evolution, and misconceptions held by teachers were found to be some of the problem. Abrie’s (2010) study on assertiveness and preparedness of South African teachers has found that teachers dismiss the hypothesis of evolution, citing religious beliefs.

A study by Knippels *et al.* (2005) has found that teachers are challenged by the terminology in evolution, which is often not used consistently and explicitly in curriculum materials. The complex nature of the evolution concept, which engages teachers and learners in to-and-fro thinking between molecular, cellular, organism, and population levels among others may partly be to blame (Knippels *et al.*, 2005).

A study by Sanders (2008) on some difficulties that South African school teachers face in the teaching of evolution shows that challenges with the approach to teaching evolution are based on religious views and understandings. This is echoed by Sutherland and

L'Abbe's (2019) study, which further suggests that learners should be given a fair deal, and their beliefs should be respected when teaching the science of evolution, as poor Pedagogical Content Knowledge; and controversy in evolution; misconceptions held by teachers; and a poor learner understanding of science were found to be problems. Abrie's (2010) investigation has found that teachers reject the theory of evolution, citing religious beliefs.

Life Sciences is required if the public is to become involved in some informed expressive discussions on social issues such as human and plant evolution (Haga, 2006). The main source of Life Sciences knowledge is through biology education (Sanders, 2018). Knippels *et al.* (2005) have found that Dutch teachers are challenged by the terminology in evolution, which is often not used consistently and explicitly in curriculum material, as well as by the complex nature of the evolution concept, which engages teachers and learners in to-and-fro thinking between molecular, cellular, organism and population levels, among others.

According to the literature, other factors contributing to the difficulties in teaching the Life Sciences concepts in schools include learners' prior knowledge, which either provides a context for their understanding of the concepts or is a source of confusion in the learning of the topic (Tsui & Treagust, 2007); traditional methods of teaching often rely on textbooks; yet, textbooks tend to focus more on theory than the conceptual understanding of evolution (Reddy, 2012); the abstract nature of the concept; limited area of focus for examinations, which makes other aspects of the topic look useless, yet important in conceptual understanding (Sanders, 2010). Few of the literature reviewed so far explore the difficulties faced by Life Sciences teachers' teaching of evolution.

2.6 CONCLUSION

In conclusion, the topic of evolution is a controversial subject in many parts of the world where Christianity and other religions that subscribe to the idea of creation are dominant. When evolution somehow finds its way into the school curriculum, it can be expected that teachers face a constant challenge on how to approach the subject in a way that is

sensitive enough to some of the stakeholder concerns, while doing justice to the curriculum requirements. Considering the various studies that have been conducted and areas recommended for future study by the various research reports outlined above, I noted that most of the studies conducted focus on the teacher and learner beliefs, and teacher training, and do not examine how teachers instruct learners to understand evolution in the classroom. The theoretical and literature analysis outlined above assisted in synthesizing the research findings that are discussed in Chapter 4.

CHAPTER THREE: RESEARCH, DESIGN, AND METHODOLOGY

3.1 OVERVIEW

The researcher gave an explanation of the theoretical framework in Chapter 2, i.e. the cognitive framework of curriculum implementation, and the literature review in which the study is grounded. The national and international literature related to how teachers teach controversial topics such as evolution in the classroom were reviewed. Findings from the literature review, together with the study questions, guided the researcher to adopt the research methodology to respond to the research questions. To make the connection between the techniques and the research questions, the researcher has itemized the study questions and their objectives again below.

3.2 RESEARCH QUESTIONS

Main research question: *How do Life Sciences teachers in South Africa teach the topic of evolution within the school science curriculum?*

The following sub-questions were proposed to explore the research problem:

- What are the Life Sciences teachers' perspectives and beliefs about evolution as a topic in the curriculum?
- How do selected teachers' perspectives and beliefs influence the approach to the teaching of evolution in their classrooms?
- What are the challenges and opportunities for teaching evolution in the Life Sciences curriculum?
- How can the South African teachers' perspectives and practices on evolution be understood and/or explained?

This chapter addresses the research paradigm, research approach, research design, sampling procedure(s), data gathering techniques, and research ethical issues which form part of the study. The research methodology also discusses how data were collected

and analysed. The focus of this section is to clarify the research design that this research study followed and substantiates the approaches that were applied to collect the data. An appropriate research design was adopted to explore how Life Sciences teachers teach topics such as evolution, in the school science curriculum.

The words *research, design*, and *methodology* are important in research. According to Ormrod and Leedy (2013), the term *research* is applied in our daily language and covers a full range of implications, meaning, and repercussion, which makes it an indistinguishable term. It is used incorrectly, with multiple values and connotations. Research is a procedure and practice through which one tries to find a method and logic to find the answer, purpose, and/or the resolution to a problem. Furthermore, Cohen *et al.* (2011) express research as a procedure of arriving at a reliable solution to problems through the planned and orderly collection, examination, and interpretation of data, which results in adding the unit of data clarification. Therefore, research must be planned, rational, and designed understandably (Leedy, 1989). As explained earlier, research is an organized and systematic inquiry and needs an accomplishment and achievement strategy to follow.

In this research, the researcher reflected on the kind of data, the technique, and the practice to collect the information**.** Creswell (2014) and Opie (2004) state that research methodology clarifies measures to be applied and offers an awareness of how facts should be studied, as well as potential boundaries in inferring the outcomes of the study. According to McMillan and Schumacher (2010), research design has to do with creating a plan or procedure for data collection. The research design provided me with a framework that was followed to perform the study as indicated by Creswell and Plano-Clark (2011) and Creswell (2014). This included making assumptions at the beginning of the study, the means of data collection, and how these would be analysed. This is a plan that connects the theoretical expectations of the structure of the study to specific methods that are used.

A study by Creswell and Plano-Clark (2011) proposes that a study depends on the researcher's intention to determine the precise research questions and the design that

offers the best way to attain valuable answers. In this study, the best design suitable for the research problem was a qualitative research design.

3.3 RESEARCH PARADIGM

Cohen *et al.* (2011) report that the approaches to methodology in research are located in paradigms and societies of scholars. According to Johnson and Onwuegbuzie (2004), an inquiry about worldview can be communicated as a set of what an individual sees and believes, as well as understandings and values that different researchers have in mind concerning the kind of research.

Research by Creswell (2014), and Sikes (2004) describes a paradigm as views, beliefs, and understanding about the kind of information that leads and guides the researcher's practice when conducting the study. Hatch (2002) also indicates that paradigm guides and assists a researcher to create meaning of the information that has been collected. Therefore, a paradigm is a belief structure that assists and leads the researcher during the study (Creswell, 2009; Yin, 2014). Denzin and Lincoln (2000) further pronounce paradigms as human ideas and thoughts that deal with beliefs and values that define the worldview of the researcher. According to Yin (2014), a paradigm, in its broadest sense, can be explained as the basic worldview that guides and leads the actions taken concerning a measured analysis.

As indicated before, this study used the social constructivist research paradigm, because according to this theory, individual knowledge and understanding are built (Hatch, 2002; Cimer, 2007). Therefore, it is expected that teachers in this study have different reasons for the difficulties in teaching evolutions, they use different techniques for different reasons in dealing with the challenges hence their pedagogical content knowledge may be different. In social constructivism, knowledge construction is an active process and social interactions among learners enhance the construction of knowledge by individuals. Therefore, the quality and type of the learner’s prior knowledge are crucial if s/he is to understand new information or concepts (Cakir, 2008). When teaching for conceptual understanding teachers need to understand their learners’ prior knowledge on the topic,

identify the issues that may cause confusion, and then create opportunities for the learners to integrate the prior and new ideas (Cakir, 2008). For Cimer (2007), principles that govern effective teaching in science, especially Life Sciences, should include dealing with learners' existing ideas and conceptions, encouraging the application of new concepts or skills to different contexts, encouraging learner participation in lessons, and cooperative learning among others.

It was hence critical that I pronounce my investigative worldview because it determined my activities, elucidation, and interpretation of the findings during the study. According to Tshui and Treagust (2007), Life Sciences is one of the most social means for planning and development, speaking to, and communication of social issues made by mankind and knowledge construction. A report by Yin (2014) further suggests that a researcher should have certain assumptions that form the structure and shape of the study. In my study, the assumptions were consistent with the critical stances that are evidenced in my research questions and interest.

3.4 RESEARCH APPROACH

Research involves skills, expectations, practices, and assumptions, which I all used in this study. I used a set of beliefs in the empirical world to approach a research study. Creswell (2014) and McMillan and Schumacher (2010) identify three research approaches that should be considered when conducting research: quantitative, qualitative, and mixed methods. In other words, any research has its resolutions, procedures for guiding the analysis, and approaches of gathering and creating meaning to the data and its quality. The study explored how Life Sciences teachers teach evolution topics in the school science curriculum. In this study, the best design suitable for the research problem is a qualitative research approach.

MacMillan and Schumacher (2010) suggest that during the qualitative approach, a researcher gathers data in a confrontational state of affairs, and interact with nominated persons in their setting. Creswell (2014) explains an approach as a process of understanding what is developed during the study when analysing words and developing

detailed reports about the views of participants. In support of the explanation by Creswell (2014), according to Opie (2004), this approach strives to recognize incidences in particular settings.

The qualitative research approach enabled me to observe a set of material and practices in the classroom. This practice can alter the world into chains of pictures, photographs, recordings, and memos of itself, and further involves a constructive approach to the world. Researchers observe things in natural settings and attempt to make meaning of what people bring to them. The qualitative research approach was pertinent to my study since it permitted a thorough review of phenomena in their social context which then help me answer my research questions

Creswell (2014) shows some of the characteristics of qualitative research, i.e. natural setting, researcher as a key instrument, multiple methods, and reflexivity. These characteristics best depict my research approach in this study. According to Yin (2014), the researchers gather data in the location where participants experience the matter being investigated. To provide a thoughtful explanation of occurrences, the subjective analyst should take account of the setting in which such information is delivered (Opie,2004). In this study, data were collected by observing real Life Sciences classroom settings and lesson presentations. Life Sciences instruction and significant information such as instruction methodologies, classroom size, learner reactions, addressing strategies, etc., were watched and recorded.

The assortment of data was done in an accepted setting to learn how participants made meaning of their daily practices and highlight interpreting themes that occur from the information. In this study, I collected data during classroom observations and recorded the teacher presenting the lessons when attempting to negotiate curriculum implementation strategies in the classroom, and exploring the teachers' beliefs, perceptions, and understanding of teaching evolution in the classroom.

3.5 RESEARCH DESIGN

Ormrod and Leedy (2013) show that a design exposes an approach of how the researcher intends to do the research and bridge the gap between the research questions and implementation process. This also led to the procedure and techniques of circumstances for the collection and analysis of data. Opie (2004) explains a research design in terms of the selection available to researchers to study certain occurrences. Creswell (2014), Yin (2014), and Cohen *et al.* (2011) concur with the aforementioned explanations and outline five traditions that could be practised in qualitative research.

Considering the different traditions as outlined by Creswell (2014) and others, in qualitative research, i.e. case studies, ethnographies, grounded theories, and biographies, this study is a qualitative case study of teachers from different regions and schools using semi-structured interviews and classroom observations.

3.6 CASE STUDY

Opie (2004) regards a case study as a thorough study of communications in a single instance of a fenced system. In my study, each teacher represented a case of teaching evolution, and they were observed and interviewed as a way to get information. According to Opie (2004) and Denscombe (2007), a case study can give the researcher opportunities to understand certain social practices happening in a classroom, such as the use of prior knowledge, and classroom arrangement. The use of a case study method allowed me to consider collaborations between the teacher, the learner, and the subject matter. The table below summarises how the different cases were identified for this study.

Table3-1: Conducting a case study

Activity	Action taken
1. Identifying cases to provide in-depth information on the issue at hand.	Schools that offer Life Sciences as a subject, where teachers teach evolution were identified to address the issue of teaching the controversial topic in the curriculum adequately.
2. Consideration of the most useful type of case study for the issue.	Case-study methods were chosen to be able to compare results: three teachers teaching evolution from three different schools were selected.
3. Selection of cases that present different perspectives on the problem.	Different teachers from schools in the Johannesburg, West Rand, and Ekurhuleni regions in charge of teaching evolution were chosen.
4. Collection of data drawing extensively on multiple sources of information and using different strategies.	Semi-structured interviews, observations, and scheduled analysis were used with different participants at different sites.

This was done to discover the teachers' beliefs, perspectives, and understanding of teachers' teaching of evolution. Each case was visited to observe the classroom practices, and to know the condition of schoolteachers at their school; hence the study was embedded in the case study practice. Creswell (2014) further shows that a case study is the most suitable method used in school-based research.

There are several categories of the case study. Yin (2014) notes three categories, namely exploratory, descriptive and explanatory case studies. Yin (2014) describes exploratory case studies as a set to explore any phenomenon in the data which serves as a point of interest to the researcher, and the descriptive case studies as a set to describe the natural phenomena which occur within the data in question, for instance, what different strategies are used by a reader and how the reader uses them, while explanatory case studies examine the data closely both at a surface and deep level to explain the phenomena in the data. The study adopted a descriptive case study category to describe the natural phenomena which occur within the data, for instance, how teachers' views and beliefs influence the use of different teaching strategies and justify life as it happens in a communal situation. According to Opie (2004), the selection of the method is also

influenced by what can be done; hence this is a qualitative case study focusing on teachers teaching evolution.

However, my study conclusions cannot be comprehensive or generalized to the majority of teachers, because only a few teachers were involved in the study. However, the study shows the uniqueness of each teacher and the ability to understand complications in particular settings. This benefit was paramount to my study because implications and recommendations were made from the study, which might influence how teachers facilitate evolution within the framework of the CAPS.

3.7 POPULATION

According to McMillan and Schumacher (2010), the elements of the population allow for precise conditions to generalize the outcomes, but Welman, Kruger and Mitchell (2011) describe it as all potential components that can be involved in research, and not only people. In this study, the population was a group of people from which a sample for the study was selected. Welman *et al* (2011), and Creswell (2014) also assert that it is a particular cluster of individuals to which the characteristics of matters are denoted, associated, and generalized and/or from which the researcher wishes to collect data about the topic to be researched and draw conclusions. The researcher facilitated the selection of a suitable site and sample. In other words, in this study, the population was teachers, specifically teachers who teach Life Sciences in Grade 10 to 12 in the province of Gauteng, South Africa.

3.7.1 Selection of site

The sites that were used to collect data were the ones with all the variables needed for the study. In selecting a site to use, purposive sampling was used. During the visits to schools by the researcher for data collection, access to the school was easy. The participants teaching life sciences were available and willing to participate in the study. The following ideas stated by Cohen *et al.* (2011) and Creswell (2014) were considered in selecting the sample, i.e. the purpose of the research, the representativeness of the

sample, accessibility of participants, availability of the site, and participants. The map below shows the different sites (regions) where the study was conducted.

Figure 3-1: Map of Gauteng Province

Data were collected at three schools in different Gauteng regions, Johannesburg, West Rand, and Ekurhuleni. The Metsweding, Tshwane, and Sedibeng regions were excluded from the study as the study was limited to three regions. In other words, the study was limited to three qualified teachers teaching at public schools in three different regions of the Gauteng Province, as depicted by the map above. The group was small and manageable, as this made it easier to differentiate between teachers teaching evolution**.** These teachers were teaching at high schools with more than 1 500 learners from different cultural and religious backgrounds.

3.8 SAMPLING

According to Welman *et al.* (2011), sampling encompasses an action, process, and/or technique of selecting an appropriate sample from people to provide research material. A sample is a small percentage of teachers that encompass the subject of the study (Welman *et al*., 2011) and stipulates how participants are nominated in a study, which

can be done in different ways. Creswell (2014) and Cohen *et al.* (2011) refer to the process of selecting the sample as sampling. For this study, purposive sampling strategies were used, and was based on the readiness of the participants. This study entailed a small-scale study of three teachers; hence the availability of members was important. As indicated in Table 3.2 below, the sample covers secondary school teachers teaching Life Sciences from Grade 10–12. The three teachers from different schools had a minimum qualification of Secondary Teacher's Diplomas, attended CAPS, NCS training, workshops, and used the same resources for the teaching and learning of evolution.

3.8.1 Purposive sampling of participants

According to Creswell (2014), purposive sampling involves selecting sites or participants that assist the researcher to recognize and understand the research question. McMillan and Schumacher (2010) state that purposeful sampling covers a selection of rich cases for detailed study and an understanding is required about cases without desiring to generalize all the cases. The use of purposeful sampling yields multiple insights into the topic being researched. Furthermore, McMillan and Schumacher (2010) state that purposeful sampling increases the effectiveness of data obtained from small samples. My first encounter with the participants differed from one another. I met Mr Abby at the Grade 12 Marking Centre, where we were both recruited to assess the matric examinations for the subject Life Sciences. I came to know Mr Johnson during a Life Sciences cluster meeting that was conducted at the beginning of the study. Lastly, I met Ms Dechaba when I visited the school where she taught as part of the Gauteng DoE Research Team. Yin (2014) indicates that purposive selection fulfils the necessities of the research and only participants who have the desired traits, and who have significant experience of teaching Life Sciences topics in the science curriculum. The people chosen for this study met these requirements.

3.8.2 Pilot Sample

I followed all the procedures when organizing the interview schedule, observation guide, and piloting. This was carefully planned to cater to teachers' views and ideas, learners' dialogue, and organization and involvement (Appendix E). The observation guide helped

me to discover how the selected Life Sciences teachers approach the teaching of evolution in their classrooms. My pilot study was conducted in one secondary school in Johannesburg, where I conducted one interview and observed two lessons. My pilot sample was from a different secondary school from the actual sample of the study. The pilot sample had a similar teacher qualification as the main sample, i.e. attended the NCS and CAPS training. The selection of the pilot sample was based on the accessibility. This was done to validate the instruments. Piloting was done to check if the instruments were clear and if they would capture relevant data for the research questions to be answered. The piloting of the interview schedule assisted in guiding the interview process and how the information was tape-recorded. The data collection instruments were revised to cover all aspects of the research focus, and all contextual factors were included in the observation guide. Interview questions were changed to suit the purpose of the study.

3.8.3 Participants of the study

The three teachers taught at different secondary schools in townships in the Gauteng Province. The three teachers had the necessary teaching qualifications of South Africa and attended NCS, and CAPS courses offered by the Department of Education. The teachers that were part of the study taught different grades at their respective schools. The table below shows the summary of the participants in this study.

Table3-2: Overview of the biographical data of the teachers

Name of teacher	Teacher Qualifications	Teacher Experiences	Classes Taught	Region
Mr Abby	Secondary Teacher's Diploma, Advanced Certificate in Education (ACE)	12 years' experience	Further Education Training: 10–12	Johannesburg
Mr Johnson	Secondary Teacher's Diploma, Higher Diploma in Education, Bachelor of Education with Honours	10 years' experience	Further Education Training: 10–12	West Rand
Ms Dechaba	Secondary Teacher's Diploma, ACE, Bachelor of Science Honours	8 years' experience	Further Education Training: 10–12	Ekurhuleni

3.9 DATA COLLECTION TECHNIQUES (RESEARCH METHODS)

Data in this study were gathered from the participants who had experience and knowledge of the subject. Data were gathered through observations and interviews. The interviews were audio-recorded as part of the qualitative methods of assembling data, as suggested by Creswell (2014). In qualitative research, the researcher serves as a tool for collecting data through individual and other forms of research techniques. As proposed by Creswell (2014), the scholar decided to gather information by getting to recognize the subject in its actual setting and apply informative views, which allows the researcher to be part of the context in which the exercise occurs.

The study aimed to explore how teachers teach evolution as a controversial section in the CAPS science curriculum. Hence it was important to choose secondary schools offering Life Sciences as a subject. It was tempting for the researcher to conduct a study at the nearest secondary school because of the good relationship with the science teachers and principal, since that could have made data collection and gaining access much easier. Two factors prohibited me from doing so. Creswell (2014) warns against "backyard research" among people one knows, as it is hard to assume the role of researcher with such participants and the revelation of private information might also become a concern. The second reason for not using the nearest secondary schools was that their working conditions might be the same, since they were supported at workshops and training by the same subject facilitators. Having chosen a school, the next step was to obtain the necessary permission to gain access to the school, which is discussed in detail in the section on ethical considerations. The data collection techniques unfolded as follows: building rapport, generating and recording data, lesson observation, and interviews. This will be discussed next.

3.9.1 Building rapport

Rapport building started when I first met the participants at a marking centre, marking Grade 12 end-of-year examination papers. This was strengthened by the first visit to the schools to meet the principals and the teachers. During these visits, a possible date for

the commencement of the research was discussed. The date for the visit was later finalised by a telephone call. The research was done at a later stage during a visit in the first week of March 2016. The first day was used to get to know the teachers and to build rapport. As this is a constructive study attempting to determine the lived experience of the teachers implementing the NCS, building rapport was essential. Building trust and understanding between the researcher and the teachers is very important so that teachers are encouraged to open up and share their perspectives and experiences with the interviewer.

At first, during the informal discussions about Life Sciences teachers participating in the study, Mr Abby indicated that he was too busy to participate. Similarly, Ms Dechaba explained that she was studying, and as a result, she would not be available. However, after indicating that ethical issues such as observance of anonymity and confidentiality, voluntary participation, and voluntary participation would be ensured, they agreed to participate in the study. Mr Johnson never had issues, as he agreed to everything that I suggested. It was also imperative to experience the common interaction between the science teachers to observe how this community of practice operated. The week of intensive engagement with teachers at the school was followed by 16 days of visits to each school to conduct observations and interviews.

3.9.2 Generating and recording data

Mason (2007) uses the term 'generating data' rather than 'collecting data' for qualitative research, based on the argument that a qualitative researcher cannot be seen as completely neutral when collecting data. Creswell (2014) indicates that the term 'generating data' includes intellectual, analytical, and interpretative activities. In this study, observations, interviews and documents were used to collect data to construct a considerate understanding of the problems and needs of the science teachers and help to understand the specific teacher and answer the research questions.

3.9.3 Lesson observations

A report by Myers (2010) shows that lesson observation involves a person observing other individuals from the outside, inspecting as a bystander without participating in the

activities. According to Nieuwenhuis (2011), this is a process of capturing the patterns of individuals' activities without communicating and collaborating with the participants. Nieuwenhuis (2011) further sketches four categories of the observer, i.e. complete observer, participant, participant as an observer, and full participant. Kelly (2010) also identifies four types of observations, namely participant, descriptive, focused, and selective. Lastly, Opie (2004) specifies that there are two forms of observations, namely simple and participant, and each type depends on whether the researcher participates in the setting or only ask general questions during observation, or involves particular demands for specific kinds of collaboration and includes the collection of positive proceedings, etc.

In this study, the researcher as an observer aimed to obtain knowledge and an understanding of the themes being evaluated. An observation schedule **(Appendix D)** was used to guide and direct the researcher to form an association with the participants and simply gather data. Observations formed the main method to collect the data and were designed based on how teachers negotiate controversial topics like evolution during teaching and learning.

A total of six lessons were observed however only three lessons per teacher were audio recorded. During the lessons that were not recorded, the researcher was checking on classroom arrangement, listening to learner perceptions during the lessons, and looking at available resources for teacher and learner use, lesson discussions were conducted to discuss the lessons. This was followed by lesson discussions per teacher, which helped me to understand teachers' interactions in lessons, their perceptions, and any societal influence on the lesson.

Classroom observation enabled me to look at teacher-learner interaction activities during the lessons, i.e. accepting learners' feelings, admirations, using prior ideas, asking questions, giving instructions, etc. The teaching approaches that the teacher applied during pedagogic practices were observed to check if the strategy, content, and some activities and assessment were outlined by CAPS to enable learners to understand the content.

Observation also helped me to observe if the teachers were applying stages of the cognitive framework of curriculum implementation in the classroom. The method was worthwhile in this study, as it allowed me to code the comparable activities. The observation was not a holistic approach, because teachers can change their normal practice; however, to overcome these limitations, during the lessons teachers were not aware of what I observed during the lesson. The interactions from background information and observation were documented and taken into account.

3.9.4 Semi-structured interviews

Reports by Myers (2010) and Creswell (2014) show that a semi-structured interview is one of the different three forms of interviews. In this research study, interviews were conducted in a free place for privacy purposes to get teachers' thoughts, moods, visions, and perceptions about evolution, because it allowed me to probe for answers and more information.

According to Ormrod and Leedy (2013), the interview schedule in a research report is a basis of information for constructive research and discovers how people feel about certain experiences and questions. Nieuwenhuis (2011) describes an interview as a discussion whereby the researcher gathers information and acquires ideas, beliefs, and sentiments of the participants. Creswell (2012) explains it in terms of the collaboration between the interviewer and participant, and the aim is to perceive the world through the senses of the participant. The ideas that were explored in this study using interviews were teachers' perspectives about evolution, the approaches they applied when teaching in the classrooms, and the challenges and opportunities for teaching evolution.

Semi-structured interviews allowed me to discover opinions of respondents on the teaching of evolution and allowed me to assemble detailed information from respondents such as teachers' understanding, beliefs, and use of tenets of science when teaching evolution. The interview schedule (**Appendix C**) comprised questions to ensure that the interview process managed to get its envisioned aims and objectives. According to Opie (2004), flexibility in the interview may lead to unfairness if the researcher pushes participants to supply the answers anticipated. In my research, I avoided such bias by

using the interview list to control, direct and guide the interview process. The interview questions intended to assist in responding to the research questions around the challenges and opportunities for teaching about evolution in the Life Sciences curriculum, the Life Sciences teachers' perspectives and beliefs about evolution, and how selected Life Sciences teachers approached the teaching of evolution in their classrooms.

3.9.5 Audio-recording of the interview

The interviews were conducted and recorded after I had observed their classes in Life Sciences. The interviews were audio-recorded in my study. Opie (2004) indicates that documented interviews reserve the normal semantic and the information becomes independent and objective. The audio recording further assisted me to capture and record the interviewees' inputs and influence in the interview, so that in the future the information can be re-analysed to ensure the validity and reliability of information collected during the interview. The transcriptions were used to analyse data; even though audio recordings have their disadvantages, of possibly diverting the focus of the researcher from the actual evidence the study intended to collect, analyse and interpret and cannot show pictures, but it was of benefit in my study.

3.9.6 Document analysis

According to Johnson and Christensen (2014), documents are examples of secondary data that may be personal and also official. Various documents were collected from the teachers, but only those that were relevant and directly affected the study were analysed. Amongst the most critical items were the teachers' lesson plan and preparations, and teaching aids. The selection of documents was influenced by the objectives of the study and the literature reviewed in chapter two.

It was important for me also to see how these documents helped and enabled the teacher to teach the lessons on evolution, as demonstrated in the next chapter. Ormrod and Leedy (2013) assert that accessing relevant documents and deriving information constitute document analysis. One salient point critical to document review and analysis is that they also serve as evidence of activities taking place at a particular location. I randomly

requested these documents from participants without prior arrangement, and participants were honest enough to give me the documents. This was done to establish the existence of such documents and their authenticity. I was able to follow on some of the activities and actions taking place in the classroom. Using triangulation of the three data collection methods – interviews, observations, and documents – I was able to determine the reality and authenticity of the collected data.

3.10 QUALITATIVE DATA ANAYSIS

A study by Hatch (2002) describes the process of analysing data and information as a way that entails a logical quest for implication and sense from the information. During this period, the researcher works with data, classifying and synthesising information into controllable components, finding patterns, and categorising what is significant so that the researcher can account to others in the research fields (Creswell, 2014; Hatch, 2002).

Cohen *et al*. (2011) explain data interpretation as a procedure of creating direction and developing implications to the collected information and data. Analysing data and information is also viewed as a procedure that involves inductive reasoning, thinking, and a technique that is applied to conclude empirical data. According to Creswell (2014), the process assists in considerations about the data collected, requesting reasoned questions, and writing memorandums. Lastly, Nieuwenhuis (2011) views qualitative data examination in terms of changing information to be expressive and meaningful for the researcher and is destined for the envisioned audience and readers.

In this study, analysis of data was based on a constructive model that seeks to find significant and meaningful content of qualitative data gathered (Nieuwenhuis, 2011). Information from the observation guide and in the transcripts of the audio recordings was coded under tentative headings, and these headings were adapted, as the weight of additional data helps to clarify the headings into more definite patterns and clusters of patterns (Myers, 2010). In the constructive model, interpretation assists the researcher by giving meaning and sense to the data collected and constructing logic of social situations (Hatch, 2002). The constructive model allowed me to make extrapolations,

develop perceptions, refine understandings, picture conclusions, and infer lessons (Hatch, 2002). Constructivism enabled me to be part of the study process and assists the researcher to construct and link interpretations. According to Hatch (2002), it is the researchers' wish for meaningful results that make sense of situations of what one is studying.

The processes of data collection and analysis were iterative in my study, involved forward and backward movements between collecting and analysing the evidence. Immediately after the interview, it was transcribed, printed out, and manually filed in preparation for coding and further analysis. I would then go into the classroom to observe lessons and bring back more data, which I transcribed and made some initial analysis on before filing. The processes of observing lessons, transcribing, analysing, and filing the observations were repeated back and forth until each of the three teachers was observed not less than six times. In this study, data collection, analysis, and interpretation went on at the same time, but the last two processes continued well after the data collection period. From the data collected, a story for each of the three teachers was developed, and a case analysis of the teaching methods each teacher used is made before moving on to the cross-case analysis (**Chapter 5**).

The main themes used in this study were derived from the research sub-questions. These major themes were also informed by the literature I reviewed. The subthemes and categories for my data were only decided upon after the pilot study. I attached labels to the data in the interview transcripts, lesson observation protocols, and documents. The pilot study gave me 'dummy' findings which I used to identify subthemes and smaller categories into which data could be classified for purposes of further analysis. Table 3.3 below provides a summary of analytical framework that will be used to analyse data from the main sample.

Table3-3: Themes, sub-themes, and categories

RQs	Theme	Sub-theme	Categories
1	**Theme** 1: Teachers' beliefs and perspectives about evolution	**1.1** Teacher beliefs	Religious beliefs Professional beliefs Social beliefs
		1.2 Teacher perspectives	Resource availability Historical, superficial, abstract & difficult to understand Time allocation Language usage
2	**Theme** 2: Teachers approach the teaching of evolution	**2.1** Teacher centred teaching and learning	using: Videos and cartoons eBooks and textbooks Questions and answers PowerPoint presentation Prior knowledge
		2.2 Learner centred teaching and learning	Using: Open-ended question Class discussions and, An Internet search for information
3	**Theme** 3: The challenges and opportunities for teaching evolution	**3.1** Challenges for teaching evolution	Religious belief in creation Teacher development Language usage Teachers' PCK Classroom environment Historical account of nature Availability of resources Teaching approaches
		3.2 Opportunities for teaching evolution	Historical background about the origin Skills and future career Understanding of change in an organism

3.11 VALIDITY AND RELIABILITY

The issues of validity and reliability were considered when conducting my study. Studies by Opie (2004) and Gravetter and Forzano (2009) explain validity as a research tool that measures what it is supposed to measured, and reliability as the degree to which the research tools could produce familiar results in a continual situation (Scaife, 2004; Fraenkel & Wallen, 1990). According to Golafshani (2003) and Gravetter and Forzano (2009), the validity and reliability of the qualitative research process are explained in

terms of trustworthiness, rigor, and quality of data collected. In this study, credibility was achieved by clarifying the procedures to collect data thoroughly.

3.11.1 Internal and Respondent Validity

According to Scaife (2004), the research data collection tools should be checked. During the study process, the data collection tools were checked by experts in the Life Sciences field. My findings were not generalized to a larger population of teachers, since my sample of three teachers being part of my study was small. Participants in my study, i.e. the three different teachers who teach evolution were given interview transcripts to check if I represented them accurately during interviews, as well as to allow them to add or deny the results, where possible.

3.11.2 Trustworthiness

According to Creswell (2009), trustworthiness is based on determining whether the findings are accurate. In addition, Nieuwenhuis (2011) corroborates that trustworthiness is obtained through a process of testing the data analysis, findings, and conclusions. In this study, I ensured trustworthiness by using multiple data sources (interviews, observation, and documents) to collect data and merging the findings for congruency

3.11.3 Triangulation

According to Golafshani (2003) and Scaife (2004), the use of different methods to collect data helps to address validity. This study used various ways to collect data such as lesson observations, documents, and interviews. This helped to address the element triangulation. In this study, the information gathered was triangulated with relevant literature and was evident due to the use of data collected from the various data sources.

3.12 ETHICS

McMillan and Schumacher (2006) and Sikes (2004) describe ethics as a set of values that researchers use to decide what is wrong and what is right. Ethical issues were considered in this study to avoid upsetting participants' lives in the process of doing

research. The study adhered to guidelines regarding the study and some of the most important ethical aspects is discussed next.

3.12.1 Negotiating access

Application for approval to conduct research was obtained from the University of Free State and the GDE Ethics Committees. The ethics guidelines from the GDE and the University of Free State recommend that participants are aware of the type of research to be undertaken and participants from the three schools signed the consent forms. The research process started after receiving an endorsement from the University of Free State and GDE research committees. I applied to conduct research at Gauteng schools. The GDE and the headmasters of the institutions involved in the process granted letters of approval to access Gauteng schools. Lastly, an information sharing meeting about the study was held with the three Life Sciences teachers with the purpose to inform and update the participants about the study.

3.12.2 Informed consent

The participants were guaranteed the freedom of expression and self-determination. I ensured that consent was sought from participants through the letters that I sent to all of them before starting with the research and visiting their schools. Creswell (2014) agrees that informed consent describes the procedures where participants are given the freedom to participate or decline. The members in this inquiry were Grade 12 Life Sciences teachers with the capacity to provide informed consent directly. Consequently, the researcher provided information about the purpose of the study to the participants. This was done by attaching a cover letter with information about the interview and observation schedule, including detailed information on the study. Issues related to the research, methods of examination, possible advantages or impediments were shared with the members as recommended by Creswell and Plano-Clark (2011). All the sample participants agreed to participate on the aim of the research and that all data collected would be kept safe.

3.12.3 Confidentiality and anonymity

According to Creswell and Plano-Clark (2011), in numerous studies, anonymity cannot be maintained, particularly when information is collected using interviews and/or surveys. The interviewer had direct contact with and was able to recognize each one of the respondents. In this case, respondents were ensured that the information given would be protected for privacy. To address confidentiality, the respondents were guaranteed that information would be utilized only for investigative reasons, and no other individual would have access to the information. As detailed previously, pseudonyms were utilized to refer to the teachers and schools that participated in the research.

The integrity of participants was protected, and all information was treated with the strictest confidentiality, and would not be availed to any person without their consent. This is supported by Creswell and Plano-Clark's (2011) assertion that participants have the right to anonymity of the information they provide. Since namelessness is respected as essential by numerous respondents, they must be convinced that it will be implemented. To maintain a strategic distance from conceivable hurt to members, secrecy was guaranteed by not collecting their names; invented names were utilized in the research.

3.12.5 Voluntary participation

This is the time when the researcher contacts the participants to establish rapport and a relationship. During this meeting, I provided all participants with information regarding the envisaged study, and they were offered a choice to continue or decline. This was clarified to them before the interviews commenced, as well as during the interviews. Participants were happy to participate in the study. Creswell and Plano-Clark (2011) regard the treatment of participants in a very serious light because they believe the research that involves human beings has the potential of getting out of hand; thus, doing more harm than good.

3.12.6 Respect

According to Creswell and Plano-Clark (2011), participants should be made to feel appreciated by treating them with respect and great humility. No research participants

were forced or compelled to take part in the study. They were treated with respect. Participants were allowed to agree to or decline to contribute to the study. This right was respected at all costs during the research process and all participants willingly signed the acceptance letters to take part in the study.

3.12.7 Publications of findings

A report by Sikes (2004) shows that morals request that analysts be fair, dependable, and honest in announcing their discoveries. Additionally, Setati (2005) and Creswell and Plano-Clark (2011) prescribe that the investigative report ought to be amassed as accurately, appropriately, dispassionately, and clearly as conceivable. To address the views of these authors, the findings that are reported in this study focus on the data derived from teachers that teach evolution in the Life Sciences class, and no other information from other sources was used in the final document.

3.12.8 Feedback to participants

Feedback from the data collected was provided to the teachers once the conclusions had been assembled and compiled in a report format to permit teachers to view my interpretations and claims.

3.13 CONCLUSION

In this chapter, I presented the research style, procedures, and information collection processes. Therefore, the research paradigm, research approach, research design, sampling procedure(s), information gathering techniques and instruments, data analysis, validity and reliability, trustworthiness as well as research ethics were discussed. This was an attempt to rationalise the processes that were used to collect the data for this research. The information collected and the analysis in this chapter are discussed in Chapter 4.

CHAPTER FOUR: PRESENTATION OF DATA AND DISCUSSIONS OF FINDINGS

4.1 INTRODUCTION

Thematic analysis techniques were used to analyse the data collected. The findings of each case are presented separately. The three schoolteachers from different regions of the Gauteng Province in South Africa who each represented a case in the descriptive case design, participated in this study. The following was the study main research question,

> *How do Life Sciences teachers in South Africa teach the topic of evolution within the school science curriculum?*

The following sub-research questions were formulated in line with the main research question,

- What are the Life Sciences teachers' perspectives and beliefs about evolution as a topic in the curriculum?
- How do selected teachers' perspectives and beliefs influence the approach to the teaching of evolution in their classrooms?
- What are the challenges and opportunities for teaching evolution in the Life Sciences curriculum?
- How can the South African teachers' perspectives and practices on evolution be understood and/or explained?

In the Life Sciences curriculum, there are some topics and sub-topics that form part of the curriculum. **Appendix A** shows some sections on the teaching of evolution as prescribed by the CAPS document. As depicted in **Appendix A**, the areas to be taught in evolution included the theory by Lamarck and Darwin, Artificial selection, the Formation of new species, Mechanisms of reproductive isolation, Evolution in present times, Evidence of common ancestors for living *hominids*, including humans, and the Out-of-Africa

hypothesis. In my observations, I began by comparing the topics as captured in the curriculum documents versus those taught by the various teachers during my observations. The topics and sub-topics that were taught and observed during the school visits are presented in the table below.

