The Lived Experiences of Life Sciences Teachers Belonging to Different Religious beliefs: A Focus on the Teaching of Evolution

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Declaration

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Abstract

The motivation to investigate the lived experiences of Life Sciences teachers, belonging to different religious beliefs, teaching evolution, was inspired by a recognised gap in qualitative educational research regarding Life Sciences teachers' lived experiences. An interest in learning about and understanding Life Sciences teachers' lived experiences of teaching evolution in the light of their personal religious beliefs inspired this interpretive study. The main research question asks: How do Life Sciences teachers, belonging to different religious beliefs, experience teaching evolution as a curriculum topic? Five Western Cape-based Life Sciences teachers, belonging to Islam, Christianity, were asked 12 questions over individual online semi-structured interviews about their contextual backgrounds, lived experiences of learning about and teaching evolution, as well as their religious beliefs. Their interviews were transcribed, and the data was analysed using a thematic content analysis, as well as a cross case analysis through the constant comparative method. Meaningful qualitative data was produced that aided in the understanding of how teachers experience teaching the topic of evolution, in the light of their backgrounds and religious beliefs. A unique researcher's touch was applied to the analysis process to foster compassionate understanding of complex lived experiences. The results cannot be uniformly applied to all contexts and cannot be associated with all Life Sciences teachers belonging to Islam and Christianity. According to the results, even within a certain religion, an individual's beliefs of the religion itself and of the theory of evolution differ, depending on contextual factors. Three of the teachers presented elaborate discussions of evolution in light of the nature of science and expressed enjoyment and interest towards teaching evolution; therefore, teachers' lived experiences of teaching evolution might be impacted by their understanding of the importance of evolution in Life Sciences, irrespective of their religious beliefs. The other two teachers (Muslim and Christian) expressed a reluctance to teach evolution based on the experience of evolution to be controversial and evolution's perceived contradiction to creation (as the misconception that evolution is an alternative to creation was held); however, the former teacher did not allow evolution to threaten his faith, whereas the latter teacher experienced conflict within herself. Despite their experience of evolution being difficult to teach, both teachers attempted to remain positive and resorted to assessment requirements as justification for teaching

evolution. Some teachers' experiences of teaching evolution were affected by pressure from external factors such as the limited time factor in grade 12, assessment pressures and learners, parents and/or colleagues opposing the teaching of evolution. This research study emphasises the uniqueness and humanness of each individual teacher's lived experiences of teaching evolution, which are influenced by their personal contexts, including, but not limited to their religious beliefs. Differences in the lived experiences of teachers from the same religion brings to light the problematic nature of stereotyping individuals' views of evolution based on religion.

Opsomming

Die motivering om ondersoek in te stel van die geleefde ervarings van Lewenswetenskappe-onderwysers, wat aan verskillende godsdienstige oortuigings behoort, om evolusie te onderrig, is geïnspireer deur 'n erkende leemte in kwalitatiewe opvoedkundige navorsing rakende Lewenswetenskappe-onderwysers se geleefde ervarings. ’n Belangstelling om te leer oor en om Lewenswetenskappe-onderwysers se geleefde ervarings te verstaan rakende die onderrig van evolusie in die lig van hul persoonlike godsdienstige oortuigings het hierdie interpreterende studie geïnspireer. Die hoofnavorsingsvraag vra: Hoe ervaar Lewenswetenskappe-onderwysers, wat aan verskillende geloofsoortuigings behoort, die onderrig van evolusie as 'n kurrikulumonderwerp? Vyf Wes-Kaap-gebaseerde Lewenswetenskappe-onderwysers, wat aan Islam en Christendom behoort, is 12 vrae oor individuele aanlyn semi-gestruktureerde onderhoude gevra oor hul kontekstuele agtergronde, geleefde ervarings van hul opvoeding oor en onderrig van evolusie, sowel as hul godsdienstige oortuigings. Hul onderhoude is getranskribeer, en die data is ontleed met behulp van 'n tematiese inhoudsanalise, sowel as 'n kruisgevalle-analise deur die konstante vergelykende metode. Betekenisvolle kwalitatiewe data is geproduseer wat begrip toon oor hoe onderwysers die onderrig van die onderwerp van evolusie ervaar, in die lig van hul agtergronde en godsdienstige oortuigings. 'n Unieke navorser-aanraking is toegepas op die ontledingsproses om deernisvolle begrip van komplekse geleefde ervarings te bevorder. Die resultate kan nie eenvormig op alle kontekste toegepas word nie en kan nie geassosieer word met alle Lewenswetenskappe-onderwysers wat aan Islam en Christendom behoort nie. Volgens die resultate, selfs binne 'n sekere godsdiens, verskil 'n individu se oortuigings van hul godsdiens en van die evolusieteorie, afhangende van kontekstuele faktore. Drie van die onderwysers het uitgebreide besprekings van evolusie in die lig van die aard van wetenskap aangebied en het genot en belangstelling in die onderrig van evolusie uitgespreek; daarom kan onderwysers se geleefde ervarings van die onderrig van evolusie wel beïnvloed word deur hul begrip van die belangrikheid van evolusie in Lewenswetenskappe, ongeag van hul godsdienstige oortuigings. Die ander twee onderwysers (Moslem en Christen) het 'n onwilligheid uitgespreek rakende die aanbied van evolusie en het evolusie as kontroversieel ervaar, as gevolg van evolusie se vermeende teenstrydigheid met die skepping (soos die

wanopvatting dat evolusie 'n alternatief vir die skepping is, gehuldig is); die eersgenoemde onderwyseres het egter nie toegelaat dat evolusie sy geloof bedreig nie, terwyl laasgenoemde onderwyser konflik in haarself ervaar het. Ten spyte van hul ervaring van evolusie wat moeilik is om aan te bied, het albei onderwysers probeer om positief te bly en het gebruik gemaak van assesseringsvereistes as regverdiging van die onderrig van evolusie. Sommige onderwysers se ervarings van die onderrig van evolusie is beïnvloed deur druk van eksterne faktore soos die beperkte tydsfaktor in graad 12, assesseringsdruk en leerders, ouers en/of kollegas wat die onderrig van evolusie teëstaan. Hierdie navorsingstudie beklemtoon die uniekheid en menslikheid van elke individuele onderwyser se geleefde ervarings van die onderrig van evolusie, wat beïnvloed word deur hul persoonlike kontekste, insluitend maar nie beperk tot hul godsdienstige oortuigings nie. Verskille in die geleefde ervarings van onderwysers van dieselfde godsdiens bring die problematiese aard van stereotipering van individue se sienings van evolusie gebaseer op godsdiens aan die lig.

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CHAPTER 1: INTRODUCTION AND BACKGROUND TO THE STUDY

1.1. Introduction

This introduction briefly outlines the research project, where the first section presents a brief background to the study. The background focuses on the history of evolution as a curriculum topic in the South African education system. The next section presents my motivation for this research project, which was based on personal experiences as a high school learner. Thereafter, the problem is described, which leads to the study's research question. I then briefly describe the study's research methodology, including the research design and data analysis. The scope of the research is outlined in the next section and then the ethical considerations that were taken for this study are discussed. It is explained how trustworthiness of the research was ensured. In addition, the significance of the study and operational definitions of the key terms in the study are provided. Lastly, this chapter provides an overview or summary of how the rest of this thesis is organised and presented.

1.2. Background

When *Darwinism* was introduced in 1859, South Africa remained mainly creationist-oriented and evolution was viewed as "an attack on the Biblical view of creation" (Abrie, 2010:102). Before 1994, during apartheid in South Africa, the National Education System was divided into Christian National Education (CNE) and Bantu Education (BE), where science education was mostly discouraged in BE and allowed in CNE, but evolution was ignored as a topic entirely (Sutherland & L'Abbe, 2019). Waetjen and Parle (2005) stated how white and black school curricula reflected the state's religious and political orientation at that time. Evolution was only mentioned once in a brief discussion of historical figures in governmental South African schools from 1947 to the mid-1950's, but then removed again (Abrie, 2010). Despite evolution's importance in science and biology, the CNE policy of the apartheid government (1948 to 1994) purposely omitted it from the curriculum as they believed that it does not coincide with a Christian worldview or way of life (Sanders and Ngxolo, 2009). This anti-evolution stance came about because of the National Party's "strongly religious Afrikaans-

speaking Calvinists [in South Africa's] ideological, historical, social, political, and cultural circumstances" (Sanders, 2018:411).

Sanders (2018) noted that South Africans tend to be deeply religious, referring to a 2001 census that fifteen percent of South Africans are not religious, eighty percent is Christian, 1,5% is Muslim and 0,2% is Jewish. The latter three religions (with 8% of the Christian population belonging to the Pentecostal or Charismatic churches who believe in the fundamentalist creation story) might contradict with the concept of evolution, whereas Hinduism and Buddhism do not have problems with evolution (Sanders, 2018).

The post-apartheid democratic South African government introduced the outcomes-based Curriculum 2005 in 1997 (Sutherland & L'Abbe, 2019:2). The term 'evolution' was still absent, even though the Life Sciences subject statement introduced key concepts of natural sciences (Dempster & Hugo, 2006). However, the National Curriculum Statement which followed the review of Curriculum 2005, introduced evolutionary concepts and by 2008, the Grade 12 Life Sciences curriculum included all evolution-related ideas (Abrie, 2010). The current Curriculum and Assessment Policy Statement (CAPS) for Grades 10 to 12 Life Sciences covers evolutionary concepts in the fourth term of Grade 10, as well as the third and fourth term of Grade 12 (Department of Basic Education, 2011).

1.3. Motivation

As a white female student, who comes from a conservative Christian background, choosing to be an atheist has been a difficult, but eye-opening life decision. A changed worldview has made me look back upon and think more critically about all past experiences where my religion played a role in my own life and in the decisions of the individuals in my life. One of these past experiences motivated my research project. In my own (ex model C) high school, there were two FET Life Sciences teachers. My Grade 10 Life Sciences teacher, who embraced evolution did not disclose her personal beliefs to the learners. The other Life Sciences teacher at the school, who openly made her religious views of Christianity public, openly rejected evolution and refused to teach it. My Life Sciences teacher was asked to

cover the evolution-related lessons that year, which the other teacher had to teach. This occurrence sparked my interest in how Life Sciences teachers' religious beliefs or belief systems influence their teaching (or lack of teaching) of evolution as a curriculum topic. It became an ongoing curiosity of mine as I reflected upon this high school occurrence. Therefore, I became motivated to investigate how Life Sciences teachers, holding different religious beliefs, experience teaching the topic of evolution, and how their religious beliefs contribute to their experiences of teaching evolution as a topic in the classroom. Lovely and Kondrick (2008) based their study on the Theory of Cognitive Dissonance whereby students with different worldviews encountered evolution in a course. Their study sparked my interest in exploring cognitive dissonance in teaching evolution as well, where teachers might experience inner conflict between their religious or personal beliefs and what they ought to teach according to the curriculum.

1.4. Description of the problem

Reflection upon my past experiences, as well as my ongoing interest in religion, education and Life Sciences, motivated my search for research regarding Life Sciences teachers' experiences of teaching evolution as a curriculum topic. According to Sutherland and L'Abbe (2019), when evolution was included into the South African curriculum, progress was made; however, acceptance and understanding of evolution is still low. Consequently, the teaching of evolution was either avoided by many schools and/or teachers or taught poorly and resulted in "misconceptions and distrust in evolutionary theory" (Sutherland & L'Abbe, 2019:2). Reasons for resistance with regards to the teaching of evolution might vary from a lack of content knowledge to a concern for the controversial nature of evolution, especially its controversy with regards to religion (Sutherland & L'Abbe, 2019). Abrie (2010), who found that evolution will mostly be avoided or only briefly mentioned in Life Sciences classrooms, also stated that there is a high probability that evolution might be only treated as a compulsory curriculum topic and not the foundation of modern biology. Some teachers might even "actively teach a creationist viewpoint" (Abrie, 2010:107).

Many studies focus on pre-service teachers or teachers' acceptance of and attitudes toward evolutionary theory (Abrie, 2010; Asghar, 2013; Chinsamy & Plagányi, 2007; Coleman, Stears and Dempster, 2015; Korte, 2003; Long, 2011; Rice & Kaya, 2010). Most of these studies are empirical studies. The studies that focus on teachers specifically do not highlight their lived experiences of teaching evolution. Thus, there is a gap in the literature with regards to teachers' lived experiences when teaching evolution. Taking an interpretive stance, I am interested in learning more about and understanding Life Sciences teachers' lived experiences of teaching evolution in their classrooms. As I reside in South Africa, attending the University of Stellenbosch, I have decided that an appropriate starting point for my research interest of the teaching of evolution in Life Sciences would be to explore and understand Life Sciences teachers' lived experiences of teaching evolution in the Western Cape province of South Africa. The lack of literature regarding teachers' lived experiences of teaching evolution, which is discussed in the literature review, leads me to my research question:

> ***How do Life Sciences teachers, belonging to different 'religious' beliefs, experience teaching evolution as a curriculum topic?***

1.5. Introduction to Research Methodology

Durrheim's (2006) four dimensions of research design will be used to discuss the research design of this study, which are purpose, paradigm, context and techniques. In short, the purpose of the study is to explore the lived experiences of Life Sciences teachers, belonging to different religious beliefs, as well as to understand the complexity of teaching evolution as a curriculum topic in the research participants' respective contexts. The interpretive paradigm is chosen for this study, as its primary knowledge interest is understanding. Research participants were chosen through purposive sampling and approached through my existing networks, as well as the networks made available by my supervisor, Professor Lesley Le Grange. The research techniques involve a multiple case study approach, where each Life Sciences teacher's experiences is a different case. In the midst of a global pandemic, online semi-structured interviews produced qualitative data through asking semi-structured, but

open-ended and non-leading interview questions. Seidman's (2006) guide to qualitative interviewing was used to construct the interview questions. A thematic content analysis approach was used to process and analyse the data. The constant comparative method was then used to analyse the data across the different cases. The raw data is individual transcripts of each research participant's interview including spoken words and body language. This project's research design is discussed in further detail in Chapter 3. Throughout the process of analysing the data, I have realised the significance of each individual case and incorporated what I have learned regarding qualitative data analysis and applied my own take on these methods to conduct my own take on thematic content analysis to analyse each individual case, and the constant comparative method to perform analysis across the five cases. Chapter 4 provides an in-depth presentation of the data in the order of which the interviews unfolded, as well as an analysis of the results of the study (thematic content analysis), discussing each individual case in terms of the themes guided by the literature, as well as an interpretation of the results of the study. The last step in analysing the data was across cases; thus, an inductive cross case analysis method was used, where themes emerged through analyzing the data. [1]

1.6. Scope of the research

This study focuses on Life Sciences teachers' experiences of teaching evolution and understanding the complexity of teaching evolution as a curriculum topic in the teachers' respective contexts. The Life Sciences teachers who took part in this study all come from different backgrounds, mentioned in Chapter 3 and presented in detail in Chapter 4. For this study, I have purposefully chosen to interview teachers whose religious affiliations or beliefs are different from one another in order to produce a more nuanced understanding of religious beliefs and lived experiences of teaching evolution. Unfortunately, circumstances due to the COVID-19 pandemic have complicated the research participant recruitment process. The original plan was to interview 5 Life Sciences teachers, each holding a different belief system – Creationist Christianity, Christianity embracing the theory of evolution, Islam, Hinduism and Atheism – as these were the belief systems that I was most interested in learning more

[1] This study is an open-ended investigation that focuses on an inductive analysis methodology to learn from unknown lived experiences of teachers. Therefore, this study does not test any existing theory by deduction, but rather focuses on building theory through induction for academics to develop new conceptual frameworks.

about in their relation to the teaching of evolution. Some difficulties arose in the research participant recruitment process. This is further discussed in detail in Chapter 3. In the end, I have managed to recruit and interview Life Sciences teachers that hold the following belief systems: Christianity with traditional African values, an acceptance of evolution and separation of religion and science (**Nandi**), Christianity with the personal acceptance of evolution and a spiritual outlook on life and evolution (**Michelle**), Christianity with a Creationist viewpoint and a personal rejection of evolution (**Heidi**), Islam with a Creationist viewpoint and a personal rejection of evolution (**Saadiq**) and Islam with an acceptance of evolution and a separation from science and religion (**Zafir**). The names given to the five research participants are pseudonyms. In a multiple case study, such as this one, each case serves a purpose within the scope of the study (Yin, 2009), since the different context of each teacher's lived experiences brings new information to light.

The investigation into the lived experiences of teachers in this study focused on both the teaching of macro-evolution and micro-evolution, because it was expected that there might be differences in beliefs and experiences concerning the two topics. Even though macro- and micro-evolution both rely on the same mechanisms, such as mutations, migration, genetic drift and natural selection, the education of macro-evolution refers to the instruction of the "tree of life" or evolutionary tree diagrams that spans over millions of years, whereas micro-evolution refers to the small-scale process of natural selection of a single population (Novick, Schreiber and Catley, 2014:760).

1.7. Ethical considerations

I have chosen an appropriate research paradigm (**Interpretive Paradigm**) that fits my topic and aims to produce trustworthy data and findings in order to ensure the integrity of my research project. In order to involve teachers from Western Cape schools in my study, I sent a formal application letter to the Western Cape Education Department and received official permission to conduct my research in the Western Cape Province (Appendix A and B). Since this study involves human subjects, I formally applied online for ethical clearance to the Stellenbosch University Research Ethics Committee for social, behavioural and education

research. The application forms contain a full disclosure of the research intentions, process and possible implications. I have been resultantly granted ethical clearance to conduct my research (Appendix C).

The five voluntary teachers were provided full disclosure on the intentions of the research, their value to this study and how and by whom the findings are made public. They were also thoroughly informed of their rights to confidentiality, anonymity and withdrawal, as well as potential risks (Ramrathran, Le Grange and Shawa, 2017). Together with disclosure, participants were required to complete, sign and send over consent forms containing information about the study, ethics and the participants' rights (Ramrathran *et al.*, 2017). Member-checking did not only provide credibility, but also ensured that the research was ethically produced.

Regular reflections of the research ensured that I, the researcher, have an "understanding of the ethical implications associated with social and educational investigation" (Burgess, 1989:7). In order to avoid potential ethical dilemmas, participants' religion, belief systems, professional context and the effect that the interviews might have on them was taken into consideration throughout the research process. In addition to ethical considerations, certain steps were taken to ensure the validity of the research, discussed in the section below.

1.8. Trustworthiness of the research

This study's trustworthiness was ensured through working towards validity, focusing on transferability, dependability, confirmability and credibility (Shenton, 2004). In order to avoid irresponsible transferability, I provided a detailed description of each research participant's specific context and a disclaimer stating that the findings of my study cannot be generalised. The study's shortcomings, boundaries and implications are discussed in the fifth chapter (Shenton, 2004). Dependability was ensured by providing detailed descriptions of my research design and data collection in the research proposal. In Chapter 3 of this thesis, detailed descriptions of my research techniques and data analysis methods are provided. Furthermore, the findings, implications and reflections are provided in Chapter 5. Thus, it

might help future researchers conduct similar research (Shenton, 2004). Confirmability relates to objectivity. It is impossible for an interpretive study such as this one, to be entirely objective. However, researcher bias was reduced through regular reflection upon the raw data and data presentation, which ensured that findings are based on the subjects' lived experiences and not on my – the researcher's – preferences (Shenton, 2004:72).

Well established research methods were used for my interpretive study to ensure credibility, such as a multiple case study approach as a research technique and a thematic content analysis for data analysis. Thorough research on and detail about each subject's religious, personal and school context, increases my study's credibility (Shenton, 2004). Credibility was ensured through a detailed review of past literature related to the chosen educational phenomenon, which is the education of the theory of evolution, found in Chapter 2, as well as a detailed description of the research participants' backgrounds, including their respective religious beliefs, found in Chapter 3. The research participants were guaranteed that they can withdraw from the study or refuse explanations at any point of the interview, as Shenton (2004) recommends. They were also ensured that no answer is right or wrong, which allowed for freedom of expression and honesty. To detect contradictions or falsehoods, "iterative questioning" was used (Shenton, 2004:67).

Working with a supervisor increased the credibility of my study, as well as the trustworthiness of analysis, since my supervisor was able to detect flaws and provide the appropriate guidance where required (Maykut and Morehouse, 1994). Furthermore, no leading questions were asked in the semi-structured interviews. Evaluating and reflecting upon my own project as it developed also ensured credibility (Shenton, 2004:68). Face-validity was ensured through member-checking, which is where the interview transcripts of dialogues were reviewed by the interviewees, who were interested in doing so, in order to verify accuracy. Thus, member-checking is to ensure that the participants' words match their intentions. Lastly, my inferences were re-evaluated in the light of the participants' responses (Shenton, 2004:68; Le Grange and Beets, 2005).

It is of importance to highlight that my obtained results cannot be uniformly applied to all contexts and cannot be associated with all Life Sciences teachers belonging to the specifically chosen religious beliefs. Since my personal beliefs and experiences influenced my motivation for this study, I shall bracket these and this study will focus on a compassionate understanding of the lived experiences of Life Sciences teachers, belonging to different religious beliefs, while teaching the theory of evolution. Furthermore, it is hoped that a compassionate understanding of the five Life Sciences teachers' lived experiences are fostered through a thorough and detailed data presentation, as I am aware that the original interview transcripts are lengthy to read. Thus, it is hoped that this study will bring about a better understanding of Life Sciences teachers' lived experiences of teaching evolution.

1.9. Significance of the study

This study was intended to make an academic contribution to educational research, as it fills a qualitative gap in the literature regarding the education of evolution. Therefore, it is hoped that my research makes contributions to the field of educational research and generates meaningful qualitative data. Since this study focuses on the lived experiences of teachers, it might bring to light the problems that teachers face in the classroom regarding teaching the theory of evolution. It is hoped that how Life Sciences teachers experience teaching evolution, in the light of their religious beliefs, is brought to light. Also, the focus on lived experiences is placed with the hopes of fostering a compassionate understanding for each Life Sciences teacher and bring awareness to their experiences of teaching the topic of evolution from the CAPS. It is hoped that each research participant's case is understood in terms of their uniqueness and humanness, taking their personal contexts into consideration. It is also hoped that the situatedness of each teacher's lived experiences is recognised and compassionately understood (Aloovi, 2016). This awareness might inspire other researchers to conduct studies in this field, might guide positive change such as the instigation of more teacher education programs, as well as a decrease or eradication of misconceptions held against the theory of evolution and the nature of science. Lastly, the qualitative nature of this study might enrich the educational research field by informing future qualitative studies through highlighting the importance of understanding in the interpretations of lived

experiences.

1.10. Operational definition of key terms

1.10.1. The Theory of Evolution

Holtman (2010) describes evolution as a principle that explains the relationships between living organisms, life on earth and its history, as well as the dependence of life on the physical world. A popular, but inaccurate, understanding of a theory is that it is merely a hunch or tentative idea; however, a scientific theory is an explanation derived from a body of accumulated evidence that has been tested many times (Sanders and Ngxola, 2009). The theory of evolution explains previously puzzling observations. Such observations include reasons why some organisms have vestigial structures without purpose, why homologous structures are shared amongst related organisms and why drugs and pesticides can develop resistance (Sanders and Ngxola, 2009).

This study will investigate the lived experiences of Life Sciences teachers teaching micro-, as well as macro-evolution. Macro- and micro-evolution rely on the same mechanisms, including mutations, migration, genetic drift and natural selection; however, micro-evolutionary processes extend over a large amount of time and space can result in macro-evolutionary patterns and processes (Erwin, 2000). Thus, where micro-evolution occurs on a small scale with single populations, macro-evolution refers to such processes on a larger scale with various populations, that can transcend the boundaries of species. In his book, *The Structure of Evolutionary Theory*, the palaeontologist Stephen Jay Gould discussed a critique and revision of strict Darwinism, and attempted to provide a richer synthesis of his understanding of the structure of evolutionary theory; however, he stated that Darwin's mechanism of evolutionary change, referring to the theory of natural selection, is centrally logical and "a mode of working" (Gould, 2002:331). Gould (2002) referred to natural selection only at organismic level, and not at higher selection levels. He proposed that "species play the same role of fundamental individual that organisms assume in micro-evolution", since the basic units in theories and mechanisms of change on a macro-

evolutionary level are species (Gould, 2002:703). Gould (2002:38) defines macro-evolution as a "designation of evolutionary phenomenology from the origin of species on up, in contrast with evolutionary change *within* populations of a single species." Furthermore, Gould (2002) and Niles Eldredge formulated the theory of punctuated equilibrium in the early 1970's. Punctuated Equilibrium (PE) attempts to explain the role of species and speciation in terms of macro-evolution, expressed in geological time. Gould (2002:755) explains that the operation of natural selection is not questioned through the idea of PE, but that punctuated equilibrium "explains how the insensible intermediacy of human timescales can yield a punctuational pattern in geological perspective - thus requiring the treatment of species as evolutionary individuals". In other words, PE proposes that evolution is characterised by long evolutionary stable periods that are infrequently punctuated by swift periods of branching speciation.

This study will investigate the lived experiences of Life Sciences teachers teaching the following evolution-related topics, as required to teach by the Curriculum and Assessment Policy Statement (CAPS). The CAPS requires Life Sciences teachers to teach evolution-related concepts to Grade 10 learners in their fourth academic term (DoE, 2011). The Grade 10 students are required to be taught about the history of life on earth. The CAPS document requires Life Sciences teachers to teach Grade 10 learners about changes in the atmosphere's composition, changes in climate, sea level changes, geological events (such as the continental drift), the effect of geological events on the distribution of living organisms, missing links between dinosaurs and birds and fossil formation, dating and deductive reasoning from the fossil record. Moreover, students need to learn about the three eras (Paleozoic, Mesozoic and Coenozoic), the geological timescale, Cambrian explosion (which provides the learners with insights into the origins of specific animal groups), species changes in Africa (which links to human evolution in Grade 12), as well as mass extinctions and the various hypotheses thereabout. The abovementioned topics, focused on in Grade 10 Life Sciences, link to the topic of the theory of evolution, which is the curricular focus of this study.

The CAPS document requires Life Sciences teachers to teach Grade 12 learners about evolution-related concepts during term three and four. The evolution-related content that

would have been covered in the fourth term of Grade 10, as well as genetics that would have been covered prior to term three in Grade 12, links to the following topics, which need to be taught in the third term of Grade 12. Firstly, Grade 12 learners need to learn about the origin of ideas about origin, including the difference between a theory and hypothesis, as well as an overview of different theories, including Darwinism. Secondly, artificial selection and Darwin's theory of evolution by natural selection need to be covered. Learners also need to learn how new species are formed or have emerged. It is also important to learn about the mechanisms for reproductive isolation, as well as evolution that occurs in present times, which can be referred to as micro-evolution. Examples of micro-evolution include the changes in Galapagos finches' body sizes and bills and the development of resistance to antibiotics, anti-retrovirals and insecticides. The last topic of the third Grade 12 term is human evolution. Human evolution includes evidence of common ancestors for living hominids and the Out of Africa hypothesis. In the fourth term, human evolution continues, where the learners ought to learn about the importance of the main fossil sites in South Africa, such as the Cradle of Humankind world heritage site, as well as alternatives to evolution, including Creationism, Intelligent Design, Literalism and Theistic evolution (Department of Basic Education, 2011).

1.10.2. Lived experiences

The deeper understanding of the meaning of lived experience is emphasised in phenomenological research (van Manen, 1990). Nishizawa (2017:45) describes phenomenology as "the study of lived experiences", which can also be described as a method to explore what it means to be human. Lived experiences of a research participant in a particular study focus on the hermeneutic interpretation of their human experiences. These experiences are brought to light regardless of the individuals' age, gender, ethnicity or other sociocultural factors (Nishizawa, 2017). The significance or meaning of a human experience is gathered and analysed in order to understand the deeper meaning of the specific experience "in the context of the whole human experience" (van Manen, 1990:62). Van Manen (1990:35) drew on the literature of Dilthey (1985) stating that "lived experience involves our immediate, pre-reflective consciousness of life: a reflexive or self-given awareness which is,

as awareness, unaware of itself." A reflexive awareness of lived experience only becomes objective in thought; therefore, in the immediate manifestation of a lived experience, it cannot be grasped, but only as past presence in a reflective manner (van Manen, 1990). In human science research, the 'data' gathered is human experience (van Manen, 1990). Furthermore, gathering and exploring the experiences of others allows one to become more experienced oneself (van Manen, 1990).

The totality of life is implicated by lived experience and a lived experience is part of a system of contextually related experiences (van Manen, 1990). In other words, the interpretation of lived experience needs to be done in relation to the entire life context of the individual being interviewed. This concept was kept in mind throughout the entire process of conducting this research study. According to van Manen (1990), the lived experiences of others and their reflections upon their lived experiences can inform, shape or enrich one's own knowledge and understanding of the nature of the particular phenomenon researched. In the case of this research project, the phenomenological question; "How do Life Sciences teachers, belonging to different 'religious' beliefs, experience teaching evolution as a curriculum topic?" aims to explore the lived experiences of Life Sciences teachers teaching the theory of evolution. The aim is not to solve a particular problem, but rather to shed light on the teachers' individual lived experiences on teaching evolution in relation to their respective life contexts (Nishizawa, 2017), which is focused on bringing about better awareness and understanding of the teachers' experiences.

1.10.3. Religious belief

"Beliefs are about what is perceived to be real and true." (Mpeta, De Villiers and Fraser, 2014:15). The task of defining what a '*religious* belief' is, is however a daunting one, as there is no universal agreement on what it means. Different authors define the concept in different ways depending on their understanding of the world, which is based on their individual life contexts. As my academic background is grounded in science, and my research study specifically focuses on the teaching of the theory of evolution (a scientific theory), I will be discussing the concept in terms of a scientific definition of religion by Professor James W.

Dow's research: *A Scientific Definition of Religion* (2007).

Dow (2007) aimed to find a way to define religion in order for scientists to be able to look at it. He believed that, even though the Western culture lumps religions together, religion should rather "be investigated as separate types of religious behaviour" that are "independent evolutionary complexes" (Dow, 2007:1). Dow (2007:2) states that "[t]he scientist must understand religion as the complex workings of a human brain that is not responding directly to observable reality." According to Dow (2007), religion is the acceptance and logic of the existence of a god, spirit or supernatural force that a specific religion proposes, even when the entities or gods' existence are not validated by directly observing its existence. According to Dow (2007), scientists believe that religious behaviour is not caused by myths, but rather in an understanding of why humans think and do the way they do. The short explanation to why humans do what they do is evolution, as evolution is a key to the comprehension of religion from a scientific viewpoint (Dow, 2007).

Firstly, the sociologists, Stark and Fink (2000), argue that, in an economic sense, religious behavior can be rational for humans (cited in Dow, 2007). Social and material rewards gained from participation in religious activities is an example of how religion can be rational for humans in an economic sense. Explaining the concept of different faiths in terms of a market place, humans typically choose the faith that provides them with the most rewards, whether this choice is conscious or unconscious (Dow, 2007). In terms of evolution, most species adapt this behaviour as the optimal foraging behaviour, and therefore, religion is rationalised in an economic sense. Secondly, Dow (2007) states that religion is a social construct, where some pre-human behaviours among animals (such as primates, mammals and reptiles) have rituals, which is closely related to religion. This construct is however partly contested, as many animals have rituals, such as courtship rituals, which cannot be equated to religion. Therefore, ritual behaviours of non-human animals cannot be equated to religion. Rituals of humans, such as burying the dead can be considered an important indicator of the awareness of death and the possibility of an afterlife, which are both characteristics of religion. Thirdly, in terms of psychology, religion is rationalised as a way to deny mortality, fight depression and comfort humans in difficult times (Dow, 2007). How humans became religious, however,

cannot be determined by psychology, says Dow (2007). Psychological explanations can help us to understand why humans do religious things; however, how religion started and why it continues is not merely psychology-based, as the human mind is a product of evolution.

The definition of religion, according to Dow (2007:7-8), is based on three behavioural modules or complexes ("solutions to particular problems of survival and reproduction") that evolved at different times. The first module is the mental capacity of humans to create illustrations of unobservable agents that cause things to occur in real life, such as gods, ghosts, spirits, demons, angels, extra-terrestrials etc. Dow (2007) also refers to Tylor's theory of souls as animating agents as a way of explaining pre-human adaptations to predators, since an animal would increase its chances of survival if it imagined a predator as it cannot be sure whether it is there or not. The second module refers to the mental ability of humans (and some animals) to separate things into different categories of sacredness. Sacredness, an evolutionary adaptation, according to Roy Rappaport (1999), controls how humans interact with their environment. In other words, human group responses to environmental change can happen because of coordinated sacred signals. The third module refers to the symbolic human behaviour of public sacrifice, although, not all sacrificial behaviours are religious (Dow, 2007). Within the context of a group ideology, sacrifice does, however, demonstrate commitment, activates cooperation and creates trust within a group. Religious sacrifice is typically publically performed and inspired by a "shared philosophy of the sacred" (Dow, 2007:9).

Therefore, Dow (2007) defines religion as behaviour within any of the abovementioned modules. Dow (2007) concludes that when observed with an evolutionary perspective, religion has an adaptive rationality. Dow (2007:10) calls the three modules "a set of hypotheses that organise the search for data that will reveal why human beings engage in the behaviours that they call religious."

1.10.4. Cognitive dissonance

Dow (1962) centered the concept of cognitive dissonance around the idea that if a person is

made aware of pieces of information (such as behaviour, emotions, opinions or environmental occurrences) that are not psychologically consistent with one another, they will, in different ways, try to make them more consistent. Dow (1962) further explains the concept of dissonance in terms of expectations. In the course of one's life, one forms certain expectations about things that go together and things that do not go together, and "[w]hen such an expectation is not fulfilled, dissonance occurs" (Dow, 1962:94).

Explaining cognitive dissonance in relation to the fields of science and education, I turned to a study conducted by Lovely and Kondrick (2008). They based their study on the Theory of Cognitive Dissonance whereby students with different worldviews encountered evolution in a course (Lovely and Kondrick, 2008). Lovely and Kondrick (2008) studied literature on the changes that learners go through as they become familiar with and develop internal scientific constructs. Drawing on Posner, Strike, Hewson and Gertzog (1992), Lovely and Kondrick (2008) explained how when learners encounter new and unusual experiences, they make sense of these experiences by drawing on internal paradigms that are familiar to them. When their current internal paradigms are "not sufficient to assimilate to the new experience", they experience a perception of contradictory information, an experience described as cognitive dissonance (Lovely and Kondrick, 2008:2). In order for one to make sense of such a new unusual experience, accommodation needs to occur in the form of changes in one's internal paradigm. Lovely and Kondrick's (2008) study sparked my interest in exploring whether cognitive dissonance occurs in my area of research: the teaching of evolution by Life Sciences teachers.

1.11. Summary of chapters

Chapter One: This chapter briefly introduced the readers to the subject of the study, and why it was researched. The chapter particularly provided insights into the background and motivation of the study, the problem statement, the research question, an introduction to the research methodology, the scope of the research, ethical considerations, additional measures taken for trustworthiness, definitions of key terms, and a summary of the chapter.

Following this introduction, the chapters will comprise of the following:

Chapter Two: In this chapter, the literature regarding the topic of research is discussed. Literature was found on how evolution is perceived and its connection to worldviews, teachers' religion and their attitudes toward evolution (Mpeta, de Villiers and Fraser, 2014), the correlation between religious convictions and the lack of comprehension of evolution in Oregon (Trani, 2004), student teachers' feelings toward evolution (Chinsamy and Plagányi, 2007) and how teachers' backgrounds can influence their worldviews and how they experience teaching evolution. The acceptance of evolution is researched in countries such as North America and Turkey (Korte, 2003; Rice and Kaya, 2010). South African studies include information about teachers' views and attitudes toward teaching evolution (Abrie, 2010; Mpeta *et al.*, 2014; Stears *et al.*, 2016; Trani, 2004). Further literature focuses on lack of science education, knowledge of evolution and the acceptance thereof. Misconceptions regarding evolution and rejection thereof in education is also discussed. Further literature includes studies about individual perceived emotional rules, teacher identities, assessment pressures and teacher autonomy and the connection to teaching evolution. More literature discusses the controversy between evolution and religion. The last section of Chapter Two discusses the gap in the literature.

Chapter Three: In this chapter, the research methodology of this study is discussed, which includes the purpose, paradigm, context and techniques. The data analysis process, a thematic content analysis, is described in this chapter as well, as well as the cross case analysis of the five cases through the constant comparative method. Lastly, ethics and trustworthiness is elucidated.

Chapter Four: In this chapter, an in-depth presentation of the data and findings is offered. It is shown how the data was analysed, as described in the previous chapter, and thereafter the findings are described and interpreted.

Chapter Five: In this chapter, conclusions are drawn and discussed. Recommendations are made based on the analysis of the data and findings, and a reflexive comment is made to round off the thesis.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

In this chapter, the literature related to the topic of my research project is reviewed and discussed. Firstly, the importance of evolution in biology, and specifically Life Sciences, is explained. The importance of evolution for scientific literacy and understanding basic biology is emphasised by various authors, such as Dobzhansky (1973), Haury (1996), Mathews (2001), Rutledge and Mitchell (2002), Dempster and Hugo (2006), Paz-y-Miño C. and Espinosa (2009), Rice and Kaya (2010), Schroder (2012), Mpeta, De Villiers and Fraser (2014), Coleman, Stears and Dempster (2015), as well as Dunk, Petto, Wiles and Campbell (2017). Secondly, an international perspective on evolution and school biology is provided, followed by a South African perspective, briefly covering the apartheid era, followed by a detailed discussion of evolution and biology in South Africa's post-apartheid curricula. Furthermore, a synthesis of all studies reviewed is provided, discussing recommendations from the literature that was reviewed and mentioning common themes that emerged from the literature. In addition, gaps and omissions in the literature are discussed, as well as the conclusions that the reviewed articles' authors made based on their studies' findings. Reviewing other authors' studies, recommendations, gaps and omissions might inform my research project and guide a well-researched project. Since this research project specifically focuses on Life Sciences teachers' lived experiences, this chapter lastly explains what is meant by 'lived experiences', as well as reviews studies on biology and/or Life Sciences teachers' lived experiences. This literature review aims to provide a strong foundation for this research project by offering a review of literature regarding the teaching of evolution, religion and education, religion and evolution in education, as well as lived experiences.

2.2. Evolution in education

Before reviewing literature on the teaching of evolution, the importance of evolution in biology and Life Sciences is explained. It is also important that evolution is defined in terms of the focus of this research project; thus, in the next section I explain what I mean when speaking about evolution throughout this thesis. Since a basic understanding of the nature of

science is required to understand the significance of the theory of evolution (Rutledge and Warden, 2000), the connection between evolution and the nature of science is discussed in the third section. Lastly, the challenges of the teaching of evolution are briefly explored.

2.2.1. The importance of evolution in biology and Life Sciences

Evolutionary biology has advanced science so significantly that Kennedy (2007:1869) proposed "Evolution in Action" as the breakthrough of the year in 2005, cited in Chinsamy and Plagányi (2007). Dobzhansky (1973:125) states that "[n]othing in biology makes sense except in the light of evolution". Paz-y-Miño C. and Espinosa (2009:674) contend that "[e]volution is the language of the cosmos" and Dunk, Petto, Wiles and Campbell (2017:1) regard evolution as the "unifying theme of all biology". Various academics, including Haury (1996), Mathews (2001), Rutledge and Mitchell (2002), Moore and Kraemer (2005), Dempster and Hugo (2006), Cavallo and McCall (2008), Schroder (2012), as well as Mpeta, De Villiers and Fraser (2014) support the latter statement. Chiappetta and Fittman's (1998:16) study, that focused on finding the most effective way to teach biology in order to foster a deep understanding of the "big picture" in biology in learners, resulted in recommending evolution as an important unifying topic, since it provides learners with relevance and meaning to understand biology. The theory of evolution naturally organises the teaching of biology in general as it provides the diverse life on earth with context (Rutledge and Warden, 2000). Therefore, Rutledge and Warden (2000) aver that every biology classroom ought to teach the theory of evolution. Moore and Kraemer (2005:465) deem evolution as "one of the most powerful ideas in history". Rice and Kaya (2010) emphasise the importance of learning about evolution for the development of a scientific literacy, as well as Rutledge and Warden (2000). Nehm and Schonfeld (2007) emphasise the importance of learning about evolution in science classrooms, as it is one of the few places where one has the opportunity to learn about the theory of evolution in particular. Coleman, Stears and Dempster (2015) regard evolution as a fundamental aspect of biology. It is therefore important for the general public and future global citizens to know about the theory of evolution, and for evolution to be included in biology or Life Sciences curricula, especially in today's globalised world. The absence and presence of evolution in the South African curriculum, specifically, is discussed in section

2.4.2; however, for this research project, it is firstly important to clarify the term 'evolution' and specifically, evolution education in Life Sciences.

2.2.2. What do I mean when I speak about 'evolution'?

The definition of evolution and its mechanisms is discussed in detail in Chapter 1; however, the following explains shortly what is meant by the term "evolution" in this thesis. According to Holtman (2010), evolution is the principle that explains the relationships between living organisms, life on earth and its history. Furthermore, evolution is also related to the dependence of life and living organisms on the physical world (Holtman, 2010). It is clear that the definition of evolution, as described by Holtman, concurs with Dobzhansky's abovementioned statement. Evolution can occur on a small or large scale. Micro-evolution occurs on a small scale with single populations, while macro-evolution occurs on a much larger scale over various populations and different species; however, extended micro-evolutionary processes and patterns can result in macro-evolution (Erwin, 2000; Novick, Schreiber and Catley, 2014). Erwin (2000) explains that macro-evolution and micro-evolution rely on the same mechanisms, such as mutations, migration, genetic drift and natural selection. The understanding of evolution is essential to this study, as Life Sciences teachers' lived experiences of micro-evolution, as well as macro-evolution, will be explored.

The current South African school curriculum that was first implemented in schools in 2012, is the Curriculum and Assessment Policy Statement (CAPS). With regards to Life Sciences, specifically, evolution-related concepts are explicitly covered in the fourth academic term of Grade 10, the first term of Grade 11 and the third and fourth term of Grade 12 (Department of Education, 2011). In Grade 10, such explicit evolutionary concepts include the history of life on Earth, atmospheric change, climate change, sea level changes, geological events (including the movement of the continents), the consequences of geological events pertaining to living organisms (such as the geographic distribution of plants and animals i.e. biogeography), fossil formation, the fossil record (including dating and deductive reasoning relating to the fossil record), missing links between dinosaurs and birds, the three eras (Paleozoic, Mesozoic and Coenozoic), the geological time scale, the Cambrian explosion,

species changes in Africa, mass extinctions and the hypotheses regarding mass extinctions (Department of Education, 2011). Teaching learners about the Cambrian explosions aims to provide them with insights into the origins of certain animal species, while learning about African species links to human evolution, which is covered in Grade 12 (Department of Education, 2011). In Grade 11, learners need to know about the diversity of plants and animals through their evolutionary relationships, including a basic understanding of phylogenetic trees as reconstructions of evolutionary pathways (Department of Education, 2011). Furthermore, as an investigation, learners must "[d]raw a phylogenetic tree showing the evolutionary history of the four plant groups and major structural changes in their history of development" (Department of Education, 2011:40). Another evolution-related topic covered in Grade 11 is the biodiversity of animals, focusing on the six major phyla and their developmental lines (Department of Education, 2011). The concept of body plans covered in Grade 11 lays a foundation for understanding macro-evolution (Department of Education, 2011).

Evolution is covered in much more detail in the third and fourth terms of Grade 12 Life Sciences. Grade 12 learners, who take Life Sciences as a subject, should have a background of the evolution-related content covered in Grade 10 and 11, as well as other topics such as genetics and DNA, for example. The third term of Grade 12 Life Sciences covers the origin of ideas about origin, the difference between a theory and hypothesis (which is important, as the definition of a theory is often misunderstood according to Sanders and Ngxola (2009)), an overview of various theories such as Darwinism, artificial selection, natural selection as presented by Charles Darwin, the development of new species over time, reproductive isolation, micro-evolution and hominid evolution (Department of Education, 2011). Micro-evolution refers to the process of evolution in present times and on a small scale (Novick, Schreiber and Catley, 2014), such as the changes in the sizes of the Galapagos finches' bodies and bills and the development of resistance towards insecticides, antibiotics and anti-retrovirals (Sanders and Ngxola, 2009; Department of Education, 2011). Macro-evolution refers to the same mechanisms as micro-evolution but on a larger scale, over a larger time span and between different species. The evolution of *Homo sapiens* is an example of macro-evolution. In the third term of Grade 12 Life Sciences, learners are required to learn about the

evidence of living hominids' common ancestors, as well as the Out of Africa hypothesis (Department of Education, 2011). The fourth term of Grade 12 Life Sciences covers human evolution further and includes South Africa's main fossil sites and alternatives to evolution, such as Creationism, Theistic Evolution, Intelligent Design and Literalism – which is not to be examined anymore (Department of Education, 2011).