Table 4-1: Topics presented in class during observation

TEACHER	TOPICS COVERED			
	Topic 1	**Topic 2**	**Topic 3**	**Topic 4**
Mr Abby	• Evolution: Lamarck theory	• Human Evolution	• Evolution: Alternative explanation	• Evolution and religion
Mr Johnson	• Review of Lamarck and Darwin's theory	• Alternative explanation	• Human Evolution	• Out-of-Africa hypothesis
Ms Dechaba	• Introduction of Evolution	• Human Evolution	• Evolution: Alternative explanation	• Out-of-Africa hypothesis

A total of seven topics that were presented on evolution by the teachers are summarised in Table 4.1 above.

4.2 DEMOGRAPHICS OF THE PARTICIPANTS

As mentioned earlier, data were collected from Life Sciences secondary school teachers across three different regions in the Gauteng Province, namely Johannesburg, Ekurhuleni, and West Rand. The idea of targeting individuals from various regions was to diversify the sample while still providing for accessibility of the participants to the researcher. There were no restrictions on participants in terms of gender, race, and culture, but only teachers who were qualified to teach Life Sciences were considered for the study. Two of the participants were male teachers and one was female.

Table 4-2: Demographics of the participants

Name of teacher	Teacher Qualifications	Teacher Experiences	Classes Taught	Region
Mr Abby	Secondary Teacher's Diploma (STD), Advanced Certificate in Education (ACE)	12 years' experience	Further Education Training: 10–12	Johannesburg
Mr Johnson	Secondary Teacher's Diploma, Higher Diploma in Education, Bachelor of Education with Honours	10 years' experience	Further Education Training: 10–12	West Rand
Ms Dechaba	Secondary Teacher's Diploma, (ACE), Bachelor of Science (BSc) Honours	8 years' experience	Further Education Training: 10–12	Ekurhuleni

A full story of each participant's background is explored further to introduce each case.

4.3 CASE 1: TEACHING OF EVOLUTION IN MR ABBY'S CLASSROOM

'Talkative and have all complaints on the challenges of evolution'

4.3.1 Teacher, school, and classroom background

The first section to be discussed is that of teacher and school background, including school practices to understand Mr Abby and his working environment.

a. Teacher background

My first encounter with Mr Abby at a personal level was at the Grade12 Marking Centre, where we were both recruited to assess the matriculation (end-of-high school) examinations for the subject Life Sciences (formerly known as Biology in the South African school curriculum). At the marking centre, Grade 12 teachers are often recruited as external assessors for the matriculation examinations. At the time of this study, it happened that one of the schools I had sampled was where Mr Abby taught Grade 12 Life Sciences. At the marking centre, teachers often have the opportunity to share and discuss difficulties in the question papers in line with the memorandum, and to consult one another on difficult sections of the syllabus that teachers need to pay more attention to in the next academic year.

Mr Abby, in his mid-40s, was the current Life Sciences teacher at School A, where he has been a teacher for the past 12 years. He holds a three-year STD wherein he specialized in English and Biology for the General Education and Training (GET) phase (Grades 8 and 9) and the FET phase curriculum, i.e. Grades 10–12. Abby has been teaching Life Sciences at various grades in the FET Phase and two English classes in Grade 8 and 9.

Explaining how he got to teach Life Sciences at the school, he said that when he arrived at the school, he began by helping a teacher who was offering Life Sciences at the school at the time. Mr Abby indicated, "*this was how I was spotted as having an understanding of Life Sciences*". The subject head and the principal subsequently allocated him to teach Life Sciences classes in the FET phase. When asked to describe his feelings about being assigned to teach the Life Sciences classes, he took a deep breath and indicated that "*it was difficult at first, but I was fortunate to be surrounded by helpful science teachers*". This was because he no longer assisted other teachers but taught the subject in some of the classes himself.

> *The deputy principal for curriculum and the other teachers provided me with the necessary support by sharing ideas on Life sciences teaching. It helped to ease the pressure on me even though Life sciences was my major subject at university.*

b. School background

School A was established in 1982 and is in one of the richest suburbs of South Africa, viz. Sandton in the province of Gauteng. This school is classified as part of the Johannesburg East district and is located in a township in the Johannesburg region. The school has over 1 750 learners, with over 900 learners in Grades 8 to 19 and 850 learners in Grades 10 to 12. English is the medium of instruction for teaching and learning. Therefore, the language that is commonly used during the lessons is English, complemented with other indigenous South African languages like isiZulu, isiXhosa, and Sepedi languages. The total staff complement comprises 65 teachers, 11 general assistants, and 4 administrative assistants (80 staff members). This school is one of the public ICT schools, where all classes are fully equipped with ICT equipment to enhance teaching and learning. The school is equipped with free Wi-Fi, laptops, projectors, Smartboards, etc. It has three subject-related laboratories and two computer laboratories.

One of the subject laboratories is for Physical and Life Sciences subjects. The computer laboratories have Wi-Fi that enables teachers to access the internet and most teachers were observed spending time preparing the lessons using the free internet connectivity.

c. School practices

During the school visit, I noted that the school conducted a morning assembly once a week. In school A, one can see students performing a student talk on any topic decided on earlier, reading current news headlines, and speaking on quotes of the day. In an interview, I asked Mr. Abby if the school conducted assemblies and how they were conducted. He responded by saying:

> *Usually, we have assemblies on Monday but not every Monday. Only when there are announcements then we will have assembly. We start by singing and then praying.*

When I probed further to check the type of prayer:

> *In the beginning, it was a matter of Christianity but now things have changed a little bit. Now the school came up with a constitution or a reading that is read at assembly to accommodate other religions and then we sing the national anthem, then we will pray the Lord's Prayer which is a Christian prayer.*

A school morning assembly included a worship or prayer, a group song, important announcements, and a national song or national anthem of the country. The narrative suggests that the school had adopted and continues to practice some of the Christian activities.

d. Mr. Abby's classroom context

Mr. Abby began teaching the topic of evolution in the Life Sciences when it was introduced in Grade 10 to 12 in 2008. In addition, He had also taught the old Biology syllabus before the introduction of the Life Sciences curriculum. In 2017 and 2018, he taught Life Sciences to the Grade 12 classes. The teaching periods at Mr Abby's school are 45 minutes long, amounting to a total of four hours 50-minute periods a week.

Picture 4-1: Learners in the school's Life Sciences classroom

As depicted in the picture above, the structure of the classroom is that of an ICT classroom with an installed interactive Smartboard and Wi-Fi laptops, and learners having tablets. The classroom environment is generally conducive to learning, with blinds in front of the windows, and attractive, colourful paint on the wall. The only major challenge noted was the overcrowding, which created a situation where the teacher struggled to give individual learners enough attention, which in turn affected student behaviour and work ethic during lessons. The classroom setup encouraged a learner-centred approach to learning, with tables arranged in groups of eight as depicted in the picture above, but all 48 learners were seated facing the interactive Smartboard.

4.3.2 Overview of emerging themes

Table 4.3 below provides a summary of categories that were developed from the data and grouped into sub-themes that were placed under the themes that were developed from the research questions to form an analytical framework.

Table 4-3: Themes, sub-themes, and categories of Mr Abby's tenets

RQs	Theme	Sub-theme	Categories
1	**4.4.2.1 Theme** 1: Teachers' beliefs and perspectives about evolution	**4.4.2.1.1** Teacher beliefs about evolution	Religious beliefs
			Professional beliefs
			Social beliefs
		4.4.2.1.2 Teacher perspectives on evolution	Resource availability
			Historical, superficial, abstract & difficult to understand
			Time allocation
			Language usage
2	**4.4.2.2 Theme** 2: Teachers approach the teaching of evolution	**4.4.2.2.1** Teacher centred teaching and learning	using: Videos and cartoons eBooks and textbooks Questions and answers PowerPoint presentation Prior knowledge
		4.4.2.2.2 Learner centred teaching and learning	Using: Open-ended question Class discussions and, An Internet search for information
3	**4.4.2.3 Theme** 3: The challenges and opportunities for teaching evolution	**4.4.2.3.1** Challenges for teaching evolution	The religious belief in the creation
			Teacher development
			Language usage
			Teachers' PCK
			Historical account of nature
			Availability of resources
			Teaching approaches
		4.4.2.3.2 Opportunities for teaching evolution	Historical background about the origin
			Skills and future career
			Understanding of change in an organism

The analytical framework above was used to guide the presentation of results. The case of Mr Abby is presented next.

4.3.2.1 Theme 1: Teachers' beliefs and perspectives about evolution

In this theme, two sub-themes were developed and are discussed, viz. teachers' beliefs and perspectives about teaching evolution, mainly supported by data from interviews.

4.3.2.1.1 Teachers' beliefs about evolution

The study identified four main categories to explain the teachers' views and beliefs when teaching evolution, i.e. religious beliefs, professional beliefs, teaching evolution, and social beliefs. These categories were identified in line with the challenges the teachers face during the teaching of evolution in the classroom. The teachers' views and beliefs range from evolution being viewed as abstract and a difficult topic to teach in terms of the language, religious position, and that teachers were poorly trained to teach evolution and insufficient resources that are available to assist teachers in presenting the concepts on evolution. These categories are described further in the next few sections:

a. Religious beliefs

During the interview, Mr Abby was asked about his beliefs regarding the teaching of evolution, to which he responded as follows,

> *You see, the way human evolution started and the way it is, there are some disagreements there because I grew up knowing Christianity. I know that humans were created by God, but when it comes to this Evolution that a human being originated from Africa, it becomes difficult.*

When asked what his take was when he first heard about evolution and how he reacted, he responded thus,

> *It was interesting to get this other part that a person did not know about, and it was difficult to believe that, and it still is difficult even now. You know that evolution has some flaws and loopholes here and there. It is very difficult to believe in human evolution.*

This narrative suggests that the teaching of evolution somewhat conflicts with his own personal and family beliefs, and as such he finds it difficult to teach and accept the theory of evolution. During observation, I noted that he tended to avoid giving more explanations on matters of evolution in the classroom, but preferred reading most of the content from the e-Books with little or no explanation. During the lesson on natural selection, for example, he read the following section,

> *Natural selection is a phenomenon whereby individuals with the most suitable characteristics based on the genotype will be able to survive/cope with challenges or*

> *adapt best to the environment. Plants and animals produce many offspring with variation, e.g., beetles produce many offspring with colour variation as this is a source of food for birds. Those beetles whose colour allows them to camouflage against predatory birds will survive.*

Mr Abby further indicated that he was willing to teach evolution, but he sometimes faced challenges, because some learners have diverse understandings and worldviews about evolution. In a post-lesson discussion, he admitted,

> *It was difficult to teach some concepts in evolution because I have my own beliefs about things. I was a Christian, I tried to separate my Christian views and beliefs from evolution on what I teach in class.*

This statement that he was a Christian and was struggling to separate science matters from religious matters when teaching evolution suggests that he may not be doing justice to the syllabus to be covered and in fostering a better understanding of evolution by learners. In this study, religion is seen as a sociocultural system of designated behaviours and practices, morals, worldviews, texts, sanctified places, prophecies, ethics, or organizations that relate humanity to either supernatural, transcendental, or spiritual elements (Durham & Scharffs, 2010).

b. Professional beliefs

Professional beliefs in this study refer to the belief that the competence of a person who is formally certified by a professional body and belongs to a specific profession by having completed a required course of studies and/or practice can usually be measured against an established set of standards (Bradshaw & Younie, 2016). These values are principles, standards, or qualities that individual people hold in high regard and guide the way he/she lives and the decisions they make. As indicated in the teacher background section, Mr Abby is a professional teacher but did not teach or had not studied the teaching of evolution at college or university before. In an interview he mentioned,

> *I did not do evolution at the secondary level, especially human evolution. It only came recently as a chapter in Grade 12. I began to know evolution as a teacher then I took it from there. I started attending workshops and had to teach because it is there in our syllabus*

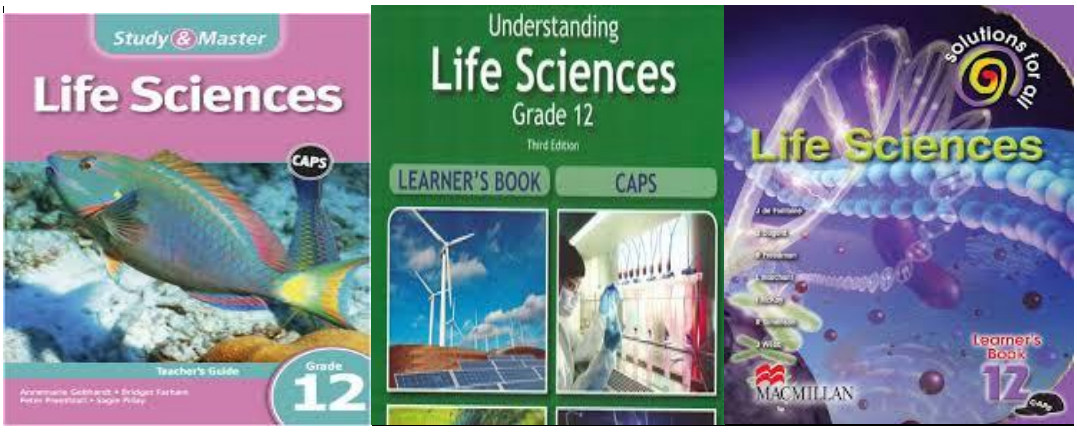
This suggests that Mr. Abby was able to attend training and workshops offered by the DBE in South Africa that were designed to introduce teachers to the new theme on evolution in the Life Sciences curriculum. When I asked how useful the workshops and training were, he responded,

> *The workshops were good but sometimes they were not so convincing because they only wanted to reach their objective. We were channelled to believe whatever they were saying and can teach in class.*

When I probed further, he said,

> *The training did not help with the strategies or approaches to manage with challenges I face in the classroom. I feel that the course was supposed to be part of a university teacher and provide approaches to teaching and learning of evolution in class.*

This narrative suggests that teachers need continuous training on evolution to prepare them adequately for the philosophy and methodology of science. During the lesson, Mr. Abby only relied on the Life Sciences textbooks/e-Books without using other concrete experiences to simplify the subject matter for the learners. He confirmed this conclusion during an interview by saying, "*The resources I am talking about are textbooks, slides, and videos.*" Picture 4.2 provides examples of textbooks/e-Books found at the school.



Picture 4-2: Life Sciences textbooks

This approach to teaching from a textbook may suggest that possibly Mr Abby was not as well prepared or informed on the topic of evolution from a professional view. As indicated earlier, the other point that seems key was that because Mr Abby had not

studied evolution at secondary school, and evolution had not been part of his formal teacher training qualification, he believed that the teaching of evolution was rather difficult.

c. Social beliefs

In this report, social beliefs are viewed as sets of ideals and worldviews by which groups in a community identify themselves (Bradshaw & Younie, 2016), which are used to campaign to promote their ideas. They are coherent from the inside, they appear to be true once they are accepted, and they seem to be wrong once they are dismissed. As reported earlier, Mr Abby indicated that teaching in a diverse classroom with learners from different religious backgrounds and beliefs also influenced the way he taught. During the lesson, I noted that different languages were spoken by learners during the lessons, including English, isiZulu, isiXhosa, and Sepedi. The teacher's understanding was that stakeholders, i.e. parents, and community members, may have different religious backgrounds and beliefs that may influence learners negatively during teaching and learning. In an interview, Mr Abby also reported that he sometimes experienced pressure from other stakeholders as he taught sections of the creation of science. He said,

> *DBEs influences it, and I had a word with other teachers and interviewed learners, and they tell me that some teachers don't even teach human evolution.*

When I checked with him which people he was referring to, he responded,

> *They are people from other schools and the people don't believe in human evolution.*

This narrative captures the frustration that the teacher seems to experience from seeing other teachers who may hold the view that evolution is not important, and how this contributes to loss of interest and the de-emphasis of evolution in the Life Sciences classrooms.

4.3.2.1.2 Teachers' perspectives about evolution

In this part, teachers' perspectives are noted as a way of thinking about something, especially that which may be influenced by the type of person one is or by one's experiences. The categories on the teaching of evolution are centred on resources,

language used, historical, superficial, abstract, and difficult to understand teaching and learning of evolution.

a. Resource availability

During the interview, the teacher was asked about his perceptions on teaching the topic of evolution. Mr Abby responded,

> *There hasn't been much development of the subject material on evolution that talks to new knowledge that has been developed, that could be incorporated to assist with understanding other areas, albeit learning is part of bringing the past to the present and projecting the future now evolution is one of those.*

According to Mr Abby's experience, the narrative shows that the section on evolution lacks adequate teaching and learning material. The indication is that there has not been much development of the subject material on evolution that talks to new knowledge that has been incorporated to assist with an understanding of other areas in the curriculum.

Resources in this study depict instructional materials that are very important to help teachers teach effectively and to help students learn better during the lesson. The purpose of the resources is to ensure that students are engaged as they learn, and both the students and the teacher enjoy the lesson. During the observation, the classes had interactive smart boards, which were installed with e-Books and other books (see Picture 4.2, e.g. *Solution for all*, *Study and master*, *Understanding Life sciences*, and *Focus Life sciences*. etc.), videos were available on evolution, and learners had tablets with e-Books and textbooks on evolution.

Picture 4-3: Classroom with interactive Smartboard

When probing how important the available resources and materials were in assisting him during teaching and learning, he said,

> *Lack of materials, low levels of knowledge and understanding, and limited reception of the evolutionary ideas fail me to enable learners to develop an understanding of the evolution ideas, concepts, and theory.*

During the lesson, I also noted that the classes had internet connections for teachers and learners to access online resources. Sanders and Nqxola (2009) have discovered that some teachers have inadequate knowledge of evolution when the topic is presented in the FET Life Sciences curriculum.

b. Historical, superficial, abstract & difficult to understand

This section refers to the study of the past, as it relates to pass events such as the memory, discovery, collection, and organization (Timo, 2010), as they were described in written documents and appeared to be theoretical, true, or real only until examined more closely. The indication was that the teaching of evolution is abstract and theoretical. When I asked during the interview, the teacher responded,

> *The language itself is a problem because many of these words are written in Greek and Latin which is a real challenge.*

When I probed further about what the problem was – understanding or teaching? He responded,

> *It's a matter of understanding, interpretation, and writing all these names which is a real problem.*

When I further asked the teacher to explain why he considered the teaching of evolution difficult, He responded,

> *Evolution is too much of a history and then you will find that learners don't even understand what happened then, they don't relate it to their everyday lives, so that is why it is really difficult, and learners don't understand it because they don't have proof of some sort that whatever happened in this evolution.*

The code term 'history' was used to elaborate and best describe his view on the teaching of evolution. The theory of evolution shows how species evolved over several years in

the past, which makes it complex and abstract to understand because of the lack of practical experience that a teacher can use in the classroom.

c. Time allocation

When the teacher was asked when the topic on evolution was taught in schools, he responded,

> *It is taught towards the end of the year. I would prefer if this topic can be taught at the beginning of the year, that is where it will be good to teach. Having enough time, because towards the end of the year, we don't have enough time and then we don't teach it as such, you just must pass.*

Mr Abby saw evolution as the last part of the curriculum that is usually covered in a month, or three weeks because it brings a lot of questions, misconceptions, because of religious issues. Religion becomes a conflict of interest amongst teachers and learners because evolution is a science idea that must compete with religious explanations.

d. Language use

In this study, language is noted as the method of human communication, either spoken or written format, consisting of the use of words in a structured and conventional way (Yu, 2014). As indicated earlier, the classrooms were diverse, with learners from different religious backgrounds and with numerous beliefs accommodated in a single classroom. Mr Abby was cautious of learner language when teaching evolution during the lessons, as reported earlier the concepts and examples used during the lesson were taken directly from textbook/e-Books and no practical, real-life examples were used. When asked if there are certain students' ideas or thoughts that may influence teacher teaching of evolution, the respondent noted,

> *There is an element of resistance, with the terminology like adaptations and competition. When you start introducing the Latin component of evolution, it becomes a problem because learners don't see the value of those words. The pronunciation of some words by learners is a problem, and if the teacher also is not pronouncing words properly, it becomes a problem.*

Mr Abby further indicated that as a teacher one should be sensitive because all have different views of evolution, and one should not give one's opinion, but just teach what

one is supposed to teach and let learners decide whether they want to believe it or not. To echo the comment, the respondent said,

> *It's the issue of differentiating the religious method and scientific method. Scientifically we have facts and proof, but we don't have religious proof of what they are talking about.*

Mr Abby's remarks also create a divide between science and religion; hence he emphasised that evolution is a science differentiating it completely from religion. Consequently, the respondent felt constrained by these factors that influenced his teaching strategies. Thus, his teaching was based on transparency and making sure that he did not impose his perceptions of the topic. During the lesson, Mr Abby also used several of the learners' languages like isiZulu, isiXhosa, and Sepedi to simplify the content for the learners.

4.3.2.2 Theme 2: Mr Abby's approach to teaching and learning of evolution

According to the DBE (2011), the practices that the teachers use to accomplish learning, e.g., using group work, class discussions, experimentation, question, and answer, or demonstration are referred to as teaching strategies. During lesson observations, the practices of teacher- and learner-centred teaching and learning were noticed.

a. Mr Abby's observed teaching-learning interactions

The data to address how Mr Abby taught Life Sciences classes were mainly derived from lesson observations carried out on Mr Abby in Grade 12. The lessons were audio-taped and later transcribed for easy content analysis. In addition to audio recording and transcriptions, entries on an observation schedule soliciting the presence or absence of some potential learner-centred classroom and teacher-centred practices were sources of analysable text (See Appendix B for the *Lesson observation guide)*. The observed lessons were on Darwin and Lamarck's theory of evolution, evolution by natural selection, human evolution, and an alternative explanation of evolution and religion. In all the lessons, some practices could be characterised as teacher- and learner-centred approaches to teaching and learning.

4.3.2.2.1 Teacher-centred approaches used during teaching and learning

A teacher-centred approach is understood as a teaching method where the teacher is actively involved in teaching while the learners tend to be passive, and in a receptive mode, listening as the teacher teaches. During the observation, the teacher used an authoritative or lecture method using several ways to influence learning, mainly employing videos, e-Books and/or textbooks, a PowerPoint presentation, questions, and answers, with minimal use of group work or discussion. The teacher-learner ratio of 1:36 (DBE, 2008) did not apply as approved by the Department, as the class had over 48 learners. In the next section, I discuss how certain teaching methods and materials were used during the lesson.

During the pre-lesson discussion on similarities and the differences between a human being and African apes, Mr Abby said,

> *Okay, all right, so my planning I have got my resources. I have some videos on the smartboard, some pictures and then I have got power point, together with the textbook. I am going to use these resources so that they try to connect this, because when it comes to evolution.*

This narrative shows that resources such as videos, pictures, and textbooks were to be used during the lesson. The following vignette illustrates aspects of how Mr Abby taught his classes represented by an excerpt of a lesson with Grade 12A on the understanding of the similarities and the differences between a human being and African apes:

1. **Teacher**: Good day. No, fine, all right let's have a look at the similarities between the African apes and humans, close your books, eBooks and **look at the video, Okay fine let's start with the similarities,** and please guys don't mix the two, you remember you were mixing the two. Please let's look at **the similarities between the apes and human beings.** OK, let's start with the first one 'yes'.
2. **Learners:** Muscular version, flat nails)
3. **Teacher:** Flat nail, remember flat nails instead of claws, fine the other one, remember that person, that 'popayi' there come on guys, what is this, come on guys.
4. **Learners:** Up bright poster.
5. **Teacher**: Yes, up a bright poster, one person at the time opposable thumb, opposable thumb, what else (freely rotating arms) say it, one person at the time, what else can you say.
6. **Learners:** Long arms.
7. **Teacher:** Long arms, not just arms but upper arms, fine all right so you need know this thing, we not going to repeat this you must know this.
8. **Teacher:** fine let's go to the differences, let's have a video and a look at the differences. Use your eBooks and textbooks also to confirm some of the answers.
9. **Learners:** Bi-pedal.
10. **Teacher:** Just tell me that this one is like this and this are like this remember we are comparing the two.
11. **Learners:** They have got a sloping face.
12. **Teacher:** They have got sloping face 'okay' what about a human being.
13. **Learners:** Flat face
14. **Teacher:** Flat face, yes flat face. Yes.
15. **Learners:** Apes have long canines and human beings have short canines.
16. **Teacher:** Okay they have got a long and short canine; okay we are getting somewhere.
17. **Learners:** Humans between their 60 years have small space and apes have larger space.
18. **Teacher:** Exactly, okay good. Let's also look at this slide and identify other similarities and differences.
19. **Learners:** Develop chin and not, develop chin.
20. **Teacher:** What is that?
21. **Learners**: Aba humans' bane developed chin and ama apes bana undeveloped chin.
22. **Teacher:** Okay, good, okay, what else?
23. Learners: Humans have larger brains and apes have shorter brains.

Figure 4-1: Lesson on an understanding of human beings and African apes

During the pre-lesson discussion on similarities and the differences between a human being and African apes, Mr Abby said,

> *Okay, all right, so my planning I have got my resources. I have some videos on the smartboard, some pictures and then I have got PowerPoint, together with the textbook. I am going to use these resources so that they try to connect this, because when it comes to evolution.*

This narrative shows that Mr Abby assembled resources such as videos, pictures, and textbooks were to be used during the lesson. As part of the introduction of the lesson, he also requested learners to watch the video. He said,

> *Good day. No fine all right. let's have a look at the similarities between the African apes and humans, close your books, and look at the video, Okay fine let's start with the similarities Please let's look at the similarities between the apes and human beings.*

a. Animation video-based approach to teaching and learning

Mr Abby used some Life Sciences animation videos clips **(Refer to line 1, and line 8)** when presenting a lesson on Lamarck's theory of evolution, natural selection, and human evolution to simplify some of the content for the learners. Below are two of the animation videos that were used during the lesson on Lamarck's theory of evolution and human evolution.

Picture 4-4: Animation video on Lamarck's theory of evolution and human evolution

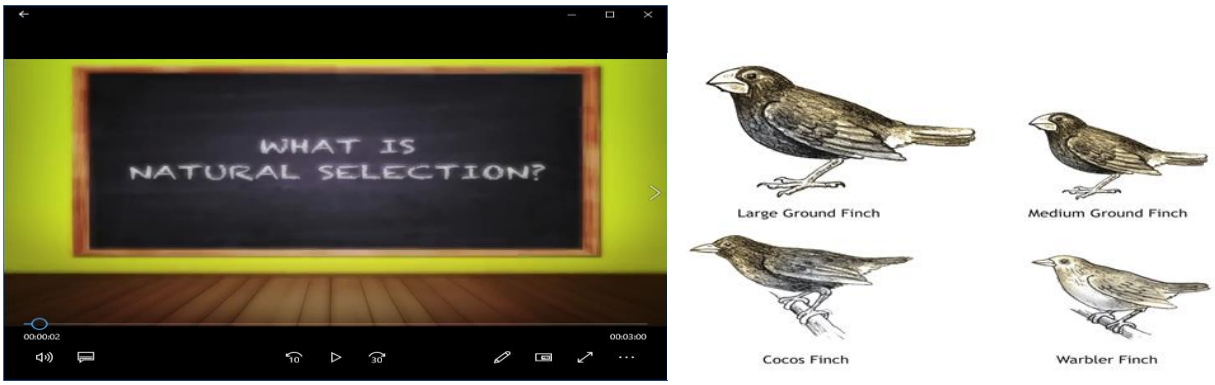
Explaining the animation on Lamarck's theory of evolution, Mr Abby said,

> *The law of use and disuse states that when certain organs become specially developed because of some environmental need, then that state of development is hereditary and can be passed on to progeny. He believed that in this way, over many generations, giraffes had short necks and were in an environment where they must eat plant leaves …*

In an interview, I asked him why he opted to use animation video. Mr Abby explained that

> *the language used in evolution is the difficult part of it" and the use of videos seems an advantage because abstract topics that once seemed difficult to teach and learn were more accessible and understandable using educational videos.*

In his view, the use of short video clips allowed for more efficient processing and memory recall and appealed to a wide audience and allowed each user to process information in a way that was natural to them. One of the videos played for learners was on natural selection by Darwin, on how certain birds survived over the period. See the picture and explanation from the video below:



Picture 4-5: Animated video on natural selection of Finches

During this lesson, Mr Abby explained everything that was happening in the video while learners were quiet and watched the video. Mr Abby explained,

> *Natural selection occurs if four conditions are met: reproduction, heredity, variation in physical characteristics, and variation in the number of offspring per individual. It is one of the four basic premises of evolutionary theory, alongside mutation and genetic drift, and works on populations with variation in traits, such as colouring.*

When he explained further the video about birds, Mr Abby said,

> *Birds feed on seeds and insects. The example in the video shows seed-feeding finches from the mainland. Many of these birds continued to eat seeds, as a result, there was lots of competition for food. Many finches did not survive, and the population of seed-eating finches remained stable …*

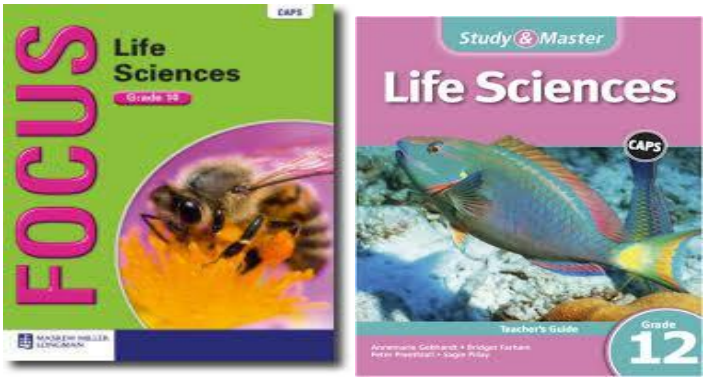
In an interview, Mr Abby further indicated that the use of these videos in the teaching and learning of natural selection served not only to benefit learners but also himself, as it improved his learning experience. During the interview, he said,

> *When it comes to evolution, it's something else when it comes to explaining to the learners is tough. So, that's why I have some videos to show*

This suggests that the videos explained some of the processes that he maybe was not familiar with. During lessons on fossil evidence, Mr Abby also requested learners to watch the videos during the lesson (**refer to lines 19 and 20).**

b. Use of e-Books and/or textbooks

During lesson observations, some learners had tablets, and some had Life Sciences textbooks. Tablets were installed with electronic books. During the lesson on similarities and differences between apes and human beings, the teacher referred learners to the Life Sciences e-Books/textbooks to check and verify the information and also referred to learners to textbooks **(Refer to line 8)** for more information. This was also noted during the lesson on fossil evidence; Mr Abby requested learners to use the textbook/e-Book during the lesson (**refer to line 19)**. Some of the e-Books and textbooks that I noticed during the lessons were *Siyavula Life Sciences, Viva Life Sciences, Focus Life sciences,* and *Understanding Life Sciences*, e.g.:



Picture 4-6: Grade 12 Life Sciences e-Books/books

The use of textbooks and e-Books promoted the learning process. Textbooks enabled the subject content material to be covered and the design of each lesson to be carefully spelled out to improve the understanding of learners and provide learners with organized units of work, including all the plans and lessons. Although during the lesson the

instructional strategy was teacher-centred, he also accommodated learner participation through questioning techniques.

a. Question-and-answer method

During lessons on fossil evidence, natural selection, human evolution, and speciation in the Grade 12A and 12B classes, Mr Abby asked several questions, expecting learners to respond. The following vignette illustrates aspects of how Mr Abby used the question-and-answer method to introduce and drive the lesson on fossil evidence and speciation:

1. Good morning. We have our visit again. Name the 'terminology' that best describes the following statements, the first one: the development of new spices from existing spices.
2. Learner 1: speciation
3. Teacher: speciation good, let's see this one the study of the distribution in a different part of the world
4. Learner 2: biogeography
5. Teacher: biogeography, biogeography good, and the simplest structures in different organisms implicating common ancestors.
6. Learner 3: is a prothagnus
7. Teacher: fine, a group of similar organisms that can be broken to produce a fertile of spring, one person
8. Learner 4: species
9. Teacher: that is species, correct; and the group of organizing of the same species that occupy the habitant. One person yes
10. Learner 5: population **Teacher:** that is a population, only
11. Teacher: Correct; organisms with favourable characteristics survive. One person doesn't say it just raise your hand
12. Learners: naturalization (in a chorus)
13. Teacher: naturalization, okay using parent with desirable characters sticks to obtain a combination of these desirable characters sticks in an offspring, you can read it 1.8 that using parents. Yes.
14. Learners: artificial selection (in a chorus).
15. Teacher: artificial selection. One learner at a time. Simple as that. Ok, one learner at a time Okay. An opening in a scalp through which a spinal court pass.
16. Learner 6: foramen magnum
17. Teacher: that is foramen magnum, locomotion involves in use of a pair of high leads only, raised your hand, you will continue on locomotion. People what is locomotion, locomotion is moving. What is that?
18. Learner 7: bipedal
19. Teacher: yes, that is bipedal, people in life science can ask one thing in different ways because is locomotion is no longer there. Okay fine okay let's just move, seen, we have watched this one and **then we look at the video on trending human development** eeeh what I am looking for is this one let us go to this one. Eeeeeh let's see okay we started with the sequence, let's have a look, okay we started with yesterday let's continue, **let's open our textbook**. Abo Lucy. Okay let's see yesterday we did we stop. Mrs Pless okay, let's look at Mrs Pless, look at this one the first one we look at RDP tse kasi, (township houses)and then we look at the person who discovered this as team one fine and then when is the second one after repeaters we have never talk about this but it's there and then we talk about Lucy ooh remember, I remember Nontokozo fine let's have a look at this one

Taung child there discovered by Raymond that "where" (**learners>In Taung**), where is Taung? (learners> Northwest) we have got **Mrs Pless** okay. So, we are done with Mrs. Ples. Did we do? (Learners> no) never done that, it is fine. **Let's start with Mrs. Pless, there are on pages 225, 225**, so you need to know that this is the **Taung child discovered by Raymond That in Taung and we look at what? (Learners> Mrs Pless) okay, this is 2.6 million years ago,** and it is discovered by what**? (Learners>Robert Blue) where? (Learners>in Sterkfontein) okay, all right ko Marubing yes, don't forget that we have got Marubing here angithi (learners> Yes) don't forget that Mrs Pless "Lebohang don't forget that. Now let's have a look at the 'little foot' there, this is discovered by Ronny Clan, where Sterkfontein is area ko Marubing. Okay let's have a look at this one I want us to go to Karabo can you see, can you see Karabo there? Okay, let's have a look at Karabo there. Karabo means the answer, the answer can you read that one 'Karabo'.**

20. **Learners: Karabo "the answer" on 15 August 2008 nine years old Matthew Burger of the low clan went cleared the king at the Malaba sight.**
21. VIDEO: Discovery of fossils (for learners to watch)

Figure 4-2: Lesson on fossil evidence and speciation

However, most questions were close-ended questions requiring learners to say 'yes or no' asking if understood the matter, with few open-ended questions that were thought-provoking to enrich the learners learning process. I asked Mr Abby about the importance of using questions and answers during the lesson. Mr Abby said,

> *It encourages engagement from learners in class and motivates them to listen in class as well as become critical thinkers when discussing or answering the question of teachers.*

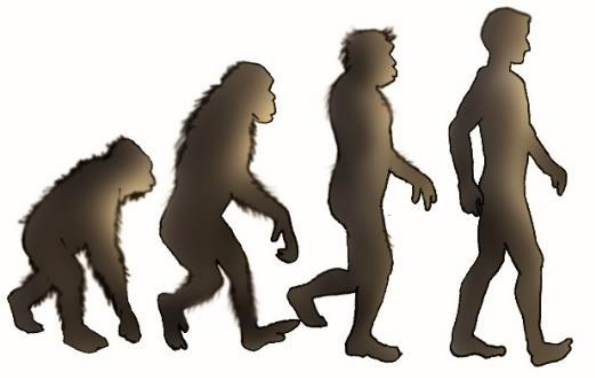
He further said,

> *However, this method was time-consuming because the classes were overcrowded. The success of this method also depends on the types of students in a class. I find short questions helpful during the lesson because usually, some learners do not participate in discussions.*

I noted that some of the students' responses were not audible enough to the researcher in the classroom, but the teacher was able to able to explain what the learners were saying.

During the lesson on fossil evidence and speciation (human evolution) Mr Abby sought to capture the interest and motivate the students during the introduction. It focused students' attention on the lesson and its purposes and further convinced students that they will benefit from the lesson. The lesson was rather teacher-centred, and he started the lesson by engaging learners and asking questions and learners answering, for

example, '*What is evolution'*. He further expected learners to give one word for explanations that were flagged on the Smartboard (**refer to 1 to 10**). Questions and answers were used during the lesson to simplify some of the content that seemed to be difficult for learners. Example: During the fourth lesson, the following picture was displayed on the Smartboard, and learners were expected to point out the similarities and the differences between the apes and human beings, and learners mostly gave short answers.



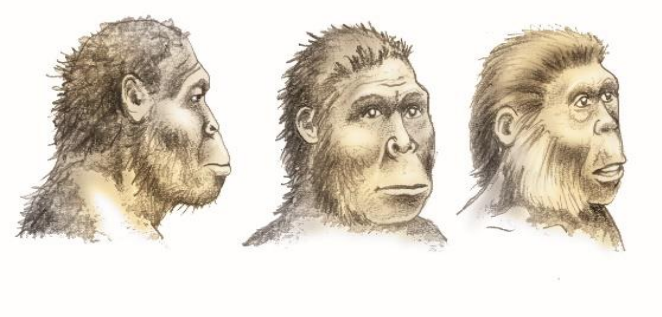
Picture 4-7: Hominid species

Mr Abby requested learners to look at the picture above and identify the similarities between the ape and human being **(Refer to lines 2 to 10).** During this period, the teacher explained everything with very little information from learners. After the teacher had introduced this lesson, the teacher then played the video on human evolution until the end of the lesson without further explanation of the lesson. All the videos shown by Mr Abby were assembled by the Gauteng Department of Education and are available at Gauteng schools, districts, and head office. Some of these videos were downloaded by Life Sciences subject specialists from the internet for easy access and use by the teachers. In most of the lessons, Mr Abby supported his lessons using prepared slides on evolution and he gave a short explanation of the content, which are discussed next.