The importance of evolution in Life Sciences is further emphasised in the Grade 12 Annual Teaching Plan (ATP), a guide to assessment for teachers. According to these governmental guidelines, Life Sciences teachers need to assess learners on the topic of evolution for 36% of Paper 2 (54 out of 150 marks need to encompass evolution), and 32% for genetics and variation, (48 out of 150 marks need to encompass evolution) which is a prerequisite for understanding the entirety of evolution, (Department of Education, 2021). The large weighting of evolution in Grade 12 examinations (68% of the entire Paper 2) further emphasises the importance of the teaching of evolution in schools. Not only is learning and writing about evolution important in Grade 12, but learning about evolution in Grade 10 also sets the tone for understanding topics such as Genetics in future grades.

2.2.3. Evolution and the nature of science

When studying the theory of evolution, one needs the syntactic knowledge and background of the nature of science (Rutledge and Warden, 2000). According to Cavallo and McCall (2008), the nature of science is an umbrella phrase for how science functions, how knowledge is explored by scientists and how scientists define which knowledge is scientific. Cited from Kagan and Sanders (2013:47) who drew on the National Academy of Sciences (2008:10), science is "the use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process". Information is collected through observation of nature (based on repeatedly tested empirical evidence) by scientists and tentative and dynamic explanations for the phenomena are provided. Dunk, Petto, Wiles and Campbell (2017) claim knowledge of the nature of science to be the most important factor associated with evolutionary acceptance. Rice and Kaya (2010) believe that the first step to understanding the nature of science is to identify common scientific

misconceptions, such as common misconceptions about the definition of a scientific theory and hypothesis. A theory is not just an idea or hunch, as commonly misunderstood (Sanders and Nxgola, 2009). If one does not understand the difference between a fact, theory, hypothesis and law, one might hold misconceptions more easily. Theories are understood as explanations of natural phenomena, incorporating laws, facts, hypotheses and observations that can be tested and are open to critical examination (McCrory and Murphy, 2009). It is acknowledged, however, that new evidence may modify an existing scientific theory (Coleman, Stears and Dempster, 2015). Evolution is regarded as a scientific theory due to a convincing body of evidence that supports it (Coleman, Stears and Dempster, 2015). Thus, it can be stated that the theory of evolution is a scientific theory that explains many unanswered questions of life on Earth. The nature of science in general, refers to the "epistemology and sociology of science, science as a way of knowing, or the values and beliefs inherent to scientific knowledge and its development" (Lederman, Abd-El-Khalick, Bell and Schwartz, 2002:498). The concepts related to the nature of science are dynamic and tentative, since science is always undergoing development and change (Lederman *et al.*, 2002). It is often found that authors define the nature of science as the combination of all scientific processes; however, Lederman, Abd-El-Khalick, Bell and Schwartz (2002) state that the nature of science is more related to the values and epistemological suppositions that underlie such scientific processes, such as data collection and interpretations and the formation of conclusions.

2.2.4. The topic of evolution is a challenge in the education field

Even though it is acknowledged by many that it is important for evolution to be included in biology curricula (Esterhuysen and Smith, 1998; Dempster and Hugo, 2006; Nehm and Schonfeld, 2007); Sanders and Ngxola, 2009), evolution is, however, still perceived as a "troubling" topic, since it challenges many different worldviews and religious beliefs (Chinsamy and Plagányi, 2007:248; Sanders and Ngxola, 2009; Sanders, 2018). A review of research by Sanders and Ngxola (2009) (from 50 papers in the last 20 years since this specific paper) shows that evolution is not accepted by all teachers and students, and many are opposed to adding evolution to school curricula in various countries. On the other hand,

Coleman, Stears and Dempster (2015) state that evolution is less controversial than before, as students who enter university, having already been exposed to evolution in school, are exposed to evolution in university and taught by staff who accept the theory of evolution. Therefore, they deem it as less controversial than past times, as there is an increase in exposure to evolution. Concordantly, Plutzer, Branch and Reid's (2020) study, exploring the change in the teaching of evolution over 12 years in the United States of America, revealed an increase in the time spent on teaching evolution and a substantial decrease in the instruction of creationism as a scientific alternative to evolution. These changes are attributed to improved "pre-service teacher education and in-service teacher professional development" and the adoption of the Next Generation Science Standards (NGSS) by teachers (Plutzer *et al.*, 2020). Thus, the topic of evolution is at least not as controversial as it was in the education field 12 or more years ago. Even though many countries experience educational challenges with regards to the teaching of the theory of evolution (which is discussed in section 2.3 of this literature review), South Africa's history of evolution education and educational deprivation based on race, which is explained in sub-section 2.4.1, exacerbates the challenges of teaching evolution, as learners of colour were deprived of science education during apartheid and all learners were only properly introduced to the theory of evolution in 2008. Therefore, the elucidation of such challenges and of the experiences of teachers teaching evolution in South Africa might be a meaningful contribution to academia regarding evolution in education, discussed in section 2.4 of this literature review. This literature review shows that evolution is a curriculum topic worthy of investigation, as there remain many challenges regarding the instruction, knowledge of, understanding and acceptance of evolution in education (internationally and nationally), which will be discussed in the following sub-sections.

2.3. Evolution and school biology: An international perspective

In the following sub-sections, the literature on education of the theory of evolution will be discussed. It will specifically focus on the experiences of teachers that teach the theory of evolution, as well as the challenges that they may face in the classroom or in their teacher-training programmes. Upon reviewing the international literature, I have come across certain

recurring themes. Since various international authors emphasise the importance of evolution in education, as discussed in section 2.2.1, it is acknowledged throughout this literature review. Firstly, it is important to discuss the influence of teachers' contextual backgrounds and their learners' contextual backgrounds on teachers' evolution teaching experiences. More specifically, since this research project specifically focuses on Life Sciences teachers who hold specific belief systems, literature on religion, 'alternatives' to evolution and other belief systems and their connection to attitudes toward teaching evolution (including the acceptance, neutrality or rejection of evolution), is reviewed. Such literature is elaborated on in section 2.3.1. Secondly, several articles discuss teachers or student-teachers' knowledge and understanding of evolution, as well as misconceptions regarding evolution. Various authors discuss whether there is a connection between teachers' knowledge and understanding of evolution and their acceptance of the theory of evolution, which is discussed in section 2.3.2. Lastly, a variety of pedagogical and other pressures can influence teachers' experiences of teaching evolution, as is elucidated in section 2.3.3.

2.3.1. Evolution and school biology: Backgrounds, religion, belief systems, 'alternatives' to evolution and the acceptance of the theory of evolution

Before embarking on the review of literature covering evolution and religion, a concept that is a worthy addition to this section is Gould's (2014) concept of nonoverlapping magisteria (NOMA). He distinguished between science, that focuses on the empirical universe of facts (tackling the question of: what is it made of?) and theories (why does it work this way?), and religion, that covers questions of moral meaning and value (Gould, 2014). Gould (2014) brought attention to the friction between science and religion and proposed NOMA as a conventional resolution to the supposed conflict between science and religion. NOMA was proposed to advocate that the two concepts represent different areas of inquiry, namely fact (science) versus values (religion). In other words, science documents the factual character of natural phenomena in the world and theories are developed to explain such facts, whereas religion, even though equally important, focuses on the area of human purpose, morals, meanings and values (subjects that might be illuminated by science but never resolved).

Goldston and Kyzer (2009) focused on the narratives of three teachers teaching evolution. They found that the teachers' individual perceived teacher identities were dependent on their sociocultural environment and background (Goldston and Kyzer, 2009). Delving into religion and belief systems specifically, a number of international studies made specific statements about the relationship between religious convictions and the acceptance of evolution amongst biology educators (Trani, 2004; Moore and Kraemer, 2005; Moore, 2008; Paz-y-Miño C. and Espinosa, 2009; Long, 2012 and Baker, 2013).

Based on his research in the United States of America, Trani (2004:419) found that religious convictions can directly correlate with a lack of comprehension of the nature of science and evolutionary theory. He also found that 16% of Oregon biology teachers refuse to present evolution and lack an understanding of science and, specifically, evolution due to their strong religious beliefs (Trani, 2004). In another American study on biology teachers' attitudes and actions toward teaching evolution in Minnesota, Moore and Kraemer (2005) found that even though it is unlawful to teach a creationist viewpoint in the classroom, the prevalence of biology teachers in public schools that do so, is high. Moore and Kraemer (2005:465) describe the teaching or promotion of creationism in public schools, as well as the hiring of teachers who do it, as an "educational malpractice" that impedes learners' understanding of evolution.

In another study by Moore (2008) on evolution education, it was found that almost one fourth of the teachers in his study completely omit the teaching of evolution in order to respond to pressure to teach creationism or the pressure to omit evolution. Moore (2008) aimed to answer questions regarding whether, what kind of and how creationism is taught by biology teachers in public schools. The results of Moore's (2008) study showed that, if creationism was taught in biology classrooms, it was mostly presented as a scientific alternative to the theory of evolution. Eighty-three percent of respondents acknowledged that, if creationism was taught in the biology classroom, the "Christian or Biblical story" of creation was presented (Moore, 2008:81). The results of Moore's (2008) study – two percent of biology teachers that present creationism in the classroom, present it as an exclusively religious topic – suggest that the distinction between science and religion is poorly understood by many

biology teachers. Many of the teachers in Moore's (2008:83) study claimed that they taught creationism because of the demand from their learners; however, "it is unlawful for public-school biology teachers to teach creationism" regardless of their learners' demands. Moore (2008) concluded that even though evolution is supported by ongoing and growing scientific evidence, court decisions and professional standards, some teachers are still continuing and will continue to substitute science with their own religious beliefs. As a result, their learners are deprived of an understanding of the theory that explains the history of life on Earth (Moore, 2008). As will be discussed in detail in sub-section 2.3.2, Paz-y-Miño C. and Espinosa's (2009) research showed that individuals' acceptance of evolution is influenced by their interactive familiarity with processes of evolution (such as mutations, natural selection and genetic drift), comprehension of the essence of science; however, their personal religious convictions may also influence their acceptance of evolution. Their conclusions regarding the influence of religion on the acceptance of evolution in education are in accordance with Moore's (2008) findings and conclusions.

Rutledge and Mitchell's (2002) study, which is discussed in more detail in section 2.3.2, attempted to map biology teachers' conceptions on the theory of evolution and made similar conclusions on the relationship between teachers' religious convictions and their acceptance of evolution. They found that some teachers related their rejection of evolution to religious understandings, such as creationism (Rutledge and Mitchell, 2002). Thus, Rutledge and Mitchell (2002) attributed teachers' acceptance of evolution to their personal religious convictions, as well as their teacher academic backgrounds and teaching of evolution, which is elucidated in section 2.3.2. They connected a thorough understanding of the nature of science to an increased ability to avoid confusion with evolution and religion (Rutledge and Mitchell, 2002).

In accordance with Trani (2004) and Moore and Kraemer (2005), according to Long (2012), a large amount of biology teachers in the United States of America omit evolution in their classrooms or downplay it because of religious beliefs and commitments, with specific reference to those who hold creationist beliefs in Long's case. Long (2012) emphasises the competition between different official knowledges and science education that is situated

within different contexts regarding the curriculum, pedagogy and politics. According to Long (2012:137), citizens have the right to believe in what they choose; however, it is suggested that democratic education requires teachers to uphold and explore science, without "curtailing it in the name of religion".

In the USA, Lovely and Kondrick (2008) surveyed 538 liberal arts college students before and after a biology course on the theory of evolution in order to determine whether and/or how students' understanding of evolution is influenced by their religious views, as well as whether and/or how their understanding and views change after learning about evolution. After the course on the theory of evolution, almost half of the students in Lovely and Kondrick's (2008) study shifted their viewpoints to a scientific one, while the other half shifted toward creationist views. Lovely and Kondrick (2008) did not expect or intend that religious students shift their viewpoints. Forty percent of the students who were undecided about their viewpoints on evolution remained undecided, while half of those who changed their viewpoints from an undecided one, shifted to a scientific viewpoint, while the other half to a more creationist viewpoint, which is inconsistent with the theory of evolution. Thus, amongst the initial undecided group, Lovely and Kondrick (2008) discovered a, not yet understood, wedge between shifting to a scientific viewpoint, creationistic viewpoint or remaining undecided.

According to Baker (2013), public acceptance of evolution in the USA remains relatively low compared to other Western countries. According to Baker (2013), students' choice of higher education is influenced by their worldviews and religious views; thus, when predicting the acceptance of evolution, there is an interactive relationship between level of education and religious affiliation. Baker's (2013) study on American adults and their stance toward evolution and creationism, found mixed results pertaining to the effects of educational attainment (on the theory of evolution) on individuals' stance toward evolution and creationism. Baker (2013) found that religious identity influences such consequences. Hence, it was concluded that educational attainment only shifts the attitudes of those who interpret the Bible in a non-literalist manner toward evolution, or decreases the number of people with literalist religious identities, whereas certain literalist individuals' acceptance of evolution can

even be reduced with an increase in educational attainment (Baker, 2013). Drawing upon Ammerman (1987:52), Baker (2013:217) explained that individuals with literalist religious identities view any contradictions with religious scriptures as "the work of Satan".

While on the topic of religion and evolution, Clément (2015) used a questionnaire validated by the Biohead-Citizen Project to ask 15 evolution-dedicated questions to analyse Muslim teachers' conceptions of evolution in several countries. Varying degrees of Muslim or Christian culture was compared in nine francophone countries, such as France, Morocco, Algeria, Tunisia, Lebanon, Senegal, Burkina Faso, Cameroon and Gabon, showing a strong contrast between France and the other countries. The study focused on research questions such as: "Are Muslim countries, and Muslim teachers, more creationist than other ones? Is the teachers' knowledge related to their more or less creationist conceptions? Are Muslim teachers more creationist in European countries?" (Clément, 2015:2). Taking Muslim teachers' conceptions of evolution into consideration, Clément (2015) recognised that their conceptions might be compared on an international level to discover how they differ amongst other countries, if they differ from their Christian colleagues and what the other parameters for difference are. Clément (2015:3) drew from the InterAcademy Panel (IAP) (2006), which represents 68 national science academies across the world, that "scientific evidence, data, and testable theories about the origins and evolution of life on Earth are being concealed, denied, or confused with theories not testable by science". When comparing teachers' conceptions of evolution in nine francophone countries, important differences were recognised, such as the topic of evolution being absent in Algeria, recently re-introduced in Morocco and Lebanon, only present at the end of secondary schools in Tunisia (while omitting the origin of humankind) (Clément, 2015). In Burkina Faso, teachers' (from the Catholic, Protestant and Muslim faith) conceptions of evolution were compared (Clément, 2015). No significant difference was found between Muslim and Catholic teachers' conceptions; however, a difference was found between Muslim and Protestant teachers (Clément, 2015). The results confirmed that, within the same socio-cultural and economical context in Burkina Faso, Muslim teachers do not have more creationist conceptions than Christian ones, but that Protestant teachers were found to have more creationist views than Muslim teachers (Clément, 2015). Compared to Burkina Faso, it was found that there was a clearer absence of

difference in conceptions in Cameroon, as well as for Senegal (Clément, 2015). In Lebanon, significant differences were found between teachers' creationist or evolutionist conceptions. For example, Sunni and Shiites do not differ in conceptions, but differ drastically from Catholic and Orthodox teachers (Clément, 2015). Interestingly, most creationist teachers recognised the importance of natural selection in the evolution of species (Clément, 2015). Clément (2015) found that the minority of teachers sampled in Tunisia were Agnostic or Atheist and had more evolutionist conceptions than the Muslim teachers. In France, nearly all agnostic or atheist teachers (who were in the majority) are evolutionist, whereas 7 out of 11 Muslim teachers recognised the importance of God in the evolution of species, while 3 identified as radical creationists (Clément, 2015).

Clément's (2015) results further show that the answer to whether Muslim teachers are more creationist than Christian teachers is more complex than expected; thus, Muslim teachers are both evolutionist and creationist. Whatever their religion, it was found that the degree of belief in God had a greater effect on teachers' conceptions of evolution than the effect of the Muslim religion itself (Clément, 2015). The analysis of Clément's (2015) findings brought about the conclusion that socio-cultural identity of a country links more to creationist conceptions than the Muslim or Christian religions do. Thus, a country's *culture*, including religion, affects the people's conceptions of evolution, not only religion. Clément (2015) also found a link between teachers' knowledge of the importance of natural selection and evolutionist conceptions. Another interesting finding of Clément (2015) is that Muslim teachers sampled in European countries were found to be more evolutionist than those sampled in their countries of origin. Clément's (2015:21) final comment raised an important issue: "The challenge of biology education is not to struggle against the Muslim religion, nor to hope that in a country where 98% of the teachers believe in God, they would have to stop, as Dawkins (2006) proposed. The challenge is to help all teachers and students, including Muslim or Christian ones, to be "*evolutionist*" or "*at the same time evolutionist and creationist*" […] and to struggle against all the fundamentalisms of any religion."

Silva, Clément, Silva Leão, Garros and Carvalho (2017) conducted a comparative study about teachers' conceptions of the origins of life in Brazil, Argentina and Uruguay (with

Brazil being formally secular but not in practice, Argentina being a Catholic institution and Uruguay practicing consolidated secularism). They sampled 62 Brazilian teachers, 50 Argentinean teachers and 57 teachers from Uruguay (Silva *et al.*, 2017). A questionnaire inspired by the BIOHEAD-Citizen Project, teachers' conceptions were explored, and the results showed that the majority of teachers in Argentina and Uruguay are evolutionist, even when some believe in God and there was a clear separation between science and religion for Argentinean and Uruguayan teachers (Silva *et al.*, 2017). Most Brazilian teachers attributed the origin of life to a creationist standpoint, or an evolutionary and creationist standpoint, where most teachers were evangelicals and few were agnostics or atheists (Silva *et al.*, 2017). The Brazilian teachers that were Catholic were more creationist than the Catholic teachers in Argentina and Uruguay (Silva *et al.*, 2017). Silva, Clément, Silva Leão, Garros and Carvalho (2017) recommend that further studies should analyse the influence of the national context on teachers' conceptions of the origins of life.

Tolman, Ferguson, Mann, Maskiewicz Cordero and Jensen (2020) conducted a study inspired by the phenomenon that many individuals reject the theory of evolution because of a perceived conflict with their religion. This study focused on the effectiveness of a reconciliatory model for the acceptance of evolution within the framework of religion for biology and theology students (Tolman *et al.*, 2020). It was found that such an approach does increase evolutionary acceptance in both fields, without a decrease in religiosity, but more in biology than theology with a probable explanation of higher content knowledge of evolution in biology classrooms (Tolman *et al.*, 2020). Tolman, Ferguson, Mann, Maskiewicz Cordero and Jensen (2020) stated that an increase in acceptance of evolution amongst religious students might have to be induced by an increase in the knowledge of evolution (including knowledge of the nature of science) paired with the reconciliatory approach. Furthermore, if these approaches are used by an educator, who both accepts evolution and religion, the educator as role model might inspire the acceptance of evolution for students (Tolman *et al.*, 2020).

Stahi-Hitin and Yarden's (2022) research in Israel aimed to explore scientists' and teachers' attitudes toward relating to religion when teaching evolution. Twenty teachers' attitudes

toward relating to religion in a science class (and particularly an evolution class) were explored through semi-structured interviews. An online survey was taken by 124 scientists regarding whether teachers should relate to religion when teaching evolution. Stahi-Hitin and Yarden (2022) found that most scientists do not want teachers to relate the teaching of evolution to religion and 10 religious teachers agreed that the teaching of evolution should be related to religion. Their reasoning was the importance of making a connection with the learners' inner worlds by relating to their culture and self-choice, as well as the responsibility of a teacher to provide a proper response to their learners (Stahi-Hitin and Yarden, 2022). Most religious scientists agreed; however, they pointed out the challenges of relating to religion in the teaching of science. Most scientists that were interviewed emphasised the role of a teacher to make the boundaries between science and religion clear, or that external figures (such as rabbis or religious educators) should do it. According to Stahi-Hitin and Yarden (2022), the differences in responses between scientists and teachers regarding the issue of relating to religion in a science class, emphasise the need for a relation to teachers' experiences. Exploring religious scientists' and teachers' views and attitudes about the possible co-existence between religion and science might help to find practical solutions to such conflicts (Stahi-Hitin and Yarden, 2022). Almost all religious scientists and teachers acknowledged that students may feel conflict between their religion and evolution (Stahi-Hitin and Yarden, 2022). Furthermore, teacher professional development programs may assist teachers with facing the challenges of the presumed conflict between religion and evolution (Stahi-Hitin and Yarden, 2022). The above studies' findings about religion and conceptions of evolution, lead me to the discussion of teachers' knowledge of the theory of evolution, their understanding thereof, as well as their attitudes toward evolution.

2.3.2. Evolution and school biology: Knowledge of, understanding of, misconceptions about and the acceptance of the theory of evolution

A large number of studies, focused on evolution and education, were conducted in the United States of America. Rutledge and Warden (2000) specifically focused on teachers' understanding of the theory of evolution in Indiana in the USA. A teacher determines the quality of education in the classroom; thus they need to be able to make informed and responsible decisions regarding instruction and the curriculum; however, their understanding

of the subject matter impacts such decisions (Rutledge and Warden, 2000; Rutledge and Mitchell, 2002). According to Rutledge and Warden (2000), as well as the article by Rutledge and Mitchell (2002), biology teachers must possess a thorough knowledge of evolutionary theory and the nature of science in order for such important instructional and curricular decisions to be made. Furthermore, understanding evolutionary theory is not only important in biology instruction, but it is also a critical aspect of scientific literacy (Rutledge and Warden, 2000). The Indiana teachers in their study showcased a relatively low acceptance of the theory of evolution, where evolutionary concepts, such as human evolution, evolution's scientific validity and the age of the Earth, were either rejected or undecided about (Rutledge and Warden, 2000). Rutledge and Warden (2000) believe the understanding of evolutionary theory and the nature of science to be important when deciding to accept or reject evolution; thus, the teachers' low acceptance levels make sense in the light of their low levels of knowledge and understanding of the topics. Rutledge and Warden (2000) concluded that the teachers' inadequate academic backgrounds ill-prepared them to teach the theory of evolution.

Rutledge and Mitchell (2002) acknowledged that while it is important to address learners' educational needs, in relation to learning about the theory of evolution, factors that impact the teaching of evolution, specifically, also need addressing. Rutledge and Mitchell (2002) noted that little research has been done on teachers' conceptions of the theory of evolution. They used concept mapping to investigate teachers' (with varying levels of acceptance of the theory of evolution) evolutionary conceptions and knowledge structures (Rutledge and Mitchell, 2002). The teachers' cognitive structures were mapped and sixty-seven percent of the teachers who participated in Rutledge and Mitchell's (2002) study, claimed that they accepted evolution, twenty-seven percent were undecided, while nineteen percent rejected evolution. The majority of teachers who rejected evolution, regarded it as "only a theory" or "only a hypothesis", which suggests that these teachers have misconceptions regarding the definition of a theory (Rutledge and Mitchell, 2002:24). A theory is not just a hunch or tentative idea; it is an explanation derived from a body of accumulated evidence that has been tested numerous times (Holtman, 2010). Some teachers in Rutledge and Mitchell's (2002:24) study stated that evolution had "little evidence" to support it. Based on what they have

observed from the results of their research, Rutledge and Mitchell (2002) found the knowledge of the teachers who rejected evolution to be superficial with respect to the evolutionary process. Many of the undecided group of teachers also believed evolution to be '"only a theory" that […] is "weakly supported"' (Rutledge and Mitchell, 2002:24). This group of teachers seem to be totally undecided, believe in "theistic evolution" or regard science and religion as mutually exclusive (Rutledge and Mitchell, 2002:24). The group of teachers who accepted evolution produced the most elaborate, detailed, mechanistic and evidential maps, containing concepts, such as "speciation", "natural selection", "genetic variation" and "competition for limited resources", and generally avoided the topic of religion (Rutledge and Mitchell, 2002:24-25). The teachers who accepted evolution regarded it as a well-supported scientific theory and were able to cite the evidence (Rutledge and Mitchell, 2002). Rutledge and Mitchell's (2002) data suggested that the high school biology curriculum in Indiana does not emphasise the topic of evolution appropriately. Rutledge and Mitchell (2002) attribute teacher academic background, teachers' personal religious convictions and the teaching of evolution to teachers' acceptance of evolution. Rutledge and Mitchell (2002) stated that teachers who lack a thorough understanding of the nature of science, may struggle to distinguish between evolution's scientific validity and strong religious views, which may confuse their teaching of evolution. Teachers might also find teaching evolution uncomfortable because of a lack of understanding of evolution and its supporting evidence (Rutledge and Mitchell, 2002).

Other than most American studies, Korte's (2003:3) research, adapted from Rutledge and Warden's (2000) study, attempting to determine the acceptance of the theory of evolution of secondary life science teachers in Ohio, found that most teachers do accept the theory of evolution. Out of the three hundred surveys that were sent out, 87 questionnaires, that were usable, were returned (Korte, 2003). Korte's (2003) results, stating that 77 of the respondents accepted evolution and 10 rejected it, therefore showed that the majority of the secondary life science teachers accepted evolution. The levels of knowledge of the theory of evolution were compared between the two groups; the "Acceptance Group" and "Rejection Group" (Korte, 2003:39). The results suggested that knowledge of evolution correlates with the acceptance thereof (Korte, 2003). Korte's (2003) results led to the claim that disagreement with the

theory of evolution might be attributed to a lack of scientific knowledge, as opposed to morally rejecting the theory of evolution. In addition, Korte (2003) noted a correlation between knowledge of evolution and teaching experience. In other words, it was stated that a teacher's level of knowledge on the theory of evolution was high if they had many years of teaching experience, specifically pertaining to the theory of evolution. Furthermore, Korte's (2003) results suggested that a teacher's personal acceptance of evolution corresponds with their level of knowledge of evolutionary theory, as also concluded by Rutledge and Mitchell (2002). It was thus recommended by Korte (2003) that teacher training courses covered more information on evolution, specifically, for the improvement of teachers' knowledge and consequential teaching of evolution.

Similar recommendations were executed by Nehm and Schonfeld based on their research. Nehm and Schonfeld (2007) studied the effect that an evolution-focused teacher training course had on the knowledge of their research participants, including their level of evolutionary acceptance. The course aimed to decrease antievolutionism in American secondary science teachers and increase their knowledge of evolution and the nature of science, since most teachers held misconceptions regarding evolution, natural selection, as well as the nature of science before the course started (Nehm and Schonfeld, 2007). In the case of Nehm and Schonfeld's (2007) study, antievolutionism specifically referred to creationism and intelligent design. The results of their study demonstrated that the assumption that a biology teacher's educational background in biology determines their knowledge of evolution and the nature of science, cannot be made (Nehm and Schonfeld, 2007). This statement is in conflict with conclusions made by Rutledge and Warden (2000). Commonly held misconceptions regarding the nature of science included the conception that a theory can only become a fact if it is scientifically proven with well-supported evidence, and that the theory of evolution cannot be proven (Nehm and Schonfeld, 2007). Such findings are in accordance with the findings of Rutledge and Mitchell (2002), as discussed above. Furthermore, Nehm and Schonfeld's (2007) study has shown that an increase in the knowledge about evolution, as well as the nature of science, of secondary science teachers has led to a decrease in misconceptions about evolution and natural selection; however, the majority of teachers continued to hold anti-evolutionary worldviews and preferred to teach it

over teaching their learners about evolution. Moreover, they have found that the acquisition of knowledge about evolution does not induce a change in attitude toward evolution (Nehm and Schonfeld, 2007).

In the USA, Lovely and Kondrick (2008) wished to determine whether and/or how students' understanding and views change after learning about evolution in a biology or zoology course. In contrast with most studies, Lovely and Kondrick (2008) found that an increase in knowledge about the theory of evolution does not necessarily shift students' viewpoints to a scientific one, but it can. In other words, among the 60% of the pre-course undecided students who changed their views post-course, half changed their views to a scientific one, while the other half to a creationistic viewpoint.

Paz-y-Miño C. and Espinosa (2009) compared a religious and secular college's perspectives on evolution, creationism and intelligent design in the USA, as there was a lack in the literature regarding college students' evolution-related views. They studied these college students' views, awareness of, attitudes and openness toward evolution, creationism and intelligent design in order to improve evolutionary teaching approaches in colleges (Paz-y-Miño C. and Espinosa, 2009). Even though my research project revolves around Life Sciences teachers' experiences of teaching evolution, Paz-y-Miño C. and Espinosa's (2009) research provide insight regarding the influence of education on the acceptance of evolution. Their research found a positive correlation between years of education and acceptance of evolution (Paz-y-Miño C. and Espinosa, 2009). Their intra-institutional comparisons showed that the acceptance of evolution increased gradually over time from freshman to senior biology students, because of more exposure to upper-division courses containing evolution-related content (Paz-y-Miño C. and Espinosa, 2009). Moreover, they have found that college students are enthusiastic about learning about life's origin and diversification (Paz-y-Miño C. and Espinosa, 2009). Their results suggested that exposure to biology courses determines college students' acceptance of evolution (Paz-y-Miño C. and Espinosa, 2009), which is in accordance with Korte's (2003) research results, but in conflict with Nehm and Schonfeld's (2007) conclusions.

Biologists tend to accept evolution and use it to guide their work; however, acceptance of evolution is less prevalent in the general public, despite efforts to improve the acceptance and understanding of the theory of evolution (Dunk, Petto, Wiles and Campbell, 2017). Thus, Dunk, Petto, Wiles and Campbell (2017) conducted a quantitative study to determine how certain factors collectively determine an individual's acceptance or rejection of the theory of evolution. These factors include content knowledge of evolution, "religiosity" (the degree to which religion impacts daily life), "epistemological sophistication" and comprehension of the nature of science (Dunk *et al.*, 2017:2). They claimed that rejecting the unifying theme of biology, referring to evolution, leads to the misunderstanding of and inability to reason regarding biological phenomena (Dunk *et al.*, 2017). According to Dunk and colleagues, stakeholders in policy settings who deny essential scientific understandings implicate the successful implementation of sound science curricula, as the nature of science is not emphasised enough in science education (Dunk *et al.*, 2017). Based on the results of their research, Dunk, Petto, Wiles and Campbell (2017) concluded that the nature of science is significantly related to evolutionary acceptance and that many evolutionary criticisms stem from misunderstanding the nature of science. Therefore, a sound understanding of the nature of science is required for the acceptance of evolution. Furthermore, acceptance of evolution can also strongly be influenced by cognitive factors, such as openness to experience and religiosity (Dunk *et al.*, 2017).

Quessada and Clément (2018) investigated the conceptions of evolution of French teachers and students in two French regions (Rhône-Alpes and Languedoc-Roussillon) and they found that 98% of the French teachers and 94% of French students accept evolution. They drew on numerous studies conducted under the BIOHEAD-Citizen project (Biology, Health and Environmental Education for better Citizenship) and found that out of 15 evolution-related questions, 6 tested teachers' possible creationist conceptions, 2 explored teachers' knowledge of evolutionary processes and 2 detected finalism (goal-ended evolution). According to a comparison of 28 countries, French, Danish, Swedish, Spanish and Estonian teachers are primarily evolutionist and creationism has a low impact on French teachers' conceptions (Quessada and Clément, 2018). The great acceptance of evolution in France can be attributed to the French secular school system that includes the teaching of evolution (Quessada and

Clément, 2018).

Plutzer, Branch and Reid (2020) investigated a 2007 survey in the USA regarding the teaching of evolution and compared it to the teaching of evolution, obtained through an identical survey, 12 years later. They found a significant increase in the amount of time spent on teaching evolutionary theory, including teaching human evolution, as well as a decrease in the instruction of creationism as a scientific replacement for evolution (Plutzer *et al.*, 2020). The results have not only improved for new teachers, but also amongst in-practice senior teachers, especially those who have adopted the Next Generation Science Standards (NGSS) (Plutzer *et al.*, 2020). Plutzer, Branch and Reid's (2020) results suggest that the American state standard reforms have been successful in at least bringing about some improvements, leading to Plutzer and colleagues recommending the continuation of such reforms, including scientific rigor.

Two studies in Turkey focused on the education of evolution in university or college, focusing on the acceptance of evolution (Peker, Comert and Kence, 2010; Rice and Kaya, 2010). Peker, Comert and Kence's (2010) study found a significantly low acceptance and understanding of evolution. According to the conclusions of Peker, Comert and Kence (2010), an individual's level of acceptance of the theory of evolution is not likely to change when at college; however, an individual's understanding of the theory of evolution can improve more easily. Furthermore, they interestingly found that individuals majoring in biology education and science education better understood evolution than those majoring in biology (Peker *et al.*, 2010). Peker, Comert and Kence (2010) also found that the individuals in their study who were interested in learning about evolution had better acceptance and understanding thereof compared to individuals who were not interested in learning about it. Conversely, they stated that individuals who accept the theory of evolution benefit more from learning about it compared to those who reject it (Peker *et al.*, 2010). Rice and Kaya (2010) investigated how pre-service teachers' ideas regarding evolution were related to their understanding thereof and of other basic scientific concepts. Rice and Kaya's (2010) results revealed that the theory of evolution was not accepted by forty-two percent of their 240 research participants. Furthermore, those participants held inaccurate conceptions relating to

science, such as that humans and dinosaurs co-existed, which does not coincide with the theory of evolution (Rice and Kaya, 2010). Similar to Korte (2003), Trani (2004) and Dunk, Petto, Wiles and Campbell's (2017) results, which is discussed in the above subsections, Rice and Kaya (2010) found a positive correlation between scientific knowledge and acceptance of evolution. It was also found that the individuals who rejected evolution were more sceptical regarding believing the factuality of tectonic plates and human evolution (Rice and Kaya, 2010). It has been shown that knowledge and understanding of evolution can be a challenge pertaining to the acceptance and teaching of the theory of evolution; however, other factors, such as external pressures impact the teaching of evolution as well, as will be discussed below.

2.3.3. Evolution and school biology: The challenge of assessment, pedagogical and environmental pressures in the classroom

Chiappetta and Fittman (1998) gathered information from seven experienced science supervisors in order to find the most effective manner in which biology can be taught that results in biologically literate learners. They have found that many biology teachers claim that their subject matter is overwhelming, which stifles learners' meaningful learning, understanding and engagement if too much content needs to be covered in a limited amount of time (Chiappetta and Fittman, 1998). Thus, an overwhelming content-rich curriculum creates additional challenges for teachers when having to deal with the instruction of a controversial topic, such as the theory of evolution. Furthermore, Chiappetta and Fittman (1998:16) concluded that it is important for learners to understand the "big picture" in biology as the unifying principles of biology aid in the understanding of evolution. It is thus important for teachers to teach that the unifying principle of biology *is* the theory of evolution. However, an overwhelming content-rich curriculum implicates the process of teaching the "big picture" in biology to learners (Chiapetta and Fittman, 1998:16). Together with the pressure of getting through a content-dense curriculum, teachers' decisions to teach evolution are influenced by assessment pressures, "state standards, [...] and teacher autonomy, as found by Goldston and Kyzer (2009:762). As stated by Dunk, Petto, Wiles and Campbell (2017) the acceptance of evolution is important; however, it is influenced by

individuals' openness to experience. Thus, if teachers are not open to learning about and teaching evolution, it may influence their teaching of evolution. As shown in section 2.3, the international literature reveals various challenges pertaining to the teaching of evolution. In the next section, the teaching of evolution in South Africa will be discussed.

2.4. Evolution and school biology: A South African perspective

In the sub-sections below, there will be focused on the absence and introduction of the theory of evolution into the South African curriculum. The South African governmental influences to omit the theory of evolution from the apartheid-based South African school curricula is discussed in sub-section 2.4.1. Thereafter, the governmental influences to introduce and extend the theory of evolution in post-apartheid curricula will also be explored. The history of evolution in the South African curriculum provides an essential background to this research project, as many individuals, including some of today's teachers, still have to live and deal with the aftermath of South Africa's apartheid-influenced education (Chinsamy and Plagányi, 2007). After discussing evolution in the South African curriculum, the literature on the teaching of evolution in South Africa will be reviewed, with a specific focus on teachers and pre-service teachers. Similar to the three themes found in the international literature, the South African literature is organised to discuss evolution and school biology. Specifically, the influence of teachers' backgrounds and learners' backgrounds on the teaching of evolution will be discussed. Since purposive sampling was used to interview five Life Sciences teachers holding different belief systems from one another, South African literature on religion and the education of evolution is reviewed in sub-section 2.4.3.1. Secondly, the South African literature on teachers' knowledge of evolution, understanding of evolution and teachers' acceptance of evolution is discussed. Similar to international research, some authors discuss whether there is a relationship between the abovementioned topics. Lastly, sub-section 2.4.3.3 focuses on the external, environmental and pedagogical challenges of teaching evolution in South African classrooms.

2.4.1. School biology and evolution in curricula during apartheid in South Africa

Charles Darwin's book, *On the Origin of the Species*, was introduced in 1859. At that time, the main paradigm on which South Africa based its governance was creationism (Abrie, 2010). Therefore, evolution was omitted from the South African school curriculum, since the perception that evolution was an attack on creation and God's authority prevailed (Dempster and Hugo, 2006; Abrie, 2010; Schroder, 2012). In 1947, the concept of evolution appeared in the South African curriculum in a brief section about historical figures in the field of science (Abrie, 2010). This section was removed from the curriculum in the mid nineteen fifties because of the new biology curriculum stating that it aimed to foster an appreciation for the "Creator" and what has been created by this "Creator" in the universe (Abrie, 2010:102). As a result, the theory of evolution was nullified by South African schools for many years (Abrie, 2010).

During the apartheid era (1948-1993), Afrikaner Nationalism and Calvinism was expressed in the South African education system, especially through Christian National Education (CNE) from 1967 until 1994, where racial segregation and the education of Christianity was encouraged (Esterhuysen and Smith, 1998; Lever, 2002; Abrie, 2010; Sanders, 2018). The National Education System in South Africa during apartheid was divided into CNE and Bantu Education (BE), since the Christian National Policy aimed to prepare white and black children separately "for their respective superior and inferior positions in South African social and economic life" (Esterhuysen and Smith, 1998:135; Sutherland & L'Abbe, 2019). The education system at that time made the instruction of the Bible compulsory (Esterhuysen and Smith, 1998). The education of science was allowed in CNE; however, evolution was not covered in the curriculum, since it was believed not to be a topic that coincides with Christianity (Sanders and Ngxola, 2009; Sutherland & L'Abbe, 2019). According to Esterhuysen and Smith (1998), evolution was omitted from the curriculum, since it was regarded as an anti-Biblical concept. Science education was mostly discouraged in the BE curriculum, which reflected the government's political, as well as religious objectives (Waetjen and Parle, 2005; Sutherland & L'Abbe, 2019). Hence, at the time of apartheid, the majority of South Africa's adult population, did not receive a proper science education (Chinsamy and Plagányi, 2007). Meanwhile, CNE required the spirit of a particular Christian world-view to be reflected in all subjects of the curriculum (Lever, 2002). Therefore, for most

of the twentieth century, curricula, whether aimed at black or white learners, omitted the theory of evolution (Abrie, 2010).

2.4.2. School biology and evolution in post-apartheid South African curricula

The African National Congress, which came to power in South Africa in 1994, stressed the urgent need for South African school curricula to be reformed (African National Congress, 1994). The reconstruction of the South African education system needed to provide all learners with equal learning opportunities, implement social transformation and foster democratic citizens that are creative, literate, critical and competitive in the global world as a result (Dempster and Hugo, 2006). The post-apartheid ANC introduced the outcomes-based Curriculum 2005 in 1997 (Sutherland & L'Abbe, 2019). This curriculum was reviewed in the year 2000 and gave rise to a Revised National Curriculum Statement (RNCS) (Le Grange and Beets 2005). The RNCS, for Grades R to 7, covered concepts related to evolution, such as environmental change, changes in living organisms, natural selection, extinction, adaptation, classification and biodiversity (Department of Education, 2003); however, the word 'evolution' was not used, or rather "carefully avoided" (Abrie, 2010:103). Instead, the concept of evolution was only referenced by using phrases such as "change over time" and "development" (Abrie, 2010:103). Following further review the National Curriculum Statement introduced evolution, and subsequently the nature of science, into the South African school curriculum in 2006 for Grades 10 to 12 (Abrie, 2010; Coleman, Stears and Dempster, 2015).

The purpose of the Life Sciences curriculum in the National Curriculum Statement of South Africa includes expecting learners to understand the nature of science and the interrelationship between science, indigenous knowledge, technology, society and the environment (Department of Education, 2003). According to Cavallo and McCall (2008), the inclusion of evolution into the curriculum might achieve the abovementioned purpose. According to this curriculum, that first introduced evolution in South Africa, teachers are required to teach all aspects of the theory of evolution, such as Darwinism, natural selection, evolutionary mechanisms (micro- and macro-evolution), mass extinctions and hominid

evolution (Sanders and Ngxola, 2009). It is important for evolution to be in the curriculum as its understanding has led to numerous scientific advances in fields such as medicine, agriculture and conservation (Sanders and Ngxola, 2009). Sanders (2018) emphasised a statement by the Academy of Science of South Africa stating that students cannot be prevented from learning about evolution as it is crucial for understanding modern biology. Furthermore, a lack of knowledge on the topic might prevent students from entering certain professions (Sanders, 2018). It is especially relevant for evolution to be taught in South African schools, since South Africa is a rich source of fossil evidence (Sanders, 2018). Moreover, South Africa has a substantial geological record, various museums and national parks, and is also a rich source of biodiversity and environments (Dempster and Hugo, 2006). Esterhuysen and Smith (1998) emphasise the importance of learners to learn about hominid evolution, as it helps develop skills, such as observation, inference, logical argumentation and creativity. In addition, according to Esterhuysen and Smith (1998), considering South Africa's history of racial segregation, Life Sciences teachers can use hominid evolution to approach racial issues in the classroom.

After careful investigation of South Africa's Natural Sciences and Life Sciences curricula at the time of Dempster and Hugo's (2006) study, in order to determine whether the South African biology curriculum is adequate enough for the development of a solid understanding of evolution, they have concluded that, for various reasons, it is inadequate. A deep understanding of evolution requires highly specialised teachers, already skilled learners and well-resourced schools; however, these conditions are not realistic in a post-apartheid developing country such as South Africa (Dempster and Hugo, 2006). According to Dempster and Hugo (2006), only advantaged learners and teachers might benefit from such a curriculum, which unfortunately perpetuates past inequalities. The latter is confirmed by Chinsamy and Plagányi (2007) stating that after apartheid has ended, as a result of the restricted BE and Christianity-focused CNE during the apartheid time, many university students carried misconceptions about evolution and many teachers were poorly equipped to teach it, which in turn fostered learners with minimal evolutionary understanding. Sanders and Ngxola (2009) researched teachers' concerns and needs regarding teaching evolution in South Africa and found that many teachers find evolution to be a problematic curriculum

addition. Since evolution has not been explicitly taught in South African schools before 2008, many teachers faced the challenge of becoming familiar with evolutionary concepts that were new to them (Holtman, 2010). Misconceptions and a lack of evolutionary understanding will be discussed in detail in section 2.4.3.2.

2.4.3. A South African perspective of the teaching of evolution

2.4.3.1. Evolution and school biology: Backgrounds, religion, belief systems, 'alternatives' to evolution and the acceptance of the theory of evolution

A number of South African research papers focused on the attitudes of learners and/or teachers toward the theory of evolution (Chinsamy and Plagányi, 2007; Schroder, 2012; Mpeta, De Villiers and Fraser, 2014; Stears, Clément, James and Dempster, 2016). According to Chinsamy and Plagányi (2007), support for intelligent design and perceived incompatibilities between various religious faiths and evolutionary theory drive an international resistance to evolution. In Chinsamy and Plagányi's (2007) study, students expressed their feelings regarding evolution, where ones that were deeply religious rejected the theory of evolution (Chinsamy and Plagányi, 2007).

As discussed in the international literature, a challenge pertaining to the teaching of evolution is the misconceptions that individuals hold regarding evolution, whether these individuals be teachers or learners. Such misconceptions motivated Schroder's (2012) research on the attitudes of learners and teachers towards the theory of evolution. Schroder's (2012) sample was 2 teachers teaching 2 Grade 12 classes at a single school; therefore, generalisions about her findings cannot be made. She discussed many misconceptions about the theory of evolution (see sub-section 2.4.3.2). Sanders and Ngxolo (2009), as well as Schroder (2012) acknowledge that misconceptions regarding evolution (and the contradiction with religious beliefs) are promulgated by some religious parties or through ignorance. One of the concepts of evolution that learners found most conflicting in Schroder's (2012) study is human evolution, as the evolution of humans from primitive primates over millions of years challenges the notion that God created the Earth in 6 days and humans in his own image; a

notion held by many creationists. Another common misconception is that evolution is regarded as a belief system rather than a scientific theory (Schroder, 2012), which was also found in Moore's (2008) study in the USA. Furthermore, misconceptions regarding the controversy between evolution and certain religious belief systems are common amongst learners in Schroder's (2012) study, where learners, for example, feel that their beliefs need abandoning if they were to accept evolution. Thus, based on her results, Schroder (2012) found that the other main barrier to learning about evolution, other than resistance to change, is the misconception that the acceptance of evolution and religion is an either/or decision, as also found by Mpeta, De Villiers and Fraser (2014). Schroder's (2012) statements regarding resistance to change are in accordance with conclusions made by Coleman, Stears and Dempster (2015), who noted that students struggle to align their existing beliefs with newly presented views when learning about evolution, since religious learners' (who are prevalent in South Africa) acceptance of evolution is influenced by their religion. As a result, students might resist these new concepts, which might influence their understanding of evolutionary theory (Coleman, Stears and Dempster, 2015).