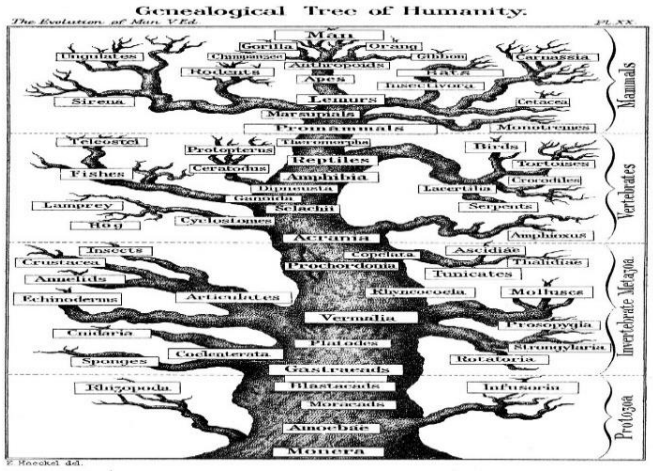
a. Use of PowerPoint presentation

During lesson observation, I noted that Mr Abby also used Life Sciences prepared slides and created slides based on the lesson presentations. Some of the PowerPoint slides

presented were on human evolution, common ancestors, and creation (**Refer to line 18** in a lesson on human beings and African apes).



Picture 4-8: Common Ancestors



Picture 4-9: Human evolution

The following is an excerpt from a lesson on evidence of common ancestry. Mr Abby asked a question to the class

> What evidence shows that different *species* are related*?*

As he presented the slides on common ancestry, Mr Abby said,

> *Biological evolution, the process by which all living things have evolved over many generations from shared ancestors, explains both the unity and the diversity of species. The unity is illustrated by the similarities found between species, which can be explained by the inheritance of similar characteristics from related ancestors ... Evidence for common ancestry can be found in the fossil record, from comparative anatomy and embryology, from the similarities of cellular processes and structures, and comparisons of DNA sequences between species …*

I noted that the PowerPoint presentation created visual, content-rich presentations, which increased the visual impact to learners in a classroom to be more focused. See Picture 4.10 for the other presentation used during the lesson on natural selection.

Picture 4-10: PowerPoint presentation on human evolution and natural selection

When asked during the interviews about teaching strategies he used in the classroom when teaching, Mr Abby said he made sure he used and developed a language that could be understood by the learners,

> *I try and develop the vocabulary around the knowledge, because at times you may find that you are dealing with students who did not do history, you know, they last did history maybe in Grade 9.*

I rephrased the question and asked him how he taught in the classroom. Mr Abby responded by saying,

> *I guide them, so you become a guide in the topic, and you can only do that if you know about evolution at your fingertips.*

The interviewer probed the respondent to what extent the CAPS document influenced the teaching strategy. He said,

> *The CAPS documents did not define an approach, they have put evolution with all the other defined topics. Here we are teaching a hypothesis and is surely the outcomes are going to be different, because, in terms of a hypothesis, it is like an experiment. If you experiment correctly, these are the results you would expect.*

Considering the teaching and learning approaches used by Mr Abby when teaching evolution, during the lesson I noted that the question-and-answer method was dominant

during the lesson. During the post-lesson discussion, I asked Mr Abby to clarify the use of the question-and-answer method during teaching and learning of evolution. He said,

> *The teacher-centred strategy works when teaching evolution because it does not allow classroom management to be scattered. After all, once it is scattered around the hypothesis, each learner can come up with their interpretation, and you are allowing the learners to be part of the learning process and share these ideas.*

The narrative suggests that the teacher also preferred a question-and-answer approach to teaching to promote guided learning of evolution. This was one of the teaching strategies he used one day and, on another day, he used another strategy.

b. Use of prior knowledge influences learner understanding of evolution

During the interview on whether Mr Abby understood or used learners' previous experience in the classroom, he responded by saying,

> *I use learners' prior knowledge. However, it is a very difficult one, because you know, when you talk about evolution, you know sometimes you need to consider some learners' knowledge and some people's knowledge that has to do with their beliefs.*

During the lessons on fossil evidence, natural selection, human evolution, and speciation, Mr Abby started the lessons by asking learners about what he taught in the previous lesson, and not as the knowledge inherited from society, Learners were asked questions of content that was part of the previous lesson (Refer to line **2 to 8** of a lesson on apes and humans, **1 to 10** on lesson in natural selection, and **12 to 15** on lesson in fossil evidence. However, he agreed that learners' prior knowledge is essential for learners to understand new content,

> *Prior knowledge makes learners understand the new content and encourage learners to construct their knowledge.*

Mr Abby agreed that prior knowledge emanating from society, home, or environment can be useful to help learners to understand new content on evolution. Some of the learner-centred practices are discussed next.

4.3.2.2.2 Learner-centred approach in teaching and learning

Learner-based teaching is used as an approach that places the learner at the centre of the lesson, and is responsible for their learning, while the tutor is responsible for facilitating the learning. In some of the lessons observed, there were practices of learner-centred learning; learners were engaged during the lessons using open-ended questions, discussions, and searching the internet for information.

a. Open-ended questions

In this study, the open-ended question refers to questions asked by the teacher that requires a full answer, using the subject's knowledge or feelings and are objective, do not lead the person being asked, and result in an answer that requires an explanation. The use of open-ended questions was not dominant during the lessons. This was noted on the vignettes from a lesson on the Out-of-Africa hypothesis (lines **1 and 2** of the lesson).

1.	**Teacher**: (looking at the video clip) there comes *Homo* species, end then let's said and look at all, are they Homo species, what is first one *Homo habilis* and then *Homo erectus* and then … **Who can tell me who has an idea of what is out of Africa**, what is it that we going to talk about when we talk about out of Africa hypothesis?
2.	**Leaners**: *Sir ngokucabanga kwami kuthi* (isiZulu) I think people were living here in Africa and there were people out of Africa (in) continent

Figure 4-3: Use of open-ended questions

The use of open-ended questions was again applied in lines **25** to **28** of the same lesson on the Out-of-Africa hypothesis. Mr Abby indicated that he used some questions to encourage learners to think to promote understanding. According to him,

> *Open-ended questions enable learners to critically think about what they learn and allow the teacher to get more information when answers are not sufficient.*

The narrative suggests that Mr Abby asked questions that enable learners to think during the lesson and use their ideas to identify learners' prior knowledge to help them to learn. During the observation, he used a series of questions in his teaching.

During the post-lesson discussion, the respondent indicated the importance of open-ended questions. He said,

> *I prefer open-ended questions you know when teaching the learners, that would allow learners to discuss, initiate debate, and guide them you know.*

It can be concluded that the use of open-ended questions, while present, was minimal in Mr Abby's lessons during teaching in the classroom.

b. Discussions

The data collection process checked if teachers involved learners in dialogue. According to Spillane *et al.* (2002) and Brooks and Brooks (1993), social discourse offers learners a chance to use their thoughts. During the interview Mr Abby said,

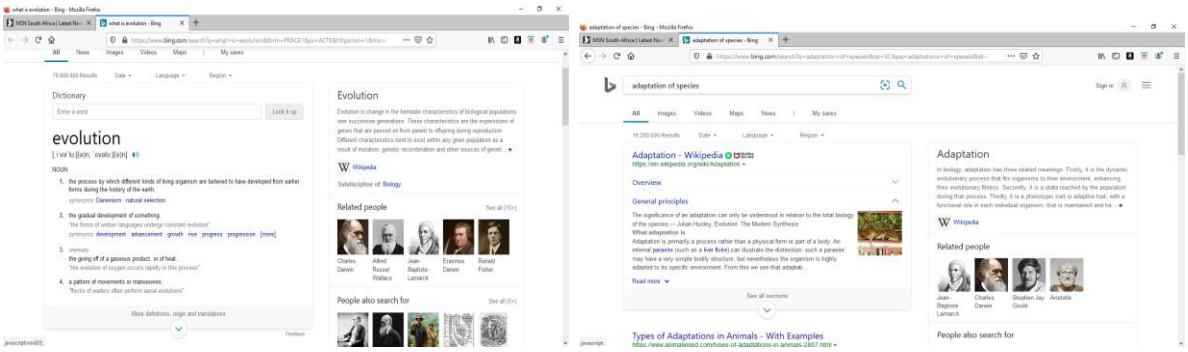
> *I encourage learners to engage in a dialogue during the learning process, dialogue amongst learners themselves sometimes is not fruitful because learners tend to discuss matters of their interest and indicated that dialogue works best if the teacher walks around the groups, giving instructions, directions and asking questions that will enable learners to engage further.*

During my observation, I noticed that Mr Abby did not involve learners in a dialogue, but the question and answers method was used to engage teachers and learners during the lesson. The discussion activity seemed difficult to apply due to overcrowded classrooms, i.e. over 45 learners were accommodated in one classroom.

c. Internet search for information

During the lesson on the introduction to evolutionary theories, I noted that learners were allowed to search for additional information related to the topic on their tablets using a search engine. Some of the information that learners were required to search was,

> *What is evolution, human evolution, natural selection, adaptations, etc.*



Picture 4-11: Internet search on what is evolution and the adaptation of species

An internet search engine is a software system designed to carry out a web search, which means to search the World Wide Web in a systematic way for information specified in a textual web search query. The search on the adaptation of species shows that

> Adaptation has three related meanings. Firstly, it is the dynamic evolutionary process that fits organisms to their environment, enhancing their evolutionary fitness. Secondly, it is a state reached by the population during that process …

The other search on 'what is evolution' was,

> Evolution is a change in the heritable characteristics of biological populations over successive generations. These characteristics are the expressions of genes that are passed on from parent to offspring during reproduction …

These search results show that Mr Abby had access to internet information to supplement subject content from the books.

4.3.2.3 Theme 3: Challenges and opportunities for teaching about evolution in the Life Sciences

In this theme, data from the interview were mainly used to substantiate the two sub-themes that were developed and discussed, which were on challenges and opportunities for teaching evolution in the Life Sciences classroom.

4.3.2.3.1 Challenges and/experiences for teaching evolution

From the analysed data collected it emerged that the teacher experienced some challenges when teaching evolution. The challenges emerged from the following

experiences, namely religious beliefs on creation, teacher development, and language usage, historical accounts of science, availability of teaching materials, and teaching approaches. Other associated challenges include teaching and learning evolution, learning evolution in a particular classroom environment, the abstract language used in the section, poor content knowledge, and inadequately prepared teachers to teach evolution.

a. Religious beliefs on creation

When the participant was asked about what the challenges were for teaching evolution in the Life Sciences classrooms, he responded by saying,

> *I know that humans were created by God. We know the bible put of things but when it comes to this Evolution that a human being originated from Africa, it becomes a challenge.*

According to Mr Abby, content on evolution affected some learners during learning. In this case, it was noted that the teaching of evolution conflicted with learner beliefs, and as such, it made it difficult to accept and/or teach the theory of evolution. In an interview, he said,

> *I often find myself in between, because you are a teacher and need to convince learners on whatever you are teaching but as a human being who grew up being a Christian and going to church.*

During the observation, it was also noted that teaching of evolution was taught late during the term, as a result, they rushed through the work just before the examination and did not place great emphasis on it, thus leaving learners without adequate conceptual understanding. The teacher said,

> *I get some weird questions like 'What created these human beings?', 'Who created the earth?' and it gets deeper which becomes tough. They just want to show you that they don't believe in what you are saying and have their own religious beliefs.*

When asked how he dealt with challenges before, during, and after lessons, he responded,

> *I don't have any other option but to try and convince them that either way we must learn this and explain that this comes from a scientist.*

Even though the study was not about learners, certain comments by learners during the lesson affected the learning of evolution. One learner said,

> *Evolution cannot be true, because God created it all, or evolution is also a belief, you just believe in it or you do not, it is just a theory because you have no proof whatsoever.*

The narratives suggest that teachers' religious position affected the teaching and learning of evolution. This further suggests that a teacher may be confronted with some challenges regarding learners who hold contradictory ideas about evolution, and experience tension amongst learners, who then become passive participants. The claims made by learners may imply that the learners seem to have a narrow understanding of evolution and science.

b. Teacher development

As indicated in the section on the background of Mr Abby, evolution was not part of his formal teaching qualification course, but it was only introduced after 2006 (Sanders, 2010). From the discussions, it became clear that Mr Abby had completed his teaching diploma before 2006 and had never had training on evolution at university on how to approach evolution in class.

> *I did not do evolution at the secondary and university levels, especially human evolution. It only came recently as a chapter in Grade 12. I began to know evolution as a teacher then I took it from there.*

A research report by Sanders (2010) found that most teachers were not exposed to this topic either at the secondary or tertiary level of their education. The DBE organised pieces of training and workshops to support all Life Sciences teachers, especially those who may not have encountered the topic during their teacher training (Sanders, 2010). Mr Abby also said that the training conducted did not assist teachers to handle problems encountered in the classroom but was a way to introduce the section into the syllabus. During the interview he said,

> *I think the training was not enough and if I still remember, we were trained for only 2-3 days, and this needed time. This is a complicated topic, and those days were just not enough. Remember, as a teacher we are trained for 3-4 years.*

The excerpt above suggests that the development that was offered was not enough because the theme of evolution has some sections to be covered that require understanding. Mr. Abby indicated that he was one of the teachers who did not receive formal training on the topics at university or college as part of his teaching qualification, but he attended the workshops on evolution organised by the DBE.

c. Language usage

On language usage, Mr Abby highlighted the complex nature of the terms used when teaching the topic of evolution. He said,

> *The language used when talking about scientific concepts often varies with the context and purpose of the communication. The terminology used to present, explain, or even ask questions about evolution makes a change in the understanding of concepts.*

This suggests that multiple meanings of scientific terms are often implicit and the use of meanings and understanding to describe evolution gives misinterpretation of evolution and may lead to misconceptions. Despite the challenges, Mr Abby indicated that, during the lesson, he used mother tongues to simplify the content to the learners. In an interview he also said,

> *The language used is the difficult part of it, you don't have proof, you cannot experiment that even though there are some examples in the textbooks and the like, it is not easy to believe in most things.*

He further indicated that he had challenges regarding differentiating some of the words used in evolution.

> *I usually struggle to distinguish these concepts for learners even in a formal class and often switch back and forth between everyday language and scientific meanings.*

The finding shows that the understanding of what teachers and learners are intending to communicate to each other becomes a challenge. During the lesson observations, the evolution concepts of 'adaptation' and 'competition' were often confused with the everyday meaning of these terms, which contributes to common misconceptions such as the idea that the individual, not the population, adapts to the environment. During the observations, it was noted in the different lessons that Mr Abby could not provide a simple

way for the learners to understand some of the scientific terms, i.e. hypothesis, theory, law, and fact, but relied on the eBooks/textbooks on evolution

d. Teachers' limited content knowledge

Mr Abby indicated a lack of resources was impacting negatively on the teaching of evolution, and that lead to teachers' poor content knowledge. Poor content knowledge was attributed to a shortage of textbooks and material. He read from the available e-Books/textbooks on evolution or used videos to present the lesson and did not give sufficient explanation of the concepts. This suggests that he perhaps lacked appropriate knowledge of evolutionary theory, which may suggest that he had limited content knowledge and understanding.

During the lesson, there was no sign of difficulties encountered by the teacher when teaching evolution; this was because the teaching was e-Books/textbook-based, video and PowerPoint presentation based, with minimal opportunities given to learners to discuss or ask questions. When asked during the interviews about the difficulties or limitations connected to teaching evolution, he responded by saying,

> *It is a distant topic to present to the learners because once you are talking, you bring in an element of Geography, theory, and an element of hypothesis, so there is a lot of scientific interpretation that you need to impose on the learner. Therefore, the teacher needs training on the topic because most of the material that the learner would be able to apply to learn any further concept in evolution, they must be given. Making matters worse is that evolution is a link between three subjects being Life Sciences, History, and Geography which is a challenge especially when you do it from a Life Sciences perspective.*

Mr Abby further contextualised the situation in the teaching of evolution stating,

> *It goes against what we are trying to do that learning should be learner centred and the learners should be able to drive their own learning experience, but now with evolution, because of how it is structured, it calls for the teacher to be an expert.*

The narrative suggests that teachers find it challenging to incorporate knowledge from the other subjects, as that would further confuse both the learners and the teachers, depending on their competency in general and proficiency in English for non-English home language speakers.

e. Historical accounts of science

The history of science is the study of the development of science and scientific knowledge, including both the natural and social sciences. Science in the study was understood as the body of empirical, theoretical, and practical knowledge about the natural world, produced by scientists who emphasize the observation, explanation, and prediction of real-world phenomena (Probiner, 2016). During the interview, he said,

> *Many of these science words are written in Greek and Latin. It's a matter of understanding, interpretation, and writing all these names.*

It was seen to be of value for learners to know evolution as science, evidence of evolution, history of evolution, natural selection, etc. so that they can have a better understanding of life.

f. Availability of teaching materials

The availability of information in line with teaching and learning of evolution was noted as a challenge. The main challenge pointed was that there was not enough previous information, historical references, or practical evidence that the teacher can use to simplify the lesson for learners, even though one can say there was enough study material looking at the available books. In an interview, Mr Abby said,

> *There hasn't been much development of the subject material to talk to new knowledge that has been added, that could be incorporated to assist with understanding other areas. It is a learning chain, it is trying to put together a historical view of how man, and how the continents came about.*

This was evident during the lesson because the teacher was only using information from e-Books or textbooks during teaching and learning.

g. Teaching approaches

In this case, the teaching approaches used by teachers to enable student learning are determined partly on the subject matter to be taught and by the nature of the learner. For a particular teaching method to be appropriate and efficient, it has to be concerning the

characteristic of the learner and the type of learning. Mr Abby indicated that one of his challenges was that he was not trained on how to approach the teaching of evolution.

> *The training did not help with the approaches to manage with challenges he faces in the classroom. The course was supposed to be part of the university teacher programme so that teachers can gain more insight and understanding and offer approaches to teaching and learning of evolution in class.*

This implies that there was a need for training on teaching approaches that applied to the teaching and learning of evolution in the classroom. Therefore, he applied methods that he learned to teach other sections that he completed as part of the university programme.

4.3.2.3.2 Opportunities for teaching evolution

The study looked at the favourable or advantageous circumstances for teaching evolution and learning of evolution. The information collected and analysed shows that the opportunities for teaching and learning evolution were about knowing the history of the earth and the origin of life, an understanding of changes in organisms, the application and relevance of science, survival of the fittest, development of species, adaptation/competition, and skills development.

a. Historical background about the origin

In more technical terms, 'historical context' refers to the social, religious, economic, and political conditions that existed during a certain time and place. Analysing historical events context can help us understand what motivates people to behave as they did. Mr Abby said,

> *Learning is a part of bringing the past to the present and projecting the future, as a result, it was important to have historical views of how man, continents came about, why we probably have white and black, which involves a lot of doing the theories. Evolution is something like a history subject, you must study it.*

This narrative suggests that teaching and learning of evolution were important because they deliver answers to questions of life on earth and its origin.

b. Skills and future career

This section covers the skills and abilities that learners naturally do well; talents and strengths that they bring to the table, which may be natural capabilities they always had, in addition to specific knowledge and skills they have acquired through experience and training. The discussions with Mr Abby show that evolution theory allows learners to choose different careers from various fields. During the interview he said,

> *Teaching and learning of evolution are linked between, three subjects being Life Sciences, History, and Geography.*

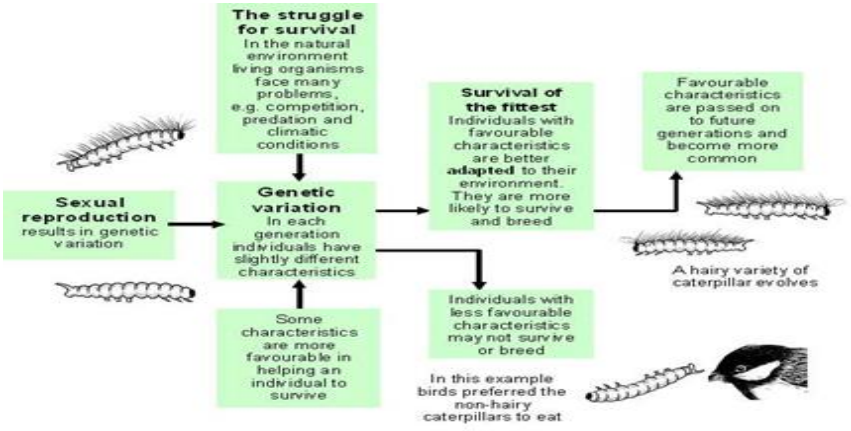
The respondent further said,

> *It is worthwhile for students/learners to know evolution as they will be imparted with investigative and reasoning abilities essential for their careers in the future.*

This suggests that learners who study evolution will understand other subjects, which then can help them to decide on the career of their choice.

c. Understanding of change in organisms

During the development of species over time, a few activities happened to the species, which includes the survival of the fittest, the development of species, mutation, and competition.



Picture 4-12: Natural selection (genetic variation)

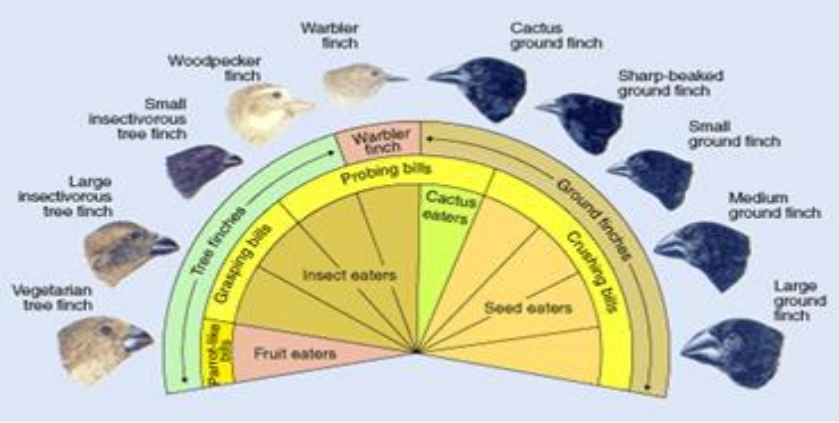
In the first lesson, Mr Abby used the diagram to explain the natural selection/survival of

the fittest with the advantageous gene. He gave the following explanation,

> *Natural selection is a phenomenon whereby individuals with the most suitable characteristics based on the genotype will be able to survive/cope with challenges or adapt best to the environment. Plants and animals produce many offspring with variation e.g., beetles produce many offspring with colour variation as this is a source of food for birds. Those beetles whose colour allows them to camouflage against predatory birds will survive …*

Mr Abby then concluded the introduction of the lesson and immediately flagged another diagram that explain the evolution in present times with regard to Darwin's finches.

For the second lesson, Mr Abby explained that natural selection still occurred on Daphne Major, a Galapagos Island, where small, medium and large beaked finches were present. See the picture below.



Picture 4-13: Variation in the size of beaks

He started explaining that looking at the size of beaks as depicted in the picture.

> *There was variation in the size of beaks. Between 1976 and 1978 there was a serious drought. Many of the small to medium beak finch species could not survive the drought and died. Environmental selection pressure eliminated finches with small beaks due to a lack of food. During normal wet seasons plants are used to produce small and large seeds. The small seeds could be eaten by the finches with small and medium beaks …*

This suggests that the theory of evolution enables learners to know about the process that results in changes in the genetic material of a population over time and reflects the adaptations of organisms to their changing environments.

4.3.2.4 Conclusion on Mr Abby's case

The previous section has reported on Mr Abby, one of the Life Sciences teachers whom I studied. A description of the biographical background and the institutional context in which he works as a Life Sciences teacher was given. This was followed by indicating how he taught the Grade 12 classes when implementing the CAPS. The narrative suggests that the school had adopted and practised some of the Christian activities. The classroom set up was learner-centred, with the tables arranged in groups of eight, with all 48 learners seated facing the interactive Smartboard. The study identified four main categories to explain the teachers' views and beliefs, which were religious beliefs, professional beliefs, teaching evolution, and social beliefs. These categories were identified in line with the challenges the teachers face during the lesson on evolution. The teachers' views and beliefs ranged from evolution being abstract and a difficult topic to teach in terms of the language, as well as a religious position. Also, the teachers are poorly trained to teach evolution, and insufficient resources are available to assist teachers in presenting the concepts on evolution. During the observation, the teacher used an authoritative or lecture method using several ways to influence learning, mainly using videos, e-Books and/or textbooks, a PowerPoint presentation, questions and answers with minimal use of group work or discussion. The challenges emerged from the following experiences, namely religious belief of creation, teacher development, language usage, historical accounts of science, availability of teaching materials, and teaching approaches. Other associated challenges include teaching and learning evolution, learning evolution in a particular classroom environment, the abstract language used in the section, poor content knowledge, and inadequately prepared teachers to teach evolution. The data show that the reason for teaching and learning evolution was to get to know the history of the earth and the origins of life, understanding changes in organisms, the application and relevance of science, survival of the fittest, development of species, adaptation/competition and also skills development.

Next, I present Case 2 of Mr Johnson.

4.4 CASE 2: TEACHING OF EVOLUTION IN MR JOHNSON'S CLASSROOM

4.4.1 Teacher, School, and Classroom Background

a. Teacher Background

My first encounter with Mr Johnson was during a Life Sciences cluster meeting. The cluster meeting focused particularly on Life Sciences pacesetters, work schedules, and school-based assessment to be conducted within the district. Although he showed an interest and contributed actively to the discussions about teacher knowledge, classroom practice, and the use of manipulatives, he was initially hesitant to participate in the research project. I had to initiate an appointment to engage with him separately and explain to him the drive of the research project and what benefits it might have for the teaching of Life Sciences in general.

Mr Johnson, in his mid-40s, is a Life Sciences teacher at School B, where he has been a teacher for the past 10 years. He holds a three-year STD, Higher Diploma in Education, and Bachelor of Education with Honours in which he was trained as a generalist teacher for the FET phase curriculum, i.e. Grades 10–12. However, he had been teaching Natural Sciences in various grades in the GET Phase (Grades 8–9), and he was currently teaching Life Sciences to two of the four Grade 12 classes at his school. Explaining how he got to teach Life Sciences at the school, he described that when he arrived at the school, there was no teacher to teach Life Sciences at the school. That was how he was allocated Life Sciences at the school. Next, he had to teach Natural Science classes in the GET Phase (Grades 8–9). When asked to describe his feelings about being assigned to teach the Life Sciences classes, he took a deep breath and indicated that it was scary at first because he was the only person to teach Life Sciences, but he was confident that he could teach the subject. He further indicated that a supportive district subject specialist, school subject head, and cluster meetings helped to ease the pressure.

b. School background

The school was established in 1974 and is based in Soweto, in the Gauteng Province in South Africa. This school is situated in the Johannesburg South District in one of the townships. The school has over 1 600 learners, with over 600 learners in Grades 8 to 9 and 1 000 learners in Grades 10 to 12. The staff personnel comprises 38 teachers, 9 general assistants, and 4 administrative assistants, in total 63 staff members. Like in the previous case, this school is also one of the public schools that had educational ICT equipment, where classes are fully ICT equipped to promote effective and efficient teaching and learning in the classroom. The school is further equipped with free Wi-Fi, laptops, projectors, Smartboards, etc. The language of teaching and learning is English. The school is dominated by learners who speak Sepedi and Setswana, with a few isiZulu and isiXhosa learners. It has one subject-related laboratory and one computer laboratory. The subjects that are offered in the laboratory are Physical and Life Sciences subjects. The computer laboratories are connected to the internet and are used as centres for the Computer Application Technology (CAT) Subject.

c. School assembly practices

Communication in South African schools differs from one school to the other; in this case, communication was promoted via school assemblies, as and when the need arose. No formal assemblies were conducted for weeks or months. In an interview, I asked what happened when there was an assembly. The respondent said,

> *We normally have an assembly, not every week or every month. We normally call the learners if there is something important to be announced to learners.*

During a school assembly, South African schools can exercise any religion as prescribed by the Constitution and agreed on by the School Governing Body (SGB) and the parents. When I probed further on the practice if learners were called to assembly, he answered,

> *We normally go there and have a song and the principal will come to announce whatever she wants to tell the learners from there they disperse. No prayer, nothing, takes place at the assembly*

In support of the religious practice at the school, Mr Johnson said they sometimes prayed during assembly, but that was not a daily practice. He further said,

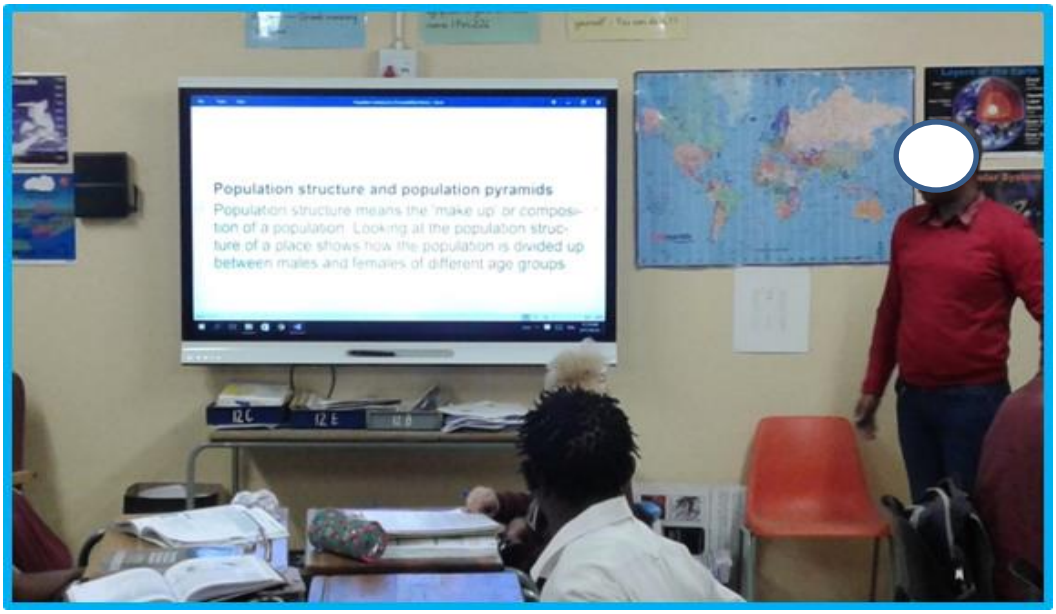
> *They do pray sometimes, sometimes they put on some music ... but we have people with different religions. So, most of us here are religiously orientated.*

The narratives show that the school assembly in this case was called mostly to make important announcements and did not include worship or prayer, which therefore suggests that the school did not adopt active religious activities.

d. Mr Johnson's classroom context

Mr Johnson has been teaching Natural Sciences in various grades and was teaching Life Sciences to two of the four Grade 12 classes at his school. When he joined the school, there was no teacher to offer Life Sciences. The teaching periods at Mr Johnson's school were 45 minutes long, which amount to 4 hours 50-minute periods a week.

The classrooms were designed to allow the use of ICT. The classroom was attractive with blinds and colourful paint on the wall.



Picture 4-14: Life Sciences classroom in the school

The classroom setting is an important factor for learners and teachers during teaching and learning, as it contributes to the creation of a positive learning environment that enhances effective teaching and learning. As depicted in the picture, in addition to ICT equipment, learners are provided with textbooks to use to gain more knowledge. The arrangement of learners in the classroom is important for learning, as it encourages learner concentration and participation. The learners are placed in an arrangement that keeps them focused on the lesson. As depicted in the picture, the classroom setup is arranged such that four learners form a group, with two learners on each side, but in a position where they can see the Smartboard.

4.4.2 Overview of the emerging themes

During the school visits that I conducted, Mr Johnson presented six lessons, which were based on four main topics of the syllabus on evolution, i.e. a review of Lamarck and Darwin's theories, alternative explanation, human evolution, and the Out-of-Africa hypothesis. These lessons were observed with a group of 45 learners doing Grade-12 during normal school hours between March 2017 and November 2018. The lessons on the origin of ideas by Charles Darwin and Jean-Baptist Lamarck were presented over two lessons and were on the theories of evolution. The objective of the lessons was for learners to be able to explain the two ideas of Lamarck's theory, apply Lamarck's theory to specific examples, and explain why Lamarck's theory was rejected.

Table 4.4 below provides the themes, sub-themes, and categories that came out of data analysis generated for this research and were used to guide the presentation.

Table 4-4: Themes, sub-themes and categorise

RQs	Theme	Sub -Theme	Categories
1	**4.5.2.1 Theme** 1: Teachers' beliefs and perspectives about evolution	**4.5.2.1.1** Teacher beliefs on evolution	Professional Development Religious and/or Christian views Social views
		4.5.2.1.2 Teacher perspectives on evolution	Use of Language Resource and Teaching Materials Historical viewpoints
2	**4.5.2.2 Theme** 2: Teaching methods	**4.5.2.2.1** Practices of teacher centred teaching and learning	Use of e-Books or textbooks Use of videos and cartoons Questions and answers Use of PowerPoint presentation
		4.5.2.2.2 Practices of learner centred teaching and learning	Use of prior knowledge Teacher-learners' interaction Groupwork
3	**4.5.2.3 Theme** 3: The challenges and opportunities for teaching about evolution	**4.5.2.3.1** Obstacles in teaching evolution	Religious position
			Lack of training and teacher development Poor learner commitment Historical accounts of science
		4.5.2.3.2 Benefits for teaching evolution	Historical background about the origin Scientific process Application and relevance of science Development of species Adaptation and development of an organism

In the next section, themes, sub-themes, and categories were used to present results from Mr Johnson.

4.4.2.1 Theme 1: Teachers' beliefs and perspectives about evolution

Data from the interviews supported the two sub-themes that were developed on beliefs and perspectives by Mr Johnson are captured in the next section.

4.4.2.1.1 Teacher's beliefs about evolution

This sub-theme covers the views that Mr Johnson had about negotiating the topic of evolution in schools. Three categories were used to explain views in this case, which are professional views, religious and/or Christian views, and social views.

a. Professional views

Mr Johnson's background shows that he is a qualified teacher with vast experience in the teaching of Life Sciences. As indicated in the previous case, in South Africa, the section on evolution was only added to the curriculum in high schools in 2008 (Sanders, 2010), was also confirmed by Mr Johnson,

> *I never did evolution at school. I just started knowing about it here at school. I never study it even at secondary school or at tertiary.*

Considering that the participants did not do evolution during teacher training at the College of Education and University, I asked further as to how he came to know about evolution. Mr Johnson responded,

> *I just learned throughout the books and attend some workshops.*

The narrative suggests that Mr Johnson was not exposed to this topic of evolution either at the tertiary or secondary level as part of formal training towards the teaching qualification. He only got exposed to the topic via the DBE training and workshops to support all Life Sciences teachers. During the interview, he pointed out,

> *I don't have challenges to understand the section in evolution.*

Even though Mr Johnson indicated that teaching evolution is not a challenge, he acknowledged that poor training on evolution content led to poor teaching and learning of the sections on evolution. He pointed out,

> *Poor formal training offered by the DBE contributes to poor teaching and learning of the sections on evolution.*

This suggests that even though he pointed to a need for more development on the topic, Mr Johnson felt confident when teaching evolution in the classroom. This further suggests that he believed that if he could be developed on knowledge and understanding of evolution, his pedagogical content knowledge will be improved.

b. Religious and/or Christian views

It was noted in the previous case that Mr Abby tried to avoid teaching evolution because he felt that teaching evolution conflicted with learners' beliefs in one way or the other. Mr Johnson did not do the same; he was willing to teach evolution, even though he may be faced with a predicament, as some learners may have different understanding and worldview of evolution. In an interview he said,

> *Most of us here are religiously orientated but we are disciplined to separate evolution from religion, especially for the learners. Most teachers are Christians, I don't know about learners. I am a Christian.*

When I asked about what happened when he first heard about evolution, he indicated that all he knew was that in most cases evolution is more about science and he was surprised and asked himself about the possibility of evolution. He answered,

> *It's a question of religion and science. In most cases evolution is more about science and then us from where we come from, we know that although those things which happened, which are explainable there they are based on religion. So, I started asking myself how it is possible.*

This section shows that at the beginning, the participant was shocked by the introduction of evolution in secondary schools because of his religious position. The respondent further acknowledged that learners always referred to religious issues during the lesson, which then influenced the teacher's way of teaching evolution and/or engaging with the idea of evolution. After the lesson, I asked the teacher about learners' views, which influenced his teaching of evolution, and he expanded on the above point by stating,

> *I don't even know if they understood, or they were just interested in talking. Honestly, I tried not to dwell on it, I just highlight and pass, I don't go in their talking, of Jesus said, I just say, for instance, can I make an example or the time we were doing the beginning of the earth, and then they said that we were talking about how other organisms developed because they said there were only the bacteria which were using carbon dioxide because oxygen was not present. And then they said, yes, but then how did humans evolve on the plant, that was, honestly that was the hardest one to explain, they said that God created us, and then when He created us there was oxygen, that is why we are living.*

The above interview demonstrates that the teacher was conscious about what he taught the learners to avoid any reference to Biblical or any religious texts to limit "too much argument", as indicated in one of the themes above. Besides that, the teacher responded to my question by saying, "*No, I don't think so*," regarding being influenced by any learner's thinking during teaching and learning. At one of the pre-lesson discussions, Mr Johnson said,

> *Evolution itself is a very sensitive topic because we have got learners of different backgrounds, religions. So, at the beginning of evolution, I usually tell them that whatever your belief is, I am not here to raise it but here we are learning the science knowledge, and it is fine if you not going to apply it in your everyday life*

When I probed further, Mr Johnson indicated that he did not want parents to come to school and complain about what he taught their kids, and he emphasised to the learners that they just had to learn to pass if they did not feel comfortable about topics in evolution.