Kagan and Sanders (2013) investigated the nature and extent of prior ideas of 32 Grade 12 learners at a religious Jewish South African school through the use of a knowledge survey. It was found that there was a high frequency of unscientific ideas about evolutionary mechanisms, as expected, since the students had not been taught the topic; however, unexpectedly, there was a low frequency of erroneous ideas associated with the understanding of the nature of science and religious beliefs (Kagan and Sanders, 2013). Specifically, six of the students did not agree with the theory of evolution, whereas five were unsure (Kagan and Sanders, 2013:45). Eighteen students believed that "evolution explains how living organisms first appeared on Earth"; however, such idea is a misconception, since evolution does not address how life originated, but it explains why some species existed later than others (Kagan and Sanders, 2013:46). Eleven of the students in Kagan and Sanders's (2013) study stated the belief that life on Earth began less than 6000 years ago, which is another misconception, which is likely in relation to the learners' religion. Only 2 of the 32 students in Kagan and Sanders's (2013) study stated the belief that one cannot believe in evolution if one believes in God, which was unexpected to the researchers, as the students came from strong religious backgrounds. Misconceptions regarding the mechanisms of

evolution were held by some of the 32 students, for example, 50% of them believed that single organisms can evolve (Kagan and Sanders, 2013). According to Kagan and Sanders (2013), the study had a lower frequency of nature of science-related misunderstandings which could be attributed to the focus on teaching the nature of science in early grades. Kagan and Sanders (2013) concluded that it is useful for teachers to be aware of learners' erroneous ideas about evolution in order to plan their approach to teaching evolution; however, it is also important for teachers to be aware of the factors that may influence their learners' conceptions about evolution, as such awareness can help teachers to develop approaches that may help their learners to cross the border between their own worldviews and the world of science.

Through a questionnaire and open-ended questions, Mpeta, De Villiers and Fraser (2014) investigated the acceptance of evolution and views regarding learning about evolution of a sample of Grade 12 Life Sciences learners in Limpopo, where almost all research participants held creationist Christian beliefs. They wanted to investigate the influence of religion on South African teachers and learners' attitudes toward evolution (Mpeta *et al.*, 2014). Their results showed a moderate acceptance of evolutionary theory and almost half of the participants regarded evolution as a valid theory (Mpeta *et al.*, 2014). This meant that many religious learners found evolution to be a valid scientific theory and accepted evolution; however, the learners whose religious beliefs were deeply entrenched, found it difficult to accept evolution (Mpeta *et al.*, 2014). Since the religious learners were first exposed to the explanations of creation in the scriptures of their respective religions (in other words; their backgrounds determined their current worldviews), conflicts and doubts about reality arose when they learned about evolution (Mpeta *et al.*, 2014). According to Mpeta, De Villiers and Fraser (2014), the validity of evolution might have been evaluated in terms of these learners' religious views or worldviews. Based on the latter findings, Mpeta, De Villiers and Fraser (2014) suggested that a religious individual does not need to abandon his or her beliefs in order to understand and accept the theory of evolution. The learners who experienced conflict with evolution and their religion had no inclination to learn about evolution, where some claimed that it weakened their faith (Mpeta et al., 2014). The latter statement is in accordance with Schroder's (2012) conclusions about resistance to change, discussed in sub-section

2.4.3.2. Mpeta, De Villiers and Fraser (2014:17) suggested that these learners perceived religion and science as "either/or" and stated that learners' perceptions regarding the epistemology of evolution and religion influences their decision to support evolution. The ways in which the learners in Mpeta, De Villiers and Fraser's (2014) study were influenced, includes a positive or negative attitude toward evolution, or no influence. Mpeta, De Villiers and Fraser (2014) noted that some learners sensed that their educators attempted to convince them that evolution should be accepted and their religion, abandoned.

Stears, Clément, James and Dempster (2016) studied 300 South African teachers and pre-service teachers' views and attitudes toward evolution. The results with regards to views on evolution differed largely depending on the teachers' different religions (Stears *et al.*, 2016). Specifically, Stears, Clément, James and Dempster's (2016) study showed that South African teachers value their religious affiliations more than their specialisation subjects. They also value their religious affiliations more than their teaching experience (Stears *et al.*, 2016). With a specific focus on creationist beliefs, Stears, Clément, James and Dempster (2016) found that seventy percent of Protestant, other Christian or Muslim participants, twenty-five percent of Hindu participants and forty percent of Shembe participants held creationist views. Seventeen percent of participants who fell under the agnostic or atheist category, also held creationist views; in other words, they believed that God created the Earth; however, since atheists reject the idea of the existence of a God, it was assumed that those participants were agnostic (Stears *et al.*, 2016). Furthermore, they found that a large group of South African teachers are "theistic evolutionists", which means that they accept evolution in the light of their respective religions (Stears *et al.*, 2016:8). With regards to accepting evolution, the Hindu teachers in Stears, Clément, James and Dempster's (2016) study were more evolutionist than the Protestant or Roman Catholic teachers, but less than the agnostic and atheist teachers. This finding makes sense, since neither Hinduism nor Buddhism relates to the creation story (Stears *et al.*, 2016). South African teachers' views regarding creationism and evolution were very diverse compared to other countries and could be explained by South Africa's diverse socio-cultural context (Stears *et al.*, 2016). Stears, Clément, James and Dempster's (2016) findings about the contradictions between religions and evolution were similar to statements made by Sanders (2018). According to Sanders (2018), Christianity,

Islam and Judaism are the three religions which might contradict with theory of evolution, whereas no contradictions between evolution and Eastern religions, such as Hinduism and Buddhism, are found. The reason why Christianity, specifically, might contradict with the theory of evolution is because of the Pentecostal or Charismatic belief in the fundamentalist story of the Earth's creation, believed by eight percent of the Christian population in South Africa by 2001 (Sanders, 2018). As shown in the international, as well as South African literature, teachers' backgrounds and belief systems may influence their attitudes toward the theory of evolution. Therefore, pursuing my interest in this topic through this research project would be befitting. In the next sub-section, the relationship between teachers' knowledge of, understanding of and acceptance of evolution, is discussed.

2.4.3.2. Evolution and school biology: Knowledge of, understanding of, misconceptions about and the acceptance of the theory of evolution

Chinsamy and Plagányi (2007:248-249) emphasised how developing countries lack proper "secondary science education" and public engagement with scientific issues; therefore, they investigated the effect of an evolution course on the views of a group of South African students at the University of Cape Town, as South Africa's population is diverse in terms of race and religion. Their study investigated the attitudes of first-year students toward learning about evolution before and after an evolutionary course (Chinsamy and Plagányi, 2007). With a fairly diverse student body, no statistically significant change in the students' views about evolution, from before and after the evolution-based course, was found (Chinsamy and Plagányi, 2007).

It was acknowledged by Abrie (2010) that the rejection of evolution by adults, teachers or biology students in the United States of America was prevalent, as also noted by Dempster and Hugo (2006); however, rejection by these groups is rarer in other Western countries. Abrie (2010) found that most student-teachers who rejected evolutionary theory, discouraged the teaching thereof in South African schools. According to Abrie (2010), this is problematic, since, even though it is unknown to what extent knowledge and acceptance of evolution may influence the quality of teaching evolution and the time spent on teaching evolution in the classroom, Rutledge and Mitchell (2002) and Trani (2004) have linked increased teacher

acceptance of evolution to an increase in time spent on teaching it. Therefore, based on previous literature, Abrie (2010) predicted that many student-teachers would avoid teaching evolution in their future classrooms, or only briefly mention it. Abrie's (2010) South African study investigated 46 student-teachers (studying at a historically Afrikaans university), who intended to become biology teachers, and their attitudes towards evolutionary theory, as well as their willingness to teach evolution. The study was motivated by a lack in research regarding South African teachers and student teachers' attitudes toward and knowledge of evolution (Abrie, 2010). Abrie (2010) collected data through questionnaires, similar to those of Rutledge and Warden (2000) and Moore and Kraemer (2005). The acceptance of evolution in the small sample of university students, who participated in Abrie's (2010) study, was found to be low. Most participants in Abrie's (2010) study rejected evolution. Abrie (2010) found that most student-teachers who rejected evolutionary theory, discouraged the teaching thereof in South African schools.

As previously stated, misconceptions can cause confusion regarding the understanding and instruction of the theory of evolution. A major concern that motivated Sanders and Ngxola's (2009) study was teachers' lack of content knowledge, as well as misconceptions about evolution. Sanders and Ngxolo (2009), as well as Schroder (2012), believe that misconceptions regarding evolution can exist because of ignorance. Together with low acceptance of evolution, Abrie's (2010) data shows that poor understanding and misconceptions of evolution are prevalent amongst the student teachers. Common misconceptions were supported by many of the research participants of this study and many of them showed a lack of understanding of the nature of science (Abrie, 2010). A misconception held by some of the learners in Mpeta, De Villiers and Fraser's (2014:19) study was that individual animals undergo evolution "out of choice" due to environmental changes or pressures. Such misconceptions are similar to the previously disproved theory of Lamarckism (Mpeta *et al.*, 2014). In their respective studies, Sanders and Ngxola (2009) and Schroder (2012) found that many learners believe evolution to be only a theory. However, the meaning of a theory, as previously defined, is often misunderstood as an idea that is only speculative. Moreover, Schroder (2012) found that teachers also hold similar misconceptions, which might negatively affect their learners' attitudes towards learning about and accepting

evolution. Also, if teachers hold misconceptions regarding evolution, it will likely lead to them teaching those misconceptions to their learners (Mpeta *et al.*, 2014).

Schroder (2012), in her study about teachers and learners' attitudes towards evolution, believes that resistance to change may be the reason for low levels of acceptance of evolution, regardless of an increase in knowledge about evolution. She also investigated the conceptual changes that occur when learners are taught about evolution, as well as the factors that influence their conceptual changes (Schroder, 2012). Coleman, Stears and Dempster (2015) support Schroder's (2012) statement, as their study found that students' understanding of evolution did not influence their levels of acceptance of evolution. Similar to international research, such as Peker, Comert and Kence (2010) and Rice and Kaya (2010), a quantitative study focused on the correlation between University of KwaZulu-Natal student-teachers' acceptance of evolution and their scientific knowledge regarding evolution and the nature of science (Coleman *et al.*, 2015). Coleman, Stears and Dempster (2015) aimed to quantitatively explore PGCE and BEd students' understanding and acceptance of evolution, as well as their beliefs about the nature of science. Coleman, Stears and Dempster's (2015) study revealed that only the graduate students demonstrated a moderate understanding of evolution. Their results fostered a concern, as it is essential that all biology or Life Sciences teachers ought to demonstrate an adequate understanding of evolution, as well as the nature of science (Coleman *et al.*, 2015). They explained the possible reasons for the students' poor understanding of evolution, which, firstly, included a lack of understanding of the nature of science (which was confirmed by the results of Rutledge and Warden's (2000) study), as the students in their study accepted the nature of science, but lacked knowledge regarding concepts related to it (Coleman *et al.*, 2015). The second possible reason for students' lack of understanding of evolution is a resistance to conceptual change (Coleman *et al.*, 2015), as also found by Schroder (2012). In order for conceptual change to occur, students need to engage deeper with evolutionary concepts, as well as the nature of science, which explains why in Coleman, Stears and Dempster's (2015) study, PGCE students demonstrated a better understanding of evolution and the nature of science, compared to the BEd students, as their undergraduate science studies entailed deep engagement with these concepts. Resistance to conceptual change might in turn influence students' understanding of the theory of evolution

(Coleman *et al.*, 2015). Furthermore, comparing their results to research done by Cavallo and McCall (2008) in the USA, Coleman, Stears and Dempster (2015) found that South African pre-service teachers have a higher acceptance of evolutionary theory and the nature of science.

Coleman, Stears and Dempster (2015) emphasise the importance for South African biology teachers to be competent and demonstrate an understanding of the nature of science and other fundamental concepts, such as evolution, especially since South Africa is a developing country in a very competitive global economy. However, many South African biology teachers lack proper training and education regarding the theory of evolution as a biological process (Coleman *et al.*, 2015). Teachers' understanding of the nature of science and evolution may influence the way they teach the theory of evolution, which has a consequential influence on the way their learners understand the nature of science, as well as evolution, which can be particularly problematic due to its controversy, where numerous misconceptions may abound as a result (Coleman *et al.*, 2015). In order to foster competent biology teachers, teacher education programmes need to include adequate education of evolution and the nature of science (Coleman *et al.*, 2015).

Kyriacou, de Beer and Ramnarain (2015) investigated the evolutionary ideas of 57 practicing Natural Sciences and Life Sciences teachers (from different cultural and educational backgrounds) undergoing professional development in evolution education. Half of the teachers taught at affluent suburban schools and half taught at less affluent township and rural schools (Kyriacou, de Beer and Ramnarain, 2015). A poor understanding of natural selection was displayed in 78% of responses. Moreover, discrepant data about human evolution was found, such as the acceptance of human evolution responses and creationistic responses which indicated the possibility of fragmented knowledge of human evolution (Kyriacou, de Beer and Ramnarain, 2015). The development of critical thinking skills through focusing on the data and mechanisms of evolution was recommended by Kyriacou, de Beer and Ramnarain (2015) after some responses contained the idea that people evolved from monkeys, which was linked to a racist agenda. Certain respondents' answers suggested that "cognitive bias constrains an understanding of evolution" (Kyriacou, de Beer and Ramnarain,

2015:126). Kyriacou, de Beer and Ramnarain (2015) stated that cognitive biases of essentialism and teleological reasoning (which is resistant to change) need to be taken into account for the design of teacher learning programmes. An interesting alternation between creationist and evolutionist responses was found and evolutionary ideas were more accepted when questions focused on more concrete ideas, rather than theoretical ones (Kyriacou, de Beer and Ramnarain, 2015). Furthermore, about half of the respondents in Kyriacou, de Beer and Ramnarain's (2015) study suggested that evolution does not disprove their religion; in other words, that the two concepts are not mutually exclusive. The latter suggested that teachers who willingly attend teacher professional development programmes might be more open to new information.

Keke's (2014) study, aiming to understand biology teachers' engagement with professional development programmes and the benefits of such programmes, found that evolution-related topics were the topics of the Grade 10 to 12 Life Sciences curriculum where teachers expressed the greatest need for professional development. Keke (2014) has found that teachers benefit significantly from professional development programmes, as well as hands-on training. Even though professional development programmes and other training can improve teachers' teaching of the theory of evolution, they may still face other challenges pertaining to the teaching of evolution, which are explored below.

2.4.3.3. A South African perspective on evolution and school biology: The challenge of assessment, pedagogical and environmental pressures in the classroom

Educational contexts experience controversy with evolution through conflicting demands and the reluctance to teach it, as many perceive it a contradiction to various religious beliefs (Sanders and Ngxola, 2009). While having to accommodate all belief systems in the classroom, many teachers fear public antagonism or undermining students or communities' beliefs or rights (Sanders and Ngxola, 2009). In 2008, when evolution was officially introduced into the curriculum in South Africa, some teachers omitted it from their teaching and others waited until the last minute, only to skim over it (Sanders and Ngxola, 2009). The Life Sciences matriculation results of 2008 revealed that a number of schools' learners omitted evolution-related questions, which, according to Sanders and Ngxola (2009),

suggests that they have not been taught about evolution. Abrie's (2010) study, which is elaborated on in sub-section 2.4.3.2, also found that many teachers are reluctant to teach the theory of evolution, which is a challenge for the education of evolution in schools. Also, teachers face the challenge of dealing with learners or parents reluctant to learn about evolution (Holtman, 2010). Schroder's (2012) study found that a main barrier to learning evolution is resistance to change. A lack of motivation to learn about evolution is another challenge that teachers might face in the classroom. Teachers can encourage learners to become motivated toward learning about evolution; however, the learners' decision to learn ultimately relies on themselves (Mpeta, De Villiers and Fraser, 2014). Some creationist-orientated learners indicated a "strong will to learn", whether their motivation was to falsify evolution or pass their examinations (Mpeta et al., 2014:18).

2.5. A synthesis of studies reviewed

Based on the international and South African literature, recommendations were made regarding issues pertaining to the education of evolution. Such recommendations are discussed below in sub-section 2.5.1. After reviewing the literature, recurring themes were identified. Such themes are elucidated on in sub-section 2.5.2. Lastly, the gaps and omissions pertaining to the literature reviewed are acknowledged in sub-section 2.5.3.

2.5.1. Recommendations based on the literature reviewed

2.5.1.1. Recommendations regarding the challenges pertaining to religion, belief systems, 'alternatives' to evolution and the acceptance of the theory of evolution

Teachers face certain challenges in the classroom when having to teach the theory of evolution, especially pertaining to strongly religious learners (Abrie, 2010). Therefore, Abrie (2010) recommends, as previously stated, that teachers be provided with instructional material and development strategies in order to deal with issues pertaining to evolution conflicting with learners' belief systems. Moore (2008) recommends that biology teachers make learners aware of the fact that many scientists include evolution into their religious beliefs; thus, one does not need to reject evolution to hold religious beliefs. Similarly, Kagan

and Sanders (2013) drew on Martin (2011:420) who noted that a stumbling block to the teaching of evolution is "the common perception that secular people are pro-evolution and religious people are anti-evolution", especially if individuals believe that evolution will contradict their religion. Kagan and Sanders (2013) recommend that teachers become aware of whether their learners have fundamentalist religious ideas, as it may assist them in helping their learners adjust form their familiar worldviews into the world of science. Mpeta, De Villiers and Fraser (2014) also suggested the latter. Based on the results of their study, as discussed, Mpeta, De Villiers and Fraser (2014) recommended that future studies might explore ways in which the acceptance of evolution can be fostered, through using religious beliefs or worldviews as scaffolds when teaching evolution, which might be especially helpful for deeply religious learners who experience conflicts with their religious beliefs and evolution. Furthermore, they also suggest that critical evaluation of evolution might be enhanced through placing an emphasis on the nature of science when teaching evolution (Mpeta *et al.*, 2014). Stears, Clément and Dempster (2016:8) recommend that the conflict that teachers experience with regards to teaching evolution might be reduced if a better understanding is obtained regarding the relationship between teachers' religious beliefs and their positioning on the "creationist-evolutionist continuum". Furthermore, they encourage the intervention of pre-service teacher education and in-service professional development programmes (Stears *et al.*, 2016). Coleman, Stears and Dempster (2015) emphasise the importance for student teachers to accept evolution, as it is a fundamental aspect of biology. Based on their results, Coleman, Stears and Dempster's (2015) recommend that sound pedagogies be adopted in order to present evolution in a better light in order to foster the acceptance of evolution. Another way in which acceptance of evolution might be fostered, especially in classrooms with religious students who perceive conflict between evolution and their religion, might be the reconciliatory approach recommended by Tolman, Ferguson, Mann, Maskiewicz Cordero and Jensen (2020). Such an approach emphasises the compatible nature of religious beliefs (in Tolman and colleagues' (2020) case referring to Judeo-Christian beliefs) with the nature of evolution, which might minimise the dichotomy between religious beliefs (faith) and science and increase the acceptance of the theory of evolution in biology classrooms - without decreasing individuals' religiosity (Tolman *et al.*, 2020).

Stahi-Hitin and Yarden (2022), who researched scientists' and teachers' (from Israel) attitudes toward relating to religion when teaching evolution, made various recommendations based on their findings. Firstly, Stahi-Hitin and Yarden (2022) recommend that students' free choice of personal belief must be considered and that the attempt to actively try to convince students to accept evolution might achieve the opposite result. Secondly, it is important for teacher professional development courses to include solutions to conflicts that different cultures might have regarding evolution (Stahi-Hitin and Yarden, 2022). Thirdly, it is important that the border between religion and science be defined; emphasising the meaning of the nature of science and the nature of religion might enable teachers to help their students distinguish between the two (Stahi-Hitin and Yarden, 2022). Fourthly, it is suggested that teachers collaborate with experts, such as religious leaders and scientists. Stahi-Hitin and Yarden (2022) state that many Jewish rabbis, for example, the understanding of the creation story should not be understood literally; therefore, it might be helpful for teachers to be aware of possible religious perceptions of the creation story.

2.5.1.2. Recommendations regarding the challenges pertaining to knowledge of, understanding of, misconceptions about and the acceptance of the theory of evolution

Based on the fact that Rutledge and Warden's (2000) study found teachers that are unequipped to teach the theory of evolution in their biology classrooms, they recommended that pre-service teachers develop a thorough understanding of the theory of evolution and the nature of science in their teacher-education in order to combat the challenges of teaching evolution. Rutledge and Mitchell's (2002) results suggest that biology teachers' preparatory programs need critical evaluation and modification in order to improve teachers' teaching of evolution. Based on the results of their study, Rutledge and Mitchell (2002) recommend teacher education to include specific evolution courses, as well as courses on the nature of science in order to promote biology teachers' appreciation for and responsibility towards their teaching of evolution as the foundation of biology. Furthermore, in-practice teachers ought to be able to access courses on evolution and the nature of science to improve their understanding thereof (Rutledge and Mitchell, 2002). There are many unknown factors that impact the teaching of evolution (Rutledge and Mitchell, 2002). In order to further improve the teaching and preparation of the teaching of evolution, the manner in which evolution is taught, the methods used for its instruction and the focus of its instruction need elucidation

(Rutledge and Mitchell, 2002).

Given that Korte (2003) found that one in eight secondary Life Science teachers in Ohio rejects the theory of evolution, the assessment of how teachers' personal and religious convictions could negatively impact their teaching of evolution, is strongly recommended. Based on the conclusion that teachers' knowledge of evolution correlates with their acceptance of evolution, and vice versa, Korte (2003) recommended teacher training courses that covered more information on the theory of evolution in order to improve teachers' knowledge and consequently their pedagogical outcomes with respect to evolution. Based on the fact that Korte (2003) found a positive correlation between knowledge of evolution and teaching experience, Korte recommends that teachers educate themselves on the theory of evolution by using available sources, as well as partaking in university courses to increase their knowledge. Korte (2003) also recommends that the teacher training courses, in-service and professional development programmes in Ohio offer satisfactory coverage of evolution in order to increase pre-service and in-service teachers' knowledge and ensure successful curricular planning. Lastly, it is recommended that the national and state standards (in the USA) be revised to ensure that proper emphasis is placed on the education of the nature of science and that the expectations for science teachers regarding the teaching of evolution is clear (Korte, 2003).