> *I don't want parents to be coming here and say you teach our kids this and then you are saying this. So, I also told them if they don't feel comfortable with this lesson just learn it to pass sciences*

This suggests that evolution was viewed as a sensitive topic to teach and therefore Mr Johnson taught it using scientific knowledge and respected people from other religions, particularly in a class comprising learners from different backgrounds. The narratives also suggest that the teacher tried to be professional enough to deal with influences from the learner's views on the lesson.

c. Social views

Mr Johnson was teaching in a diverse classroom with learners from different religious backgrounds. The class was dominated by learners who spoke Sepedi and Setswana, with a few isiZulu and isiXhosa learners in the classroom. In this case, I noted that the teaching of evolution conflicted somewhat with the teacher's own beliefs and as such, during the lesson, he preferred to use the scientific explanations of the theory of evolution. In an interview, he said,

> *Because according to the Bible they are saying everything is created by God. According to science here they take you through all those steps, how the ape develops how the living organisms develop, and how they evolve.*

When asked about any influence by the community or learners, he indicated that he sometimes came across what learners normally say in class, which are different ideas and views and the influence of religion on their upbringing from home. He responded,

> *No, the only thing I sometimes come across is what learners normally say in class because they will be coming up with different ideas and views and most of them, are influenced by their upbringing from home and their religions. So, they will be asking if I know.*

The respondent also mentioned that he loved and believed in sciences and could not confuse himself with other things. He said,

> *Because I love science, and I believe in it, for me evolution … I don't try to confuse myself, with other stuff, I just concentrate on it. However, my view is that it should be removed from the syllabus.*

Despite his confidence when teaching, his views on the teaching of evolution were rather negatively skewed as he even suggested that it should be removed from the curriculum. The discussion further raised and reinforced this point when I asked the respondent about the negative and positive effects of teaching and learning evolution? The respondent stated,

> *I am going to bring the religion, so if some learners feel like you shouldn't be teaching it because it is like you are undermining their religion or God. Because they normally say, I am not a Christian based on what I am saying. So, the negative part is that at some point it brings confusion to the learners, to say what the Bible says, and then suddenly you are telling me that evolution is real. Which one between the two is telling the truth? The positive part is about exploring the different perspectives of things.*

According to the participant, it was clear that the views on teaching evolution were prominently negative, with the indoctrination of religion being the prime factor for this. Best put in the respondent's words,

> *Evolution is not a difficult topic to teach, but you should be sensitive because we have different views of that, you shouldn't give your opinion to say I believe in, just teach what you are supposed to teach and let them decide whether they are going to believe or not.*

During the observation, it was also noted that teachers taught superficially because the topic was taught late in the term. As a result, they rushed through the work just before the examination. In an interview, he said:

> *Evolution is the last part, so it is for the report term, we only do it for like, let's say almost a month or three weeks. It brings a lot of questions because learners have misconceptions about the topic, and because when they bring in the religion part, it becomes a conflict of interest, that when we talk about evolution, which is a science and now compare it with religion. As a result, we end up with too much argument instead of learning.*

When I asked how he separated his religion from the teaching of evolution, he said that he forgets about religion and advised learners to do the same and focus on what was written in the Life Sciences books. Mr Johnson responded,

> *When I go to class I forget about my religion. I focus on, tell my learners that if you are a Christian or have got your religion when it comes to this topic just focus on what is in the book. For the sake of passing of course. Because if you can come with your religion and beliefs then you are going to have a problem.*

This narrative shows that Mr Johnson may not explain the section on evolution enough for learners to understand. This further suggests that he often does not allow learners to engage in discussions about the origin of man and life, thus leaving learners without adequate conceptual understanding.

4.4.2.1 2 Teachers' perspectives about the teaching of evolution

The categories derived from Mr Johnson's viewpoint on the teaching of evolution were centred on the use of language, resource and teaching materials, and historical viewpoints of teaching and learning of evolution.

a. The use of language

As indicated earlier, the diverse classroom with learners from different religious backgrounds and beliefs was accommodated in a single classroom. Mr Johnson perceived the language used in evolution to be difficult, because of the scientific words involved. He indicated that he was cautious of learner language when teaching evolution during the lessons, and prefer the concepts and examples used in the textbook. The

following vignette illustrates aspects of how Mr Johnson was cautious about language when teaching Grade 12 classes about Charles Darwin and Lamarck's theories.

29. **Learner:** in response to that change, they have to develop (not clear) … (Learner's laughing) this resulted in the growing some skin between their feet … (not clear)
30. **Teacher: Be careful using the big words and forgetting the meaning of what you are trying to say, you move from saying food or land was scarce (depleted) … (Leaners laughing) … (Clapping). He was accredited by subs equate generation because in the first century then those acquired characteristics were transferred (not clear). (Clapping hands).**
31. **Teacher:** organisms produce large numbers of offspring more than what the environment can take. Among those off-spring there is variation. (Example) if you were all my kids, your large number … (Not clear). First thing variation talks about difference *akere* (not clear) … with the black competition you will not all get distinction … (not clear) among the competition some will get distinctions … (not clear) because you got a distinction you will go to varsity then when you do your kids *batlorotega lebone* … (making noise) … (not clear)

Figure 4-4: Lesson on evolution by Charles Darwin and Lamarck

In **line 30**, Mr Johnson indicated to the learners that they had to be careful of using big words and forgetting the meaning of what they wanted to say. To develop learner understanding, during the lesson on fossil evidence, Mr Johnson used English as a medium of instruction, simplifying some content using Sepedi, Setswana, isiZulu, or isiXhosa. In one of the lessons on evidence of evolution, he regularly explained some of the content in Sepedi,

> *The terminologies there, it's also difficult for them to grasp it. So, like I said these learners don't like studying so those terms they don't see often, or you don't practice writing them there is no way you are going to remember them. It requires you to use all your senses*

The narrative shows that the language used in evolution often required learners to study so that when the teacher explained the content using the mother languages, they may understand the terminologies used.

b. Resources and teaching material(s)

Mr Johnson perceived the teaching materials available in the section on evolution to be enough for teaching and learning. During the interview, I asked for comment on the available teaching material and his reply was,

> *This year we had resources. I have used more visual aids. I added some videos, some slides I think it was better compared to last time because this time there were better interested in whatever I'm saying in class. Because it will be displayed on the smartboard*

When I probed further as to how many videos were available, he indicated that the school had several videos saved on the laptop about topics in evolution and other topics in Life Sciences. He said,

> *I don't know how many they are, but we have got several of them like on my laptop and some activities. So generally, I can say we have enough resources. This includes study guides and the Understanding Life Sciences textbook*

During the classroom observation, I noted that the classroom had interactive smart boards which were installed with e-Books and videos on evolution. Very few learners had tablets with e-Books and textbooks on evolution.

c. Historical viewpoints about the teaching of evolution

During the interview, the respondent indicated that evolution content is difficult because it is more historical and requires learners to study hard. When I probed why that was a challenge, he responded,

> *The history part of evolution is difficult. The history part yes, these learners, it requires them to read in most cases, so you know our learners in terms of them studying they don't like it much; so, you must persuade them, convince them, be patient with them*

When I checked if history was not important, he indicated that learning was part of bringing the past to the present and projecting the future, and it was important for learners to learn the historic views of how humankind and continents came about, and why there were white and black people. He said,

> *Their [learners] understanding was that learning is a part of bringing the past to the present and projecting the future, as a result, it was important to have historical views of how man, continents came about, why we probably have white and black, which involves a lot of doing the theories.*

The indication was that teaching of evolution is abstract and theoretical. The code term "history" was used to elaborate and best describe the situation of the view of teaching evolution.

d. Time allocation

The participant perceived the time allocation for teaching evolution not sufficient. The teaching of evolution was done in Term 3 of every year before the preliminary examination. In an interview about how it was taught during that time of the year, he said,

> *Time is the issue with teaching evolution, you must fly because now they [the learners] are given a limited time while the Department doesn't understand that it will take time for them [the learners] to understand. You are running after ATP [annual teaching plan], yet some learners don't understand, so you just must either as a teacher stay behind with others, or with the rest of them; you must make a plan. I think they [the Department] don't consider the time and what they don't consider as well is, I am not sure how, when they do this, do they consider different learners from different environments, because it is like, they are doing it for those that can understand only.*

The narratives suggest that Mr Johnson may compromise learners' opportunities to engage in discussions, leaving learners without adequate information about evolution. The narratives also suggest that the time allocated for teaching evolution was perhaps not enough and clashed with examination time.

4.4.2.2 Mr Johnson's observed teaching-learning interactions

The data to address how Mr Johnson taught Life Sciences classes were mainly derived from lesson observations carried out in Grade 12. The lessons were audio-taped and later transcribed so that I could analyse the information easier. The teaching methods comprised the principles used by the teacher to enable student learning, which included classroom environment and arrangement, learner engagement, and use of prior knowledge to influence learner understanding during the lesson.

The following vignette illustrates aspects of how Mr Johnson taught his classes represented by an excerpt of a lesson with Grade 12 classes on evolution by Charles Darwin and Lamarck.

1. **Teacher:** you need to be able to define and explain evolution and you have to explain evolution by Charles Darwin and Lamarck. So firstly, **let's see from the slides** what evolution is, evolution is the process by which species of organisms arise from earlier life forms and undergo change over time through natural selection. For example, the way we are now is not how we were millions of years ago so with change throughout such an event that cause changes, so when we go into details with theories you will understand, what are those differences, that made us, who we are now. But the first thing you must start to those who accumulated in the past as I said. Somebody can say we used to look like this no why are saying this, and the main thing its evidence and evidence goes with camphene's that's another part of fossil that is another part that we have so that our part of fossils, so you can't say it functions with evidence that's the evidence that we have is a fossil that is the main evidence and mitochondrial DNA as evidence also the tool they used a long time ago, now we have got the knife that you have in the house but before they used bones so that the example that we fell too. But for now, we have to dram on the evidence on how to come to that will have to look at the theories of the evolution. So, I also have **a video** that tries to explain what Is evolution, but in simple terms, evolution is just a matter of explaining the changes that have occurred from previous to now, so this video is in simple English (video playing on the background)
2. **Teacher**: **(Explaining the video) the video** is trying to explain when we evolve we were that and we come to that, I am not saying we were like those guys (giggles) we have common ancestor, with common ancestor if you look out you find majority trees that are here are not clear…the leaves that differentiate at the end we all come down and then the is a common ancestor and it comes back from Homologous structures were by we are compared to animals like cat, bats, and horse.
3. **Learner 1:** We evolved, we come a long way and biology does not make sense but in the line of evolution there is a sense, first thing there are a lot of questions that says we have a common ancestral, you can say we are similar with the common structure that we have but we are not the same also when you look at the consoles, we are not the same**. Looking at the theories of evolution from the eBooks.**
4. **Teacher:** What DBEs Lamarck saying?
5. **Learner 2**: He explains evolution, the law of use not to disuse, the law of inheritance law of Lamarckian inheritance.
6. **Teacher**: Let's look at the law of use not use- it stated that it changes the environment let's assume we are leaving as we are leaving now then the is a change probably the thing that will make us change its food (giggles) we cannot make an example about a shack because there won't be any

change anytime soon (learners laughing) … Also u**se your textbooks and eBooks to get more information.** cont …

Figure 4-5: Lesson on evolution by Charles Darwin and Lamarck

During the lesson on evolution by Charles Darwin and Lamarck **(Figure 4-5)**, some practices of teacher-centred and learner-centred methods of teaching and learning were identified and are discussed next.

4.4.2.2.1 Practices of teacher-centred teaching and learning

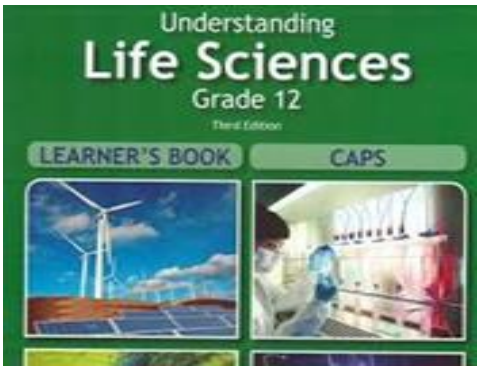
During the lesson observations, in most of the lessons, Mr Johnson was providing learners with information by using videos, e-Books or textbooks, PowerPoint presentations, and questions and answers were used to enhance teaching and learning.

a. Use of e-Books or textbooks

Mr Johnson used e-Books and textbooks during the lesson. Lines **3 and 6** of the lesson on evolution by Charles Darwin and Lamarck show how books were used as a source of information during the lesson. In an interview, he was asked about the teaching strategies employed during the lesson,

> *I use different textbooks because if I use their [the learner's] textbook, I am teaching them what they already know. After all, it is written; in so doing, they see things differently as some are very deeper in terms of explaining the topic.*

During the lesson I only saw learners with the textbook *Understanding Life Sciences*; the other books were installed on the interactive Smartboard in the form of e-Books.



Picture 4-15: Understanding Life Sciences

I noticed that some of the learners had tablets with uploaded e-Books, while others used a textbook. The e-Books that were installed on the Smartboard and tablets were *Siyavula, Study and Master*, and *Solution for all Life Sciences*.

a. Animation videos on evolution

In addition to the use of textbooks, Mr Johnson used some animation videos of evolution during the lessons. He said,

> *I bring a lot of videos that talk about evolution, it's like a lesson, but that is not done by me, it is on the internet because they normally use different pictures in their videos and all of this*

During the lesson, the use of video on evolution by Darwin and Lamarck dominated the lesson (Refer to **lines 1 and 2**). During the lesson, Mr Johnson showed a video on how giraffes ended up with long necks (available on grade GDE learning materials). The main idea that I have noted from Mr Johnson was to indicate that,

> *Inheritance of acquired characteristics in an organism means an organism is determined to change a particular organ to adapt to the environment and the offspring of the changed organism will then inherit their parents' new body part and adapt to the new environment. The theory on the Law of use and disuse was the way organisms change the structure of their body organs by either using it more often, causing it to become stronger and longer and if the organ is used less, it will become smaller and slowly disappear.*

Other explanations that were given as an example where Lamarck's two laws apply were on the discovery of fossils of short-necked giraffes in the Western Cape. He said,

> *Initially, there were short-necked giraffes, as fossils of this were found in the Western Cape. These short-necked giraffes fed on the lower leaves of trees. There was competition with other herbivores that also feds on lower leaves. To avoid competition, the giraffes started stretching their necks to eat leaves on higher branches. This stretching made the giraffe's neck longer (Law of use and disuse) and this characteristic will then be passed onto the offspring (Law of inheritance of acquired characteristic). Eventually, all giraffes will have long necks as they no longer need to compete with a buck for leaves on lower branches.*

At the end of this lesson, learners were referred to the library to find and use the pictures from their textbooks to explain the two theories. One may conclude that this lesson was

promoted using a Smartboard, e-Books/textbooks, and video as strategies to negotiate the topic mentioned earlier in the paragraph.

The use of videos looked important to Mr Johnson during the lesson. The interviewer probed as to why he was using videos during the lesson. He said,

> *Mostly confusion comes when I talk, that is why I try to use something different like video because some … they won't understand when I am telling them, or something, but then when they see it, they [come] to understand and then from there, that is when most, after watching the video, then we can discuss, okay then the understanding becomes deeper.*

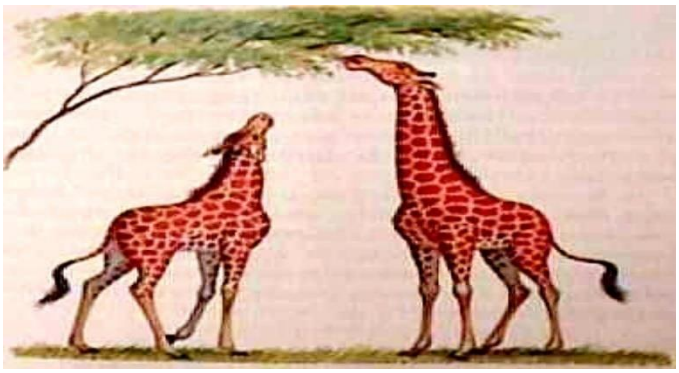
This narrative suggests that the use of videos during the lesson was used to improve learners' understanding of content during the lesson. In another lesson on human evolution, Mr Jonson allowed learners to watch a video. This was the same video used in the first case by Mr Abby.

Picture 4-16: A video on human evolution

This suggests that schools may have been given the same material to use by the department. The other similar videos that were used during the lessons were on natural selection and evidence of evolution.

b. Use of PowerPoint presentation

Mr Johnson used some PowerPoint slides **(line 1)** to present some of his lessons. During the lesson on evolution by Lamarck, he used a slide presentation, with one of the slides presented on the Smartboard showing a picture with two giraffes.



Picture 4-17: PowerPoint slide of giraffes

Mr Johnson explained the above two theories using examples from activities in various e-Books which were available on the learners' tablets, slides, and video, as well as past exam papers to show how the two theories applied, in explaining Lamarck's theory. I further probed the respondent to find out if he used other teaching strategies. He replied,

> *Yes, I do; they discuss on their own, I then asked them to present what they have discussed, in that way they present and other learners would ask questions and I also ask questions and help them answer the questions.*

The teacher pointed out that he allowed learners to discuss some of their understanding about the topic, but during the lessons, i.e. the lesson on fossil evidence, the teacher read the subject matter from the PowerPoint slides:

> **Teacher**: fossil evidence, refers to the fossils. The bones can be fossils. When we look at the fossils the evidence shows the characteristics that make us similar or different from African apes or our ancestors, so when you look at the fossils, they can be the same or they can be different from our ancestors. Fossil evidence is the bones or the remains that are left behind to show what existed, for instance, a dinosaur we don't have a dinosaur in the present moment but there are remains of those of dinosaurs that were left behind that can prove that before or the past life there was an animal called dinosaur so the foresail evidence it helps to trace certain things that existed that does not exist anymore or it will show the difference from what was existing before and what is existing now. We can now check the anatomy or the structure of the bones if there are still the same or they have evolved from the environment. When the environment changes the organism also needs to evolve to adapt to that kind of environment and secondly, we have the genetic evidence, which states that organisms are closely related or are likely to have common ancestors if they have the same DNA structure, like for instance, *Homo sapiens* and the apes, they have some identical or have something identical to each other that is why now we are closely related with apes

One can conclude that Mr Johnson preferred using both the e-Books, prepared slides, and videos, although it appeared the latter was frequently identified in the interview (see the above theme). Reinforcing this notion, he stated,

> *I stand by explaining and then I emphasize by the video, whereby some learners don't understand when you talk, but when they started to see what you are talking about in terms of the videos, that is when they [get a better understanding of the topic], so I think for me to explain, the reason being some of the things they can read, but not understand, so what I am trying to do, I try to make them understand, make it like simple, file it, and then from them watch what you have been talking about.*

Practically, the teacher applied a teacher-centred approach to teaching, which was influenced using e-Books/textbooks and videos to check if learners followed the lesson.

4.4.2.2.2 Practices of learner-centred teaching and learning

a. Teacher's use of prior knowledge to influence learner understanding

During the introduction, the teacher provided interest and motivation to the learners, focusing the learners' attention on the lesson and its purposes, and further convinced them that they would benefit from the lesson. Learners were arranged in groups to allow for groupwork or learner-centred learning, but the lesson was mostly teacher-centred, i.e. engaging learners and asking questions about the topic on evolution and learners answering, example: What is evolution? Next, the teacher prepared a slide on evolution and gave a short explanation of the content. Short or closed-ended questions were used to drive the lesson, even though some of the content seemed to be difficult for learners. Although the teacher used questioning techniques, the lesson was still teacher-centred, with some questioning techniques promoting learner participation so that the lesson gained a degree of learner-centredness.

During the lesson on the introduction to evolution **(lines 1 to 7),** the teacher determined some of the students' previous knowledge using questions and answers.

1. Teacher: Good afternoon learners. Today we are going to learn about evolution. What is evolution?
2. Learners: (No response)
3. Teacher: Is evolution a theory or hypothesis? What is the difference?
4. What is the difference between a hypothesis and a theory?
5. Learners: Theory, it's an explanation that has been proven
6. Teacher: Explanation of what? That has been proven
7. Learners: **H**ypothesis it's a scientific explanation that still needs to have experimented

Figure 4- 6: Lesson on introduction to evolution

During the lesson on evolution by Charles Darwin and Lamarck, Mr Johnson recapped the content of the previous lesson (**refer to line 1**),

1. **Teacher:** you need to be able to define and explain evolution and you have to explain evolution by Charles Darwin and Lamarck. So firstly, let's see what evolution is, evolution is the process by which species of organisms arise from earlier life forms and undergo change over time through natural selection. For example, the way we are now is not how we were millions of years ago so with change throughout to such an extent that causes change, will go into details so that you can understand what instances that make us be who we are now.

   Somebody will say we used to look like this 'no' the main thing it's evidence and evidence goes which are fossils. Now we have got the knife that you use in the house but before they used bones so that the example that we fell too. But for now, we have to look at the theory of evolution. So, I also have a video that explains what Is evolution, but in simple terms, evolution is just a matter of explaining the changes that have occurred before now, so this video is in simple English (video on human evolution: playing on the background, struggling to hear)

Figure 4- 7: Lesson on evolution by Charles Darwin and Lamarck

However, the questions required precise answers to what was learned in previous work. The teacher very rarely used learners' responses during the lessons. In an interview, I asked Mr Johnson if prior knowledge was important during the lesson. He responded,

> *Learners' prior knowledge can help a teacher to understand how much they know about the topic, so then we can work around it, to say, okay this learner lacks this part or they didn't all understand too much about this, and then you don't have to focus too much on that part.*

Mr Johnson did say exactly how he used prior knowledge to enhance teaching and learning. This suggests that learner's previous knowledge helps the teacher during the lesson. However, the teacher gave the learners more information about the content.

a. Teacher-learner interactions

The teacher understood the significance of learners' prior understanding and asked questions during the lesson (see some questions asked above in **Figure 4.5, line 3 to 4, and Figure 4.6 line 1 to 7**) which encouraged learners to be part of the lesson. In an interview, the respondent further stated,

> *With evolution, it mostly needs those learners explain, so yes, I would ask them questions before, like before I start a topic, to check the background of how much they know, from there we discuss the question, and then from there, I can get them to the topic of the day.*

I further probed the typology of the questions by inquiring whether they were open-ended or not and reply by saying open-ended questions were questions that required long answers, i.e. questions that required explanations. He replied,

> *I think so, open-ended are those long ones.*

From what I observed, the teacher tended to use closed questions during the lesson that required exact answers from what had been learned previously to link the previous lesson to the new lesson and to check if learners understood.

b. Group discussions

During the classroom observation, there were no group discussions, but during the interview, the respondent said, after watching videos,

> *We can discuss and ask, okay then the understanding becomes deeper. In this process, I then ask them questions [and] they answer me. From there we discuss the question and then from there, we can get them to their topic. In certain instances, they discuss on their own first, then from there, when, I like to say that they represent, in the way they present that is when either learner would ask questions and I also ask questions, and I help them answer the questions.*

Even though the use of group discussions was not visible during the lesson, the teacher showed that they played an important role in most of his lessons and helped to simplify the subject content for the learners to understand. One can conclude by saying that during the lesson on fossil evidence learner engagement was minimal.

4.4.2.3 Theme 3: The challenges and opportunities for teaching about evolution

This section is divided into two sub-themes, data mainly from the interview were used to discuss challenges and opportunities for teaching about evolution.

4.4.2.3.1 Challenges for teaching evolution

From the data collected, it emerged that the teacher experienced some challenges when teaching evolution. The challenges emerged from the following experiences, namely religious positions, lack of training, poor learner commitment, and abstract terminologies; all of which are discussed next:

a. Religious position

As indicated above, Mr Johnson indicated he was a Christian and the teaching of evolution could conflict with many learners' beliefs. Even though he accepted the teaching of evolution, he felt that he could be faced with a dilemma. When I asked what would cause the dilemma, he said,

> *Some learners have their understanding of evolution or experience. During the lesson, they may have inner tension, which can make them become passive participants.*

Mr Johnson's religious position seems to be a challenge in teaching and learning of evolution because in an interview he further claimed that:

> *Evolution cannot be true, because God created it all, or evolution is also a belief, you just believe in it or you do not, it is just a theory because you have no proof whatsoever.*

This suggests that during the lesson Mr Johnson might not fully interpret, make additional comments, and use day-to-day examples of evolution to support the lesson. This also implied that the learners would receive restricted knowledge of the NOS and evolutionary theory.

b. Lack of training

Mr Johnson indicated that he had not studied evolution or trained to teach evolution as part of his formal teaching programme. He acknowledged that he had attended training

offered by the DBE in South Africa but lacked enough information and understanding that would enable him to deliver the content to the learners. In an interview he said,

> *I never studied (evolution), even at secondary school or at the tertiary level.*

This suggests that teacher training and teachers' professional development may be key to evolution education or teachers should be well-prepared from colleges and universities to teach evolution in Life Sciences classes. This may further that teachers' background, training, confidence, and commitment to teaching are important in teaching and learning; however, lack of subject matter knowledge by teachers may be a major problem.

c. Poor learner commitment

Learner commitment and preparedness during teaching and learning are important for learners to understand the curriculum content. During the interview, I asked if there were any challenges regarding the teaching of evolution. The respondent said learners did not work hard, and reading was important. He said,

> *Challenges are there, especially when coming to presenting the topic itself. It's not easy because it requires learners to read more, but they are not committed. It is a subject like history It requires hard work from learners; not only, and from the teacher. Mine is just to guide them here and there. So, some of them I think they seem to be less interested in the topic.*

When I probed on what is his feeling was about teaching learners who are not committed to learning, and how he promoted learner involvement, the respondent said,

> *I'm not feeling good because it will end up affecting their marks at the end of the day. I try to make them interested.*

These narratives suggest that learner understanding during the lesson was important and that could only happen if learners were committed and studied hard. Even though the analyses show some challenges encountered, during the interview Mr Johnson's comments show that there were no challenges. When I continued asking during the interview about the difficulties connected with the teaching of evolution, he stated,

> *No, there are no difficulties in teaching evolution]. He insisted that "If I was teaching, religious studies, I was going to concentrate on what the Bible says, but because I am not teaching it, I am teaching Science, so I am focusing on what science is saying.*

He further stated that evolution is an interesting course, and if learners were committed and did a regular reading during the lesson, they would be able to ask questions during the lesson in a more science-related way. During the interview, he said,

> *For me it is interesting, I mean it will make them want to know more, and then they will try, they will be inquisitive so when they ask questions that are more science-related now you can be able to explain it, instead of telling them something then they will keep quiet. As a result, you can inter-relate with them easier; and you don't try to convince, that [this] is what I am thinking. It is not difficult in that regard as, we shouldn't take sides, and it will be easy in that way.*

Mr Johnson further indicated that teaching evolution was a bit complicated, and learners had a particular conception about evolution, which needed clarification during the lesson. However, it is important to note that the respondent did admit that the course was complicated. He said,

> *It is a bit complicated, topic, but not complicated, because it has a lot explaining, as most of the time you find them having this conception about the topic which needs further clarification.*

Under the subtopic 'Limitations', the respondent expressed the view that the teaching of evolution was not challenging. He only gave in after I probed about how difficult it was to maintain performance as a teacher, to which he replied,

> *it makes it difficult to perform; because now I have to be running after the ATP [annual teaching plan], while others don't understand and if now, I have to take my own time, while I should be going home, or while I should be doing something, to stay behind to make sure that everybody understands.*

It was also established during the exercise that ATP stands for the Annual Teaching Plan derived from the CAPS document. This demonstrates that extra support is needed by such teachers to teach evolution better. The only challenge that I noted during the lesson was that Mr Johnson was unable to give real or day-to-day practical or concrete examples, he only relied on the examples from the e-Books and videos to ensure that the learners understood the lesson.

d. Abstract terminologies

The section on evolution has some scientific terms that require understanding so that one can come up with proper meaning during the lesson. Data show that the terms used are difficult to understand. During the interview, Mr Johnson said,

> *The terminology, it's also difficult for them to grasp. So, like I said these learners don't like studying so those terms they don't see often, or you don't practice writing them there is no way you are going to remember them. It requires you to use all your senses*

This suggests that teachers and learners needed to prepare in advance so that there can be a common understanding of the scientific terms in the evolution syllabus during teaching and learning in the classroom.

e. Historical account of science

Mr Johnson perceived the history of science as important, as it helped to bring the past to the present and project the future, and it was important to have historical views of how humankind and continents came about. During the interview, he indicated that evolution content was a challenge because it was more historical. I probed why that was a challenge and he replied,

> *The history part of evolution is a problem. It requires learners to read in most cases. So, you know our learners, in terms of them studying they don't like it much.*

This suggests that the history of science becomes a challenge during teaching and learning as there are no concrete or practical activities to substantiate the position. This, therefore, implies that one has to read because learners are not good at finding information by themselves.

4.4.2.3.2 Opportunities for teaching evolution

In this sub-theme, three categories were identified, i.e. an understanding of scientific processes, the adaptation of species, and the history of the origin of life.

a. Understanding of scientific processes

The findings from this case point out that learning about evolution helps learners to develop knowledge about life, and helps them to understand population changes, which assist in explaining biodiversity (National Science Teachers Association, 2013). During the interview, Mr Johnson was asked about the importance of students knowing the evolution, and the respondent further expanded on the above theme, stating that as much as the topic of evolution was difficult, it was important for students. He said,

> *Know how things happen; how did it move from one level to another. Ironically explains the past, more like a Bible, it explains how certain things happened until we are today. In addition, when you are doing Life Sciences, whatever, you must know what is happening around you and I think for me it is like, one of those topics that the students find it interesting as well.*

In as much as the respondent stated that it is important for students to know the evolution, he also stated that during the lesson, he wanted learners to know how things are in life. He said,

> *What I want them to know, or learn, is I don't know if it is relevant to their life, but I want them to know, the same way I learned of it; I want them to know how things happened.*

However, Mr Johnson indicated that he did not see the relevance of evolution in learners' education, and it was not that important, but learners should at least know the background of how things are and why they are like that. He emphasised that learners should at least know something about the process of evolution because it is important in their daily lives,

> *Honestly, it is not that much, okay the relevance of it in their learning, I think it is not that much important; because it is more like knowing a locust that it has this part and that part, you don't really use it in your life, but then again, I think it has that little importance, you know, as a person you should know a bit of, the background of how things are and why they are like that.*

He further said that the evolution content in the Life Science curriculum was irrelevant and may create confusion during learning,

> *I think or my view, as part of the curriculum, is a bit irrelevant. If you want to know about that and you study it later, but for now, I think it is a bit irrelevant. But I think it just creates confusion.*

The above demonstrates that the teacher's view on the importance of evolution is sterile, which may hamper his overall commitment to ensuring that evolution is taught well in the Life Sciences curriculum. The opportunities outlined above were for learners to know the importance of evolution in their daily lives, the origin of species, and the relevance of the topic.

b. Adaptation of species

During the interview, Mr Johnson indicated that the understanding of how the world operates, and where people come from as human beings are important for learners to know. He also indicated that learner understanding of how life started may be important as it can help learners to understand how living organisms live. When I probed him about the importance of students to know the evolution, he said,

> *I think just the understanding of how the world operates or works. Where we come from as human beings. Just general information. I don't know I don't think there is much they can use after matric. Just to understand how life started maybe. I think those they can, it can help them just to understand how living organisms live.*

Mr Johnson's narrative suggests that it is important for learners to know how life started, and how species adapt and survive in their living environment.

c. History of the origin of life

Mr Johnson argued in an interview that it was important to teach learners about evolution because that would improve their understanding of the past and then they would not rely on their religious practices only for an understanding of the origin of life. He further said,

> *It is like a history subject. To teach and learn about evolution because that improves their understanding of the past before they depend on their religious principle.*

This implies that learners will have a prior understanding of the origin of life because they will use the religious and scientific understanding, resulting in a new meaning of life from an informed position.

4.4.2.4 Conclusion on Mr Johnson's case

The previous paragraphs reported on the perspectives and practices of Mr Johnson, one of the Life Sciences teachers that I studied. The biographical background and the institutional context in which he works as a Life Sciences teacher were given. This was followed by an account of how he implemented the Life Sciences Curriculum and Assessment Policy Statement. Mr Johnson has 10 years' teaching experience, a three-year STD, Higher Diploma in Education, and Bachelor of Education with Honours in which he was trained as a generalist teacher for the FET phase curriculum. As in the previous case, this school is also one of the public schools that have installed educational ICT equipment, where classes are fully ICT equipped to promote effective and efficient learning in the classroom. The data show that the school assembly in this case was to make important announcements and did not include worship or prayer, which therefore suggests that the school did not adopt religious activities. Mr Johnson was not exposed to this topic of evolution, either at the secondary or tertiary level of his education as part of formal training for his teaching qualification, but he was exposed to the topic via the DBE training and workshops to support all Life Sciences teachers. He pointed to a need for more development on the topic but felt confident when teaching evolution in the classroom. This further suggests that he believed that if he could be developed to teach evolution, some of the challenges that he faced may be eliminated. He highlighted that evolution was a sensitive topic to teach using science knowledge only and he respected people from other religions, particularly in a class comprising learners from different backgrounds. Mr Johnson's viewpoint on the teaching of evolution was centred on the use of language, resource and teaching materials, and historical viewpoints of teaching and learning of evolution. During lesson observations, practices of the teacher-centred and learner-centred method of teaching and learning transpired. In most of the lessons, the teacher tended to narrate, giving learners information using videos, e-Books or textbooks, a PowerPoint presentation, and questions and answers were used to enhance the teaching and learning. The challenges that emerged focused on religious positions, lack of training, poor learner commitment, and abstract terminologies, while opportunities

identified were understanding scientific processes, an adaptation of species, and history of the origin of life.

In the next section, I present Case 3 of Ms Dechaba

4.5 CASE 3: TEACHING OF EVOLUTION IN MS DECHABA'S CLASSROOM

'The outspoken, confident lady'

4.5.1 Teacher and school background

a. Teacher background

My first encounter with Ms Dechaba at a more personal level was when I visited the school where she taught as part of the Gauteng DBE Research Team. At the time, I was to conduct a study on the impact of ICT when teaching Life Sciences in the classroom. I also met her at the Matriculation Marking Centre marking Life Sciences subject. At the marking centre, teachers who teach matric or Grade 12 subjects are appointed to mark external examination learner scripts. She was the senior marker, moderating the marked scripts. At the time of this study in 2017, Ms Dechaba was teaching Grade 12 Life Sciences at one of the public secondary schools in the Ekurhuleni region. At the marking centre, she facilitated the discussion on the difficulties of the question papers in line with the memorandum, pointing out difficult sections of the syllabus teachers should pay more attention to in the next academic year.

Ms Dechaba, in her mid-30s, is the current Life Sciences teacher at the school where she has been a teacher for the past eight years. She holds a Secondary Teacher's Diploma majoring in Mathematics and Life Sciences, an ACE in Natural Sciences, and a BSc with Honours in Education. She has eight years' experience as a teacher in the GET Phase and the FET curriculum, i.e. Grades 10–12, catering for secondary school learners. She was teaching two Grade 12 classes at the time of the interview.

Explaining how she got to teach Life Sciences at the school, she explained that when she arrived at the school, she was one of the teachers appointed specifically to teach Life Sciences at the school. She was the Life Sciences subject head and the principal appointed her because she had a qualification to teach Life Sciences classes in the FET phase. When asked to describe her feelings about being assigned to teach the Life Sciences classes, she indicated that it was not difficult at first, as she was fortunate to be surrounded by helpful science teachers. The principal and the other teachers provided her with the necessary support by sharing ideas on Life Sciences teaching.

> *It helped to ease the pressure on me, even though Life Sciences was one of my major subjects at university.*

b. School background

The school was established in 1978 and is based in Tembisa, Gauteng Province in South Africa. This school is situated in the Ekurhuleni North District, in one of the townships. The school has 1 250 learners, with 650 learners in Grades 8 to 9 and 600 learners in Grades 10 to 12. The staff personnel comprise 32 teachers, 4 general assistants, and 3 administrative assistants, with a total of 39 staff members. The medium of instruction is English. The school is dominated by Sepedi and Zulu-speaking learners. This school is also a public ICT School and has one computer laboratory and no subject-specific laboratory. The computer laboratory is internet-connected and used as a centre for the subject, Computer Application Technology (CAT).

c. School assembly practice

In schools, school assemblies serve as powerful motivators for the entire school whereby learners and teachers assemble in one space before the start of the school day. Some schools use morning assembly to instil discipline and to set a joyful and focused tone for the day, while others convey a lot of information, including assigning duties to the monitors and prefects, and utilise the assembly to talk about topics such as cleanliness and good manners, which need to be reinforced every day. During the school visits, School C conducted several morning assemblies. In an interview, I asked Ms Dechaba how the school conducted the assemblies. She replied,

> *We have an assembly on Mondays. The dominating religious belief of our school is Christian, so we usually sing and praise God. We would have pastors come and pray for us. This is a multi-cultural school. So, if kids feel that their beliefs don't allow them to come to the assembly due to the Christian prayers, the learners are welcome to stay behind; however, we have not experienced anything like that before.*

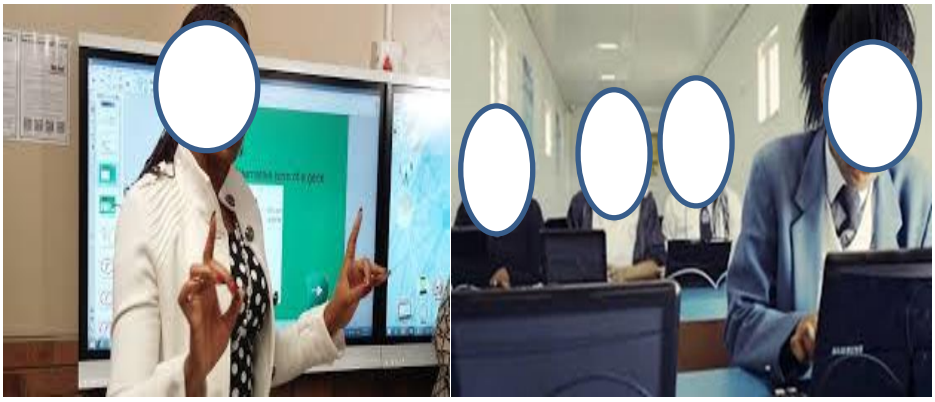
When I probed further to understand if she thought Christianity was a dominant religion at the school, she responded,

> *Yes, Christianity is dominant, we start the day by opening prayers of the Christian religion and when we have meetings or assemblies, but we don't side-line any teachers or learners for having different religious beliefs.*

The narrative shows that the School Governing Body and the concerned stakeholders adopted Christianity as the religion to be practised at the school. It was also clear that the school sometimes asked religious leaders to pray for the learners and the school in general.

d. Ms Dechaba's classroom context

Ms Dechaba started teaching the topic of evolution in Life Sciences subject from Grade 10 to 12 in 2014. In addition, she also taught mathematics in 2017 and 2018, and she taught Life Sciences to the Grade 12 classes. The teaching periods at Ms Dechaba's school were 30 minutes long, which amounted to four sixty-minute periods a week. Like other ICT schools, classrooms were designed to allow the use of ICT equipment, i.e. installed with interactive Smartboards, with the teachers' using laptops and learners having tablets, to influence teaching and learning.



Picture 4-18: Life Sciences classroom at School C

As depicted in the picture above, the classroom environment was generally conducive to learning with window curtains in the form of blinds and attractive colourful paint applied to the wall. Classroom settings contributed to the formation of a healthy learning environment that enhances effective and efficient teaching and learning.