Nehm and Schonfeld (2007) recognised that the problem of the teaching of anti-evolutionism cannot be addressed when only focusing on the knowledge of evolution; problems in relation to beliefs need also be addressed. The literature that addresses the latter issues is discussed in section 2.3.2. Paz-y-Miño and Espinosa (2009) recommend that a proper education of scientific literacy should generate an appreciation for and the acceptance of science and technology, including the scientific discoveries with regards to evolution. Dunk, Petto, Wiles and Campbell (2017) deem the acceptance and understanding of the theory of evolution as essential in education. Therefore, the results of Dunk, Petto, Wiles and Campbell (2017) led to the recommendation to increase the instruction of the nature of science, as well as the instruction of liberal arts in order to increase the acceptance of evolution. Based on the results of their study, as previously discussed, Plutzer, Branch and Reid (2020) recommend that the

mixed messages being sent in classrooms regarding evolution be examined. They further recommend the identification of strategies to discourage the teaching of creationism, as well as to foster teachers who are able to present the theory of evolution in a scientifically accurate manner (Plutzer *et al.*, 2020).

According to Peker, Comert and Kence (2010), in order for undergraduates to make better informed decisions about life's origin and history, they need better education of the theory of evolution. Furthermore, they believe that a student's democratic right to learn about the science of the origin of life is taken away if they are deprived of learning about evolution (Peker *et al.*, 2010). The results of Peker, Comert and Kence's (2010) study led to their criticism of Turkey's evolution education and a call for change towards better evolution education in Turkish schools. Their concerns regarding Turkey's science education were motivated by their belief that biology educators and biologists are ethically responsible to promote evolutionary theory over pseudoscience (Peker *et al.*, 2010). According to Peker, Comert and Kence (2010:754), rather than being another chapter in a biology textbook, the theory of evolution ought to be "the guiding theoretical lens in interpreting and explaining biological phenomena". Also concerning the education of evolution in Turkey, Rice and Kaya (2010) recommend that steps need to be taken to foster a better understanding of the theory of evolution, rather than avoiding the issue (of the rejection of evolution) or compromising conflicting religious beliefs. They concur with Scharmann (2005) in that discussing the benefits of evolution, such as the development of antibiotics, vaccines and herbicides, can encourage evolutionary understanding (Rice and Kaya, 2010). Thus, Rice and Kaya (2010) agree with Scharmann (2005) that the focus of evolutionary instruction should not be on believing, but rather on understanding, which might foster acceptance as a result. According to Rice and Kaya (2010:176), it is of vital importance that learners be taught "correct science", where they refer to evolution as a crucial topic for acquiring scientific literacy.

Chinsamy and Plagányi (2007) propose that evolutionary biologists ensure that teachers are well informed about evolution, by developing evolution-based workshops for working teachers, for example. Such workshops might better equip them to teach evolution (Chinsamy and Plagányi, 2007). Better trained and informed teachers might result in better informed

individuals, where the ones who enter university are better prepared and the ones who do not, have a more informed perception about evolution (Chinsamy and Plagányi, 2007). Regarding university students, they recommend that lecturers emphasise the scientific method of inquiry, as well as provide the students with examples of experimental evolutionary studies, as students tend to be more amenable to changing their opinions if they are presented with "facts" (Chinsamy and Plagányi, 2007:253).

Based on the results of Abrie's (2010) study, the educational implications were discussed and recommendations were made. Firstly, Abrie (2010) emphasises the importance for teacher training programmes to improve future biology teachers' understanding of the theory of evolution, with a specific focus on student teachers who have never been exposed to evolution. In addition, practicing teachers who have not been exposed to evolution should be offered re-training of evolution (Abrie, 2010). Thus, it is recommended that biology-focused teacher training programmes be critically evaluated and specifically offer courses on evolution and the nature of science (Abrie, 2010). The National Curriculum Statement (Department of Education, 2003), the curriculum statement at the time of Abrie's (2010) study, allowed teachers with 20% of freedom to adapt curriculum content to their locational contexts; however, since Abrie (2010) found a lack of understanding of the theory of evolution, these student teachers might find it difficult to evaluate and apply the content to their own contexts when they become teachers.

Based on their results, which showed that there was a lack of understanding of the theory of evolution, Coleman, Stears and Dempster (2015) recommend that all biology-related teacher education modules include an integration of evolution and the nature of science in order to engage students at a deeper level and consequently develop a better understanding of evolution and the nature of science. According to Coleman, Stears and Dempster (2015) this is important, as South African teachers ought to demonstrate in-depth knowledge and understanding of their respective disciplines in a competitive global economy. Furthermore, considering South Africa's economic constraints, they recommend that funding for teacher professional development courses ought to be considered very carefully (Coleman, Stears and Dempster, 2015). Therefore, their study's findings suggest that teacher professional

development courses focus on developing the understanding and knowledge of evolution and the nature of science (Coleman, Stears and Dempster, 2015). They also propose that students' measure of exposure to evolution in their university setting, as well as professional development programmes, may possibly strengthen their acceptance of evolution (Coleman, Stears and Dempster, 2015). Based on their research in France, Quessada and Clément (2018) recommend that evolution education might be improved by an interdisciplinary approach, combined with an epistemological and historical approach to aid students in understanding scientific knowledge and to distinguish between science and religion. Teacher training is recommended to focus on facilitating debates between students (Quessada and Clément, 2018).

2.5.1.3. Recommendations regarding the challenge of assessment, pedagogical and environmental pressures in the classroom pertaining to evolution in education

Based on the results of their research, Chiapetta and Fittman (1998) emphasise the need for the core biology topics that unify the "big picture", to be specified, as teachers might struggle to choose the important topics on their own (Chiappetta and Fittman, 1998:16). Chiappetta and Fittman's (1998) study resulted in the recommendation that biology teachers ought to teach their students about the big ideas of biology, rather than teaching too much content and focusing on specific topics. Specific topics need only be covered in order to unify principles and develop the major themes of biology (Chiappetta and Fittman, 1998). In South Africa, there remain a number of challenges pertaining to the teaching of evolution. In order to prevent the perpetuation of the educational inequalities of the past, Dempster and Hugo (2006:112) recommend the explicit "teaching of Darwinian evolution at school[s]". The results of Chinsamy and Plagányi's (2007) study led to an emphasis on the importance of teachers to be aware of the challenges they might face when teaching their learners about evolution. Chinsamy and Plagányi (2007:253) recommend that teachers create a supportive classroom atmosphere in order to ensure that evolution is well understood, even if challenges may arise, such as conflicts with learners' belief systems, as "evolution often challenges pre-existing conceptual ideas". Focusing on what happens in the classroom, teachers need detailed instructional material and development strategies that may help them deal with some of the challenges they may face (Abrie, 2010). Abrie (2010:107) states that, even though such

actions may not change the minds of many learners, "learners would at least be encouraged to explore the issues with more information at their disposal." Abrie (2010) also recommends that all teachers should be able to access detailed instructional material, prepared by well-informed professionals who are aware of the challenges of the teaching of evolution.

2.5.2. Common themes emerging from the literature

Throughout the review of the literature on this topic, certain recurring themes emerged. Overall, it was found that teachers' experiences of teaching evolution are largely dependent on their attitudes toward evolution. Their attitudes toward evolution determine their acceptance, neutrality or rejection of evolution. Their attitudes, as the literature indicates, can be influenced by various factors such as their background, religion, belief system, worldviews, knowledge of evolution, understanding of evolution and/or by the influences of assessment, pedagogical and environmental pressures. The following sub-sections name these themes.

2.5.2.1. Worldviews, including religious beliefs, of learners and teachers influence the teaching of evolution in terms of the acceptance of evolution, controversy and conflicts in the classroom

The literature has shown that teachers' cultural, political and even socio-economic backgrounds can all have an influence on their worldviews and subsequently on how they experience teaching evolution. Teachers' identities are influenced by their backgrounds and sociocultural environments (Goldston and Kyzer, 2009). According to Mpeta, De Villiers and Fraser (2014), one's exposure to the world, one's existence and the world's existence and how one matures in one's world, determines one's worldview. Worldviews, which are collections of beliefs based on ontology, can be relevant when discussing the theory of evolution. Studies conducted by Rutledge and Mitchell (2002), Paz-y-Miño C. and Espinosa (2009), Mpeta, De Villiers and Fraser (2014), Coleman, Stears, James and Dempster (2015) and Stears, Clement, James and Dempster (2016) found that religion influences the acceptance of the theory of evolution. Research has also shown that religious beliefs and/or belief systems can interfere with people's understanding or acceptance of scientific concepts,

such as evolution, and vice versa (Rutledge and Mitchell, 2002; Trani, 2004; Chinsamy and Plagányi, 2007; Abrie, 2010; Mpeta *et al.*, 2014; Coleman *et al.*, 2015, Stears *et al.*, 2016). Abrie (2010) pointed out that religion is a stumbling block to evolutionary acceptance in their study, and is also supported by Downie and Barron (2000), Rutledge and Mitchell (2002) and Trani (2004). Thus, people's deeply entrenched religious beliefs may interfere with their objectivity towards appreciating or acknowledging the scientific validity of certain topics, such as evolution (Mpeta *et al.*, 2014). Even though worldview and religion can correlate with one another, it is also important to note, however, that an individual with a theistic worldview is not necessarily religious (Mpeta *et al.*, 2014).

Alters and Nelson (2002) state that many religious students in The United States of America might seek compatibility between their own religious beliefs and scientific origins, whereas Chinsamy and Plagányi (2007), Schroder (2012) and Mpeta, De Villiers and Fraser (2014) highlight the conflicts that individuals experience with regards to their belief systems and the theory of evolution. A topic of discussion in various studies on evolution and education is creationism (Moore and Kraemer, 2005; Chinsamy and Plagányi, 2007; Paz-y-Miño C. and Espinosa, 2009; Sanders and Ngxola, 2009; Abrie, 2010; Schroder, 2012; Stears *et al.*, 2016). According to Paz-y-Miño C. and Espinosa (2009), creationism refers to the assumption that a Creator created the universe and all forms of life. Most scientists do not regard creationism as a naturalistic explanation of the cosmos (Moore and Kraemer, 2005; Paz-y-Miño C. and Espinosa, 2009). However, it is important to note that different kinds of creationism exist; therefore, even though opposition to evolution might result in anti-evolutionism, not all creationists deny evolution (Mpeta *et al.*, 2014). Furthermore, Mpeta, De Villiers and Fraser (2014:3) have noted that the acceptance of evolution seems to vary depending on the different levels of the "creation/evolution continuum". The famous evolutionist, Dobzhansky (1973:127), acknowledged that he himself is a "creationist and an evolutionist", since he believed that God or Nature created life through evolution. Sanders and Ngxola (2009) acknowledged that the influence of creationism has caused problems in education relating to the instruction of the theory of evolution. According to Cooper (1996), when evolution is discussed, one cannot avoid the discussion of creation, since learners will raise the issue if not raised by teachers; however, raising such issues allows the introduction of creationism

into the classroom as an alternative to evolution by religiously bias teachers (cited in Abrie, 2010), which is further elucidated in sub-section 2.5.2.2. Thus, it is recommended by Abrie (2010) that teachers are provided with the tools to inform learners about evolution and deal with issues in relation to evolution conflicting with their belief systems.

It was acknowledged by Chinsamy and Plagányi (2007) that anti-evolutionism appears to be driven by advocates for intelligent design. Intelligent design is the assumption that a Designer guided the complex biological systems we have today, according to Paz-y-Miño C. and Espinosa (2009). Moreover, intelligent design disregards Darwinism as an explanation for the natural world's origin and evolution (Paz-y-Miño C. and Espinosa, 2009). Stears, Clément and Dempster (2016) acknowledge that there is a connection between creationism and intelligent design, stating that the latter is a branch of creationism. Furthermore, they describe intelligent design as a belief that finds evidence of an "intelligent being['s]" creation in the study of the complexity of living organisms (Stears *et al.*, 2016:3).

2.5.2.2. Worldviews, including religious beliefs, of learners and teachers influence the teaching of evolution in terms of the time spent on teaching the theory of evolution or the teaching of 'alternatives to evolution'

According to Moore (2008) and Trani (2004), a large portion of public school biology teachers in the USA still teach creationism in their classrooms. Abrie's (2010) study in South Africa also concluded that a creationist viewpoint is taught in some biology classrooms. Abrie (2010) stated that some teachers might even alternatively teach their own beliefs in the place of evolution. According to Sanders and Ngxolo (2009), several studies found a correlation between teachers' beliefs regarding evolution and the time they spend teaching evolution (Sanders and Ngxola, 2009). The perceived controversy of evolution in education has caused its teaching to be omitted by many teachers or the inappropriate teaching thereof (Sanders and Ngxolo, 2009; Abrie, 2010). Supporting Trani's (2004) statement that teachers' religious convictions may influence their likeliness to teach evolution, Abrie's (2010) study showed that, even though evolution is a compulsory part of the South African curriculum, the majority of student teachers were unwilling to teach it. It was predicted by Abrie (2010) that some of them might even treat evolution only as a compulsory topic, rather than the unifying

theme of modern biology.

Long (2012) suggests that democratic education be upheld without undermining science in the name of religion. Considering the results of Moore (2008), Trani (2004), Sanders and Ngxola (2009) and Abrie (2010), in terms of the inappropriate teaching of evolution, the latter requirement can be regarded as another challenge that teachers might face in the classroom while teaching the theory of evolution, as many teachers fail to meet this requirement. As shown, an individual's background, religious beliefs and environment can influence their experience of teaching evolution; however, their knowledge of the theory of evolution and exposure to evolution need elucidation as well.

2.5.2.3. Knowledge and understanding of the theory of evolution can influence the acceptance and teaching of evolution and vice versa

As shown in the review of the international and South African literature, knowledge of evolution and the nature of science (in other words, education of evolution), and subsequently the understanding of the theory of evolution influences an individual's stance for evolution as a scientific theory (Korte, 2003; Trani, 2004; Paz-y-Miño C. and Espinosa, 2009; Rice and Kaya, 2010; Baker, 2013; Dunk *et al.*, 2017). Rutledge and Warden (2000) has found that an understanding of evolution impacts the teaching thereof, and knowledge and understanding thereof influence the acceptance of evolution. Korte (2003) found that knowledge of evolution has a positive correlation with the acceptance of evolution and vice versa, as also found by Rutledge and Mitchell (2002). Peker, Comert and Kence (2010) found a positive correlation between biology and science education and the acceptance of evolutionary theory; similar to Rutledge and Warden (2000) who found that academic background impacts the teaching of evolution. An interest in learning about the theory of evolution has a positive correlation with the acceptance and understanding of evolution (Peker *et al.*, 2010). Thus, most studies found a positive correlation between knowledge and/or understanding of evolution and the acceptance of evolution. However, Nehm and Schonfeld (2007) made the conclusion that one cannot assume that educational background determines a teacher's knowledge of evolution, nor does increased knowledge of evolution necessarily induce a change in attitude toward evolution. Nehm and Schonfeld (2007) found that an increased

knowledge of evolution, does, however, lead to a decrease in misconceptions regarding the theory.

2.5.2.4. Misconceptions on evolution and/or the nature of science influence the teaching of evolution

Misconceptions regarding evolution and/or the nature of science influence individuals' attitudes toward evolution (Rutledge and Mitchell, 2002; Chinsamy and Plagányi (2007; Nehm and Schonfeld, 2007; Moore, 2008; Sanders and Ngxola, 2009; Rice and Kaya, 2010; Schroder, 2012; Mpeta *et al.*, 2014). If teachers hold misconceptions regarding evolution, it will likely lead to them teaching such misconceptions to their learners (Mpeta *et al.*, 2014), which creates more educational challenges. Such challenges include the following. If misconceptions are held against evolution by teachers or learners, it might influence the attitudes toward and/or acceptance thereof. When learners hold misconceptions regarding evolution, it creates challenges for teachers to attempt to rectify those misconceptions. Even though lack of knowledge and misconceptions might contribute to the rejection of teaching evolution, other factors – such as assessment, pedagogical and environmental pressures, emotional rules and the importance of evolution in biology – may also be relevant.

2.5.2.5. Assessment, pedagogical and environmental pressures, as well as the importance of evolution in biology and emotional rules, influence the teaching of evolution

An overwhelming content-dense curriculum can influence teachers' teaching of evolution, as it might cause pressure to get through the content, instead of focusing on other important pedagogical factors (Chiapetta and Fittman, 1998). Twenty-two percent of the Grade 12 Life Sciences curriculum consists of evolution-related topics, which places great pressure on teachers to teach it effectively to obtain good results (Stears *et al.*, 2016). Dempster and Hugo (2006) highlighted how core content statements relate to evolution in the South African curriculum for Natural Sciences and Life Sciences. Their investigation of these curricula, stating that, for example, one quarter of the Grade 12 Life Sciences curriculum related to the theory of evolution (Dempster and Hugo, 2006), emphasises the importance of evolution in Life Sciences. Dobzhansky (1973:125) believed that "[n]othing in biology makes sense

except in the light of evolution". Some teachers might feel pressure or the need to promote the acceptance of evolution. Some teachers might want the opposite. As discussed before, Long (2012) made the conclusion that public education teachers ought to uphold and explore science in the name of democratic education. Long (2012) and Dunk, Petto, Wiles and Campbell (2017) emphasise the importance of public education to foster an openness to change in beliefs; however, resistance to change, as found by Schroder (2012) might complicate teachers' experiences of teaching evolution. The importance of the theory of evolution in Life Sciences (as stated by Dobzhansky), as well as the external expectations of teachers to uphold science in the name of democratic education, with a focus on fostering an openness to experience, may put extreme pressure on teachers who experience any discomfort or conflict with teaching the theory of evolution. Furthermore, conflicting demands from parents and/or learners, as well as the external expectations of teachers to motivate their learners to learn about the theory of evolution, further complicate their experiences (Sanders and Ngxola, 2009; Holtman, 2010).

Lastly, not only do the parents and/or learners influence teachers' experiences of teaching evolution (Sanders and Ngxola, 2009; Holtman, 2010), but teachers' own worldviews, as stated, and attitudes toward evolution influence their experience of teaching evolution. Zembylas (2003) mentions how not conforming to emotional rules, such as being reluctant to teach a certain pedagogy, might make a teacher feel isolated, foster negative emotions or make them feel like the subject of attention. Emotional rules might also influence teacher-self identities (Zembylas, 2003). Thus, emotional rules, such as expecting of teachers to teach evolution no matter their cultural and religious background, might influence teachers' lived experiences of teaching evolution.

In this synthesis of studies reviewed, I have shown that there are various factors that influence teachers' experiences of teaching the theory of evolution in public schools. Such factors include external pressures from the government and parents, pressure from learners, emotional rules and teachers and learners' worldviews, including religion or belief systems, knowledge of, understanding of and misconceptions about the nature of science and the theory of evolution.

2.5.3. Gaps and omissions in the literature reviewed

Many studies focus on pre-service teachers or teachers' acceptance of and attitudes toward evolutionary theory (Korte, 2003; Chinsamy & Plagányi, 2007; Rice & Kaya, 2010; Abrie, 2010; Long, 2012; Coleman *et al.*, 2015). Most studies reviewed regarding the education of evolution are empirical or are based on student-teachers and the controversy between evolution and religion. Various studies focus on the acceptance of evolution, teachers' attitudes toward teaching evolution, their concerns regarding teaching evolution or misconceptions that teachers or pre-service teachers might have regarding evolution (Rutledge and Warden, 2000; Rutledge and Mitchell, 2002; Korte, 2003; Trani, 2004; Moore and Kraemer, 2005; Chinsamy and Plagányi, 2007; Nehm and Schonfeld, 2007; Moore, 2008; Paz-y-Miño C. and Espinosa, 2009; Abrie, 2010; Peker *et al.*, 2010; Rice and Kaya, 2010; Long, 2012; Schroder, 2012; Baker, 2013; Mpeta *et al.*, 2014; Stears *et al.*, 2016; Coleman *et al.*, 2015; Dunk *et al.*, 2017). However, there is a lack of research regarding the individual lived experiences of teachers having to teach evolutionary concepts, not only in South Africa, but also internationally. The studies that focus on teachers specifically do not highlight their lived experiences of teaching evolution; thus, my research project focuses on the latter.

Furthermore, it would be interesting to witness how Life Sciences teachers' religious beliefs contribute to their experiences of teaching evolution as a topic in the classroom. Even though the latter has been addressed quantitatively by authors, such as Rutledge and Warden (2000) in the USA and Abrie (2010) in South Africa, Baker (2013) recommends that more qualitative research be done on individuals' educational paths in order to understand how their education influences their general religious identities, as well as their views on human origins and evolution. It has been realised that there is a lack of studies focusing on the individual lived experiences of Life Sciences teachers holding different belief systems and the influence that their religious beliefs might have on their experiences teaching evolution. Furthermore, according to Baker (2013), research on the role that specific types of education plays on individuals' acceptance of evolution might be a meaningful contribution to educational

research. Thus, my research project aims at making such contributions to educational research through asking open-ended questions about the five Life Sciences teachers' educational backgrounds in general, their educational backgrounds with regards to learning about the theory of evolution, their respective religious beliefs and their experiences of teaching evolution in their semi-structured interviews. It is hoped that the teachers' answers to these questions might bring about meaningful qualitative data and conclusions.

Moore and Kraemer (2005) recognised the fact that the research participants in their study were voluntary, as well as the fact that they all came from diverse backgrounds, contributed to the limited nature of the study. Therefore, it is acknowledged that a limitation to my research project is that purposive sampling was used, as there are only five research participants, each holding a different religion or belief system from one another. Thus, limiting the study to only the contexts of the specific individuals interviewed. Furthermore, the research participants who agreed to take part in this research project did so voluntarily; thus, it is a limitation, as only Life Sciences teachers who are willing to speak about this specific topic took part in this study. Also, based on the limitations of Moore and Kraemer (2005), it is realised that the conclusions made from this research project will be limited to the specific contexts of the respective research participants. Hence, generalisations cannot be made.

Sanders (2018) made a number of conclusions from research she has done, as well as from others' research. My study takes these lessons into consideration. Firstly, Sanders (2018) emphasises the importance of addressing teachers' needs and concerns regarding teaching evolution. Secondly, knowledge about evolutionary theory reduces concerns and misconceptions and promotes positive attitudes towards it (Sanders, 2018). Sanders (2018) points out the problematic nature of stereotyping people's views about evolution based on their religions. The latter shall be avoided in my study as only open-ended questions are asked in the semi-structured interviews. Another problem is the over-generalisation of literature based on minimal evidence which can create unrealistic expectations (Sanders, 2018). As stated, my research project's results cannot be generalised, as it focuses on the detailed lived experiences of individuals with unique contexts; however, what can be learned

from each individual case might enrich the value of this study and possibly inform larger studies. The importance of results being context-dependent is emphasised by Sanders (2018); therefore, my study acknowledges the individual contexts of all five research participants.

The international and national research mentioned in my literature review might contribute and provide the foundation to my potential study; however, the gap in the literature might be interesting and academically contributive if explored. This gap, as mentioned in my problem statement, is the lack of the interpretive investigation or compassionate understanding of individual teachers that experience teaching the theory of evolution. Therefore, this study specifically focus on Life Sciences teachers, belonging to different 'religious beliefs', and their experiences of teaching evolution.

2.6. A focus on lived experience

As this research project focuses on the lived experiences of five Life Sciences teachers, belonging to different 'religious' beliefs, focusing on the teaching of evolution, it is important to clarify what is meant by 'lived experience'. Thus, in this section, I will define lived experience, as well as briefly discuss a few studies that particularly focused on biology or Life Sciences teachers' lived experiences.

2.6.1. What does 'lived experience' mean?

In Max Van Manen's (1990:35) book, *Researching Lived Experience: Human Science for an Action Sensitive Pedagogy*, drawing on Dilthey (1985), he described lived experience as "our immediate, pre-reflective consciousness of life: a reflexive or self-given awareness, which is, as awareness, unaware of itself." Van Manen (1990) explains that lived experience can only become apprehended upon reflection of the past and cannot be fully understood at presence. Since lived experience is dependent on all aspects of life, it is difficult to grasp the full "richness and depth" of lived experiences (Van Manen, 1990). If a particular lived experience of an individual is interpreted, it must always be examined in relation to the totality of the individual's life, since a particular lived experience is "part of a system of contextually

related experiences" (Van Manen, 1990:37). When doing research upon lived experiences, it is more important to focus on how the research participant experienced a particular incident than the actuality of the incident (Van Manen, 1990). Lived experiences are described from the inside (referring to feelings, emotions and moods), it typically focuses on specific examples or incidents and, lastly, takes the five senses into consideration (Van Manen, 1990).

2.6.2. A brief review of studies done on biology and/or Life Sciences teachers' lived experiences

Focusing on the narratives of three biology teachers in Alabama, USA, Goldston and Kyzer (2008) explored the factors that influenced their teaching of the theory of evolution. Even though their study's focus was not particularly on these three teachers' lived experiences of teaching evolution, their study provides meaning to this literature review as it is closely related to my topic of research. They gathered information through observations, as well as interviews with the teachers regarding their "backgrounds, education, teaching experiences and general demographics", as well as teaching strategies for dealing with controversial topics such as the theory of evolution (Goldston and Kyzer, 2008:768). They have found that the biology teachers' identities, which were dependent on their sociocultural backgrounds, as well as state standards, assessment pressures and teacher autonomy, influenced their pedagogical decisions regarding the teaching of evolution (Goldston and Kyzer, 2008). Their study explains how the complicated nature of the enactment of the curriculum can be understood through looking at teachers' sociocultural worlds (Goldston and Kyzer, 2008). The teachers' decisions regarding the teaching of evolution were influenced by their community's perceptions on the topic, as well as the impact evolution might have on their learners' religious views (Goldston and Kyzer, 2008). Furthermore, the teachers' own acceptance of evolution influenced their pedagogical decisions regarding the theory of evolution, as well as concerns regarding conflicts pertaining to evolution, the state's standards and their accountability regarding examinations (Goldston and Kyzer, 2008). One of the teachers in Goldston and Kyzer's (2008) study, used her teacher autonomy and decided not to teach evolution due to the community's perceptions regarding evolution, her own religious affiliations, as well as the knowledge that evolution will not be present in the

graduation examinations, whereas the other two teachers accepted and taught the theory of evolution, but in different manners. Although, both teachers used the textbook as a reason to avoid conflict (Goldston and Kyzer, 2008). Goldston and Kyzer (2008) found that the reconstruction of pedagogy occurs when controversial topics, such as evolution, is taught, which is not the case for non-controversial topics. Moreover, such reconstructions are influenced by the teachers' perceptions of the community and their learners' belief systems and perceptions of evolution (Goldston and Kyzer, 2008). Goldston and Kyzer (2008) acknowledge that the subjective nature of their research participants' experiences and thoughts is a limitation to the study, such as their perceptions of the local community's perceptions on evolution. As my research project will only obtain data (lived experiences) through semi-structured interviews, the subjective nature of the data is, therefore, a limitation. The number of participants interviewed, as well as the snippets of experiences discussed, also limit Goldston and Kyzer's (2008) study, as will my study's number of research participants and subjective experiences limit it to particular individuals and contexts.

A Master of Art thesis' study by Nishizawa (2017) in Canada, focused on how and if five biology teachers' lived experiences in place influenced their teaching. Unstructured open-ended interviews were used to gather data and thematic analysis was used for data analysis (Nishizawa, 2017). The former differs from my research project, while the latter coincides therewith. It was found that the biology teachers shared experiences that were similar, but with different meanings to the individual teachers (Nishizawa, 2017). It was also found that the degree to which their pedagogies were influenced by their lived experiences in place, are different from one another (Nishizawa, 2017). Furthermore, Nishizawa (2017:82) found overlapping themes in relation to the biology teachers' "personal and professional lifeworlds." In relation to my research project, the findings of Nishizawa's (2017) study are not as relevant as the particular focus on lived experiences is. Nishizawa's (2017) study emphasises the uniqueness and humanness of each individual teacher's pedagogy, which is influenced by their respective contexts. As Van Manen (1990) states, the researcher needs to let the research participant narrate their experiences freely, while also having to interpret such experiences based on the participants' lifeworlds, all the while refraining from imposing one's own agenda. Based on the requirements made by Van Manen (1990), the difficulty of

representing the biology teachers' lifeworlds from the writer's perspective is acknowledged by Nishizawa (2017). Through reflection upon the deep and passionate conversations with the biology teachers about their pedagogy, it was suggested by Nishizawa (2017) that more holistic approaches be used for science education, with a specific focus on individuals' consciousness of the spaces they occupy.

A study conducted in Namibia for a master's thesis, focusing on the lived experiences of biology teachers regarding the implementation of the country's biology curriculum, specifically the Namibian Senior Secondary Certificate (NSSC), was done in a qualitative manner in order to understand the research participants' holistic worlds (Aloovi, 2016). As with my research project, Aloovi's (2016) qualitative data was gathered through semi-structured interviews in order to gain insightful knowledge about the teachers' lived experiences through the adoption of an interpretive research paradigm. Aloovi (2016) highlighted the situatedness of lived experiences, as it happens in a particular space and time. Another partial similarity to my research is the thematic analysis of data that was used by Aloovi (2016). As in Goldston and Kyzer's (2008) study, Aloovi's (2016) findings showed that the teachers' implementation of the biology curriculum (the focus of the study) was influenced by social, as well as contextual factors.

Focusing on Hindu teachers, there is only one South African study that particularly focuses on Life Sciences teachers' lived experiences of teaching evolution. A lack of qualitative research on the teaching of evolution in secondary schools (especially since evolution was only 'recently' introduced into the curriculum) and research on Hindu teachers' perspectives on the topic of evolution, motivated Reddy (2012) to use a qualitative research approach to understand the world from the perspective of Hindu Life Sciences teachers teaching the theory of evolution. Phenomenology was used to find deep meanings in the teachers' lived experiences of teaching evolution in relation to their beliefs and worldviews (Reddy, 2012). Reddy (2012) highlighted the interconnectedness between the teachers' worldviews, belief systems and emotions and their acquired knowledge and information in the light of the teaching of evolution. It was found that the Hindu teachers in Reddy's (2012) study did not experience conflict between their beliefs and worldviews, and the theory of evolution, as

there are similarities in the Hindu scriptures and the theory of evolution. Even though many Hindu teachers were ignorant of their own belief systems, they nevertheless accepted the theory of evolution (Reddy, 2012). Reddy (2012) acknowledged that the teachers' pedagogical content knowledge regarding evolution was adequate; however, their knowledge of the nature of science (which is important for the studying of and acceptance of evolution, according to Rutledge and Warden (2000) and Dunk, Petto, Wiles and Campbell (2017), respectively), was limited. Thus, Reddy (2012) recommended a focus on the nature of science in teacher training courses. Moreover, Reddy (2012) recommended that the harmonic nature between Hinduism and evolution, as well as the concept of a nearest common ancestor in human evolution, can be used in such courses to show that religion and science can co-exist and to decrease misconceptions about evolution, respectively. Reddy (2012) acknowledged that a limitation to her study was that a single method of data collection was used. Since my study also only obtains data through semi-structured interviews, this is similarly a limitation, although an accepted approach in studies of this kind.

Nishizawa (2017) discussed the general impact of biology teachers' lived experiences on their teaching, whereas Goldston and Kyzer (2008) focused more on the impact of biology teachers' sociocultural backgrounds and contexts on their pedagogies. Where Aloovi (2016) focused on the lived experiences of biology teachers regarding the implementation of Namibia's biology curriculum, Reddy (2012) focused on the relationship between Hindu Life Sciences teachers' religion and their stance on the theory of evolution. It has been shown that the studies that do focus on biology and/or Life Sciences teachers' lived experiences do not specifically focus on their lived experiences of the teaching of evolution. Thus, my study might bring about unique qualitative data regarding the five individual Life Sciences teachers' lived experiences of teaching the theory of evolution.

2.7. Conclusion

This literature review provides a strong foundation for my research project by offering a review of literature regarding the teaching of evolution, religion and education, religion and evolution in education, as well as lived experiences. An emphasis on the importance of the

teaching of evolution in Life Sciences provides meaning to the focus of this study. In an attempt to provide a well-researched foundation to this study, a thorough review of international and South African literature on evolution and school biology was provided. The recurring themes found in the synthesis of studies reviewed provided a guide to the process of thematic content analysis used in this research project. The history of evolution in the South African education system provided the necessary background for this research project, and the gaps and omissions needed exploration as well. The focus of this study, which is the lived experiences of Life Sciences teachers teaching the theory of evolution, identified as research that need more elucidation in South Africa, required an explanation of the term 'lived experiences'. A brief review on studies that focus on biology and/or Life Sciences teachers' lived experiences provided me with guidelines and recommendations for my study, as well as the ability to recognise my study's limitations.

CHAPTER 3: RESEARCH METHODOLOGY

3.1. Introduction

In this chapter, I firstly state what is the research question of this research study, since the rest of this chapter is guided and inspired by the research question. Secondly, the research design for this study is discussed through the four dimensions of research design articulated by Durrheim (2006). These dimensions include the purpose of the study, the paradigm underpinning this research project and the respective contexts of all five research participants, including how their pseudonyms were chosen. The last dimension is the techniques used in this study, which includes a discussion of a multiple case study approach, purposive sampling, negotiating access to research participants and the discussions pertaining data collection. These include a discussion of interviewing as data collection, how the interview schedule was constructed, a discussion of online interviewing, the responsibilities of myself as interviewer and how the interviews unfolded. Thereafter, I present discussions pertaining to the data presentation and data analysis including transcription and coding, how and why the data was presented in this particular way, and how themes were derived through content analysis and the constant comparative methods. Please take note that my own take was applied to these methods. Lastly, the protocols followed for this project to maintain ethicality are specifically discussed, as well as additional measures that were taken to ensure trustworthiness.

3.2. Research Question

The first step in making sure that the purpose of this research project is realised, is to state the research question. The research question informs the methodology of this research project, and directs the process of data collection, as well as data analysis. The research question is:

How do Life Sciences teachers, belonging to different religious beliefs, experience teaching evolution as a curriculum topic?

During the process of interviewing, each research participant was informed of the above question as the purpose of the study. As this study focuses on the experiences of teaching evolution of five Life Sciences teachers, who each hold a different religious belief system, it is necessary to ask the research question for each research participant's individual case. In other words, the research question, as stated above, differs based on each individual research participant's case study. Thus, the research question asked for each research participant in their respective interview, is the following:

for Zafir:

How does a Muslim Life Sciences teacher, who personally embraces the theory of evolution, experience teaching evolution as a curriculum topic?

for Saadiq:

How does a Muslim Life Sciences teacher, who personally rejects the theory of evolution, experience teaching evolution as a curriculum topic?

for Michelle:

How does a spiritual Christian Life Sciences teacher, who personally embraces the theory of evolution, experience teaching evolution as a curriculum topic?

for Nandi:

How does a Christian Life Sciences teacher (with additional African traditional values) who personally embraces the theory of evolution, experience teaching the theory of evolution as a curriculum topic?

for Heidi:

How does a Creationist Christian Life Sciences teacher, who personally rejects the theory of evolution, experience teaching evolution as a curriculum topic?

As indicated, it is clear that the research questions focus on the *how*, since the focus of the study is a qualitative one. In the following section, the research design of the study is discussed in detail, focusing on purpose, paradigm, context and research techniques.

3.3. Research Design

According to Durrheim (2006), research design provides a bridge between the research questions and the execution of the research. I, the researcher, sought to draw plausible inferences from the results of this study. Therefore, a carefully and well-planned research design was necessary for this project to produce academically significant results. In the light of the unpredictable world we live in today, taking the COVID-19 pandemic into consideration, a more flexible and pragmatic research design was chosen for this qualitative research project. The research design of this study is discussed in terms of the purpose, theoretical research paradigm that informs the research, the individual context of each research participant and of the research 'setting', as well as the techniques used to conduct research and analyse data to produce conclusions and inferences (Durrheim, 2006). After all the different elements of research design have been discussed in general terms, I shall discuss the specific design type used in this study, which is a multiple-case study.

3.3.1. Purpose

The lack in the literature regarding the lived experiences of Life Sciences teachers pertaining to the teaching of evolution, led to the research question. The answers of the research questions, focusing on each individual Life Sciences teacher who participated in this study, aimed to provide the purpose of this research project with meaning. According to Durrheim (2006), the purpose of the study focuses on what the researcher wants to draw conclusions about, as well as what kind of conclusions the researcher aims to draw from the objects of analysis. Therefore, the object of study will be discussed. The object of study specifies what

the researcher aims to draw conclusions about, which includes the units of analysis – "the focus of the investigation" (Durrheim, 2006:41). The units of analysis in this research project are the five respective Life Sciences teachers who each hold a different religious belief from one another. Thus, the main focus of this research project was to explore the context-dependent lived experiences of these five teachers, respectively. The decision to interview the research participants for data collection stemmed from an interest in others' stories. According to Seidman (2013), the purpose of in-depth interviewing is not to test a hypothesis nor to retrieve answers to questions, but it is to explore an interest in understanding the lived experience of the human beings who are interviewed, as well as to understand the meaning they make from their experiences.

Human experience is the 'data' gathered in human science research (van Manen, 1990). Variables are the features of the objects under investigation (Durrheim, 2006). Life Sciences teachers' experiences of teaching evolution might be influenced by various different aspects of their respective lives – variables. Variables that may influence the Life Sciences teachers' experiences of teaching evolution, retreived in the literature review, include factors such as their personal and educational backgrounds, general demographics and their teaching experiences. Religion and belief systems may influence teachers' experiences of teaching evolution and their attitude toward and their acceptance of evolution. Other variables might include the teachers' undergraduate education, their teacher education, their level of experience teaching the theory of evolution, their understanding of evolution and the emotional rules in their community, school (place of work) and classroom. Misconceptions about evolution might also be a variable that influences their experiences of teaching the theory of evolution.

This study aims to determine what these experiences are for the five Life Sciences teachers teaching the theory of evolution in the Western Cape province. Furthermore, I aim to understand the complexity of teaching the theory of evolution in each Life Sciences teacher's respective context, specifically taking their religious beliefs into special consideration. In other words, the purpose of this research project is to use a multiple case study approach in order to explore the unique experiences of five different Life Sciences teachers, belonging to

different religious beliefs, teaching the theory of evolution. The aim, as Nishizawa (2017) also states, is not to solve a particular problem, but rather to shed light on the research participants' individual lived experiences on teaching the theory of evolution in relation to their belief systems.

This research study's purpose is one of an exploratory and descriptive nature. Exploratory studies investigate relatively unknown research areas and descriptive studies attempt to describe a certain phenomenon (Durrheim, 2006). Thus, this research study is exploratory as this area of research (the lived experiences of Life Sciences teachers teaching the theory of evolution) is relatively new. The study is also descriptive as each respective Life Sciences teacher's lived experiences of teaching evolution is discussed in detail. Aiming to explore, understand and describe a specific case study is best categorised under the interpretive paradigm. In the following section, this research study's research paradigm, which is interpretive, will be discussed.

3.3.2. Paradigm

The interpretive paradigm was chosen for this research project. According to Connole (1993), with the interpretive paradigm, the researcher must attempt to empathetically understand the research participant's subjective experiences and identify meanings from their experiences. A positivist or critical approach is not appropriate for this study, considering that the knowledge interest is not prediction and control, nor emancipation. The interpretive paradigm is the appropriate choice of paradigm for this research project as the ontological belief of such a paradigm is that there are multiple realities based on subjective experiences. This is relevant since each research participant (Life Sciences teacher) has a different experience of reality influenced by their context. A multiple case study approach to research is elucidated in the data collection section.

The particular strand of interpretive research that will guide the study is phenomenology. Phenomenological research emphasises the deeper comprehension of lived experiences (van Manen, 1990). Phenomenology is the "study of lived experiences" (Nishizawa, 2017:45).

Thus, the paradigm entails an exploration of what it means to be a human Life Sciences teacher teaching the theory of evolution. The interpretation of each research participant's lived experience therefore needs to be done in relation to the totality of life comprising of contextually related experiences (van Manen, 1990). Regardless of age, gender, ethnicity and other sociocultural factors (while taking them into context), the research participants' experiences are brought to light in order to understand the deeper meaning of their specific experiences in the context of their entire human experiences (van Manen, 1990; Nishizawa, 2017). According to van Manen (1990), in the process of gathering and exploring human experiences in this research study, I, the researcher, might become more experienced myself. The lived experiences of others and their reflections upon their lived experiences might inform, shape or enrich my own knowledge and understanding of the nature of the particular phenomenon researched.

Rather than testing a theoretically set-up hypothesis (deductive approach to research), the semi-structured interview questions allow me to discover important categories and interrelationships within the teachers' lived experiences in an inductive manner (inductive approach to research). Thus, this links to the exploratory nature of this research study. This research study is naturalistic as it explores real-world situations (the lived experiences of Life Sciences teachers teaching the theory of evolution) without manipulation, judgement and constraints on outcomes (Durrheim, 2006). Thus, there is an "openness to whatever emerges" (Durrheim, 2006:48). The lived experiences of the research participants are holistically understood, meaning that their experiences are understood as a complex system. Since I am the interviewer, data analyst and interpreter of knowledge for this study, it is acknowledged that the integrity of my findings are dependent on my "social, linguistic and cognitive skills" (Connole, 1993:23). Due to the holistic nature of this study, it is essential to discuss the context of each research participant, as well as the context in which the research study takes place. Thus, the context will be discussed below.

3.3.3. Context

This section discusses the context of the research study, the choosing of pseudonyms, as well as the context of each research participant in detail. It is important to discuss each research participant's personal and professional context, as the results of the study will fully take their biographies, educational background, religious beliefs and school contexts into consideration.

3.3.3.1. The context of the research study

The in-depth interviews conducted for this research study took place virtually over Microsoft Teams meetings on different days that suited each research participant's schedule. The semi-structured interviews were conducted and recorded with the spoken and written permission of the research participants, since they orally agreed to the recording of the semi-structured interview at the start of their interview, as well as completed and signed an informed consent form. Before the interviews commenced, I established rapport with the research participants, establishing an open and non-judgemental environment. The teachers were also reminded of their rights to withdraw from the study at any point during the interview. The ethics of the interviews are discussed in detail in section 3.6.

3.3.3.2. The choosing of pseudonyms

Seidman's book: Interviewing as Qualitative Research (2013) inspired my research questions, as well as prepared me for the individual in depth interviews that I conducted with the five research participants. According to Seidman (2013), it is important for the researcher to choose a pseudonym for each research participant that does the participant justice. The process of choosing pseudonyms for the five research participants was done carefully and considerately, while aiming to preserve the participants' dignity. All five research participants' pseudonyms were chosen after I had conducted the interviews. I highly regard the research participants' confidentiality, their spoken words and the opportunity that I had in spending time with experienced Life Sciences teachers.

The first pseudonym, Zafir, was chosen because of its meaning: victorious. It had been clear from conducting the interview with Zafir, that he was a victorious man, not only in his successful career as a Life Sciences teacher and later as high school principal, but also in his

respectful way of treating me as an interviewer and in his way of talking about his passion for Life Sciences and education. Secondly, Saadiq's pseudonym was chosen, because of the sincerity that I have noticed in my interactions with him during his interview. The name Saadiq is associated with sincerity, honesty and trustworthiness, which are exactly the characteristics of Saadiq that stood out to me during his interview. The name Michelle means "who resembles God" or represents a closeness to God. I chose this pseudonym for Michelle after the interview, as Michelle discussed her spirituality and her closeness to her God with passion during her interview. Nandi, meaning "sweet", was chosen as I experienced her sweet and calm presence while interviewing her. Nandi was a warm and considerate interviewee who clearly showed care for her job as a Life Sciences teacher and for her students. The name Heidi represents nobility. Heidi's kind, considerate and caring personality, as well as her soft nature, noticed during her interview, reminded me of the character Heidi from the classic and highly regarded book of 1880, Heidi. Below are the contexts of each research participant in terms of their biography, educational background, religious beliefs and occupational contexts.

3.3.3.3. The context of each Life Sciences teacher

3.3.3.3.1. The context of Zafir

As indicated by his pseudonym, Zafir is a victorious man who comes from the Muslim faith. In terms of Zafir's religious beliefs, he regards Islam as "a way of life". He believes in the Islamic doctrine, the Shahada, he believes that there is only one God and he believes that the final messenger of his God is the prophet, Muhammad. He tries his best to perform his five daily prayers, he fasts during the month of Ramadan, he gives back to charity and he still hopes to perform his pilgrimage to Mecca. He upholds the foundations of the Hadith and the Sunnah, the actions and sayings of his prophet, Muhammad. Zafir was brought up in a home where his father taught him religious tolerance. With regards to Zafir's educational background, he had obtained a BSc degree after high school, followed by a PGCE and BEd degree. In high school, Zafir developed a passion for the subject of Life Sciences as he was "blessed" with having "excellent teachers at high school and then also lecturers at university". At the time of Zafir's interview in 2021, he had been a Life Sciences teacher for 34 years and was 57 years old. Together with being a Life Sciences teacher, Zafir is also the

principal at the school where he is currently teaching two to three Life Sciences classes. Zafir sees himself, not as a Muslim teacher, but as a teacher that upholds the Constitution of his country. In his career as a Life Sciences teacher, Zafir has also been part of programs teaching teachers to teach Information Technology, as well as the topic of evolution. When teaching Life Sciences, Zafir lays the foundation for his students by emphasising the scientific method. A typical day in Zafir's classroom is a busy day. As a Life Sciences teacher at Zafir's school, he needs to prepare his own demonstrations or experiments, as the school does not have laboratory assistants. Through his teaching of Life Sciences and influence as the principal of his school, Zafir aims to develop citizens that are inclusive and tolerant.