The learners were seated in such a way that they remained focused on the lesson. They were seated in rows so that they could all see the interactive Smartboard, with learners behind one another.

Picture 4-19: Learners in the Life Sciences classroom

The classroom arrangement suited the teacher-centred methods, where the teacher was in front of the classroom and could narrate the content during the lesson. The day the picture was taken was when the school had a fundraising event and learners were clothed in casual attire.

4.5.2 Overview of the emerging Themes

During the school visits, Ms Dechaba presented four lessons that were based on four main topics of the syllabus on evolution similar to the lessons taught at Schools 1 and 2. I visited the school eight times in 2017 and 2018 to conduct lesson observations, i.e.

about a review of Lamarck and Darwin's theories, Alternative explanation, Human Evolution, and the Out-of-Africa hypothesis. These lessons were observed at School C for a group of 40 Grade 12 learners during normal school hours between March 2017 and November 2018. Table 4.6 below provides a number of the themes, sub-themes, and categories that came out of the data analysis generated for this research.

Table 4-5:Themes, sub-themes and categorise

Theme	Sub-theme	Categories
4.5.2.1 Theme 1: Teachers' beliefs and perspectives about evolution	**4.5.2.1.1** Teacher beliefs about evolution	Classroom environment and arrangement. Religious views Teacher development (Professional views) Social views
	4.5.2.1.2 Teacher perspectives about evolution	Language Teaching materials (Resource)
4.5.2.2 Theme 2: Teaching methods applied during teaching evolution	**4.5.2.2.1** Practices learner centred teaching and learning	Learner to learner interaction Teacher to learner's interaction
	4.5.2.2.2 Practices learner centred teaching and learning	Use of eBooks or textbooks Use of videos and cartoons Questions and answers Use of PowerPoint presentation
4.5.2.3 Theme 3: The Challenges and Opportunities for teaching evolution	**4.5.2.3.1** Challenges in teaching evolution	Diverse classrooms Evolution is all about science
	4.5.2.3.2 Opportunities for teaching evolution	Understanding of population changes Scientific process Mutation in organisms

4.5.2.1 Teachers' beliefs and perspectives about evolution

This theme was divided into two sub-themes that were teachers' opinions about evolution and teachers' viewpoints about evolution.

4.5.2.1.1 Teachers' beliefs about evolution

The opinions of Ms Dechaba on teaching and learning of evolution were categorised into teacher development and training on evolution, and religious position.

a. Teacher development and training on evolution

During the interview, I asked the respondent how she got prepared for the topic of evolution. Ms Dechaba stated,

> *I started studying evolution in 2010 as a foundation and at university we did evolution and when I started teaching and doing teacher development with the department.*

When I probed to check what her feelings were about the topic, she indicated that it was an interesting topic to teach but there were certain aspects of human evolution topic that needed to be improved and clarified. She indicated that it was an interesting topic, whether one did one aspect or not, but there were certain aspects where more needed to be done on human evolution.

During interviews, Ms Dechaba indicated that she was exposed to the topic of evolution at the tertiary level during her teacher's training and was also trained by the DBE to teach the topic. Ms Dechaba had received formal training on evolution at university and college as part of her teaching qualification. She also added,

> *During my upbringing I was the type of person who didn't believe in ghosts or witchcraft and things like that, I only believed in scientific evidence and facts. So, a part of me does believe in evolution. So, my educational background was science-based so every time I wanted to verify something someone tells me, I would simply Google.*

This suggests that Ms Dechaba's training as a Life Sciences teacher made her believe in scientific evidence and facts, resulting in her belief in evolution. This further implies that her educational background was science based.

b. Religious position

As part of the study, I wanted to check if her understanding of evolution was influenced by her religious position. She responded by saying,

> *I think the only aspects of evolution I don't understand are the ones that are too complex for me but someone with knowledge could come and break it down for me I would adopt and believe. I also believe in certain aspects of Christianity but sometimes I would just leave it to God to help me.*

I probed if she belonged to any Christian organisation, Ms Dechaba agreed that she was a Christian and lived by the words from the Bible. She said,

> *Yes, I do, depends on the Bible that I read, but if it doesn't make sense, I would reason it in the way of being faithful and letting God give me the answers, but in a situation, that has to do with human behaviour, I would use evolution to explain it.*

The storylines show that Ms Dechaba is a religious person who has a science-based educational background; hence, she felt that the teaching of evolution was not a challenge. During the interview, she pointed out that one should be sensitive to one's religious position.

> *You should be sensitive because we have different views of evolution; you shouldn't give your ideas, or opinion to say I believe in, just teach what you are supposed to teach and let them decide whether they are going to believe or not.*

The description shows that teaching evolution can be multifaceted and challenging if a teacher provides ideas and opinions about what he/she believes in, because it may contradict individual people's beliefs.

4.5.2.1.2 Teacher's perspective about evolution

The viewpoints of Ms Dechaba on the teaching evolution were categorised into effective training, the language of teaching and learning, and teaching material.

a. Effective training

It has to be noted that Ms Dechaba studied the theory of evolution as part of her teaching qualification, and she was confident about the content. As part of the study, I asked Ms Dechaba about the training offered to teachers by the department to improve their level of understanding of evolution. She responded,

> *The Department is doing a lot, but certain questions are not answered. Though one attends teacher development, I still go home with certain questions that are not answered, like how certain things come up, because some of the things you turn to say or ask a question and they will answer it exactly like what is in the textbook and not simplified.*

When I asked what happened if there was not enough explanation, she indicated that when there was no explanation, she believed that it was God's will that it happened. She said,

> *This is where the Christians will enter to say if there is no explanation, it is God's will that it happened, but support is there, and material is there; I just feel that certain content is for tertiary students.*

The descriptions show that the department provided enough support to schools and the teacher was happy with the training offered, except that some training did not explain questions asked by the teachers enough.

b. Language of teaching and learning

The medium of instruction in Life Sciences classrooms is English. However, Ms Dechaba perceived the language used to document the theory of evolution to be too scientific for the teacher to simplify for the learners. In an interview, she said,

> *When one attends teacher development, one still goes home with some questions, because some of the things you turn to, say, you ask a question, and they will answer it and when you look at the textbook is the same definition, but they are not breaking it down to explain it thoroughly. I will also feel like this explanation is for scientists and tertiary-level learners.*

When I asked what was missing from the information that made the language difficult, the respondent referred to Greek or italic words used in the textbook,

> *You see, things like Homo habilis, Homo erectus, and Homo neanderthalensis, are difficult suffixes that must be explained all the time, which is a challenge, so they must break down certain words. Especially scientific language is a problem. You end up giving the kids the wrong spelling and when you go to Google for assistance, it's not even there. It is a real challenge; so if they could just make it easy for us.*

Despite pointing out the difficulty of the language, during the lesson, Ms Dechaba and learners used English as a medium of instruction and simplified some of the content by using other languages like Sepedi, Setswana, isiZulu, or isiXhosa. The following vignette illustrates the lesson on human evolution. Ms Dechaba used pictures from the Smartboard like the one used in Case 1 **(Figure 4.7 and Figure 4.8),** asked learners questions.

Teacher: What is it that you see on the Smartboard?
Learner 1: Aba humans bane developed chin and *ama apes bana* undeveloped chin (humans have developed chins and apes do not have developed chins)
Teacher: Okay, well, okay, what else?
Learner 2: Humans have larger brains and apes have smaller brains (laughs).
Teacher: Yes, they have got larger brains, which is what you are going to write. Okay, I am looking for something here, okay talk about Foreman magnum.
Learner 3: Sir, Foremen magnum, the foremen magnum for the apes *ila amaphakathini yema human being ila ekugcineni. 'unamanga ye apes ila yabantu* (in Zulu it means you are lying; apes don't eat people)

Figure 4-8: Use of vernacular languages

This narrative shows that the use of different languages was useful during the lesson to enhance learners' understanding. This was noted when other learners tried to clarify what apes can do to human beings using their home language.

c. Misconceptions about evolution

During the interview, the participant also mentioned the issue of learners' misunderstanding and misconceptions around the theory of evolution. She indicated that the pre-assessment before teaching the topic on evolution shows learners about evolution. She said,

> *When I do a pre-assessment before teaching the topic the learners have misconceptions about evolution. The learners will think people are from monkeys. So, they think we and monkeys are the same. I don't know who said we and monkeys are the same and that is one of the problematic situations. I must change the mindset that they come and it's not an easy thing.*

These narratives suggest that even though the participant is confident to teach evolution in the classroom, she is expected to deal with some of the learners' misunderstandings and misconceptions around the theory of evolution so that learners can learn with ease. During the lesson, no misconceptions were noted.

4.5.2.2 Ms Dechaba's observed teaching-learning transactions

The data to address how Ms Dechaba taught Life Sciences classes were mainly derived from lesson observations carried out in Grade 12. The lessons were audio-taped and later transcribed (See Appendix for the Lesson observation guide). The observed lessons were

on Darwin and Lamarck's theory of evolution, evolution by natural selection, human evolution, and an alternative explanation of evolution and religion. The following vignette, an excerpt of a lesson for Grade 12 on Lamarck's illustrates aspects of how Ms Dechaba taught her classes.

1. **Teacher:** Good afternoon, learners.
2. **Learners:** Afternoon Madam, and how are you?
3. **Teacher:** I am fine, today you are going to learn about theory by Lamarck**.** Can I ask, what is the difference between theory and a hypothesis? Because I saw that this is a Lamarck theory and so now you talking about theory, but I want to know is evolution and hypothesis or is a difference? What is the difference between a hypothesis and a theory?
4. **Learner 1:** Theory, it's an explanation that has been proven.
5. **Teacher:** Explanation of what? That has been proven**, check on your books or the net (internet)**
6. **Learner 1:** Hypothesis, it's a scientific explanation that still needs to be experimented with.
7. **Teacher:** Alright, so a hypothesis it's a scientific gas that still needs to be experimented based on to be proven whether it was correct or incorrect, and then a theory, theory it was a hypothesis then it was tested and accepted or may be rejected on a different perspective of the scientist then you can call it a theory, it was tasted then once it becomes tasted for the instance we have Lamarck, when we look at Lamarck he got his theory but his theory was not accepted, but we are not saying it is a hypothesis is a theory, so the theory has to be put on test first if it's accepted or not accepted based on the fact that is it is bringing up above. And let's check Lamarck. Who is Lamarck? Alright, is Lamarck … Lamarck its scientist that developed or came up with two laws I mean theories which call the law of use and its use as well as the law inheritance and acquired characteristics? **Now based on the video that we watched, we saw some giraffes** and then the giraffe was reaching out to the kids and then all of sudden the giraffe started to enlarge. So, what is he saying? And then according to the law of use and its use. If this is an environment all the things that happen in the environment must change. So, he is saying that there was a change in the environment whereby now there was a competition of foods among the giraffes. So, the giraffe was forced now to enlarge they are or use their necks out to reach tall trees, so the constant use of the neck then the neck of the giraffe started to be enlarged, is it possible? So, like looking at me I am short so if I constantly reach out to the high plug so it means that my hand will automatically scratch according to Lamarck 'it's not true. Okay let's **look at the slide**, what he is saying then we will get to that. Changing the environment create a new mean so the giraffe was living nicely, no problem everything was okay. Then there was a competition among the giraffes because others were realizing that were fed on the same plate or tree then there was a changing environment that cause the organism to modify its existing organ. So, because of that change, they had to modify. To modify it's to change something. So, they had to change from being short to long necks. Repeated use of organs will cause to enlarge and to become more efficient, so when this giraffe every day 'every day they reach out to tall trees, then it means their necks will automatically become longer and stronger so that it can reach out to trees. This use of organism this use of 'organs will cause the generation, so he is saying that if you use it then it will become longer and stronger and if you are not using it will generate and disappear 'That is Lamarck'.
8. **Learner 2:** so, he is saying the person with … (did not finish).
9. **Teacher**: If you can explain in that way because if we check this theory like for instance **look at the picture on the slide** for snakes, he is saying that the snakes, apparently snakes once had legs and then due to change environmental change how would he explain that? I am saying that the question **is according to Lamarck the snake initially had legs but currently when you look at snakes do, they have legs?** (Learners: No). According to Lamarck how would he explain the theory or how would he have explained what happened to the snakes?
10. **Learner 3**: Ma'am, Lamarck could properly say that snakes couldn't walk faster with their legs so they prefer to use their stomach so that they can walk faster. So since then, they have used this part they then use it frequently

11. **Teacher:** so properly when they were chasing the shades there were faster than when using the legs and so they now usually stopped using their legs. How could he explain that he could say then because legs were disused then they started to disappear when the snakes now evolve from one generation to another.
12. **Learner 4:** Inheritance of acquired characteristics?'
13. **Teacher**: Yes, inheritance of acquired characteristic, the modification of organism acquired during this time could be caused by one of a stream to the other. So, he is saying that if I maybe or you decide to change something let's say I am dark in the skin and I decide to bleach myself it's mean now I am going to have a light on skinned changed. "Why is that never?' so the phenotype type there's no way if you can check phonotypical …

Figure 4-9: Vignette of a lesson on theory by Lamarck

During the lesson on theory by Lamarck, I noted some practices of the teacher- and learner-centred method of teaching and learning. These are discussed next.

4.5.2.2.1 Practices of teacher-centred and learner-centred teaching and learning

During the interview, the teacher did not wait for me to finish asking a question on what teaching approaches she used when teaching evolution. She responded confidently,

> *I use analogies so I would use different styles audio, visual; pictures for evolution **(refer to lines 7 to 9)**, I use cartoons to explain Lamarck's theory. I don't like doing a lot of talking because it becomes boring.*

When I probed as to how she could do that, she indicated that when teaching speciation, she used videos that were provided by the DBE and the lesson became more teacher-centred,

> *When we talk about speciation, we use videos provided by the DBE but when I talk about evolution it's a more teacher-centred approach unless it's human evolution where I would ask questions and answers. The learners find pictures funny.*

Due to the level of confidence shown, she indicated that 80% of learners understood and 20% failed to understand when teaching evolution when I asked if learners had a good level of understanding of evolution. She said,

> *When I teach evolution, 80% understand and 20% don't; maybe they are not interested. I use social media (what's app group) where I can communicate and help people who don't understand I also give them level 1 and 2 questions to answer that 30% of the content. When I feel that they are improving I move them up to levels 3 and 4. But usually, in the WhatsApp group, I would send videos and pictures of content.*

The account shows a confident teacher who applies various methods of teaching and learning, such as using pictures to make lessons interesting; using group work and debates and discussions as well as videos, while other learners want me to draw on the smartboard for visual learners. Ms Dechaba also told learners with their own beliefs, to learn to pass tests and examinations. She said,

> *During the lesson, I don't only use pictures to make lessons interesting; I would use group work and debates and discussions as well as videos. Other learners want me to draw pictures. I also share different websites for learners to see at home. For the learners with their own beliefs, I tell them to learn to pass. if I ask them why evolution occurs in humans in test, and they say it's because God created, I won't give them their marks because I don't want to change their beliefs but make them understand the content.*

I noted that Ms Dechaba promoted her lessons using videos and cartoons, pictures, e-Books or textbooks, PowerPoint presentations, and questions and answers. This was confirmed in an interview when she said,

> *I use analogies, and I use cartoons to explain.*

Ms Dechaba indicated that the topic of evolution is not easy for learners to understand. As a result, she used real-life examples that are related to explanations about evolution so that learners can understand the content. She responded as follows when I probed to understand what she meant when she said she used analogies,

> *Evolution is not easy for learners to understand. I use real-life examples that are similar or related to explanations about evolution so that learners can understand the content.*

The narratives show that Ms Dechaba used several teaching strategies such as using videos and cartoons, pictures, e-Books or textbooks, PowerPoint presentations, and questions and answers when teaching evolution in the classroom. In the next section, I explain how each teaching approach was used.

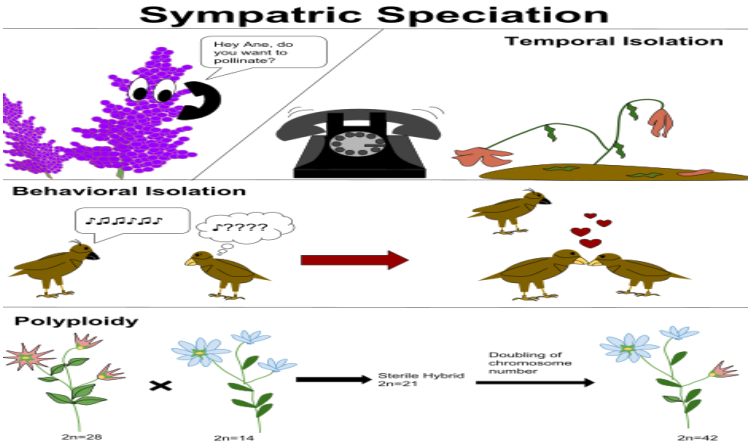
a. Use of e-Books or textbooks

The vignette **(Figure 4.9)** on the lesson on Lamarck's theory shows that Ms Dechaba used pictures from the eBooks/books, internet, and smartboard to promote her lessons

(**refer to line 5**), which was common at all the sampled schools. During the interview, Ms Dechaba explained the use of textbooks,

> *The textbooks explain the same thing and the explanation is at the university level so they must be made simpler. The textbooks and videos were provided by the department. We also go on excursions to Wits University for professors to explain the theory of evolution. I just want to explain it the way I understand it, the way the textbook explains it.*

During the lesson observation, the participants used three e-books that were installed on the interactive whiteboards. The e-Books were like the ones in Case 1 **(Picture 4.2),** which were, Study and Master, Understanding and Solution for all Life Sciences. During the lesson, some of the learners had tablets installed with the same e-Books, while other learners had Life Sciences textbooks from the same publishers. During the lesson on speciation, using the interactive Smartboard, a section sympatric speciation was shown from e-Books.



Picture 4-20: Sympatric speciation

When reading and explaining Sympatric speciation from the textbook, she defined sympatric speciation and allopatric speciation as that Sympatric speciation is 'the development of a new organism from a remaining inherited classes' and Allopatric speciation is the evolution of species caused by the geographic isolation of two or more populations of a species. She said,

> *Sympatric speciation is the evolution of a new species from a surviving ancestral species while both continue to inhabit the same geographic region. In evolutionary biology and biogeography, sympatric and sympatry are terms referring to organisms whose ranges overlap so that they occur together at least in some places. If these organisms are closely related, such a distribution may be the result of sympatric speciation. Sympatric speciation is one of three traditional geographic modes of speciation. Allopatric speciation is the evolution of species caused by the geographic isolation of two or more populations of a species. In this case, divergence is facilitated by the absence of gene flow. Parapatric speciation is the evolution of geographically adjacent populations into distinct species. In this case, divergence occurs despite limited interbreeding where the two diverging groups come into contact. In sympatric speciation, there is no geographic constraint to interbreeding*

This suggests that Ms Dechaba had enough e-Books/textbooks to refer to during the lesson to enhance learner understanding. It was confirmed during the interviews that the school had enough resources. She said,

> *In addition, regarding textbooks, textbooks are there, they have textbooks, they've got their study guides; they do have templates that have got some extra information on the topics. On the other hand, with videos because learners do have smartphones there, I try to get videos from all over that I show them.*

The narrative suggests that the school had Life Science textbooks and study guides that help during teaching and learning, and learners used their smartphones to download videos on evolution.

b. Use of Videos and cartoons

During the first interview, Ms Dechaba indicated that she used videos provided by the DBE to present the lessons on evolution. She said,

> *I use videos provided by DBE, but when I talk about evolution it's a more teacher-centred approach unless it's human evolution where I would ask questions and answers. We also go on excursions to Wits for professors to explain to them.*

During the lessons (**refer to line 7**), the teacher used videos to deliver evolution content. One of the videos on Darwin and Lamarck's theory was used to ensure that learners understand the content.

Picture 4-21: Video on theories of evolution

When explaining the content of the video she explained that theories of evolution deal with the way organisms change over time, she said,

> *The theories of evolution deal with the way organisms change over time, and how current organisms have come about. Darwin's theory is the most famous, but it was not the first. French biologist Jean-Baptiste Lamarck proposed a theory of evolution before Darwin.*

In another lesson on natural selection, the teacher allowed learners to watch videos (also refer to **lines 7 to 9** on lesson on Lamarck's theory**)** on Darwin's theory on Natural Selection and explained,

> *Darwin's Theory of Evolution by Natural Selection shows that more individuals are produced in each generation, and some individuals survive while others die. Phenotypic variation exists among individuals and the variation is heritable. Those individuals with heritable traits better suited to the environment will survive. When reproductive isolation occurs, new species will form.*

Picture 4-22: Video about Darwin's theory on Natural Selection

In all the videos, the teaching and learning was teacher centred. The teacher always explained what was happening in the video to simplify the subject matter. During the classroom visits, it was clear that she preferred using both a textbook and videos. This appeared frequently in the interview. The respondent explained the rationale for this preference as follows,

> *I believe learners understand better if they see things, so I am trying, not to imagine things, only, they must imagine and they see also seeing of those things. I think it gives them a better understanding of the topic.*

The narrative shows that learners learn better and understand the content of the lesson when lessons are based on videos so that learners can see visuals of species development during the lesson.

c. Questions and answers

The use of questions plays a role during the lesson because it stimulates learners' thinking and understanding, with both open-ended and closed-ended questions. However, during class visits the teacher used more closed-ended questions, requiring a 'yes' or 'no' answer. The next vignette, an excerpt from a lesson with Grade 12 on 'Out of Africa hypotheses illustrates aspects of how Mr Dechaba used questions and answers to drive the lesson.

3. **Teacher:** Refer to your e-Books? To what, that life begins… So out of Africa, it's telling us that life began in Africa. OK, so which evidence can you use to support your statement?

4. **Learner 1**: It's maths (wrong answer).

5. Teacher: Maths (the teacher repeated the learner's answer thinking that the learner will remember Mitochondrion.

6. **Learner 2:** Mitochondrion (correct).

7. **Teacher**: OK, we can have mitocholith and nutrition mitochondria in mitochondria DNA. What else?

8. **Learner 3**: Cultural evidence.

9. **Teacher**: Cultural evidence, OK, Mashego (pseudonym)

10. **Learner 4:** Fossils found out of Africa,

11. **Teacher**: Correct, these are fossils found out of Africa, for example, in Europe, Asia, and America, etc.

Figure 4-10: Use of question and answers

These narratives show that the learners struggled to understand the teacher's questions, and, in most instances, the teacher did not ask for justification of answers from learners.

The use of questions and answers teaching and learning during the lesson was also noted during the lesson on human evolution. The following vignette illustrates aspects of the lesson on human evolution.

Teacher: What is it that you know about evolution?

Learner 1: Organisms change over time, teacher do we also change?

Teacher: Yes, Evolution is the process whereby organisms change over time. Any other different answer?

Learner 2: So are you saying everything that we see today evolves from what existed before.

Teacher: Yes, everything that we see today evolves from what existed before as is like the same or there is a bit of difference.

Teacher: Do you understand the similarities between apes and human beings?

Learners Yes (Chorus)

Learner 3: Yes, is the first. Humans have an upright poster, but apes do not have an upright poster.

Teacher: OK, refer to your Grade 10 syllabus, we did that …

Figure 4-11: Use of questions and answers

During the interview, I asked Ms Dechaba if she used open-ended questions to drive the lesson. She responded,

> *In most cases, I ask them open-ended questions, so I can get the different views, from the different learners in class.*

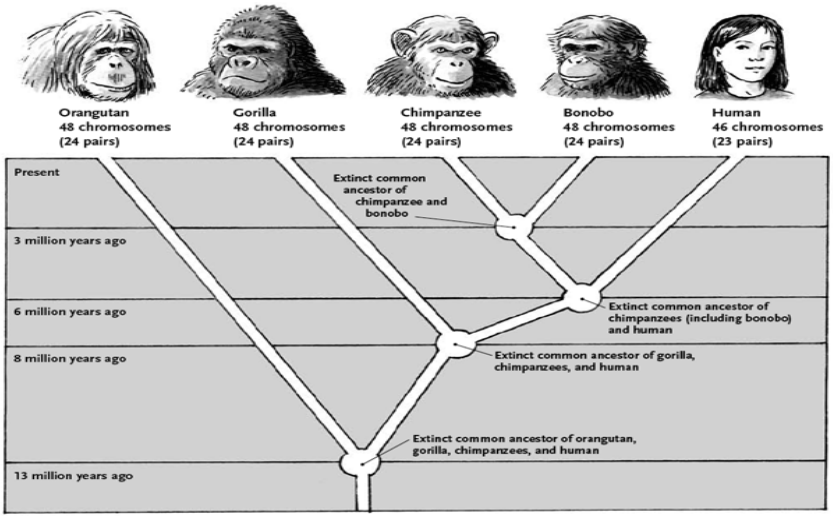
During these lessons, only closed-ended questions were. It was clear that the use of questions and answers enabled and encouraged learner dialogue. She further stated,

> *I normally use the question-answer method in a class, wherein they tell me the way they understand the topic before I can explain it to them.*

The use of closed-ended questions was dominant over the use of open-ended questions during the lessons.

d. Use of PowerPoint presentation

Ms Dechaba used a PowerPoint presentation in some of her lessons (**see lines 7 and 9**) on Lamarck's theory. During the lesson on human evolution, she used an interactive whiteboard to show PowerPoint slides on common ancestors, i.e.



Picture 4-23: Common ancestors over years

The tutor then requested the learners to review the diagram and comment on their understanding of the branching of species as reflected on the slide **(Picture 4.23)**. The learners' understanding was not in line with human evolution or what was presented, but religion related. I noticed that learners believed that humans were created by God. Ms Dechaba was brave enough to indicate to the learners that the developments they see from the slides are scientifically proven. Experiments and investigations had been conducted to ensure the correct interpretation of evolution. She also used **Figure 4.9** on human evolution to explain more and show the branching of humans. At one stage the lesson was chaotic, with learners having discussions on what they believed, and the teacher trying to explain the pictures. She said,

> *If you're ever feeling lonely, remember this statistic: You're related to every human being on the planet. And you don't need to go back that far to find where your lineages intersect. Every person alive today shares a common ancestor who lived a mere 3 000 years ago. Because humans are as new as a species, your global family is especially tight knit. Chimps living in the same jungle in Africa, for example, have more genetic variation between them than you have*

> *with someone on the opposite side of the planet. For more facts about how billions of people ended up in your family tree, check out the video below from It's Okay to Be Smart.*

In another lesson on the origin of mankind, which focused on the *Homo* species, the teacher presented several prepared PowerPoint slides with various pictures of the different Homo species. Ms Dechaba flagged a PowerPoint slide with the picture of a human being on the Smartboard. She explained,

> *About 2,5 mya (million years ago) a more human-like hominid species appeared. They had larger and more complex brains. Their brow ridges were smaller, with smaller faces and no ridges on top of their skulls. Their dentition indicated a diet that comprised more meat than fruit and seeds. It is thought they have evolved from the recent Australopithecus genus, which was light boned.*

Ms Dechaba indicated that there were three *Homo* species, *Homo habilis, Homo erectus*, and *Homo neanderthalensis*. She used a PowerPoint to show the three different pictures and to explain each picture. The first was on the *Homo habilis*, which she said is also known as Handyman because they created tools from stones.

 ,

Picture 4-24: *Homo habilis* (Handyman)

She further explained that *Homo habilis* had a big brain and migrated to East Africa, making tools that required intelligence and dexterity. Its brain size was big, with a lightly built, rounded skull. She said,

> *Homo habilis (Handyman) migrated to East Africa, hunted animals. Making of tools required intelligence and dexterity. Its brain size was big, with a lightly built, rounded*

> *skull. They had pronounced brow ridges, big toes in line with other toes as in humans, small, generalised teeth, with legs positioned upright for walking.*

Ms Dechaba then went to the next slide. Pointing to the picture she explained that the second picture on the slide was *Homo erectus* or the Java man (upright man), who lived two million years ago.

Picture 4-25: *Homo erectus*

Ms Dechaba explained that *Homo erectus* was taller than humans and evolved in Africa and moved out of Africa into Asia, Europe, and Indonesia. She said,

> *Homo erectus evolved in Africa and moved out of Africa into Asia, Europe, and Indonesia. They were tall as humans, but more strongly built. Made more complex tools. Had a frightening appearance as they were more heavily boned and built. Needed to be strong to survive the cold European climate. Modern hands, bipedal, strongly built jaw, thick shelf-like brow ridges.*

The last or the third *Homo* species was *Homo neanderthalensis*, which evolved 200 000 years ago, was bipedal, and had hands like modern humans. She explained,

> *They are the humans' closest ancestral relatives. They were bipedal and had hands like modern humans. It was discovered in a limestone valley in Neander Valley in Germany. Their brain capacity was large, and the skull had no ridges. The femoral bone and pelvic bones were strong indicating that they spent most of the time on foot.*

After the explanation, Ms Dechaba showed learners another slide pictured below.

Picture 4-26: *Homo neanderthalensis*

In conclusion: Ms Dechaba indicated that there was another *Homo* species, which is the last of the Homo species. The last *Homo* species is said to be *Homo sapiens* (wise man or Florisbad man), who originated 100 000 years ago. She explained,

> *We (modern man) are Homo sapiens, and our first human ancestor originated 100 000 years ago. Homo sapiens have a larger cranium which is more rounded and smoother, and their jaw is slightly curved with very short canines.*

The narratives show that Ms Dechaba uses videos and PowerPoint prepared slides to present most of her lessons to ensure that learners understand the content.

4.5.2.2.2 Practices of learner-centred teaching and learning

During an interview, the participant indicated some of the practices of learner-centred teaching and learning that she applied during the lesson, i.e. groupwork, debates, and discussions.

> *I use pictures to make lessons interesting, we would use group work and debates, and discussions as well as videos in the classrooms during the lesson. Other learners want me to draw for the visuals, I also share different websites for learners to see at home.*

The vignette of the lesson on Lamarck's theory shows that Ms Dechaba used several pictures from the e-Books/books, the internet, and the Smartboard to present her lessons (**Refer to Figure 4.9 line 5**). The lesson promoted learner-to-learner and teacher-to-learner interactions.

a. Learner-to-learner interaction

During one of the lessons on human evolution, learners were arranged in groups and were expected to discuss the similarities between apes and human beings using the pictures projected on the smart board: This is what Ms Dechaba said,

> *Oh, right, before we can even go forward I want us to sit in groups, I want us to sit in groups of three ok so guys I'm leaving a diagram right now hello class this one here I want you to sit in a group don't shout, don't sit on top of the tables., Try to discover the characters that you see there between us and the apes, discuss that if other similarities are not included and include them (conversation between learners were not clear) ... I gave you a picture (additional evidence to **line 5 on lesson on Lamarck theory**) one oh right hey cooperate oh right we can choose like one or two groups to present what the differences are that we looking for, oh, right, which group should I pick?*

During the discussion, learners were noisy and at the end of the lesson, each group was allowed to present to the whole class. The capturing tool did not manage to capture the learner discussion; only Ms Dechaba had an audio recorder, and it was difficult to record learner discussions.

b. Teacher-learner interactions

During some of the lesson observations, I noted that some lessons were promoted through interactions between the teacher and the learners. The vignette **(Figure 4.12)** of the lesson on the evidence of evolution shows the teacher-learner interaction that took place during the lesson.

Teacher: The bones can be the fossils when we look at the fossil the evidence shows the characteristics that make us similar or different from African apes or our ancestors, so when you look at the fossils, they can be the same or they can be different from our ancestors.

Learner: Teacher, what is it that ancestors used as protection during their days?

Teacher: Anyone to help to answer the question. The question is what is it that ancestors used as protection? Lastly, we have biological evidence that it is the study of the distribution of organisms based on time.

Learner: Palaeontologist, study the biological evidence which was based on geographical factors found.

Teacher: I mean, we're crossing over, remember that crossing over is when organisms become too alive and less to each other and chromosomes will start to cross over, that cross over. It is because it brings about variation. Secondly, we have a random

arrangement of chromosomes; it occurs in metaphase whereby it allows different combinations of chromosomes. What happens is that in metaphase, chromosomes are aligned on an equator, so, when they are aligned on the equator they just align randomly; they are going to address themselves randomly. That is why we call it a random arrangement.

Learner: Is it okay if we say, 'random assortment'?

Teacher: Yes, random assortment occurs in anaphase (during cell division) so what happens is that if this has already been arranged so it means the chromosome of this side will go to the left and this one to the right. Remember, in anaphase, they are going to be put on opposite sides, so it will pull A and pull B, so the ones that are these sides will go to pull A and this side pull B, so there is no way that the one supposed to go to pull B will go to pull A.

Figure 4-12: Vignette of the lesson on the evidence of evolution

During the lessons on the Out-of-Africa hypothesis, I noted other interactions. The next vignette shows the lesson on the Out-of-Africa hypothesis, which also shows other interactions.

Teacher: Exactly, when they settle their learners because of the environment the conditions there that's why you know what the colour the skin colour change, Ok. These are the conditions that led them to leave, remember, even those when we talk about the history of the earth, remember, firstly, it was one thing Ok, it was continental drift Ok and then it separated like that ok, hence the continents are formed. Different continents there ok its fine will come to that let us come to mitochondria DNA remember mitochondria as genetic evidence there remembers during fertilization what happens during fertilization. Let us use English because when you write you going to write in English.

Learner: The head of sperm has a spare chromosome uses and that is now going to form a zygote.

Teacher: OK, fine, let us see what is going to happen there now the mother's ovum containing mitochondrion is fertilized by the sperm remember during fertilization only what? That enters there the ovum what is it that enters there? Eggs the nucleus ok and these other parts the mitochondria are not going to enter there, only the mitochondria of the egg are going to be utilized there so they can be able to trace I want us to read this one mitochondrion DNA please read that one so that we can understand better.

Learner: We already know that every cell has organelles' called mitochondria within which the energy lives in process of cellular respiration takes place, mitochondria also contain DNA the fact mitochondria DNA. During fertilization only, the nucleus of the sperm cell enters the egg cell to fuse within its nucleus, the original egg cell then there becomes a cell of the zygote cell after the fertilization, the mitochondria of the egg cell continue as the mitochondria of the zygote.

Figure 4-13: Vignette of the lesson on the Out-of-Africa hypothesis

In most instances, Ms Dechaba did not ask for explanations from the learners. During interviews, I asked the respondent whether she promoted teacher-learner and learner-learner interaction during the lesson. She said,

> *I don't restrict them. They are allowed sometimes, to ask me questions, because sometimes when I am in the process, they do raise their hands, they ask me some questions and I do entertain them, yes, and sometimes I will note the question, and I will answer it at the end of the lesson and talk about it as a class.*

In other instances, Ms Dechaba indicated that she also gives learners a topic in evolution and requires them to go and research for information that will enable them to understand when she teaches. She mentioned in the interview that,

> *Sometimes I give them a topic and they go and research, they write all the important points down and then they come and present it in the class.*

The above remarks illustrate that Ms Dechaba encouraged learners to interact using question-and-answer sessions and learner presentations. During the lesson, some of the said activities were not implemented in the class, for example, information searches for research purposes and excursions. I probed whether there were issues/challenges with the former method, to which she stated,

> *Sometimes when you are using other methods, you don't find a maximum response from the learners, they are intended to keep quiet, In most of them, you will find that only a few learners participating.*

The narrative indicates that the use of the question-and-answer method of teaching and learning promotes maximum learner participation during the lesson, compared to other teaching methods.

4.5.2.3 The challenges and opportunities for teaching evolution

4.5.2.3.1 Difficulties in teaching evolution

a. Diverse classroom

All the classes had learners from different religious backgrounds and beliefs. According to Ms Dechaba, which was challenging. During the first interview, Ms Dechaba said,

> *I must find the balance amongst all learners. Some learners do question, how you are saying human beings come from this one, and the Bible put it this one, so you have to find a balance. There are those arguments, but learners understand.*

The above statement illustrates the dynamic environment the teacher encounters during the lesson and which she should manage to teach evolution. Reinforcing this notion, Ms Dechaba stated that,

> *even though I am a Christian, when I am in class I focus because I have to present the topic there", which demonstrates the level of preparedness by the teacher to teach the lesson on evolution in the classroom.*

The level of teacher preparedness to teach influenced how she taught evolution and engaged the learners as she stated,

> *Because when you get to a class, where they've got information about, it is not so much important to know much about it, but if you get a class where they have read the sources or watch some videos, it is very much easy that way.*

This, therefore, suggests that Ms Dechaba had a religious perspective and had to be professional enough to teach the topic of evolution. The above remarks enabled predictable responses from the respondent about the next theme.

b. Evolution is all about science

Findings from this case show that the teaching of evolution did not conflict with her personal beliefs, and as such, she did not find it difficult to teach the theory of evolution. It was also noted that the teacher confidently taught evolution in her classrooms because she felt that the teaching of evolution did not conflict with the learners' beliefs in any way. During the interview, Ms Dechaba mentioned,

> *Remember, in evolution, it is all about science, and, even if I've got my own belief or maybe, as a professional, my religion must not affect my teaching.*

The views of the respondent on teaching evolution were not biased towards her religion. Ms Dechaba indicated in her remarks that there was no relationship between science and religion; hence, she emphasised that evolution was a science differentiating it completely from religion. I further deemed it necessary to probe whether Ms Dechaba believed in evolution, to which she responded,

> *I believe in evolution, but as a Christian, according to me everything which is on earth is created by God. So those things state that we come from apes, I don't think so, I find it difficult, but I have got no choice, if I am in class, I must just do that, not to show learners that I've got some questions.*

The interview transcript shows that Ms Dechaba believed in the theory of evolution as science, despite her religious position. Her religious position did not affect teaching and learning.

4.5.2.3.2 Opportunities for teaching evolution

a. Understanding of population change

The findings from this case show that evolution helps learners to understand various life developments and helps learners to understand that populations change. Ms Dechaba also believes that the teaching of evolution also helps one to explain biodiversity. During the interview, the respondent further expanded on the above theme, stating that as much as the topic of evolution is "all about science" it will enable learners to think and reason on issues. She further indicated that she saw no importance for learners to know evolution. However,

> *For the learner, I think I can say it is important because they must learn, and then it helps them to be able to trace things [and] maybe, of remembering things, in that way it is good but to know the popular information, other important things, no, I don't think it is important.*

The interviewer then further probed Ms Dechaba about whether it was important for learners to know their origin, to which she responded,

> *Yes, I think it is important although I don't believe it is important. Learners will understand how species develop over time.*

Ms Dechaba's religious belief overshadows her perception(s) on evolution, even though she tried to ensure that it did not interfere with the teaching of evolution. During the classroom observation, she showed understanding and simplified the concepts of evolution for the learners:

> *You need to be able to define and explain evolution and you must explain evolution by Charles Darwin and Lamarck. So firstly, let's see what evolution is, evolution is the process by which species of organisms arise from earlier life forms and undergo*

> *change over time through natural selection. For example, the way we are now is not how we were millions of times years ago so with change throughout to such an extent that causes change, will go into details so that you can understand what instances that make us be who we are now. The main thing is evidence I have a video that explains what Is evolution, but in simple terms, evolution is just a matter of explaining the changes that have occurred in organisms, so this video is in simple English (video playing in the background).*

During the lesson, I noted that the views and beliefs of the teacher did not influence teaching and learning. The opportunities identified by Ms Dechaba were that learners should be able to trace their origins after learning about their common ancestors.

b. Understanding of scientific terms (Mutation in organisms)

When I probed Ms Dechaba about the benefits or gains that learner will have from studying evolution, she said learners can talk about changes that happened to the *Homo sapiens* species. She said,

> *You find learners talking about Homo sapiens where learners would answer something related to mutation (change in organisms) and say, wow, you have a talent of knowing evolution, and say the change is called a mutation.*

This narrative suggests that during the lesson on change in organisms, learners gain an understanding of what and how mutation occurs in living organisms when they learn about the theory of evolution.

4.5.2.4 Conclusion on Ms Dechaba's case

The previous paragraphs reported on Ms Dechaba, one of the Life Sciences teachers that I studied. A description of the biographical background and the institutional context where she works as a Life Sciences teacher was provided. This was followed by explaining how she taught the Grade 12 classes when implementing the Curriculum and Assessment Policy Statement (CAPS). The data show that the school governing body and the concerned stakeholders adopted Christianity as the religion to be practised at the school. This was clear when noting that the school sometimes asked religious leaders to pray for the learners and the school in general. The storylines show that Ms Dechaba is a religious person who has a science-based educational background; hence, she felt that the teaching of evolution was not a challenge. She pointed out that one should be

sensitive when teaching evolution because of one's religious position. Data further show that Ms Dechaba received formal training on evolution at university and college as part of her teaching qualification. Ms Dechaba perceived the language used to document the theory of evolution to be too scientific for the teacher to simplify for the learners. These narratives suggest that even though the participant is confident to teach evolution in the classroom, she was expected to deal with some of the learners' misunderstandings and misconceptions around the theory of evolution so that learners can learn with ease. During the lesson on theory by Lamarck, I noted some practices of the teacher-centred and the learner-centred method of teaching and learning. Ms Dechaba presented her lessons using videos and cartoons, pictures, e-Books or textbooks, PowerPoint presentations, and questions and answers. The findings also point out that teaching evolution helps one to explain biodiversity in organisms.

4.6 CONCLUSION

This chapter summarised how data attained were analysed and assisted in examining

How do Life Sciences teachers negotiate controversial topics in the school curriculum?

The following guiding questions were answered: What are the Life Sciences teachers' perspectives and beliefs about evolution as a topic in the South African curriculum; How do select Life Sciences teachers approach the learning of evolution in their classrooms; and 'What are the challenges and opportunities for teaching evolution in the Life Sciences curriculum? The findings were presented in themes, subtopics, and codes to capture the respondent's experience, wherein the ideas and/or patterns were mapped out further, and clarifications were provided to formulate this report. Moreover, additional points and themes that ensued from interviews, supplementing the research questions, were explored, where necessary, and the strengths and weaknesses of the interview were identified and corresponded with the demands of the study.

The next chapter, Chapter 5, seeks to present cross-case analysis, findings, discussions, and the conclusion.

CHAPTER FIVE: CROSS-CASE ANALYSIS, DISCUSSION OF FINDINGS, RECOMMENDATIONS, AND CONCLUSIONS

5.1 INTRODUCTION

In the previous chapter, I offered, analysed, and interpreted the qualitative results of the study thematically in response to the study problems. Built on the results provided in Chapter 4, this chapter deliberates on the key findings obtained from the practical evidence according to the abstract base of related literature presented in Chapter 2. The chapter offers a summary of the report and highlights key procedural issues in line with the methods discussed in Chapter 3, and an overview of important points about this research. Concluding remarks will be given after highlighting the limitations of the study. In this chapter, I present cross-case analysis, discussion of findings, recommendations, and the conclusion. The analysis and discussions of the findings are discussed in sections that follow under the themes that emerged from the participants' narratives and the related literature. The themes are guided by the following questions.

- What are the Life Sciences teachers' perspectives and beliefs about evolution as a topic in the curriculum?
- How do selected teachers' perspectives and beliefs influence the approach to the teaching of evolution in their classrooms?
- What are the challenges and opportunities for teaching evolution in the Life Sciences curriculum?
- How can the South African teachers' perspectives and practices on evolution be understood and/or explained?

Before discussing this interesting phenomenon of how Life Sciences teachers negotiate controversial topics like evolution in the school science curriculum through cross-case analysis, I will discuss how the cognitive framework on implementation was useful in this study.

5.2 SUMMARY OF THE STUDY

5.2.1 Introduction

The topic of evolution is a controversial subject in many parts of the world where Christianity and other religions that subscribe to the idea of creation are dominant. When evolution finds its way into the school curriculum, it can be expected that teachers would face a constant challenge on how to approach the topic in a way that is sensitive enough to some of the stakeholders' concerns while doing justice to the curriculum requirements (Sanders, 2010; Abrie, 2010; Van der Mark 2012). This study sought to explore how teachers in South Africa deal with this challenge of teaching evolution in a country where Christianity remains dominant and is celebrated through public and/or national holidays. The theoretical framework underpinning this study was the cognitive framework of implementation, as explained by Spillane *et al.* (2002), Coburn *et al.* (2016), and Alkahtani, (2017), which takes into consideration the basic data processing such as the problems and effects tangled in the handling of data about intellectual ideas. This study used this framework because the study explores how teachers create knowledge of the policy note; build an understanding of their practice; and how they come up with conclusions for possible alterations in their exercise (Cotton, 2006; Lefstein, 2008). It is anticipated that this study will complement the current frame of academic literature and scholarship on the teaching of evolution in secondary schools.

A qualitative approach was employed for this study with the case study as the design to explore how Life Sciences teachers in South Africa convey controversial topics like evolution in the school science curriculum, and what were the challenges and opportunities for teaching about evolution. I found the qualitative approach useful in seeking insights and explanations (Creswell, 2014; McMillan & Schumacher, 2010) on how teachers negotiated controversial topics in the curriculum. The participating teachers held various religions that they used during the lessons as a filter because two teachers thought that religious beliefs supersede the role played by evolution to explain the earth's origins. This was a study of three cases involving teachers from different schools, racial,

cultural, and/or religious groups. In this study, the qualitative approach was also aligned with the theoretical framework, i.e. the cognitive framework of curriculum implementation.

The qualitative research design that was selected was an in-depth case study that allowed me to visit each teacher's classroom and observe how each teacher taught the theory of evolution. Information was gathered using interviews and classroom observation.

5.2.2. The cognitive framework of implementation as a theoretical lens for the present study

The Cognitive framework on implementation is one of the most widely used frameworks in education generally and this study was not an exception. The framework, as discussed by James Spillane, posits that the implementing agents which are teachers in this case set up interactions of learners existing cognitive structures such as perceptions, their circumstances and situation, and the policy motions (Spillane *et al.,* 2002). This framework also involves taking into account the basic information processing, the difficulties, and the effects that are involved in the handling of evidence about intangible philosophies (Coburn *et al.*, 2016; Spillane *et al.,* 2018). The three stages of the cognitive framework of implementation are used to shape the study, which are individual cognition, situated cognition, and role of representation (Coburn *et al.,* 2016; Spillane *et al.,* 2018; Tikkanen *et al.,* 2019). The relevance of the chosen theoretical framework was shown in different ways in this study.

5.2.2.1 Individual cognition

In all three cases, special consideration was put on how individuals (teachers) receive information, understand change, and how the perceptions impact the formation of new understanding. According to Spillane *et al.* (2002), teachers as agents integrate experiences and information through the existing knowledge buildings. The three teachers all depended on the amount of existing knowledge and experience to understand evolution. According to Tikkanen *et al.* (2019), cognitive processes assist in the understanding of challenging activities during teaching and are influenced by policy

on practice (Spillane *et al.,* 2018; Tikkanen *et al.,* 2019). The outcomes of the report can best be explained by considering how prior knowledge impacted the sense-making, how different interpretations arose from the same message, how agents can misunderstand new ideas as familiar, and how the understanding may centre on artificial structures while omitting deeper connections (Spillane *et al.,* 2018). Teachers were given explanations of difficult terminologies during the lesson on evolution as a topic in the Life Science syllabus to simplify the subject matter for the learners to understand.

5.2.2.2 Situated cognition

Situated cognition shows that the context is central in understanding how the teachers create knowledge and understanding (Alkahtani, 2017; Blackman, 2016). A research report by Spillane *et al.* (2018) shows that the situation is essential in understanding human cognition and perception. The three cases were influenced by the social situation, individuals' views and opinions of evolution, and representations for understanding new knowledge (Spillane *et al.,* 2002). The situation of the three teachers influenced how the teachers taught evolution in the classroom, moving their understanding from individuals' knowledge construction to the coordination of the activity (Coburn *et al*., 2016). Research suggests that knowledge that is embedded from public contexts as the practices and common beliefs of a community, affects the understanding of curriculum implementation (Spillane *et al.,* 2002; Gudyanga & Jita, 2018). The situation is a multifaceted concept that Includes identities to the features of organizations in which people work. The three teachers who participated in this research belonged to various thought of communities because of their identities, affiliations, membership, and learning from political backgrounds (Coburn *et al*., 2016), and this had an impact on their teaching and learning of evolution. The way one categorizes the world we live in impacts how we explain certain things and how we give value to them. Individuals grow a distinctive set of capabilities, expectations, and opportunities from their own experiences.

5.2.2.3 Role of representation

According to Spillane *et al.* (2002), the role of representations places more emphasis on the part of policy motivations in implementing agents' understanding, focusing on the

creation of knowledge. During teaching and learning of evolution, the teachers' implementation process involved mutual understanding among members concerning the beliefs, values, and assumptions that originate from the programme, and how they understand the programme in line with the school, community, and class situation (Coburn *et al.*, 2016; Blackman, 2016; Alkahtani, 2017).

In the next sections, I cross analyse the biographical data of the three cases in relation to their qualifications and experiences, as well as the findings of the study.

5.3 CROSS ANALYSIS OF FINDINGS OF THE STUDY

This section offers a cross-case analysis of the findings by pointing out the similarities and differences between the three cases studied. Literature from Chapter 2 was used to enlighten the discussion and analysis, followed by the discussion and analysis of the findings.

5.3.1 What are the Life Sciences Teachers' Perspectives and Beliefs about Evolution as a Topic in the South African Curriculum?

To respond to the question, I explored the three Life Sciences teachers' beliefs and perspectives about evolution as a section in the Life Sciences curriculum that must be taught, and how their beliefs and perspectives influence teaching and learning in the classroom.

5.3.1.1 Teachers' beliefs about evolution

The study identified three main categories to explain the teachers' views and beliefs when teaching evolution, namely religious position, teacher development, and societal views. These categories were identified in line with the challenges educators face during teaching and learning of evolution. These categories are described in the next few sections.

a. Religious position

According to Coburn *et al.* (2016), a sense-making process during curriculum implementation is situated in particular communities, like professions, nations, religions, and organizations. In Cases 1 and 2, the teachers indicated that the teaching of evolution was somewhat in conflict with their own personal and family beliefs and as such, they found it difficult to teach and/or accept the theory of evolution. However, Teacher 3 did believe in evolution as a theory of science. The findings in Cases 1 and 2 were similar to those of Bowman (2008); Reddy (2012), Baker, (2013), Yalvac (2011), and Mpeta (2014), who also found that some teachers find teaching evolution challenging due to their religious position. In Cases 1 and 2, it was also noted that educators tried to avoid teaching evolution in their classrooms because they felt that the teaching of evolution further conflicted with learners' beliefs in one way or the other. Research by Mpeta (2014) and Baker (2013) shows that teachers who teach evolution may have challenges because some learners have different understandings of evolution. Case 3 shows the opposite of Cases 1 and 2. Ms Dechaba believed in evolution as a science and was confident to teach the topic, despite her personal beliefs.

b. Teacher development

Glaze and Goldston (2019) reveal that some teachers accepted evolution as a useful and valid theory within the science society after helping one another so that everyone can understand evolution as useful in the science community. Cases 1 and 2 claimed that training and workshops, offered by the Gauteng Department of Education and the DBE in South Africa did not help teachers much to deal with the challenges in the classroom (Abrie, 2010, Stears, 2012), while Case 3 found the workshops helpful in improving her understanding of evolution. Data show that Life Sciences Cases 1 and 2 did not study evolution at university and were never taught approaches that they could implement in class while Case 3 had studied evolution at university as part of her teaching qualification. Reports by Abrie, (2010) and Sander (2018) indicate that not all teachers in South Africa studied evolution at Universities or Colleges The training on evolution has been offered by higher educational institutions since early 2008 (Abrie, 2010; Molapo & Pillay, 2018)

when teachers were concerned about their insufficient knowledge of evolution. During this period, some teachers did not know the theory of evolution; therefore, teachers need to be provided with training (Stears, 2012) on evolution, which will prepare teachers on the philosophy and methodology of science.

c. Social views

Cases 1 and 2 indicated that they did teach learners from different religious backgrounds and beliefs, which also influenced the way they teach. The data show that the teachers' understanding was that stakeholders (i.e. parents, community members, and school administrators may have different religious backgrounds) (Robins *et al.*, 2003; Mpeta, 2014) and they believed that they might influence how evolution should be taught in the school. It was also reported by Case 1 that he experienced pressure from other stakeholders when he taught sections on creation. In Case 1, the teacher made a comment expressing the frustration they received from learners and teachers, that evolution was not important, and this contributes to not emphasising evolution in the class (Audi, 2009). It was further noted that teachers avoided teaching evolution and taught only creation science as an alternative's theories to evolution. It was also discovered by Robins *et al.* (2003) and Audi (2009) that some teachers teach evolution superficially**.** Data collected from Case 3 show no sign of social views influencing the teaching and learning of evolution.

5.3.1.2 Teachers' perspectives about evolution

The teachers' perspectives ranged from evolution being abstract and a difficult topic to teach, i.e. lack of teaching material, abstract and difficult to understand, language used, and time allocation that can assist teachers to teach the concepts on evolution.

a. Lack of material

Findings from Cases 1 and 2 show that the section on evolution lack teaching and learning material. Lack of material indicates that there has not been much development on the subject material on evolution that may include new knowledge to assist with understanding other areas. A study by Sanders (2018) discovered that some teachers

feel that there is not enough teaching material to support content on the textbook. Case 3 was satisfied with the available teaching material. In all the cases, the teachers had interactive smart boards which were installed with e-Books videos on evolution, learners had tablets with e-Books and textbooks on evolution. The understanding of all the cases was that learning is a part of bringing the historical issues to the existing and projecting the forthcoming. As a result, it was important to have historical views of how humankind came about on continents, why people do not look the same, for instance, white and black, which may involve studying various theories.

b. Historical, Superficial, Abstract & difficult to understand

The three Cases agreed that the teaching of evolution is abstract and theoretical. The code term 'history' was used to elaborate on and best describe the situation of the view of teaching evolution. This finding is similar to findings by Hahn *et al.* (2005), Neubrand and Harms (2017), and Sanders (2018), who found that some teachers feel that scientific terminologies used were complex and difficult to pronounce and understand. This implies that the core field of study for evolution was broad and cannot be classified under a singular classification. All the cases show that the religious part causes a conflict of interest amongst teachers and learners (Sanders, 2010), because evolution is a science and now one has to compare it with religion. Sanders (2010) agrees with this view as she argues that teachers' religious position influence how teachers teach evolution in the classroom. This, therefore, shows that the views on the teaching of evolution are then negatively skewed.

Case 3 also indicated that evolution is not a difficult topic to teach and understand, but one should be sensitive because one has different views of that. This finding could be ascribed to the point that the teacher in Case 3 received training during in-service training. One should not give one's own opinion but just teach what one is supposed to teach and let learners decide whether they believe it or not. Her remarks also made it clear that a divide amid science and religion exists; hence, she emphasised that evolution is a science, differentiating it completely from religion. A study by Berkman, Pacheco and

Plutzer (2011) indicates that evolution is a science and should not be compared when religion.

c. Language usage

The explanation of language and terminology is one of the necessary features of teaching. All teachers agree that most terminology on evolution is difficult to understand and explain. It, therefore, becomes difficult to explain to learners, and it was commonly established that the concepts are difficult for learners to understand. A study of a district committee by Hill (2001) shows how teachers can correctly use the language in ways that miss its intentions (Hill, 2001; Spillane, 1999). The three Cases used the same policy language to signify different notions.

In all the Cases, the language that was commonly used during the lessons was English. The teachers complemented the lesson with other languages, mainly isiZulu, isiXhosa, and Sepedi. These languages were used to clarify some perceptions that were difficult for the learners to understand when clarified in English. Knippels *et al*. (2005) found that Dutch teachers were challenged by the terminology in evolution, which is often not used consistently and explicitly in curriculum materials. During the lesson, learners also used other languages when they had challenges with English.

The curriculum expectations were met at all the sampled schools, and the Cases covered the appropriate material required by the CAPS, e.g. learners were involved in the learning activities and no discrimination based on religious affiliation or belief was noticed. The Cases accommodated learners' philosophies that were opposing what was offered on evolution. This was promoted by class debates, which allowed the interchange of opinions and notions.

d. Time allocation

Cases 1 and 2 perceived the ATP (Annual Teaching Plan) as one of the limitations connected to evolution, while Case 3 did not see any problem with time allocation. What was mostly highlighted by Cases 1 and 2 was that, according to the ATP, the topic of evolution was only allocated a short period immediately before the final exams. With the

exam pressure approaching, learners and teachers were forced to rush through the topic. As a result, learners found it difficult to explore the topic further in terms of asking more questions and gaining a thorough knowledge of the topic. Reports by Sanders (2018), Hahn *et al.*, (2005), and Hermann (2013) show that the section on evolution is on the last quarter of each academic year. All the Cases perceived evolution as the last part of the curriculum, which was covered in a month, or three weeks, and as a result, it brings a lot of questions, misconceptions, and a lot of religious discussions.

5.3.2 How do selected teachers' perspectives and beliefs influence the approach to the teaching of evolution in their classrooms?

To answer this research question, a question on which approaches do three teachers used when teaching evolution in their classrooms was asked during interviews. A classroom observation also played a role in responding to these questions. Other areas that I focused on were the analysis of learners' day-to-day knowledge linked to evolution; use of learner support material; checking whether or not the teacher engaged learners by asking/inviting questions; and/or by giving explanations to learner's questions and how the teaching and learning approaches were used engaged the learners during the lessons.

5.3.2.1 Understanding of teaching approaches

According to Wilcox and Lawson (2018), and Coburn *et al.* (2016), teachers as mediators know and understand their practices and their potential to change learners' beliefs and attitudes in the classroom. The outcome of the data from the interviews and discussions shows that all three teachers were aware of the curriculum needs as prescribed by the CAPS document, i.e. the use of teacher-centred and learner-centred interactions. The application of the teaching method differed from one case to the other. The outcome of the classroom observation shows the dominance of teacher-centred approach to learning. The three Cases negotiated the teaching and learning of evolution differently, using both a teacher-centred and learner-centred approach using e-Books, textbooks, videos, question-and-answer methods, teacher-and-learner dialogue, internet searches for information, and groupwork. In discussing the teaching approaches below, I made a

deliberate effort to discuss how the teachers attempted to use both the teaching approaches to give a picture of the extent of the success achieved in each case. The content analysis allowed me to list a variety of approaches used by the teachers.

a. Practices of teacher-centred approach

In this study, the teacher-learner interaction refers to a teaching process where the teacher takes the leading role and facilitates the learning process. During the lessons, all the teachers used this method, coordinating the learning process from the front. The teaching and learning materials used were e-Books, textbooks, videos, question-and-answer methods, and teacher-and-learner dialogue. Although question-and-answer methods and teacher-and-learner dialogue strategies are supposed to be learner -centred when conducted correctly, the types of questions asked made learners give short responses which did not involve sufficient knowledge construction through critical thinking and reflection.

The Cases used the power of discussion, and interacted with their learners, using questions and videos. The classes had a minimum of 45 learners per class. These techniques assisted in learning, and they were active during the lessons. Cohen (1990) and Spillane *et al*. (2018) indicate that supportive learning enriches learners' philosophy of new content. However, sometimes learners' questions that required explanations were not simplified by the teachers.

These findings indicate that all three Cases believed that the role of teachers was to plan the lesson, engage learners in the learning process. Their understanding of how to negotiate the concepts on evolution differed from one teacher to another possibly because they used their prior knowledge and experience as filters (Spillane *et al.,* 2002). As a result, the role of the teachers often did not match their practice.

b. Practices of learner-centred approach

This section discusses how the three teachers attempted to use learner-centred approaches highlighting the successes and the failures. One way of considering an approach to be learner-centred was to look at the level of learner-leaner interaction and

learner engagement. Learner-learner interaction refers to a learning process where the learners take the leading role and facilitate their learning process. During the lessons, Cases 1 and 2 used very little learner-learner interaction such as learner dialogue, an internet search of information, discussions, and groupwork, while Case 3 used some of the learning styles on several accessions. According to Scott *et al.* (1994) and Neubrand and Harms (2017), teachers should use learners' previous and existing ideas, when organising teaching material for evolution lessons. Scott *et al.* (1994) further show that consideration of previous understanding is essential to prepare activities that are suitable for promotion intangible improvement and modification.

5.3.2.2 Common teaching and learning style

The pedagogical tactics that the three teachers used in their Life Sciences classes were more outdated teacher-dominated practices, with only some learner-centred approaches. During the school visit period, in all three cases, teachers used some learner-centred methods, with varying degrees of success. The Cases were mainly using an authoritative or lecture teaching method. Case 3 (Ms Dechaba's) teaching methods stood out as unique in this case study, because she equally applied rote-learning practices and learner-centred practices in all the six lessons I observed her in her class. What can be observed as an interesting finding is that the teachers were able to use both teacher-centred and learner-centred approaches although they tended to favour teacher-centred approaches. This finding may be explained by the fact that SMT teachers use situated cognition when implementing the curriculum (Spillane *et al.,* 2002). Therefore, there could be contextual factors that force teachers to favour teacher-centred, more than learner-centred approaches.

a. Use of e-books/textbooks

Studies by Harris and Graham (2019) and Chimbi and Jita (2020) explored the necessity of teachers to use innovative teaching approaches to change pedagogical practice. In this study, the degree of sampled teachers' confidence in the manner they presented the lessons was positive when using e-Books and textbooks. E-Books and textbooks were used to drive the teacher-learner interactions by the three teachers. All the Cases mainly

read the text to the learners and allowed learners to read some relevant similar sources as a way to provide learners with an opportunity to confirm what the teachers read from the books. Interestingly, despite recommendations to utilise several textbooks by the DBE, both the e-Books and textbooks as well as any additional books used by all the schools in the sample were similar.

During the lesson, learners mainly utilised e-Books (textbooks loaded onto tablets, and study guides) to refer to a diagram during teaching and learning. In a lesson, the teacher showed learners a picture showing apes developing from the same ancestor, using a Smartboard, and asked if they believed the diagram presented. Learners checked the information about the picture to get to understand its meaning. Even though the lesson was teacher-centred, learners were able to engage in open classroom discussions. The e-Book and video resources proved to be useful in the teaching of evolution because the teachers could use the readily available media as they made efforts to explain the concepts. However, the teachers used these media in teacher-centred ways (Harris & Graham, 2019).

The teaching plan for this content on evolution that the teachers presented, and the lessons followed one another as arranged in the e-Book or the textbooks, and learners used the same e-Books and textbooks as their prescribed text for the syllabus. A study by Harris and Graham (2019) reports that some teachers teach consistently with the reforms while incorporating the change in ideas into traditional practices such as using textbooks, and hands-on activities in science. In Cases 1 and 2, some copies were provided from other textbooks as a reference, because two additional e-Books were prescribed that were installed on the learners' tablets, and which learners used as reference. The teachers were dominant in their lessons, giving simple explanations on the matter presented. The overall pattern noticed during the lesson was that teachers always applied the same approaches when teaching various Life Sciences groups at their respective schools, which shows some reliability in their choice of teaching strategies. Whole-class discussions and the question-and-answer method were observed at all the schools and dominated the lessons. A study by Dube and Jita (2018) suggests that lack

of resources and inadequate teacher preparation may contribute towards poor curriculum implementation, which was not the case in this study.

b. Class discussion

Learner sitting arrangements in the classrooms differed from one school to the other, and the level of discussion differed from one case to another. Even though learners were seated in groups in Cases 1 and 2, and in a traditional way in Case 3, the differences noted were in the manner in which teachers involved learners in groupwork and presentations. In some lessons, Case 2 invited learners to simplify and demonstrate some of the subject content while Cases 1 and 3 never tried that. However, during the discussions, learners were discouraged from applying their personal beliefs and understanding of learning about evolution.

Case 3 arranged group discussions on some of the topics related to evolution. A report by Glaze and Goldston (2019) on teacher professional development in schools indicates that teachers need to be developed on the use of teaching aids during the lesson. These class deliberations were then boosted by a PowerPoint presentation of the subject content to the rest of the class. After the teacher presentation, there would be questions and inputs from group members, where possible. In some lessons, the teacher allowed learners to present their understanding, during which the discussions would develop into a form of argument. In Case 2, learner engagement in the form of groupwork to allow learners to think critically and give their views was not used; rather, there was an open-class discussion. Sometimes the debate ended between two individuals arguing about the positive and the negative issues on evolution, which made the concept difficult to believe.

In all the Cases, as lessons advanced, few discussions were noted. Despite learners being allowed to participate in classroom discussions, the teacher-centred style was in control of the learning process. A report by Priestley and Philippou (2018) shows that teachers' local settings of enactment serve a powerful facilitating function in classroom practices. In general, learners were allowed to share their ideas in the classroom

discussions. However, learners were encouraged to explore traditional views and opinions linked to the origin of species, particularly the ideas related to humans.

c. Question-and-answer method

Scharmann (2018) reports that learners and teachers must interact during the lesson in such a way that they protect their religious understanding and knowledge. In all the cases, teachers used some questions to drive the lesson, encourage learners to inquire, and engage learners on matters associated with the subject at hand. The questions that learners asked were mainly about evolution that affected them. During the lesson, the teacher would then provide inputs to the questions to give a more correct and appropriate explanation of the scenario. The importance of prior knowledge on evolution was regarded as important, to the point that learners were sometimes requested to study the issue and/or ask around among (**4.5.2.2.a**) themselves to get information. In some cases, the teachers allowed the learners to respond in a class discussion so that they could reach a mutual view and consideration of the matter at hand.

The use of different questions plays a major role in a learning situation. All teachers used various questions to promote learning, i.e. open-ended and closed-ended questions. Borgerding and Klein (2015) and Reddy (2012) reveal that teachers resort to not asking learners certain questions because they are not open to evolution. However, teachers mostly use close-ended questions, with no justification from teachers for learners, even where learners' ideas show some misconceptions. This finding is similar to findings by Sanders (2018) and Neubrand and Harms (2017), who found that some teachers avoid classroom discussion and questions during the lessons.

Two Cases always asked learners questions to check if they understood the content and explained to learners how certain processes happened. One of the teachers also encouraged learners to participate in activities using open-ended questions and look for justification on certain answers where responses were mistaken and directed learners to the right answers. However, the teacher did not explain why certain responses were not acceptable.

All the Cases acknowledged the importance of learner discussion to promote learner knowledge and understanding. They also indicated the struggle they encountered to engage learners in dialogue so that they could share their ideas and feelings due to contextual factors in schools. They all preferred question-and-answer type questions, particularly closed-ended questions to require of learners to replicate what they were taught previously. Learner thinking about evolution was not explored; however, one of the teachers applied some open-ended questions. According to Spillane (2000) and Cotton (2006), closed-ended questions in a lesson do not stimulate learners' thinking to understand new knowledge. Nevertheless, the cases used prior knowledge during the lesson, as discussed earlier.

d. PowerPoint presentation/interactive Smartboards

Spillane *et al.* (2018) indicate the importance of concrete and visuals in promoting learner understanding and knowledge during the lesson. During the lessons, it was noted that teachers in all the cases presented evolution as a science concept using the interactive Smartboards and all the available resources. As explained earlier, teachers mostly explained what was presented in the e-Books and textbooks, using prepared PowerPoint slides. However, what was often observed was the use of interactive Smartboards (with intranet access to download evidence) and other teaching and learning support materials like videos and slides. The use of interactive Smartboards made teaching simpler and these enabled learners to focus on the same (**4.5.2.2.1.b & c**) thing during the lesson and stimulated effective and efficient classroom collaboration.

What was lacking during the lessons in all the cases was the provision of well-designed hand-outs, pictures, and models. Interactive Smartboards, laptops, and tablets were teaching materials used in all the schools. Learners were able to use e-Books of their own loaded onto their tablets. The flow of the content of the lesson was all initiated by teachers and was CAPS-aligned. In most of the lessons, teachers reviewed the learners' day-to-day understanding connected to theories of evolution. They engaged learners in class deliberations and questions. In certain scenarios, this was done to ask about knowledge, understanding, and principles about certain information. In some cases,

learners were asked questions to check if they understood the previous content taught. According to Glaze and Goldston (2019), science relies upon explanations and understanding of concrete evidence to construct justifications of the natural world. In Case 2, when the teacher gave a lesson on evolution, he first showed learners a picture on a family tree showing different shapes that seemed to have evolved and asked the learners to say what they knew, understood, and believed about the origin of life, and few learners related their knowledge and experience.

e. Dialogues

The interviews with the three teachers showed the importance of dialogue in a lesson because it allows the teacher to give instructions, and directions that enable learners to engage further. However, Case 1 believed that it was time-consuming, and affect the pace of the lesson. Hermann (2018) suggests that learners and teachers must have a discussion on evolution that does not threaten their religious understanding and knowledge. During the learning process, Cases 2 and 3 encouraged learners to engage in dialogue. According to Spillane *et al.* (2018), dialogue is important because it allows learners to share their ideas. However, Case 1 feels that it is not always successful, because learners can use the opportunity to share issues of interest that might not support learning. Cases 2 and 3 further indicated that they preferred dialogues that managed the teacher in the classroom.

During the lesson, in Cases 2 and 3, learners were groups in all classes completing the activities. Spillane *et al*. (2018) and Gudyanga and Jita (2018) suggest that teachers should choose an appropriate learning environment that suits a particular teaching style so that teachers can get inputs from learners' thinking and experience. According to Piaget (1964; 2003), learner work should be prepared in advance to allow learners to add their understanding of the lesson, enabling learners to develop their ideas (Spillane *et al.*, 2002)

f. Animation videos-based teaching and learning

Research reports by Schul (2014) show that the use of digital technology provides new opportunities for teaching lessons in the classroom. The three cases in this study used some videos when presenting their lesson. During the lesson, all the teachers utilised videos on evolution to support their teaching and learning. The cases showed some videos for learners to watch and listen to without the assistance of the teacher, which allowed learner interaction of the content, which might create a higher impact on the learning experiences. After some of the videos, learners were allowed to present their understanding of the video to the whole class. The videos that were commonly shown were mostly on natural selection and human evolution.

5.3.2.3 Exceptional teaching practices

During the classroom observation, exceptional teaching practices such as the use of field trips and educational tours, an internet search for information, and classroom presentation were utilised. These exceptional teaching practices are discussed next.

a. Field trips and educational tours

During the interview, Case 3 further highlighted that she organised field trips to assist learners in getting an idea of what evolution is all about. This was unique, compared to Cases 1 and 2. She indicated the heritage sites like Maropeng and Sterkfontein (Cradle of Humankind) as places where learners could get information and could clear the controversial understanding about evolution. The sites mentioned assisted learners with better knowledge, as they provided evidence in the form of pictures, bones, and drawings. There was an assignment completed by previous Grade 12 learners who were taken to the sites. At the time of the school visits for this study, the field trip was still in the planning stage. A study by Sanders (2010) shows the importance of organising field trips to the Cradle of Humankind to assist in the teaching of evolution. The study shows how the fossils displayed at the Cradle of Humankind can assist learners to understand evolution better. Scharmann (2018) reveals that inviting teachers to place evolution on a scientific band after receiving knowledge claims could help teachers to view evolution as important.

b. Internet search for information

Even though internet connections were available in all the cases, internet searches to gain information were unique. A report by Spillane *et al.* (2018) emphasises the influential role of social interactions during teaching and learning, and in the construction of messages about their practice. During some of the lessons (**4.4.2.2.2.c**), I observed, learners were allowed to search for additional information related to the topic on their learning tablets using a search engine. Cases 2 and 3 made some highlights of Internet search for information during the interviews, but during the lesson they never allowed learners to search for information; they did internet searches for information.

c. Classroom presentation

I observed some classroom presentations in all the cases in their lessons with changeable degrees of accomplishment, depending on the ingenuity of the individual case. Each teacher had a unique presentation style, but all used ICT equipment. Case 1 (**Figure 4.1**) presented all the lessons that I observed from the front while moving around the class during the lesson. Case 3 presented most of the lessons from the corner closer to the interactive Smartboard and used a pointer to show learners some information on the Smartboard. He moved very little during the lesson, compared to Cases 2 and 3. This approach allowed for the sharing of ideas between the teachers and the learners.

5.3.2.4 Learner engagement during the lesson

In this regard, during the lesson, observations were made on whether teachers engaged with the learners during the lesson, how they involved learners, and used different learning approaches to accommodate for learners' various learning needs. The observations showed that the teachers invited learners' views on most of the issues discussed using questions and answers. A report by Spillane *et al.* (2018) suggests that prior knowledge, beliefs, and understanding play a role during lesson planning, preparation, and presentation. As discussed earlier, there were some classwork and classroom discussions, and learners were invited to participate. It was noted that Cases 1 and 3 mainly concentrated on active learners, but in Case 2, the teacher encouraged

the less active learners and required contributions from them. Various teaching strategies were not used to suit different learner needs and were limited to teacher presentations, whole-class discussions, and question-and-answer sessions.

Generally, from all the lessons observed, it can be concluded that learners were mainly involved in the lessons through questions and answers. Learners asked questions and made views clear during class discussions, even though, most of the time, they were not allowed to discuss the topic in their groups. Learner inputs and comments during the class discussions were mainly based on religious or cultural backgrounds, which caused heated debates (**Figure 4.5 line 3; Figure 4.9 line 13**), given the diversity of religion and cultures. Despite all the discussions, the teachers accommodated learners' views and understanding, and encourage them to learn all the time, as the section is part of the syllabus. At all the sampled schools, teachers did not reveal their religious position, but from the discussion, it became clear that they were Christian. From the discussion, it could also be determined that some learners felt that they were forced to believe in evolution.

Coburn *et al.* (2016) indicate that when learners interrelate over time with new information, individuals develop an understanding and, in some instances, shared understandings about what they need, and the understandings become a filter for ideas about revising extant practice. Cases 1 and 2 believed that groupwork is the teaching strategy suitable to learner-centred learning; however, in the lessons observed this strategy was not used. During the interview, Case 1 indicated that demonstration was a teaching strategy that promoted learner-centred learning; however, the observations showed no demonstration promoted learner-centred learning. Case 3 believed that groupwork was not applicable in her classrooms because of overcrowded classes. She also indicated that, according to CAPS, the teacher-learner ratio should be 1:36, so that a teacher can guide and give instructions to support the learning (Spillane *et al.,* 2018).

5.3.2.5 Use of learner's prior knowledge to enhance teaching and learning

Before the lessons in the classrooms, learners are taught religion and different beliefs. When taught in class on any topic, learners turn to their background knowledge and then

listen to what the teacher must teach. Reports by Brooks and Brooks (1993), Spillane (2000) and Cotton (2006) indicate that learners' experience and awareness are important in teaching and learning. I have learned that the three cases take learners' past knowledge as what learners learned in previous lessons and believed that was important for teaching to progress. Reports by Spillane *et al.* (2018) and Govender (2018) suggest that teachers' prior knowledge, beliefs, and understanding play a major role during lesson planning, and the understanding gives the teacher the ability to apply the changes in the policy objectives.

Case 1 indicated that the learners' prior knowledge was the product of earlier teaching and learners' homes experience. The understanding shared by this teacher was different from those of South African teachers, as reported by Nykiel-Herbert (2004). The teachers' understanding of learners' experiences was reflected in their teaching. All three cases mostly started their lessons by asking questions about what was taught in the previous lessons. Therefore, teachers summarised previous work before progress in the new lesson for conceptual understanding.

According to the lesson observations, teachers did not encourage allow teachers did not take learner ideas from the community to a lesson and encourage them to predict and discover, as suggested by Cotton (2006) and Carr *et al*. (1994). The link between learners' ideas and scientific knowledge was only done by the teacher using examples from learners' everyday contexts (Spillane *et al*., 2002; Cotton, 2006; Okoth, 2016). All the cases attempted to determine their learners' prior knowledge about evolution at the beginning of the lessons. Nevertheless, they operated within their understanding of preceding knowledge. Teacher 2 mostly used learners' responses to drive the lessons, compared to Cases 1 and 3.

5.3.2.6 Use of physical experiences and concrete biological models

The teaching of evolution should be simplified by bringing observable items to the class so that learners can develop their understanding and relate them to daily practices this can be physical or scientific models (Vygotsky, 1996; Von Glaserfeld, 1989, Spillane *et al*., 2018). All the cases used pictures from the e-Books and textbooks, and teaching aids

like videos and prepared slides to engage learners. Brooks and Brooks (1993) indicate that teachers establish a conducive learning environment that allows learners to discover their ideas.

5.3.3 What are the challenges and opportunities for teaching about evolution in the Life Sciences curriculum?

To answer this question, during the interviews, I examined the teachers' experiences of teaching evolution so that I could explain the challenges and opportunities for teaching about evolution.

5.3.3.1 Challenges when teaching evolution

Some researchers explained a theory in evolution as a controversial topic and difficult to teach (Sherrer, 2005; Rutledge & Warden, 2000; Wuerth 2004). From the analysed data presented in Chapter 4, it emerged that teachers experienced some challenges when teaching evolution. The challenges emerged from the following experiences, namely religious affiliation, professional development, and social interaction. Other associated challenges that teachers have when teaching evolution also include lack of resources, the abstract language used in the section, poor content knowledge, and inadequately prepared teachers to teach evolution. The experiences and the challenges that make the section challenging are explained next:

a. Religious affiliation

In Cases 1 and 2, the religious affiliation of the participants contributed negatively to poor teaching of the topic, which was not the case in Case 3. All the teachers believed that evolution affected various stakeholders differently, as it conflicted with their beliefs. Various studies report that evolution influences persons' individual beliefs (Akyol *et al.,* 2012, Sanders & Ngxola, 2009, Govender, 2018), and as such teachers are not free to accept and teach evolution (Baker, 2013). A study by Long (2012) reports that some teachers do not teach evolutionary theory in their classrooms because they feel evolution challenges their religion.

During the observation, it was noted that teachers read subject content from e-Books or textbooks with very little explanation. This suggests that the teachers taught evolution superficially. A study by Moore (2008) discovered that some teachers may decide not to explain the content deeper, denying learners a platform to participate in discussions about the background of humankind and the origin of life, thus leaving learners without any adequate understanding. A report by Sanders (2010) shows that some teachers encourage learners to learn evolution only for an examination as if it is not important.

A report by Govender (2018) indicates that teachers who may wish to teach evolution might experience challenges because some learners may have their understanding of evolution (Billica, 2012; Govender 2018). According to De Villiers (2011), some learners might come up with claims that are not proved about evolution because of individual beliefs that God created all. The claims may arise because learners do not have a background in NOS and the theory of evolution (De Villiers, 2011).

Case 3 desired to teach and learn about evolution because that would improve their understanding of the past before they depended on their religious principle. This perception could have been because the teacher was the only one of the three who studied evolution during her initial teacher training, which enriched her prior knowledge. Cases 1 and 2 both specified that they sensed that it was their duty to protect Christianity, but they did not consider the understanding of worldviews. Even though the two cases had identified religious beliefs and their concerns about teaching evolution, the current outcomes point out that societal concerns also influence teachers' preparedness to study and teach evolution. Schulteis (2010) discovered that teachers' religious beliefs affect how they taught evolution. More importantly, the findings further show that at a certain point, teachers may accept evolution, and not fully understand and recognise it, and as a result plan to teach the concepts on evolution. This was in line with what was found by Abrie (2010), namely that some teachers accept evolution as a science.

b. Professional development

Cases 1 and 2 claimed that development conducted by the DBE was not helpful and did not help teachers to manage challenges in the classroom. These findings are supported

by Stears (2012) and Sanders and Ngxola (2009), who discovered that workshops conducted by DBE are not enough to empower teachers to teach evolution. Cases 1 and 2 indicated that they had inadequate knowledge to teach evolution. A study by Marcelos and Nagem (2011) indicates that novice teachers may find it difficult to teach evolution because they might not understand the theory and its importance. Teachers should be provided with continuous training that pays attention to small details (Sanders & Ngxola, 2009), and in-service training on evolution should aim at preparing biology teachers in the philosophy and methodology of science. During the lessons, Case 3 was confident, and I did not see any problem associated with teaching in the classroom.

There are studies devoted to the issues of teacher understanding, acceptance, and beliefs of evolution (Rutledge & Warden, 2000; Trani ,2004). In this study, the participants in Cases 1 and 2 had professional development concerns. Long (2011) claims that it is unrealistic to expect science teachers to disregard the political and social positions in which they are required to teach evolution in their classrooms.

All the cases agreed that teacher training and teachers' professional development are key to evolution education. If teacher candidates are well-prepared for the teaching profession, future learners will see well-equipped teachers in Life Sciences classes. Rogan (2004) states four factors related to professional development. One of the factors pertains to teachers' own experience, application, confidence, and pledge to teach Life Sciences. Case 1 also indicated that he lacked subject matter knowledge and felt that as part of professional development, teachers' pedagogical content knowledge needs to be developed.

c. Social interaction

Findings from Cases 2 and 3 did not show social interaction as a challenge, only in Case 1, which indicates that teaching in a diverse classroom with learners from different religious backgrounds and beliefs influences the way the teacher teaches. During the observation, the teachers tried to accommodate every learner's answer in the lesson because of different interpretations by different learners. Moore and Kraemer point out that many teachers in America are pressurised by communities and parents, for teaching

creation science and evolution. Moore (2004) reports that some stakeholders do not see any value in learning evolution. It is noted that the pressure that teachers receive from stakeholders contributes to the lack of emphasis on evolution in classrooms (Rutledge & Mitchell, 2002), while other teachers, because of pressure, decide not to teach evolution (Moore & Kraemer, 2005; Trani, 2004). Griffith and Brem (2004) have found that some of the teachers avoid conflict in their classrooms, ignore non-scientific discussions about evolution, and allow learners to explore their emotional concerns.

Regardless of which concepts are taught, all the cases in this study were aware of the controversy around evolution and the difficulty about teaching and learning evolution because it is an abstract and complicated theory. Case 1 further indicated that they struggled to appease all the stakeholders who have an input in the professional performance and success. As teachers, they were prepared to face potential conflicts with parents or learners about evolution.

d. Language usage

The three cases show that the language used when talking about scientific concepts often varies with the context and purpose of the communication, i.e. the terminology used to present, and drive the lessons on evolution make changes in the understanding of concepts (Sanders, 2010; Tsui & Treagust, 2007). The multiple meanings of scientific terms are often implicit, subtle, and undefined (Reddy, 2012), and the use of biologically mistaken language to describe evolution has been criticised, because that leads to the misinterpretation of evolution, and may support misconceptions (Reddy, 2012).

Research by Reddy (2012), and Tsui and Treagust (2007) reveal that learners usually are unable to pronounce some of the evolutionary terminology used during the lessons, and scientists also struggle to distinguish between these concepts for learners, even in a formal class. They often switch back and forth between everyday language and scientific terminology. In this regard, the availability of e-Books and videos could prove to be a useful resource for both the teachers and the learners. Research by Chimbi and Jita (2020) shows the influence of interpretation of the new curriculum policy and how understanding can influence the implementation of the new reforms. The findings in all

the cases show that understanding what teachers and learners intend to communicate to one another becomes a challenge. Reddy (2012); Sanders, 2010; and Tsui and Treagust (2007) indicate that terminologies in evolution content are abstract and difficult to understand. During the observation, the evolutionary concepts of 'adaptation' and 'competition' (**4.4.2.1.1 b & d**) were often confused with the everyday meaning of these terms, which contributes to common misconceptions such as the idea that the individual, not the population, adapts to the environment (Sanders, 2010). In different cases, teachers who were science specialists could not provide a simple way for learners to understand some of the scientific terms, i.e. *hypothesis, theory, law,* and *fact* (Sanders, 2010), and it was noted that textbooks on evolution frequently misrepresent evolutionary concepts, which contributes to some misunderstandings in the classroom.

e. Teachers' poor content knowledge

Case 2 indicated that lack of resources contributes to less effective teaching of evolution, and leads to teaching poor content knowledge, while Cases 1 and 3 did not see any influence. Poor content knowledge was also attributed to a shortage of sufficient textbooks. In all the cases, teachers read the available e-Books/textbooks on evolution to the learners or used videos to present the lesson and did not provide a sufficient explanation on the concepts of evolution. Tsui and Treagust (2007) claim that some teachers lack relevant knowledge, resulting in misconceptions and a misunderstanding of evolution.

Rutledge and Warden (2000), and Stears (2012) indicate that some teachers do not accept the theory because they do not have enough information about evolution (Sanders, 2010). The fact that the teacher in Case 3 was more tolerant of the topic seems to be in line with the preceding finding. Many factors contribute to poor conceptual understanding. It must be noted that even teachers who do admit that evolution is real may not recognise it. One of the factors indicated by Stears (2012) is that teachers may never have studied evolution, as is the case in South Africa (Stears, 2012). Another factor may be that teachers who studied it at university did not grasp the content of the evolution course and that contributes to poor concrete understanding.

f. Classroom environment

A unique challenge in Case 1 was overcrowding, which was noted during the classroom visit. Cases 2 and 3 had a reasonable number of learners in their classrooms. Overcrowding creates a situation where a teacher cannot give individual learners enough attention and promote discussions in the classroom. The classroom setup in Cases 1 and 3 provided for a learner-centred approach to learning, with the tables arranged in groups of eight, and all 48 learners were seated and able to face the interactive Smartboard where the teacher stood when presenting the lesson. According to Spillane *et al.* (2002), societal dialogue is a significant device, because it allows learners to come up with their ideas and understanding. In this case, learners were not allowed to share their ideas due to overcrowding, which may have influenced the way teachers negotiated teaching and learning of evolution in the classroom positively or negatively.

g. Historical accounts of science

A unique challenge in Case 1 was that the teaching and learning of evolution lacked practical knowledge about the natural world, even though it was produced by scientists who emphasised the observation, explanation, and prediction of real-world phenomena. Lack of practical knowledge disables learners to see the value of knowing about evolution, evidence of evolution, the history of evolution, natural selection, etc. According to Chinsamy and Plagányi (2007) and Naudé (2013), some students found evolution as real information which is easy to accept rather than more complex evolutionary ideas and theories because of their religious views that may be interfering with their capability to be objective (De Beer & Henning, 2010).

h. Availability of teaching materials and resources

Another unique challenge in Case 1 was the availability of teaching materials and resources. The case refers to the availability of information in line with the teaching and learning of evolution. However, there was not enough previous information, historical references, or practical evidence that the teacher may use to simplify the lesson for the learners. This was evident during the lesson because the teacher only used information

from e-Books or textbooks. Studies suggest that factors like teachers' knowledge, teaching resources, and capacity (Cohen, 1990; Spillane, *et al.,* 2002) have either a positive or a negative impact on curriculum success.

i. Teaching approaches

Another unique challenge in Cases 1, 2, and 3 was that the teachers claimed that they were not trained how to approach the teaching of evolution. However, the teacher in Case 3 studied evolution at university. Veal and Kubasko (2003) have examined how teachers combine their knowledge of teaching approaches and assessment for teaching evolution and discovered that different teachers implement different methods during the lesson. Van Dijk (2009) also discovered that teachers recognise precise approaches for teaching evolution, but their demonstrations are not related to learners' misinterpretations and misunderstandings. This suggests that an appropriate approach is important to teach evolution**.**

5.3.3.2 Opportunities for teaching about evolution

a. Learners engage in group discussions and debates

Scharmann (2018) indicates that learner and teacher engagement in discussions or debates about evolution will enable them to understand evolution much better and improve their knowledge. The data from Case 3 indicate that learners can gain from learning evolution by using the ability to engage in group discussions. About the skills development of the learners, Case 3 indicated that "learners are potential future academics"; therefore, evolution encourages them to argue effectively. Teacher 1 similarly agreed that knowledge of evolution will "equip learners with the necessary skills in their future careers". They were also of the view that there was not much benefit in studying the topic, as similar skills can be acquired in other subjects that are less

confusing. Case 2 did not value the learning of evolution to the same level as Cases 1 and 2.

b. Helps learners to understand scientific processes and explanations

Cases 2 and 3 indicate that evolution provides explanations to some of the things on earth that are unexplainable, some of the researchers who explain the importance of evolution include Rutledge and Warden (2000) and Rutledge and Mitchell (2002). They further indicate that evolution ties other science disciplines, providing knowledge in an attempt to answer complex questions about life (Rutledge & Warden, 2000), through scientific advances (National Academy of Sciences, 2008). Evolution is also seen as a science with unlimited hands-on and problem-solving significance to scientists (Scharmann, 2005). The findings from Case 2 and 3 further help learners to explain biodiversity. This was also found by the National Science Teachers Association (2013). A study conducted by Miller (2007) shows that one reason to study evolution is to have an improved scientific understanding of current genetics. Bilica (2012) further states that if learners are given the time to think effectively around new controversial topics, they will learn to situate their learning into the greater scientific context (Dempster & Hugo, 2006), and meaningful access to higher-order concepts.

c. Understanding of population change

A study by Cavanagh (2009) reveals that science allows people to understand the natural world, while religion should allow people to question why we are on earth. The findings from Cases 1 and 3 indicate that evolution helps learners to know about changes that occur in a population over some time. The respondents believed that teaching evolution also “helps one to explain biodiversity”. This was also found by the National Science Teachers Association (2013), even though the teacher does not see and believe its importance. During the interview, the respondent further expanded on the above theme, stating that as much as the topic of evolution is “all about science”.

d. Historical background about the origin

Cases 1 and 2 indicated the importance of learners to understand the historical background about the origin of humankind as it existed during a certain time and place. In analysing historical events, context can help us understand what motivates people to behave as they do. The source of Life Sciences knowledge is biology education. The origin of ideas about origins in evolution is important to teach and learn (Sanders, 2010; Tsui & Treagust, 2007). According to Sanders (2010), teaching and learning of evolution are important, because these provide a background to the past events which enable learners to have some ideas about life on Earth.

e. Encourage learners to construct their knowledge

A unique opportunity was noted from an interview in Case 1, namely that the teaching and learning of evolution encourage learners to construct their knowledge (**4.4.2.2.1.e**)**.** Dempster and Hugo (2006) indicate that there are abundant natural resources that would encourage learners to construct their knowledge. This suggests that schools should take learners to natural resource centres like biodiversity and environments centres, so that learners can learn about documented fossil and geological records. This is also seen as a possible mechanism for learners to do research to investigate relationships of evolution among species using museums and national parks (Dempster & Hugo, 2006).

f. Mutation in the organism

A unique opportunity was noted from Case 3, namely that the teaching and learning of evolution will enable learners to understand mutation (**4.6.2.3.2 b**) in organisms, one of the sections in the theory of evolution. This shows how learners were gaining an understanding of what and how mutation occurs in a living organism. This was not found as an opportunity in any of the literature studies analysed.

5.4. KEY FINDINGS AND THEIR IMPLICATIONS

5.4.1 Perspectives and beliefs on teaching and learning of evolution

5.4.1.1 Qualification, experience, and teacher development

As discussed in chapter 4 (table 4.2)**,** all the cases had a minimum training of a three-year Secondary Teachers Diploma (STD) and higher. During their formal teacher training, they all did Biology (currently Life Sciences) as one of their major subjects. Case 1 and 2 did not receive formal training on evolution as part of the teaching qualification program while Case 3 did evolution as part of the teaching course. In addition, all the cases received training organized by the Gauteng DoE, and training offered by universities in the Gauteng Province on behalf of the DoE. Case 1 and 2 still feltl that workshops and training offered did not empower them enough to can teach the evolution content, whereas Case 3 was confident when teaching the content. In terms of work experience, the teachers in all three cases had more than eight years of teaching experience, which could help when teaching and learning. However, data collected reveal that each case has its perspectives and beliefs about the teaching of evolution that impact the learning process (Sanders 2010; Neubrand & Harms, 2017; Sutherland & L'Abbe, 2019).

5.4.1.2 Teacher beliefs and perspectives about evolution

The teacher beliefs and perspectives about the teaching of evolution vary from one case to another, as shown in sections **5.3.1.1**, and **5.3.1.2**. Data from all the cases reveal that the religious position of a teacher has an impact on teaching and learning of evolution, and conflicts with their own personal and family beliefs; as such they find it difficult to teach and accept the theory of evolution. This finding was familiar to those of Bowman (2008); Reddy (2012), Baker, (2013), Yalvac (2011), and Mpeta (2014). Even though the teacher in Case 3 was a Christian, she studied evolution as part of his formal teaching qualification and was confident to teach evolution. This teacher did not let such beliefs stand in her way as a challenge when she taught evolution. During interviews, all the teachers confessed that teaching and learning of evolution conflict with teacher and learner beliefs. In Cases 1 and 2, it was also noted that teachers were not comfortable

with teaching evolution in their classrooms, because they felt that teaching of evolution conflicted with learners' beliefs in one way or the other, while the teacher in Case 3 was confident to teach despite her personal beliefs. These findings suggest that exposing teachers to the topic of evolution during initial teacher training may help to shape their perspectives of the topic and influence its teaching positively. As a result, teachers with less prior knowledge on the topic may be faced with a challenge as some learners have a different understanding of evolution (Baker, 2013; Mpeta, 2014; Neubrand & Harms, 2017).

As explained earlier in chapter 4 (table 4.2), teachers in all the cases were professionally qualified teachers, but not all teachers were trained to teach evolution. Cases 1 and 2 perceive a lack of formal teacher training on evolution during their teacher training an issue that leads to poor understanding of the content and as a result, influenced its teaching and learning. Studies by Sanders (2018), Abrie (2010), and Stears (2012), reveal that training and workshops offered by the Gauteng DoE and the DoE in South Africa did not help teachers much to deal with problems they face in the classroom, whereas Case 3 found the workshops helpful in improving understanding, because she already had a background of the topic of evolution. This finding seems to suggest that the prior knowledge developed during the initial teacher training enhanced the ability of the teacher to be receptive to the professional development activities. The other two teachers did not find the workshops helpful, because in the workshops they engaged with the topic for the first time. The teachers of Cases 1 and 2 perceived and believed that the training and development that the department offered did not focus on teachers' needs, and no programmes were designed to give teachers practical experience to teach evolution. The indication was that there has not been much development of the subject material on evolution that talks to new knowledge. Data revealed that the Case 1 and 2 Life Sciences teachers had not received university training on the teaching of evolution (Abrie, 2010), while the Case 3 teacher had studied evolution at university as part of her teaching qualification. The training on evolution is said to have been offered by the educational institutions early in 2008 (Sanders 2018; Abrie, 2010), when teachers were concerned about their insufficient knowledge on evolution. All the teachers suggested that continued

training should take place to develop teachers' knowledge of evolution (Stears, 2012) and to prepare teachers on the methods how to teach evolution as a science.

All the cases perceived terminology (language used) on evolution in the e-Books/textbooks difficult to understand and explain (section **5.3.1.2.b** and **5.3.1.2.c**), which was caused by the international Greek vocabulary used. In all three cases, the teachers indicated that it became difficult to explain some of the concepts to the learners. A study of a district committee by Hill (2001) shows how teachers can correctly use the language in ways that miss its intentions. In terms of time allocation, all the cases perceive evolution as the last part of the curriculum, which is covered either in a month or three weeks. Case 1 and 2 perceive the ATP (Annual Teachers Plan) as a limitation connected to evolution. What was highlighted the most was that, according to the ATP, the topic of evolution is allocated a short period just before the final exams (Hahn *et al.,* 2005).

The three cases, as indicated in section **5.3.1.2.c** stated that they taught in diverse classrooms with learners from different religious backgrounds and beliefs, which also influences the way they teach. The research report shows that the teachers' understanding was that stakeholders such as parents, community members, and school administrators may have different religious backgrounds (Robins *et al.*, 2003; Mpeta, 2014, Wilcox & Lawson, 2018) and beliefs, which may influence how evolution should be taught in the school. It was also reported by Case 1 that they experienced pressure from other stakeholders when teaching sections on the creation of science. In Case 1, the teacher expressed the frustration they received from learners and other teachers, indicating that evolution is not important, and this contributed to de-emphasizing evolution in the classrooms (Audi, 2009). It was further noted that teachers avoided teaching evolution, and taught creation science only as an alternative theory to evolution (Robins *et al*, 2003; Audi, 2009). Data collected from Case 3 show no sign of social views influencing the teaching and learning of evolution. The findings show that social views held by the different stakeholders may or may not contribute to the negotiation of evolution in the classroom.

In conclusion, this study makes a notable finding, namely that it is possible for teachers that receive formal teacher training on evolution to navigate the teaching of evolution as one of the controversial topics in Life Sciences better than the other teachers who rely on their religious beliefs only as they engaged with the topic. Therefore, the exposure of teachers to the topic of evolution during their teacher training seems to enhance individual and situated cognition, thereby generating a better response to the stimuli provided by the policy.

5.4.2 Life sciences teachers' approaches to teach evolution

As discussed in **5.3.2.1** to **5.3.2.6** the key findings under the theme on teachers' approaches are summarised as follows:

First, the three cases negotiated the teaching and learning of evolution differently using a teacher-centred and learner-centred approach using e-Books, textbooks, videos, question and answers methods, teacher-and-learner dialogue, internet searches for information, and group work.

Secondly, the teacher-learner interaction dominated the teaching process, where the teacher took the leading role of negotiating the learning practices. During the lessons, all the cases used this method, coordinating the learning process from the front. The teaching and learning materials used were e-Books, textbooks, videos, question-and-answer methods, and teacher-and-learner dialogue. These processes helped learners to learn by participating in the lessons. Cohen (1990) and Spillane *et al.* (2002) point out that collaborative learning enriches learners' understanding of new content (Okoth, 2016; Zhao *et al.,* 2019).

Thirdly, during the lessons, Case 1 and 2 used very little learner-learner interaction such as learner dialogue, an internet search of information, discussions, and groupwork, while the teacher in Case 3 used some of these learning styles on several accessions. According to Scott *et al.* (1994) and Piaget (1964; 2003), a teacher must use learners' previous and current philosophies when planning a lesson and select teaching activities that promote conceptual development.

On the fourth instance, all the teachers attempted to use students' previous knowledge when introducing their lessons, using closed questions, which look for precise responses of what learners have learned in the previous classes. According to Spillane *et al.* (2002), Coburn *et al.* (2016), and Dao (2018), closed-ended questions do not expose learners to theoretical understandings. Case 2 used learners' responses to recap the previous lesson, as compared to Cases 1 and 3.

Fifthly, according to CAPS, teachers were expected to use physical practices and tangible models during the lesson. This suggests that learners will develop an understanding when learning is accompanied by physical experiences and ideas (Vygotsky, 1978; Von Glaserfeld, 1989, Spillane *et al.,* 2002; Okoth, 2016; Govender, 2018). All the cases did not use any physical experiences during the lesson but used pictures from e-Books to streamline the information.

In conclusion, the study uncovered that both the teacher- and learner-centred styles of teaching were used to teach the topic; however, teacher-centred practices were dominant. This was influenced by the resources that the teacher used during lessons, such as pre-packed materials like PowerPoint presentations and videos because the teacher had to explain the content of the slides and the videos. During the instances that teachers were not well-grounded in the topics and terminologies to be taught, the teachers had to rely on textbooks and other materials. The learner-centred approaches, such as learner discussions and groupwork were applied minimally, mostly only in certain instances where the content had other religious issues linked to it. This was done to develop a common understanding by the teacher.

5.4.3 Challenges and opportunities for teaching evolution

5.4.3.1 Challenges for teaching evolution

Firstly, the data show that the religious affiliation of the participants was found to generally impact negatively on the teaching and learning of evolution. Some research studies report that evolution affects stakeholders' individual beliefs (Akyol *et al*., 2012, Sanders & Ngxola, 2009, Sanders, 2018; Neubrand & Harms, 2017; Sutherland & L'Abbe, 2019),

and as a result, they end up not accepting evolution (Baker, 2013). In studies conducted by Rutledge and Mitchell (2002) and Moore (2008), some teachers decided not to teach the section on evolution and only mentioned it briefly, if at all.

Secondly, during the observation, it was noted that all the teachers read the subject content from e-Books or textbooks, with very little explanation. This suggests that the teachers teach evolution rather superficially. A study by Moore (2008) discovered that some teacher does not explain the content on evolution, and teach it superficially, thus leaving learners without adequate knowledge (Sanders, 2010; Sutherland & L'Abbe, 2019).

Thirdly, data reveal that teachers need to be sensitive when teaching evolution. Teacher 3 wanted to teach and learn about evolution (a finding similar to that by Abrie, 2010) because that will improve his understanding of the past before he depends on his religious principles. Cases 1 and 2 both specified that they sensed that it was their duty to protect Christianity because they did not consider that they understood their worldviews. Even though the two cases have identified religious beliefs (Schulteis, 2010) and their concerns about teaching evolution, the current outcomes point out that societal concerns also impact teachers' preparedness (readiness) to study and teach evolution.

Fourthly, all the cases felt that the language used and the terminology on evolution was difficult and abstract for one to simplify and explain to the learners during the lesson. This was similar to the findings by Sanders (2010) and Tsui and Treagust (2007). A study by Reddy (2012) reveals that the multiple meanings of scientific terms are often implicit, subtle, and undefined, and the use of biologically mistaken language to describe evolution may create a challenge during learning. The abstractness is compounded by the fact that the teaching of evolution uses historical accounts and hypotheses that cannot be proven through classroom activities such as experiments.

In the fifth instance, a unique key finding in Case 1 shows that teaching in a diverse classroom with learners from different religious background and beliefs influence the way they teach. Moore and Kraemer (2005) indicate that some teachers experience some pressure from parents about teaching creation science. Poor support from stakeholders

make teachers not to expand the content on evolution, which leaves learners with insufficient knowledge (Rutledge & Mitchell, 2002; Okoth, 2016). Regardless of what concepts are taught, all the cases one was aware of are the controversy around evolution and the difficulty of learning as an abstract and complicated theory. Case 1 further indicated that they struggled to appease all the stakeholders who have an input in the professional performance and success. As teachers, they were prepared to face potential conflicts with parents or learners about evolution. These were driving factors in the three cases to want to understand evolution better.

A unique key finding in Case 2 is that inadequate resources had an adverse impact on the teaching of evolution, in addition to the teacher's poor content knowledge. Poor content knowledge was also attributed to a shortage of sufficient textbooks. In all the cases, teachers had access to available e-Books/textbooks on evolution for the learners or used videos to present the lesson, but they did not provide a sufficient explanation about the concepts of evolution. Tsui and Treagust (2007) claim that lack of resources leads to poor development of knowledge and understanding of the theory, which then leads to teachers' poor conceptual understanding of evolution.

Another unique challenge in Case 1 is overcrowding, as noted during classroom visits. Cases 2 and 3 had a reasonable number of learners in their classrooms. The overcrowding created a situation where the teacher could not give individual learners enough attention and promote discussions in the classroom. The classroom set-up was for a learner-centred approach to learning, with tables arranged in groups of eight, and all 48 learners were seated and able to face an interactive Smartboard where the teacher stood when presenting the lesson. According to Spillane *et al.* (2018), societal dialogue gives learners the chance to share their knowledge and ideas. In this case, learners were not allowed to share their ideas due to overcrowding.

In conclusion, it was noted that issues like religious affiliation of the participants, the sensitivity of evolution, the difficult language used, and terminology on evolution, the abstractness of concepts taught, diverse classroom with learners, lack of resources, and overcrowding were noted as challenges; however, it can be that teachers' poor planning

and preparation of the lessons contributed to the said challenges during teaching and learning in the classroom.

5.4.3.2 Opportunities for teaching about evolution

Firstly, the Case 2 and 3 teachers show that evolution is important because it provides an answer to questions about the origins of life on Earth. Many reports indicate that evolution is important (Rutledge & Warden, 2000; Rutledge & Mitchell, 2002) in developing learners' thinking, because it ties together with other science disciplines, and gives responses to intriguing questions on the origin of life on Earth (Rutledge & Warden, 2000; National Academy of Sciences, 2008). It was reported that evolution has real-world significance for scientists (Scharmann, 2018).

Secondly, the findings from Cases 2 and 3 further help students to understand processes in life and population changes. This was also found by the National Science Teachers Association (2013). In a study conducted by Miller (2007), it was reported that some countries do not reject evolution, because it gives them improved and precise knowledge of modern genetics.

Thirdly, a study by Cavanagh (2009) and Govender (2018) reveals that science allows people to understand the natural world, while religion should allow people to question why we are on earth. A unique opportunity identified from Cases 1 and 3 was that teaching of evolution “helps one to explain biodiversity”. This was also found by the National Science Teachers Association (2013), even though the teachers did not see and believe its importance. Dempster and Hugo (2006) claim that evolution provides learners with significant admission to advanced order perceptions. During the interview, the respondent further expanded on the above theme, stating that much as the topic of evolution is “all about science”.

Fourthly, Cases 1 and 2 indicated the importance for learners to understand the historical background about the origin, as existing in a certain time and place. In analysing historical events, context can help us to understand what motivates people to behave as they do.

The origin of ideas about origins in evolution is an important aspect to teach and learn (Okoth, 2016; Sanders, 2018; Tsui & Treagust, 2007),

Fifthly, a unique opportunity was noted by Case 1, namely that the teaching and learning of evolution encourage learners to construct their knowledge. Sanders (2018) suggests that schools should organize excursions to natural resources (biodiversity and environments centres) in South Africa that would encourage learners to construct their knowledge when teaching evolutionary theory. Sanders (2018) indicates that learners will have access to documented fossil records and geological records, which can stimulate learners' perspectives of evolution. She also indicates that during the excursions learners can be given research programmes to investigate evolutionary relationships in evolution and have relations with museums and national parks (Sanders, 2018; Govender, 2018).

In conclusion, the opportunity noted from the study was that learners will become critical thinkers, because evolution provides scientific explanations to questions about life, enabling learners to understand the historical background about origin life over time and, allowing learners to understand the natural world, while religion should allow people to question why we are on earth.

5.5 SUMMARY OF FINDINGS AND CONTRIBUTION OF THE STUDY

Five major findings emerged from the study. Firstly, from the biographical data it could be observed that two of the teachers did not study evolution during the time they trained to become teachers whilst the topic of evolution was part of the third teacher’s training programme. This finding seems to indicate that, unlike previous studies that indicated that in South Africa evolution was taught by teachers who never did evolution themselves (Abrie, 2010; Sanders, 2010), there seems to be instances where it is taught by teachers who had studied evolution. The finding is important, because it opens up opportunities to explore how the two groups of teachers approach the topic and the use of sense making in the teaching of evolution. It is anticipated that this research adds to the current body of academic literature and scholarship on the teaching of evolution. Considering that most studies on evolution were conducted internationally, this report endeavours to provide a

perspective of what is happening in South Africa, which may guide other researchers in terms of what has to be done to move forward with the teaching and learning of evolution.

The second finding speaks to the teachers' beliefs and perspectives on evolution. The beliefs were threefold, in the form of religious, social, and about teacher development. The participating teachers held several religious beliefs when teaching evolution because two teachers thought that religious beliefs supersede the role played by evolution to explain the earth's origins. The third teacher felt that her religious beliefs and the theory of evolution could co-exist. The teachers also believed that evolution should be taught, taking into consideration the societal setting and community in which the schools are located. Therefore, it emerged that the teachers may minimise the importance of evolution in the classrooms if they thought that other stakeholders such as parents do not support the teaching of evolution to learners, confirming that the topic can be controversial.

The third finding shows that teachers use both teacher-centred and learner-centred approaches when teaching evolution. However, the teachers relied more on teacher-centred instructional strategies that seemed to be motivated by contextual factors such as overcrowding, limited preparedness to teach evolution, and time constraints, among others. Furthermore, the teachers applied unique sense-making that resulted in the use of different teaching strategies, even though they used similar materials in the form of pre-prepared media, e-Books, Smartboards, and textbooks. This research report will further assist other FET Life Sciences teachers in different schools on how to negotiate different controversial topics in the classroom.

The fourth major finding indicates that the teachers experienced challenges that stood in the way of teaching the topic of evolution effectively. These challenges included the notion that evolution stands as a competing worldview to the learners' and teachers' beliefs on the origins of the earth and its people. The other challenges were time constraints, topic abstractness, the topic's reliance on historical accounts and hypotheses that cannot be proved practically in the classrooms, and lack of teachers' development in the field of evolutionary theory. However, Case 3 teacher seemed to experience fewer of these challenges and tensions, possibly due to her better training in the teaching of evolution.

The finding seems to suggest that training in the teaching of evolution improved the teacher's sense-making as they teach the teaching of the controversial topic. This research will possibly inform the DoE about the need for a curriculum implementation policy to guide teachers and help them to understand the origin of ideas on evolution specifically. It will also contribute by offering suggestions for policy and reform, which will enhance improved teaching and learning of evolution.

The fifth major finding shows the opportunities for the teaching and learning of evolution, and these were that learners could become critical thinkers, because evolution provides scientific explanations to answer questions about life, enabling learners to understand the historical background about the origin, allowing learners to understand the natural world, while religion also enabled people to question and ponder questions about why people exist on earth.

In conclusion, the teaching of controversial topics such as Evolution is influenced by several factors that include teachers' knowledge, perspectives, resources, language used, and teaching methods.

5.6 RECOMMENDATIONS

Based on the data and key findings, I would like to suggest the following recommendations in line with teaching and learning of evolution in public schools: practice recommendations, recommendations for further research, and policy recommendations.

5.6.1 Recommendations for practice

5.6.1.1 Teamwork

Teacher beliefs and perspectives about evolution were found to be a barrier in all the cases; teamwork allows teachers to share their challenges. The Life Sciences teachers and science education specialists could team up and engage in discussions with and about learners' concerns about learning and teaching of evolution. The Department and teacher colleges or universities should consider a supplementary science education course, which would allow novice teachers to develop their role identity as future science

teachers. These approaches, and increased systematic education, along with opportunities for consideration of personal, professional, and social views and experiences are likely to assist to increase the understanding of evolution.

5.6.1.2 Training programme

The formal training that Case 3 received helped her to navigate the teaching of the controversial evolution better. The DoE should come up with a developmental program that enables teachers to gain new knowledge following the CAPS. Teachers should access improved programs at universities and educational colleges for them to improve on their current teaching standards. The universities or colleges should be allowed to follow up the application process and mentorship programs should give practical experience of teaching evolution. In addition to the above, curriculum designers should give more space to different major religions' beliefs on evolution and also realize that evolution is viewed as conflicting with religious beliefs. Although the study was on teaching of evolution, the findings have an implication on other controversial topics in other subjects such as Geography, History etc. This suggests that the findings of the study can help teachers teaching other subjects to cope with the controversial topics in their classroom and be able to simplify the subject content for learners to understand.

5.6.1.3 Proper planning

The study also noted that teachers' backgrounds, qualifications, experience, and teacher development play a role in teaching of evolution in the classroom. The developmental plans should cover all teachers from different backgrounds, and tools and resources should always be used in a lesson. The teachers should design instruction, such as capturing and sustaining attention, enhancing reception, introducing diversity, and organizing information.

The teachers should encourage active and vigorous learning that will involve the learners in the learning process so that they can participate, and further translate information into practice. Learners can learn to narrate what they learn to their own experience and use it rationally and productively. This can be done using small-group work and project work.

The teachers should practice effective and efficient questioning skills that can provoke thought, encourage discussion and deliberation, and also provide learners with opportunities to ask questions to clarify their understanding.

5.6.1.4 Sufficient and effective resources

Overcrowding was noted amongst the sampled schools, which limits teachers from using various teaching strategies, i.e. group- or teamwork, discussions, etc., which help to let learners understand evolution better. The Department should build extra classes to supplement what all public schools have and provide personnel to counter overcrowding in classrooms. Enough resources will give teachers opportunities to use various teaching strategies, and possibly to apply all principles as recommended by CAPS.

5.6.1.5 Excursions and school trips

The study noted that teaching and learning of evolution are based on abstract information that lacks concrete and physical models. Since South Africa is considered the "cradle of humankind", the school could organize a school trip to visit the best evolutionary sites or museums like Maropeng and the Sterkfontein Caves to show learners real-life scientific evidence of the evolution of humankind. If the school does not have adequate financial resources to take a class to these sites, they can request a professional archaeologist to bring props and talk to learners so that they can improve their understanding and make the lesson in class more interesting for them.

5.6.2 Recommendations for further research

This study focused on how three Life Sciences teachers at secondary schools negotiate controversial topics like evolution in the school science curriculum during the lesson in the classroom. Only the practices of three teachers from three regions were sought. A more comprehensive study of teachers from different schools (urban and rural) and/or provinces can show a good picture, now that this study has given some insight into teachers' teaching at secondary schools.

I recommend a study that touches on the language and understanding of the NOS, the understanding of significant concepts of biology (Life Sciences), and other science-related topics whereby evolution is the main point of the study.

I would also like to suggest quantitative study research that will determine more broadly what teachers think, opinions, and beliefs about a classroom method of teaching as well as the importance of certain curriculum requirements, for example, in evolution.

A further closer qualitative study may be conducted on the extent to which religion specifically impacts the teaching of evolution since this is seen to be a major factor towards the effective teaching of evolution. The study will further assess the degree to which the participants that take part in church services, Sunday school, and other church-related traditions influence the teaching and learning of evolution positively or negatively.

I recommend a study that explores how controversy affects the teaching of evolution in the learning environment because it is clear that avoiding controversy may have a negative impact on the lesson and can make the teacher-student interaction passive, to the extent that it renders the lesson less effective. This might put certain pressure on the part of the students who are willing to accommodate prior knowledge learned at home and the information they receive in the classroom.

5.6.3 Recommendations for policy

Considering the outcomes of the report, the following inferences and endorsements are submitted to decision-makers, policymakers, and educational authorities responsible for the education system in Gauteng and other similar school contexts:

Since the study has revealed school-to-school variations in the way teachers teach evolution, there may be a lack of clarity on the expectation of how evolution curriculum should be implemented in all schools. Therefore, the study recommends that the DoE provide clear policy and practice guidelines on the teaching of evolution as a controversial topic in the curriculum.

More relevant continuous professional development training programs should be organized at various educational levels to equip teachers with pedagogical skills that can be used during the lessons on evolution. The policy designers need to ensure that the evolution is part of formal teaching programs at universities so that teaching and learning can be improved.

The findings of this study suggest that curriculum policy designers may not have allocated enough time to enable teachers to negotiate teaching and learning of evolution in schools. This is confirmed by the fact that the sample teachers experienced difficulty because of the time of the year when the section on evolution is taught, i.e. during the third term, when schools are preparing for examinations. This created a gap in the way teachers and learners could negotiate evolution into the curriculum as per policy effectively. A re-arrangement of the timeframes and sequencing of the curriculum topics is recommended.

5.7 REFLECTIONS ON THE RESEARCH PROCESS

In this study, data were collected mainly through lesson observation, document analysis and interviews with teachers. I also took field notes on teacher-related issues that I felt were vital in providing a clear picture of my sample and the environment in which they worked. I observed lessons to get first-hand information on the teaching strategies that three cases (Life Sciences educators) implement during teaching and learning of evolution in the classroom. I was aware that teachers may change their classroom practices while being observed; hence, decided to observe six lessons, hoping that with more visits, the teachers would behave normally. There were challenges during that data collection at one of the schools, i.e. after observing one lesson, the teacher was expected to attend a curriculum meeting at another school, so I had to arrange the interview for another day. This made me wonder if what I observed was a reflection of day-to-day classroom practices. After one month, the situation settled, and the management allowed me to continue with the research. I then interviewed the teacher. The interview mainly followed the semi-structured interview that was prepared, not following up on the practice in the classroom.

I thought that I would be able to record lessons to assist me with analysing the data. All teachers did not permit me to record videos while the lessons proceed. The interviews I had with teachers were meant to follow up on issues that I had observed and recorded in lessons, in addition to seeking the teachers' understanding of the teaching strategies that Life Science teachers used. I further wanted to elicit what the three teachers viewed as hindrances to teaching evolution during the lessons.

There is a huge gap between the theory and what I observed during lessons. Teachers did not have a clue about my focus, but they caught up as the interviews proceeded. In writing this report, I struggled to present a balanced view of my observations in terms of positives and negatives as a Deputy Chief Education Specialist for all Gauteng schools. During class visits, good practices were acknowledged, but more time was spent on engaging with teachers to improve on the shortfalls. This study has indeed been a learning curve for me, on how to balance my role as an interested observer and a distant researcher given my job as Deputy Chief Education Specialist within the education department. It is a delicate balance that could only be managed through deliberate reflexivity.

5.8 CONCLUSION

Understanding teacher beliefs, perspectives, and practices on their understanding, knowledge, and level of teaching evolution in schools might help to improve the situation where the teaching of evolution is a challenge. Following key findings of this study, the status and context surrounding the level of negotiating evolution in the schools sampled from three teachers were established. The thesis showed that teachers' beliefs and perspectives influenced their practices, which in turn influenced their use and integration of teaching approaches and strategies into the school curriculum. Teachers, therefore, play a pivotal role in setting the stage for successful pedagogical practices in schools. Teachers are thus expected to respect and use learner beliefs, prior knowledge, and perspectives to negotiate teaching of evolution in the classroom successfully.

The study concluded that teachers used different strategies to negotiate controversial topics in the school science curriculum, i.e. evolution. Reports by Spillane *et al.* (2018) and Coburn *et al*. (2016) show that teachers should be confident to teach competently. However, the judgments of this report cannot be comprehensive over the Life Sciences teachers in South Africa, but it provided in-depth and detailed insights that are still useful. The study has shown that beliefs, perception, and understanding of evolution, should be linked when teachers practice a successful approach. Hence it calls into question the current methods that are used to inform Life Sciences teachers on how to negotiate controversial topics in the school science curriculum.

The study findings enlightened me on the need for continuous teacher development training programmes for acquisition skills, knowledge, and understanding of teaching evolution. It was noted that it is possible for teachers that received formal teaching training on evolution to navigate the teaching of evolution as a controversial topic in Life Sciences better than teachers who rely on their religious beliefs only when they engaged with the topic.

The study findings further indicate that both teacher-centred and learner-centred approaches were used to teach the topic; however, teacher-centred practices were dominant over learner-centred practices. It was noted that the practices were influenced by the resources that were available in schools for the teacher to use during lessons. i.e. pre-packed materials such as e-Books, PowerPoint presentations, and videos. During the instances that teachers were not well-grounded in the topics and terminologies to be taught, the teachers had to rely on textbooks and other materials.

The study noted that religious affiliation of the participants, the sensitivity of evolution, the difficult language used, and terminology on evolution, diverse classroom with learners, lack of resources, and overcrowding were noted as challenges; however, it can be said that teacher poor planning and preparation of the lessons contributed towards the said challenges.

Finally, the study helped me to recognized how teacher philosophies, knowledge, and understanding of evolution influence teachers' practices greatly in the classroom, and this

study, influenced how teachers negotiate teaching and learning of evolution in the classroom. This study has shown that the prescribed curriculum is not a given, but something to be negotiated constantly by teachers and learners in different contexts. Policymakers, curriculum and material developers, parents, learners, and generally all stakeholders need to do their part to help teachers negotiate curriculum topics successfully, especially when new and/or controversial topics are introduced.

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APPENDICES

APPENDIX A: GRADE 12 PRESCRIBED WORK ON EVOLUTION FROM THE CAPS (DBE, 2008)

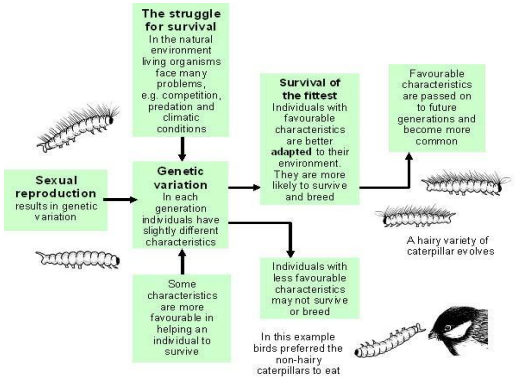
TOPIC	SUB-TOPICS
Evolution	**Introduction** ❑ Definition of biological evolution ❑ Difference between a hypothesis and a theory **Evidence for Evolution** ❑ Role of the following as evidence for evolution: **Variation** ❑ Definition of a biological species and a population ❑ A review of the contribution of each of the following to variations that exist amongst individuals of the same species: ❑ Continuous and discontinuous variation **Origin of an idea about origins (A historical development)** ❑ Ideas on evolution in the order of their origin are as follows:
Lamarckism Darwinism Punctuated Equilibrium	**Lamarckism (Jean Baptiste de Lamarck – 1744–1829)** ❑ Lamarck used two 'laws' to explain evolution ❑ Reasons for Lamarck's theory being rejected **Darwinism (Charles Darwin – 1809–1882)** ❑ Darwin's theory of evolution by natural selection: **Punctuated Equilibrium (Eldredge and Gould – 1972)** ❑ Punctuated Equilibrium explains the speed at which evolution takes place:
Artificial selection Formation of new species Mechanisms of reproductive isolation Evolution in present times	**Artificial selection** ❑ Artificial selection involving: **Formation of new species** ❑ Biological species concept: Similar organisms that are capable of interbreeding to produce fertile offspring. ❑ Speciation and extinction and the effect of each on biodiversity **Mechanisms of reproductive isolation** ❑ A brief outline of reproductive isolation mechanisms that help to keep species separate: **Evolution in present times** ❑ Natural selection and evolution in present times:
Evidence of common ancestors for living hominids including humans Out-of-Africa hypothesis	❑ Interpretation of a phylogenetic tree to show the place of the family *Hominidae* in the animal kingdom ❑ Characteristics that humans share with the African apes ❑ Anatomical differences between the African apes and humans, with the aid of diagrams, as it applies to the following characteristics: ❑ Lines of evidence that support the idea of common ancestors for living hominids including humans: ❑ Evidence for the Out-of-Africa hypothesis: ❑ Timeline for the existence of different species of the genus *Homo* and the significant features of each type of fossil to illustrate the differences amongst them ❑ Interpretation of phylogenetic trees proposed by different scientists showing possible evolutionary relationships as it applies to hominid evolution

APPENDIX B: EXAMPLES OF SOME OF LESSONS OBSERVED ON EVOLUTION

a. Lesson on Darwin theory of evolution by Natural Selection

GRADE	**12**	**SUBJECT**	**LIFE SCIENCE**	**WEEK**	**26-EVOLUTION BY NATURAL SELECTION**	**TOPIC**	**DARWINS THEORY OF EVOLUTION BY NATURAL SELECTION ARTIFICIAL SELECTION Time: 40 min**	**Lesson**	**2**

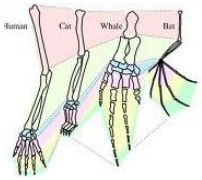
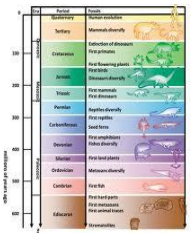
LESSON SUMMARY FOR: DATE STARTED:		**DATE COMPLETED:**	
LESSON OBJECTIVES	**The learners must be able to:** • Explain the Darwin's theory of natural selection • Use an example to apply theory of natural selection • explain artificial selection		

TEACHER ACTIVITIES	LEARNER ACTIVITIES	TIMING	RESOURCES NEEDED
Introduction: Briefly **revise** : The theories of Lamarck and why his theory was rejected. Darwin's historical background **Main Body / Presentation:** **Educator must use w/ sheets/ transparencies/ activities from various resources listed as well as other relevant resources , to explain the observations that Darwin has made, which led to his theory of natural selection :** **Teacher must ask the question:** What do you understand by the term natural selection ? Educator uses the diagram alongside to explain natural selection/survival of the fittest with the advantageous gene. **Answer**: **Natural selection** is a phenomenon whereby individuals with the most suitable characteristics based on the genotype will be able to survive / cope with challenges or adapt best to environment. • Plants and animals produce a **large number of offspring** with **variation** eg. Beetles produce many offspring with colour variation as this is a source of foods for birds. Those beetles whose colour allows them to camouflage against predatory birds will **survive**. • Individuals that had suitable or favourable genes/ genotype led to advantageous phenotypic characteristics	Learners do correction on activities based on previous lesson. Learners take down the following flow diagram to illustrate natural selection after explanation by educator  	10 min 20 min	Powerpoint presentations CAPS Solutions for All – Life Science Gr 12 by McMillan SIIP Booklets for 2014 compiled Question papers and answer booklets Worksheets Focus on Life science CAPS Gr 12 by Maskew Miller

b. Lesson on Origin of ideas about origin of Species

GRADE	12	SUBJECT	LIFE SCIENCE	WEEK	25- ORIGIN OF IDEAS ABOUT ORIGIN OF SPECIES	TOPIC	EVOLUTION BY NATURAL SELECTION TIME :40 MIN	Lesson	4

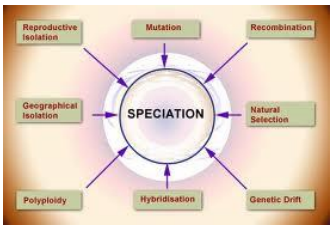
LESSON SUMMARY FOR: DATE STARTED:		DATE COMPLETED:	
LESSON OBJECTIVES	**The learners must be able to:** • Analyse a fossil record • Explain the various evidence of evolution and its link to common ancestry • Briefly explain the difference between a theory and a hypothesis		

TEACHER ACTIVITIES	LEARNER ACTIVITIES	TIMING	RESOURCES NEEDED
Introduction: Explain to learners what : • A palaeontologist does. • A fossil is. Also briefly indicate the conditions for fossilisation. **Main Body / Presentation:** Provide learners with a copy of a fossil record of living organisms, the era and time period of existence in millions of years. Briefly explain how comparative homology, biogeography, genetics and embryology indicate that all species may differ but specific features indicate that they have a common ancestor.   Educator must **explain** to learners using transparency/ chalkboard that :	Learners observe examples of fossils from pictures in their textbooks. Learners must be able to analyse eras and the types of organisms that existed in each era as well as how many millions ago each species existed. They must also be able to indicate from the fossil record which species have become extinct and which are the organisms that exists in today's era. Leaners must write down brief notes on comparative homology , biogeography ,genetics and embryology and relate to common ancestor	10 min 10 min	Pg 265 of Life science Solutions for All- McMillan(CAPS) Pg 192- 195 Understanding Life Science- Gr 12 3rd Edition (CAPS) Pg 295- Via Afrika Life Science Gr 12 (CAPS) Pg 271 of Life science Solutions for All- McMillan(CAPS) Pg 298 -Via Afrika Life Science Gr 12 (CAPS) P188 -Understanding Life Science- Gr 12 3rd Edition (CAPS)

c. Evolution by Natural Selection: Speciation

GRADE	**12**	**SUBJECT**	**LIFE SCIENCE**	**WEEK**	**26-EVOLUTION BY NATURAL SELECTION**	**TOPIC**	**SPECIATION TIME : 40 min**	**Lesson**	**5**

LESSON SUMMARY FOR: DATE STARTED:		**DATE COMPLETED:**	
LESSON OBJECTIVES	**The learners must be able to:** • Define speciation • Explain the process of how speciation occurs • Briefly describe how allopatric speciation occurs using an example		

TEACHER ACTIVITIES	LEARNER ACTIVITIES	TIMING	RESOURCES NEEDED
Introduction: **Educator must briefly revise the:** The differences between natural selection and artificial selection. Teacher must explain the differences between inbreeding and outbreeding and interbreeding. **Main Body / Presentation** Educator must explain the difference between **population** and **species** using textbooks and other resource material. **Emphasise: Population**: interbreed, live in same area and belong to same species **e**.g. bee population. **Species**: Organisms that are morphologically similar and have similar behaviour but do not necessarily need to live in the same area. They are capable of interbreeding to produce fertile young.eg. *Paramecium caudatum* and *Paramecium Aurelia* . Illustrate the following flow diagram to illustrate the concept of speciation : **population → mutations → no possibility of breeding with old species → new species formed**	Learners may ask question on natural selection and selective breeding or any other question on evolution that they may need to be revised. Learners must respond to questions asked by educator. Learners take down flow diagram in their workbook. Learners can draw this diagram in workbook to summarise speciation. 	10 min 15 min	Macmillan: Life Science for All by R Freedman; I. McKay; R Pillay etc 2007} Gr. 12 Life Science Exam Fever Study Guide Life science 12 Textbook & Workbook by J. Grogan & R Suther; April 2010 Understanding Life science G12 by T Isaac etc; February 2010 Gr. 12 Past Exam Papers

APPENDIX C: PRE-INSTRUCTIONAL PRACTICE (PRE-LESSON DISCUSSION)

Greetings

1. May you kindly explain briefly about the lesson?

2. How did you plan to achieve the objectives of the lesson?

3. Do you anticipate any challenges during the lesson? If so, is there any plan to prevent challenges that may arise during the lesson?

4. Any additional material or plans that you feel will support the attainment of the objectives of the lesson?

5. Anything you would like me to know before we visit your class for the lesson?

APPENDIX D: OBSERVATION SCHEDULE AND ITS JUSTIFICATION

Teacher: _____Class:_____

Learning area: _____date:_____

Categories	Justifications
1.1. Using learners' prior knowledge	Teacher considers learners' prior and existing knowledge to enable them to construct their understanding (Scott *et al.,* 1994; Hewson *et al.,* 1998)
1.2 Asking thoughtful, open ended questions	Teacher asks learners questions that give them the opportunity to think (Brooks and Brooks, 1993)
1.3 Allowing learners' responses to drive lessons	Learners' knowledge, experience and interest help them to understand the content (Brooks and Brooks, 1993).
1.4 Encouraging learners to engage in dialogue, both with the teacher and with one another	Gives learners the opportunity to present their own ideas (Brooks and Brooks, 1993)
1.5 Teacher uses physical experiences and concrete models to simplify the content:	To create classroom environment that provides opportunities for learners to explore their own ideas (Vygotsky, 1978; Von Glaserfeld, 1989)
1.6. Learner arrangement and other contextual factors	Reasonable number of Learners arranged in groups

Topic:

Introduction:

Body:

Conclusion

APPENDIX E: POST-INSTRUCTIONAL PRACTICE (POST-LESSON DISCUSSION)

Greetings

1. How do you feel about the lesson you have presented in the class?
2. Did you manage to achieve the objectives of the planned lesson?
3. Where there any challenges that you encountered during the lesson
4. Did you manage to prevent the challenges you anticipated?
4. To what extent do you think the additional materials supported your lesson?
5. Anything you would like to say about the lesson you have presented?

APPENDIX F (A): INTERVIEW SCHEDULE

a. Do you consider TEACHING Origin of idea(s) about origin (in EVOLUTION) a difficult topic to teach?

If yes,

Explain why you find it a difficult topic to teach.

Despite the difficulty of the topic, how do you assist your learners to understanding the concepts of evolution? Explain the different techniques/ ways/ strategies that you use

Why do you specifically use the techniques just mentioned?

Did you use some of these techniques in the lessons observed?

If yes, explain which ones and why did you use them?

If no,

Explain why you find teaching of Origin of idea(s) about origin (in EVOLUTION) easy to teach.

What techniques do you use to help your learners understand the concepts when teaching evolution?

Why do you specifically use these particular techniques? Explain

Did you use some of these techniques in the lessons observed?

If yes, explain which ones and why you used them

APPENDIX F (B): INTERVIEW SCHEDULE

Theme	Sub -Theme	Questions
Teachers' perspectives and beliefs about evolution	Teacher beliefs	What are your normal school assembly and classroom practices before the lessons?
		Do you sometimes pray at assembly when is your turn at assembly?
		Have you ever been taught about evolution? (At high school or tertiary level?)
		What was your take when you first heard about evolution?
		Does teaching evolution contradict your beliefs and religion?
		How do you separate your belief from teaching evolution?
		Do you think your belief influences your teaching? Elaborate how?
		How does the society and other staff members influence your teaching of evolution?
		What do you think are the obstacles to accepting and understanding evolution?
		How did you get to know about evolution?
		What are your feelings on teaching evolution?
		Did you learn more about evolution in tertiary or secondary level?

	Teacher perspectives	Are there sufficient resources for everyone? And to teach evolution?
		Is the language or terms used in the books difficult or understandable by learners? What can you say?
		Does the environment around you hinder teaching and learning in the classroom?
		Is there over-population in the classroom that affects teaching and learning? What then do you do with that?
Teachers' approach to teaching of evolution	Learner-centred teaching and learning	Which teaching methods do you prefer when teaching evolution
		How do you teach evolution in a classroom?
		Which method of teaching works for you and why?
		Do think learners understand your method of teaching?
		What do you think learners implement what they have learn about evolution post-Grade 12?
		What do you think is the learners' level of understanding of evolution?
	Teacher-centred teaching and learning	How do you go about helping learners who do not understand your method of teaching?
		How do you make evolution interesting for learners?
		How do you deal with learners that have their own beliefs and disagree with evolution?
	Challenges for teaching evolution	What challenges do you come across when teaching evolution?

The challenges and opportunities for teaching evolution		How do you deal with challenges before, during and after lessons?
		What are your feelings on teaching evolution?
		Are there enough resource for constructive learning? What are the resources available?
	Opportunities for teaching evolution	How will learners use what they learn about evolution in their everyday life?

APPENDIX G: UFS ETHICAL CLEARANCE

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS·UV
EDUCATION
OPVOEDKUNDE

Faculty of Education

05-Dec-2016

Dear **Mr Gumani Mukatuni**

Ethics Clearance: **Controversial topics in the school science curriculum: a case study on the teaching of evolution in South Africa**

Principal Investigator: **Mr Gumani Mukatuni**

Department: **School of Education Studies (Bloemfontein Campus)**

APPLICATION APPROVED

With reference to you application for ethical clearance with the Faculty of Education, I am pleased to inform you on behalf of the Ethics Board of the faculty that you have been granted ethical clearance for your research.

Your ethical clearance number, to be used in all correspondence is: **UFS-HSD2016/1212**

This ethical clearance number is valid for research conducted for one year from issuance. Should you require more time to complete this research, please apply for an extension.

We request that any changes that may take place during the course of your research project be submitted to the ethics office to ensure we are kept up to date with your progress and any ethical implications that may arise.

Thank you for submitting this proposal for ethical clearance and we wish you every success with your research.

Yours faithfully

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UNIVERSITY OF THE FREE STATE
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YUNIVESITHI YA FREISTATA
UFS·UV
EDUCATION
OPVOEDKUNDE

Faculty of Education

21-Nov-2018

Dear **Mr Mukatuni**

Ethics Clearance: **Controversial topics in the school science curriculum: a case study on the teaching of evolution in South Africa**

Principal Investigator: **Mr Gumani Mukatuni**

Department: **School of Education Studies Department (Bloemfontein Campus)**

APPLICATION FOR EXTENSION APPROVED

With reference to your application for extension for ethical clearance with the Faculty of Education, I am pleased to inform you on behalf of the Research Ethics Committee of the faculty that you have been granted extension from to with the assumption that there are no major changes with regards to the study.

Your ethical clearance number, to be used in all correspondence is: **UFS-HSD2016/1212**

Should you require more time to complete this research, please apply for an extension again.

We request that any changes that may take place during the course of your research project be submitted to the ethics office to ensure we are kept up to date with your progress and any ethical implications that may arise.

Thank you for submitting the application for extension. We wish you every success with your research.

Yours faithfully

Prof. MM Mokhele Makgalwa
Chairperson: Ethics Committee

Education Ethics Committee
Office of the Dean: Education
T: +27 (0)51 401 3777| F: +27 (0)86 546 1113 | E: MokheleML@ufs.ac.za
Winkie Direko Building | P.O. Box/Posbus 339 | Bloemfontein 9300 | South Africa
www.ufs.ac.za

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APPENDIX H: GDE ETHICAL CLEARANCE

For administrative use:
Reference no. D2017 / 316 A
Enquiries: Diane Buntting 011 843 6503

GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GDE AMENDED RESEARCH APPROVAL LETTER

Date:	**03 October 2016**
Validity of Research Approval:	**6 February 2017 to 30 September 2017**
Previous GDE Research Approval letter reference number	**D2017 / 242 dated 16 August 2016**
Name of Researcher:	**Mukatuni G.E.**
Address of Researcher:	**347 Donne Crescent; Lombardy East; 2090**
Telephone / Fax Number/s:	**011 355 0775; 082 515 5412**
Email address:	**gumani@webmail.co.za**
Research Topic:	**Controversial topics in the school Science curriculum: A case study on the teaching of evolution in South Africa**
Number and type of schools:	**FIVE Secondary Schools**
District/s/HO	**Johannesburg Central; Johannesburg East and Johannesburg North**

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved. A separate copy of this letter must be presented to the Principal, SGB and the relevant District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted. However participation is VOLUNTARY.

The following conditions apply to GDE research. The researcher has agreed to and may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

CONDITIONS FOR CONDUCTING RESEARCH IN GDE

1. *The District/Head Office Senior Manager/s concerned, the Principal/s and the chairperson/s of the School Governing Body (SGB.) must be presented with a copy of this letter.*

2016/10/03

2. *The Researcher will make every effort to obtain the goodwill and co-operation of the GDE District officials, principals, SGBs, teachers, parents and learners involved. Participation is voluntary and additional remuneration will not be paid;*
3. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal and/or Director must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
4. *Research may only commence from the second week of February and must be concluded by the end of the THIRD quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.*
5. *Items 3 and 4 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
6. *It is the researcher's responsibility to obtain written consent from the SGB/s; principal/s, educator/s, parents and learners, as applicable, before commencing with research.*
7. *The researcher is responsible for supplying and utilizing his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institution/s, staff and/or the office/s visited for supplying such resources.*
8. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research title, report or summary.*
9. *On completion of the study the researcher must supply the Director: Education Research and Knowledge Management, with electronic copies of the Research Report, Thesis, Dissertation as well as a Research Summary (on the GDE Summary template). Failure to submit your Research Report, Thesis, Dissertation and Research Summary on completion of your studies / project – a month after graduation or project completion - may result in permission being withheld from you and your Supervisor in future.*
10. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned;*
11. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director/s and school/s concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

.....

Dr David Makhado

Director: Education Research and Knowledge Management

DATE: 2016/10/03

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE AMENDED RESEARCH APPROVAL LETTER

Date:	**22 November 2018**
Validity of Research Approval:	**04 February 2019 – 30 September 2019** **D2017/242A**
Name of Researcher:	**Mukatuni G.E.**
Address of Researcher:	**347 Donne Crescent**
	Lombardy East
	2090
Telephone Number:	**011 355 0775 082 515 5412**
Email address:	**gumani@webmail.co.za**
Research Topic:	**Controversial topics in the School Science Curriculum: A case study on the teaching of evolution in South Africa**
Type of qualification	**PhD**
Number and type of schools:	**Five Secondary Schools**
District/s/HO	**Johannesburg Central, Johannesburg East, Johannesburg North.**

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

23/11/2018

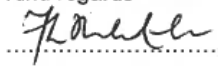
The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted: 1

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

1. *The District/Head Office Senior Manager/s concerned must be presented with a copy of this letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*
4. *A letter / document that outline the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
5. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
6. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
7. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.*
8. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
9. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
10. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
11. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
12. *On completion of the study the researcher/s must supply the Director: Knowledge Management & Research with one Hard Cover bound and an electronic copy of the research.*
13. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
14. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards



Mrs Faith Tshabalala
Acting Director: Education Research and Knowledge Management

DATE: 23/11/2018

Making education a societal priority

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

APPENDIX I: SCHOOL PRINCIPAL CONSENT LETTERS

School of Education, University of Free State

Mr Mukatuni Gumani Enos

347 Donne Crescent

Lombardy East

2090

School principal

Xx Secondary School

Alexandra/ Tembisa/Soweto

2090

INFORMATION SHEET FOR THE SCHOOL PRINCIPAL

Research study on 'Controversial topics in the school science curriculum: a case study on teachers teaching of evolution'.

I (Mukatuni Gumani Enos) am conducting research for my PHD degree at the University of the Free State. I am carrying out a study that investigates how a Life Science teacher teaches controversial topics in the school science curriculum.

I would therefore like to observe five lessons of each teacher paying attention to the how teachers negotiating the controversial topics in the school curriculum teaching and learning. I would also like to interview these teachers on their understanding of the evolution. I would like to tape-record the proceedings of the interviews in order to save time if they allow me to do so.

My research will benefit your school in that the responses from the three life science teachers will contribute to an understanding of how to negotiate the controversial topics in the school curriculum during teaching and learning of evolution. This will hopefully also assist the department, teachers, school principals and subject facilitators to address the issues or difficulties associated with the teaching of evolution as part of the current CAPS.

If you allow your school to take part in my study, I would like to make it clear that your participation is entirely voluntary, no negative consequences will result from your participation, and all

information will be treated with confidentiality. If you do accept to participate, please remember that the t life science teachers may decline to answer any questions, and you may withdraw from the study at any time. In order to protect confidentiality, all names I use in my research report and in any other publication arising from this research will be fictitious.

I will provide you with a summary of my research results on completion if you would like me to. Do not hesitate to contact me or my supervisor Professor Loyiso C. Jita for any correspondence arising from this letter at Jitalc@ufs.ac.za or +27514017522

Yours sincerely

Mukatuni G.E.

Signature: _____

Cell: 082 515 5412 or 011 355 0775

Gumani.Mukatuni@gauteng.gov.za or gumani@webmail.co.za

School of Education, University of Free State

Mr Mukatuni Gumani Enos

347 Donne Crescent

Lombardy East

2090

School principal

Xx Secondary School

Alexandra/ Tembisa/Soweto

2090

INFORMED CONSENT FORM FOR SCHOOL PRINCIPAL

Research study on 'Controversial topics in the school science curriculum: a case study on teachers teaching of evolution'.

I, _____ consent to participate in this study conducted by Mr. Mukatuni Gumani Enos on how life science teachers 'negotiate the controversial topics in the school science curriculum. I realize that no negative consequences will arise as a result of my school's participation in this study, and that the study is being conducted for purposes of improving the teaching of life sciences in South African schools. I give permission for the material to be used for research or teaching only. My school participates voluntarily and I understand that my school may withdraw from the study at any time.

Interviews:

I further consent to my three life science teachers being interviewed and tape recorded as part of the study. I also understand that the teacher has the right to review the notes made of the interview before these are used for analysis if s/he so choose. The teacher can delete or amend any material or retract or revise any of their remarks. Everything the teacher says will be kept confidential by the interviewer. S/he will only be identified by a pseudonym in the research report. In addition, any persons they refer to in the interview and the name of the school will be kept confidential.

Observations:

I consent to notes being made of classroom observations of the Grade 10–12 Life Science lessons, and the use of these notes for research purposes only. All references to the teacher will be anonymous. The teacher will be identified by a pseudonym if specific reference is made to his/her views. The school will also be identified by a pseudonym if specific reference is made to it. The data collected will be destroyed after three years.

Name: _____

Signature: _____

Date: _____

APPENDIX J: SCHOOL TEACHER CONSENT LETTERS

School of Education, University of Free State

Mr Mukatuni Gumani. Enos

347 Donne Crescent

Lombardy East

2090

Life science teacher

Xx Secondary School

Alexandra/ Tembisa/Soweto

2090

INFORMATION SHEET FOR LIFE SCIENCE TEACHER

Research study on 'Controversial topics in the school science curriculum: a case study on teachers teaching of evolution'.

I (Mukatuni Gumani Enos) am conducting research for my PHD degree at the University of the Free State. I am carrying out a study that investigates how a life science teacher teaches controversial topics in the school science curriculum.

I would therefore like to observe five lessons of each teacher paying attention to the how teachers negotiating the controversial topics in the school curriculum teaching and learning. I would also like to interview these teachers on their understanding of the evolution. I would like to tape-record the proceedings of the interviews in order to save time if they allow me to do so.

My research will benefit your school in that the responses from the three life science teachers will contribute to an understanding of how to negotiate the controversial topics in the school curriculum during teaching and learning of evolution. This will hopefully also assist the department, teachers, school principals and subject facilitators to address the issues or difficulties associated with the teaching of evolution as part of the current CAPS.

If you allow your school to take part in my study, I would like to make it clear that your participation is entirely voluntary, no negative consequences will result from your participation, and all

information will be treated with confidentiality. If you do accept to participate, please remember that the life science teachers may decline to answer any questions, and you may withdraw from the study at any time. In order to protect confidentiality, all names I use in my research report and in any other publication arising from this research will be fictitious.

I will provide you with a summary of my research results on completion if you would like me to. Do not hesitate to contact me or my supervisor Professor Loyiso C. Jita for any correspondence arising from this letter at Jitalc@ufs.ac.za or +27514017522

Yours sincerely

Mukatuni G.E.

Signature: _____

Cell: 082 515 5412 or 011 355 0775

Gumani.Mukatuni@gauteng.gov.za or gumani@webmail.co.za

School of Education, University of Free State

Mr Mukatuni Gumani Enos
347 Donne Crescent
Lombardy East
2090

Life Science teacher
Xx Secondary School
Alexandra/ Tembisa/Soweto
2090

INFORMED CONSENT FORM FOR THREE LIFE SCIENCE TEACHERS

Research study on 'Controversial topics in the school science curriculum: a case study on teachers teaching of evolution'.

I, _____ consent to participate in this study conducted by Mr Mukatuni Gumani Enos on how Life Science teachers negotiate the controversial topics in the school science curriculum. I realize that no negative consequences will result from my participation in this study, and that the study is being conducted for purposes of improving the teaching of life sciences in our schools. I give permission for the material to be used for research or teaching only. I participate voluntarily and understand that I may withdraw from the study at any time.

Interviews:

I further consent to being interviewed as part of the study. I also understand that I have the right to review the notes made of the interview before these are used for analysis if I so choose. I have the right to delete or amend any material or retract or revise any of their remarks. Everything I says will be kept confidential by the interviewer. I will only be identified by a pseudonym in the research report. In addition, any persons I refer to in the interview and the name of the school will be kept confidential.

Observations:

I further consent to being observed while teaching Grade 10-12 Life Science classes as part of the study. I also understand that I have the right to review the notes made of my teaching before

these are used for analysis if I so choose. I can delete or amend any material or retract or revise any of my remarks. Everything I say will be kept confidential by the researcher. I will only be identified by a pseudonym in the research report. In addition, any persons I refer to in my teaching and the name of the school will be kept confidential. The data collected will be destroyed after three years.

Name: _____Signature: _____Date:_____

Consent to audio recording

I do/do not consent to having my interview recorded

Name: _____Signature: _____Date: _____

APPENDIX K: SCHOOL PARENTS' CONSENT LETTERS

School of Education, University of Free State

Mr Mukatuni Gumani Enos
347 Donne Crescent
Lombardy East
2090

INFORMATION SHEET FOR THE PARENTS

Research study on 'Controversial topics in the school science curriculum: a case study on teachers teaching of evolution'.

I (Mukatuni Gumani Enos) am conducting research for my PHD degree at the University of Free State. I am carrying out a study on how a Life Science teacher 'negotiating the controversial topics in the school science curriculum. I would therefore like to observe three lessons conducted by each teacher, paying attention to the ways in which teachers facilitate learning through various teacher-pupil interactions. Your child will be in the class which I observe. I would therefore like to ask for your permission to observe your child during teaching and learning.

My research will benefit your school in that the responses from the three Life Science teachers will contribute to the teacher and learner understanding of evolution. This will hopefully also assist teachers, school principals and subject facilitators to address the issues or difficulties associated with the teaching of evolution on the current CAPS.

If you allow your child to take part in my study, I would like to make it clear that his/her participation will be entirely voluntary, no negative consequences will result from his/her participation, and all information will be treated with confidentiality. If you do allow your child to participate, please remember that your child may withdraw from the study at any time. In order to protect confidentiality, all names I use in my research report and any other publication arising from this research will be fictitious.

I will provide you with a summary of my research results on completion if you would like me to. Do not hesitate to contact me or my supervisor Professor Loyiso C. Jita for any correspondence arising from this letter at Jitalc@ufs.ac.za or +27514017522

Yours sincerely

Mukatuni G.E.

Signature: _____

Cell: 082 515 5412 or 011 355 0775

Gumani.Mukatuni@gauteng.gov.za or gumani@webmail.co.za

Informed Consent Form for parents

I consent to notes being made of classroom observations of the in the present of my child and the use of these notes for research purposes only. All references to my child will be anonymous. My child will be identified by a pseudonym if specific reference is made to his / her views.

I do/do not consent to observation

Name: _____Signature: _____Date: _____

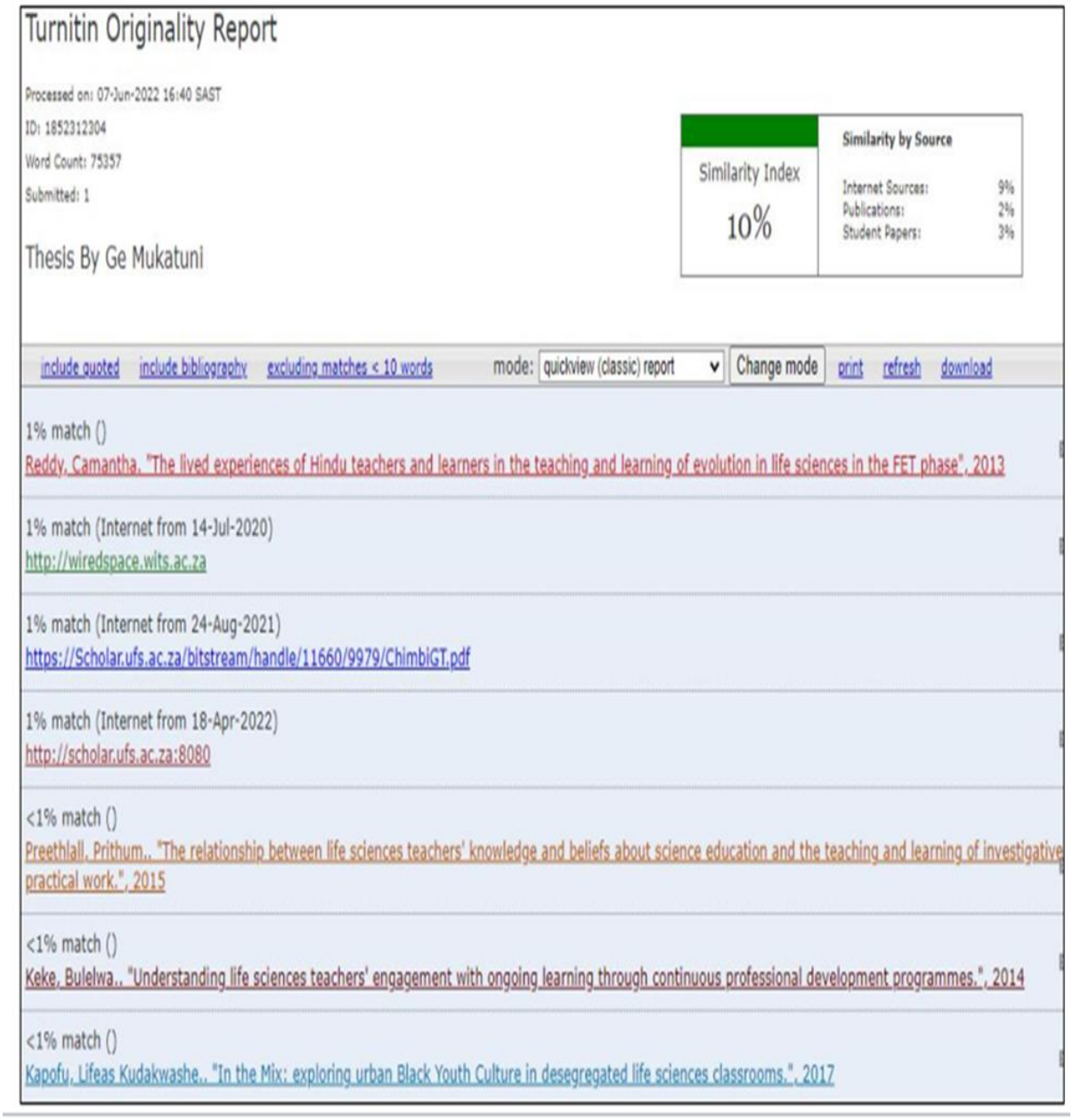
Informed Consent Form for learners

I consent to notes being made of classroom observations of in which I participate, and the use of these notes for research purposes only. All references to me as a learner will be anonymous. I (learner) will be identified by a pseudonym if specific reference is made of my views.

I do/do not consent to observation

Name: _____Signature: _____Date: _____

APPENDIX L: TURN-IT-IN RECEIPT



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APPENDIX M: EDITOR'S REPORT

CORNELIA GELDENHUYS

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corrieg@mweb.co.za

02 June 2022

TO WHOM IT MAY CONCERN

Herewith I, **Cornelia Geldenhuys (ID 521114 0083 088)** declare that I am a qualified, accredited language practitioner and that I have edited the following PhD thesis:

CONTROVERSIAL TOPICS IN THE SCHOOL CURRICULUM: A CASE STUDY ON THE TEACHING OF EVOLUTION IN SOUTH AFRICA

by

GUMANI ENOS MUKATUNI

All changes were indicated by track changes and comments **for the author to verify, clarify aspects that are unclear, make the necessary adjustments and finalise.** The editor takes no responsibility in the instance of this not being done. The document remains the final responsibility of the author.

.....
C GELDENHUYS
MA (Lin) cum laude, MA (Mus), HOD, HDL, UOLM

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