3.3.3.3.2. The context of Saadiq

Saadiq has been a Life Sciences teacher for approximately 30 years. Saadiq is "fully committed to Islam and the Quran", and believes that the prophet, Muhammad, was the last messenger of the Quran, who came down to Earth as a "practical example for humans to follow". Saadiq has started the Muslim Student Association in one of the schools that he has worked at. In terms of his religion, he has travelled to the holy sites of Mecca and Medina. In terms of Saadiq's personal life, he has friends of different faiths. Saadiq has always had a love for the outdoors and the environment. Having "good teachers" in Life Sciences in high school has further fostered his love for the subject. In terms of Saadiq's educational background, he obtained a BSc degree specialising in the subjects Zoology, Botany and Microbiology. During his first year of his BSc degree, Saadiq was introduced to the theory of evolution in "a very open minded way" by his lecturer. This lecturer emphasised how one must respect one another even when opinions and viewpoints differ. Saadiq said that he was taught not to be afraid of "controversial material" referring to the theory of evolution. He also obtained a Higher Education Diploma thereafter, specialising in Life Sciences and Natural Sciences, which qualified him as a teacher. Thereafter, he also obtained a BEd Honours degree. At the time of Saadiq's interview, he was busy with working on his Ph.D. Throughout his career as a Life Sciences teacher, Saadiq has also attended numerous workshops and training. Together with being a Life Sciences teacher, Saadiq has also spent 18 years of his career as a teacher marking matric Life Sciences examination papers, which "is a very good

learning experience". Saadiq is regarded as a "very funny teacher" and mentioned that his learners loved attending his lessons. He tries to provide variety in his lessons and to foster excitement through typically starting off his lessons with a hands-on approach. Saadiq's teaching environment consists of a laboratory which allows him to prepare "fun activities" to get the learners interested in the topic. Depending on who his learners are, Saadiq adjusts his lesson plans. When he teaches the topic of evolution, he typically has group discussions in his classroom and asks for "feedback from different […] religious groups". However, Saadiq states that a problem in his matric classes is that there is not enough time for "real life discussions". Saadiq stated that "evolution contradicts all aspects of the Quran" and voluntarily provided several examples during his interview. When Saadiq teaches learners who only belong to the Muslim faith, at Muslim faith schools, he typically shows his learners short videos of Professor Harun Yahya explaining how evolution differs from the Quran. Saadiq personally believes that the topic of evolution was "in some respects […] forced onto the schools"; however, irrespective of his own beliefs, he presents the topic of evolution with the focus of wanting his learners to obtain "good marks". Saadiq tries to foster a positive attitude towards the topic, despite perceiving evolution as "controversial". He regards teaching the topic as "training in handling controversial material".

3.3.3.3.3. The context of Michelle

Due to a "natural inquisitiveness" toward life, being inspired by a "very good Life Sciences teacher" when she was at school, and "wanting to make a difference", Michelle decided to choose becoming a Life Sciences teacher as her career path. Michelle, who at the time of her interview had been a Life Sciences teacher for 9 years of her life, is qualified to be a Life Sciences teacher by having obtained a BSc degree in Human Life Sciences, and going on to complete her Post Graduate Certificate in Education thereafter, specialising in the subjects Life Sciences and Natural Sciences. Michelle sees "nature as a whole [as a] very much […] fantastic spiritual thing". Even though evolution "was not a very big part of the modules that [she] did", Michelle briefly learned about evolution in her first year of her BSc, in the subject of biology. As for human evolution, Michelle stated that she had to teach it to herself, as she was teaching the curriculum as a Life Sciences teacher. During a typical lesson in Michelle's

classroom, she briefly goes through the work of the previous lesson before starting with the topic of the day. Thereafter, she usually covers the content and ends the lesson with an activity. Depending on the age group (grade) that she is teaching, Michelle changes her teaching pace based on the content that needs to be taught. When teaching the topic of evolution, she starts by asking the learners to reserve their opinions until the end of the topic, when they have learned all the facts. Michelle uses the learners' prior knowledge to link them to the current topics that she is teaching. As a child, Michelle was "raised in a Christian household that was very strict in terms of Bible study and going to church on Sundays". She states that she "always had a very uneasy feeling about the way that [she] was being forced to love God and the way that God has set a lot of […] conditions for His love." Now, Michelle describes herself as "technically a Christian", but she prefers to think of herself as "spiritual". She believes that her "spirit is not something different to God". She describes her relationship with God as "very personal", as she explains that her "spirituality has evolved to a more personal understanding of […] God". She believes in a non-judgemental, non-punishing, all-knowing and all-understanding God. Michelle believes that "God created this world and gave us free will to make choices for our lives", choices that aren't right or wrong. There are things in the Bible that Michelle do not agree with; therefore, "the God that [she believes] in is not necessarily the God that the Bible is telling [her] exists". Michelle emphasises to her learners that evolution and Christianity is not mutually exclusive. When it is time for Michelle to teach evolution, she looks forward to teaching the topic. She teaches her learners that "natural selection happens as you are sitting in this classroom" and that the "picture of the ape changing into a human [is] not evolution".

3.3.3.3.4. The context of Nandi

Nandi's educational background consists of a BSc degree, majoring in Physiology and Biochemistry, a HED, specialising in biology and general sciences, as well as a BEd Honours. At the time of Nandi's interview, she has been a Life Sciences teacher (grade 10 – 12) for 23 years. She also teaches Natural Sciences to grade 8 and 9 learners. Nandi's original educational plan was to study pharmacy or dentistry; however, due to slow mail at that time, she had only received her acceptance letter after the courses had already been filled. These

circumstances led to her studying for a BSc degree. After obtaining her BSc, she wanted to start working; therefore, she obtained her HED in order to become a teacher. Her BEd Honours was obtained later in her career. In her undergraduate studies, Nandi learned about certain evolution related topics, but "not really […] in detail". She described learning about evolution as "a disconnected theory that […] never came together as a theory of evolution". She mentioned that she "connected the dots" after she has started teaching and gained experience. When evolution was introduced into the curriculum, Nandi went into the topic "with no experience at all, with no content at all teaching the topic". A typical day in Nandi's classroom consists of her always emphasising "the processes of science". Nandi typically has a maximum of 50 learners in her classroom for the lower grades and maximum of 40 learners for grade 12. Nandi calls her class "chaotic" as she discusses concepts, trains the learners for the skill of writing an examination, and brings in "society". She starts teaching evolution from what the learners have learned in the previous grades, as well as from "what they know", such as using everyday examples to teach natural selection, for example, spraying cockroaches with "Doom" where some die and others survive. Nandi believes the entirety of "Life Sciences is about evolution", and teaches Life Sciences from the point of view of evolution in order for the learners to make links in Life Sciences. Nandi grew up in a Christian household and got married into a traditional home. She believes there is a "supernatural being", but is not sure whether she believes in God or ancestors. She does not believe that this supernatural being created the world. Although, she believes "in a supernatural being", she does not "believe in the Bible itself". She believes that Jesus "was probably a preacher", but "not a holy person". When asked to define her religion, she described it as a "mixture of both" "part Christian and part [African] traditional". At the beginning of each year, Nandi teaches her learners to "understand [the] distinction between science and religion". When teaching the topic of evolution, Nandi finds the entire curriculum "very interesting and exciting". She speaks to her learners about how Darwin does not state that evolution explains how life started on earth, but now that life is on earth, "it has changed overtime genetically and phenotypically".

3.3.3.3.5. The context of Heidi

Heidi's tertiary educational background consists of a BSc degree, specialising in Botany and Zoology, followed by a HED to be qualified as a teacher. Heidi stated that her passion was Botany and she wanted to become a researcher; however, since she wanted to work in the countryside, she decided to become a teacher. Heidi grew up in a Christian household and describes herself as a "creationist Christian" who believes that God is the creator. In her interview, she talks about how the "big flood" could be a possible explanation for certain "fossils that [humans] found". At the time of Heidi's interview, she had been teaching biology, Life Sciences and Natural Sciences for 17 years, with a 10-year gap where she did not work as a teacher. At the time of Heidi's undergraduate studies, she was first introduced to the theory of evolution, especially in the subject of Zoology. Learning about evolution was "difficult" for Heidi as she felt that she was not sure how her personal beliefs, being a creationist Christian, fit into the theory; however, she finds peace in "knowing" that she will one day learn about all of her uncertainties in Heaven. Heidi believes in micro-evolution, as examples such as the "pepper moths" made sense to her; however, she finds it difficult to accept the concept of macro-evolution, but finds it "interesting". When she teaches Life Sciences, she emphasises the differences between micro- and macro-evolution. Heidi has a "passion for [her] subject", Life Sciences. She enjoys making her learners part of the classroom, allowing them to ask questions, and uses models to demonstrate many concepts in her classroom. She focuses on teaching her learners to be able to apply concepts in real life and place "occurrences" in their lives in "perspective". As most of her learners are Christian, Heidi struggled to find a way to teach the topic of evolution to them without "confusing" them. She starts by teaching the topic from the concept of curiosity of where the earth comes from, talking about different perceived belief systems such as Christian creation and the Big Bang. She describes "evolution" as one of the alternatives to the Christian creation. She finds that the topic of evolution can prevent the learners from "thinking critically". Heidi finds it difficult to teach the topic of evolution and has found that, in terms of examination results, that her learners struggle with the topic. She says that she has experienced "conflict within [her]self" when she has to teach the topic of evolution. For example, she believes that before there was sin, there was no death; therefore, "before there were people on earth, evolution could not have happened". A positive experience about teaching evolution for Heidi, is the opportunity to teach learners about "something that they need to form an opinion about".

Depending on how Heidi experiences her learners' experiences, she finds that teaching evolution is different for every classroom. When teaching evolution to grade 12 learners, she says that she focuses on what needs to be learned for the examinations.

3.3.4. Techniques

3.3.4.1. Multiple case study approach

A multiple case study approach was used for this project's research design, since the purpose of this study is to explore, understand and describe the complexity of teaching evolution in five Life Sciences teachers' respective contexts (Yin, 2009). A case study approach, was chosen in order to potentially provide my research with depth, flexibility, versatility and manageability. Focusing on each teacher's respective broader context provides depth to the individual case of each Life Sciences teacher (Rule and John, 2011). Seidman (2013) states that people's stories are elicited through in-depth interviewing, showing that each interviewee is interesting, regardless of how celebrated they are. The five Life Sciences teachers' life histories are discussed in detail in the data presentation section of Chapter 4 in order to provide context and illuminate their lived experiences of teaching evolution as a curriculum topic. I chose a multiple case study approach since the focus of the study (individual experiences of the same phenomenon) and methodological replication (doing the same interview with all five participants) makes it an interesting, but manageable study (Rule and John, 2011).

A multiple case study is research where two or more cases are studied around the same phenomenon. The phenomenon of interest in this study is *the lived experience of Life Sciences teachers teaching the topic of evolution*, where each teacher's lived experiences is a different case. Therefore, this study is a multiple case study, as five Life Sciences teachers' individual experiences of teaching evolution were explored. According to Yin (2009), multiple cases need to be considered as multiple experiments. Thus, each case is unique and the cases cannot be regarded together as a sample of cases. In a multiple case study, each case serves a purpose within the scope of the study (Yin, 2009), since each teacher's lived

experiences of teaching evolution bring new information to light, as they come from different contexts. As stated, the purpose of this study was to understand the complex lived experiences of five Life Sciences teachers, belonging to different religious beliefs, of teaching evolution in their respective contexts; therefore, I trust that a multiple case study approach is the appropriate manner of research design.

In terms of this research project, each 'case' refers to the Life Sciences teacher's lived experiences of teaching the topic of evolution in their classrooms. A case study approach is appropriate, since lived experiences are unique phenomena depending on the individual's context. To be specific, drawing on Yin (2003), this case study approach is exploratory, since investigating the unique lived experiences of Life Sciences teachers teaching evolution might lay the basis for further studies in this field (Rule and John, 2011). Therefore, a summary of each individual case is reported in Chapter 4 in terms of the created themes (Yin, 2017). Thereafter, a cross-case report was yielded where cross-case conclusions were formed in an inductive manner. According to Durrheim (2006), this study is also descriptive, as discussed in 3.3.1., since this study aimed to describe the lived experiences of each Life Sciences teacher in detail (in the light of their belief systems). Rule and John (2015:3) draw on Eisenhardt (1989:548) and emphasise that the strengths that might arise from the theories developed from a case study approach, are "novelty, testability, and empirical validity" (Rule and John, 2015:10). Therefore, throughout the research process there was a focus on the articulation of my research, while carefully considering each research participant's individual life context. In order for cases to be explored, sampling of research participants was necessary. In the following section, I discuss the process of sampling research participants for this study.

3.3.4.2. Purposive Sampling

Purposive sampling was used in this research project. Purposive sampling is "the deliberate choice of a participant due to the qualities the participant possesses" (Etikan, 2016:2). Therefore, the sampling is not random, nor does it need a set sample, but it requires participants who are willing to share their experiences, that are of interest and relevant to the

specific research question (Etikan, 2016). Since interviewees have to consent to be interviewed, Seidman (2013) recognises an element of self-selection in any interview study. This also confirms that self-selection is not compatible with randomness (Seidman, 2013).

All five research participants have taught at different public schools in the Western Cape. According to Seidman (2013), it is the researcher's responsibility to explain why they chose research participants with specific qualities. In Chapter 1, all the key terms are defined, which presents the reader with a clear understanding of what the study is about and is specifically referring to. Firstly, due to a personal and academic interest in the field of Life Sciences and specifically the theory of evolution (inspired by some of my own experiences as discussed in Chapter 1), I have chosen to interview five FET (Further Education and Training) Life Sciences teachers, as their specialisation subject involves teaching topics that revolve around or include the topic of **evolution**. Secondly, all of the teachers had to reside in the **Western Cape** while teaching **Life Sciences**, as the provincial permission that I have been granted was from the Western Cape Education Department. Thirdly, I purposely chose to interview Life Sciences teachers who belong to **different religious belief systems** from one another as I aim to explore each teacher's respective lived experiences of teaching evolution in the light of their religion and background. Limitations in the recruitment process (discussed in the next sub-section), unfortunately did not allow for recruiting research participants belonging to completely different belief systems; however, differences within a religion are also regarded as differences in beliefs. My personal interest in how one's religious beliefs may influence one's life choices, career and interests also motivated the use of purposive sampling for this research study; however, it is acknowledged that my personal beliefs are bracketed for the purposes of maintaining the integrity of this study.

Are five research participants sufficient for this research project? As this research project is a phenomenological qualitative study, it does not need to represent a range of teachers. In other words, the multiple case study approach allows each individual research participant's lived experiences to be a case study that is special in its own way. Seidman (2013) states that enormous power is given to the stories of a relatively few research participants as in-depth phenomenological interviewing applied to a sample of research participants who all

experience similar structural conditions. In this study's case, all five research participants are Life Sciences teachers, belonging to different religious belief systems from one another, in the Western Cape who have to teach the theory of evolution according to the South African curriculum (CAPS).

3.3.4.3. Negotiating access to research participants

As the interviewer of this study, it was my responsibility to establish access to potential research participants and make contact with them (Seidman, 2013). Gaining access to potential research participants is an important research step as the process affects the relationship between myself, the researcher, and the research participants. In interviewing, Seidman (2013) urges the importance of the researcher's responsibility to be equitable, fair and just, to respect the research participants, as well as to respect oneself as the researcher. The very first step that I had to take toward the establishment of equity in the relationship between myself, as interviewer, and the interviewees was to take myself seriously as a researcher. My experience recruiting and interviewing participants for my BEd Honours study aided my recruitment and interviewing skills, as well as my self-confidence in this masters study.

The recruitment process of this research study posed many challenges. Firstly, the COVID-19 pandemic implicated the recruitment process in that there were not many opportunities during the year of 2021 to visit schools in-person in order to attempt to recruit Life Sciences teachers for interviews. Thus, I made use of my own existing networks, as well as the networks made available by my supervisor, Prof Lesley Le Grange, to recruit research participants. Professor Le Grange's network of contacts provided me with a list of potential research participants and/or schools where potential research participants teach Life Sciences – some potential participants were only accessible through their occupational institutions.

In the light of unpredictable policy changes in terms of nationwide lockdowns, my correspondence to make initial contact, recruit and stay in contact with research participants remained electronically throughout 2021 and 2022. I made use of phone calls in an attempt to

recruit potential research participants, together with emails being sent to schools, as well as to members of the WCED. One of the research participants was recruited using my own existing professional and educational network. As recommended by Seidman (2013), I tried to establish access to this teacher through making contact with their colleague (another teacher), whose contact details I obtained through a former colleague of theirs. The rest of the research participants were recruited with the help of using the available networks of Prof Lesley Le Grange, including the assistance of another member of the Faculty of Education at Stellenbosch University, Dr Botha. The recruitment process entailed presenting the nature of my study in broad context to the potential research participants electronically. Moreover, I informed the potential research participants of what will be expected of them as research participants. After recruitment, the interviews were conducted individually through online Microsoft Teams Meetings. Even though Seidman (2013) recommends a face-to-face contact visit to build a foundational interview relationship, the COVID-19 pandemic did not allow for contact visits to realise. Throughout the years 2021 and 2022, I made use of email and/or messaging to remain in contact with the research participants.

3.3.4.4. Data collection

3.3.4.4.1. Interviewing as data collection

While doing my BEd Honours at Stellenbosch University in 2020, in the midst of a nationwide lockdown due to the COVID-19 pandemic, I had the opportunity to conduct one online focus group interview with four research participants, as well as four individual virtual interviews. The process of interviewing research participants, presenting and analysing data, as well as connecting with and finding meaning in the research participants' words in my honours project, has established in myself a connection to the possibilities of qualitative research, specifically to phenomenological interviewing. In addition, my interviewing experience as an honours student has increased my motivation to do a qualitative masters project, as I express great interest in others' experiences and stories. Therefore, my honours experience has established that phenomenological interviewing was the way to go about conducting research for my phenomenon-driven masters project. Furthermore, my honours

interviews served as appropriate qualitative interviewing practice, which served as preparation for the actual conduction of my masters study's interviews.

The data collection process of this masters study consisted of interviewing. In the following paragraphs I explain my reasoning for using the conduction of interviews for data collection, how the interview questions were constructed, as well as the actual process of collecting data through the conduction of interviews as a qualitative researcher. According to van Manen (1990), the purpose of a hermeneutic phenomenological human science interview is to explore and gather the narrative material of the research participants' experiences, which may serve as a deeper and richer understanding of the human phenomenon, and secondly, such an interview has the potential to be used as a vehicle to arrive at the research participant's meaning of their experiences. The specific focus on lived experiences of my study indicates that this study has strong elements of phenomenology. Therefore, as previously stated, the phenomenon of interest in this study is *the lived experience of Life Sciences teachers teaching the topic of evolution*. Qualitative data was gathered through online semi-structured interviews over Microsoft Teams Meetings. The reason for choosing to conduct semi-structured interviews is that it provides a tool for adaptability to the different personal contexts and personalities of the five respective research participants, as well as provides opportunities for emotions and memories, with regards to the Life Sciences teachers' lived experiences of teaching evolution, to flow freely (Aleandri & Russo, 2015). In the last part of this section, I discuss how the interviews unfolded in actuality.

My interview questions were constructed using Seidman's (2013) book: *Interviewing as Qualitative Research: A Guide for Researchers in Education and the Social Sciences*. Simply put; planning to conduct an interview for research purposes stems from an interest in other people's stories as a way of knowing (Seidman, 2013). According to Seidman (2013), the details of a story are revealed upon reflection. In order to make meaning from experiences, Seidman (2013:7) suggests a process of "selecting constitutive details of experience, reflecting on them, giving them order, and thereby making sense of them". Seidman (2013) draws on Vygotsky (1987) stating that the words that people use in their stories, are microcosms of their consciousness, meaning that the entirety of their consciousness is

encapsulated and understood by the words and details of their stories. In the social sciences, what make humans special, compared to the natural sciences, is that, when they are able to do so freely, they are able to think, talk and share their experiences with much awareness and knowledgeability. What does it mean to be human? Seidman (2013) believes that at the very heart of this question lies human beings' ability to symbolize their lived experiences through language. Therefore, I concur with Seidman (2013:8) who believes that "[i]nterviewing […] is a basic mode of inquiry." As the interviewer, it was my responsibility to strive to understand the interviewees' words and actions, while recognizing my own limits on understanding others. Drawing on Schutz (1967), Seidman (2013) reminds interviewees of their limits in that one can never understand another perfectly, as one is not inside the other's stream of consciousness, nor has one experienced exactly what the other person has experienced. In order for one to perfectly understand another, one needs to *be* the other person. Furthermore, drawing meaning requires putting behaviour into context. Access to the context of the research participants' behaviour is achieved through interviewing where meaning is derived from their behaviour (Seidman, 2013). Furthermore, the research participants' behaviour gets put into context through interviewing and their actions are better understood as a result (Seidman, 2013).

As explained, there are numerous reasons for choosing to conduct interviews as my mode of data collection. As with many researchers, personal experiences of mine sparked an interest in others' stories, specifically Life Sciences teachers' stories regarding teaching the topic of evolution. Interviewing is a powerful method to gain insight into "social issues through understanding the experience of the individuals whose lives reflect those issues" (Seidman, 2013:14). Meaning is made through language. As a researcher who is interested in others' stories, interviewing is therefore an appropriate and satisfying method of inquiry.

3.3.4.4.2. Constructing an interview schedule

Throughout the research process, I used Seidman's (2013) in-depth discussion of phenomenologically based interviewing as a guide to the construction of my own interviews. My task as interviewer was to build on and explore the research participants' responses to the

interview questions. According to Seidman (2013), with whom I agree with, the goal of phenomenologically based interviewing is to have the research participant reconstruct their experience with the topic of study. Therefore, my goal was to have each Life Sciences teacher reconstruct their lived experiences of teaching evolution through their respective interviews. The process of constructing the interview questions is discussed below.

Seidman's (2013) recommendation was to use a three-interview series comprising of a first interview that puts the research participant's experience into context by focusing on their life history; a second interview that asks research participants to provide their experience with as much detail as possible; and lastly, a third interview asking the research participant to reflect on their experience. In this research project, I did not make use of three *separate* interviews per research participant. Instead, I conducted *one in-depth interview* per research participant (inspired by the three interview method), using Seidman's (2013) book as a guide to educate myself on interviewing as qualitative research. I constructed my own interview questions, with the assistance and support of Prof Le Grange, my supervisor, who is well experienced in qualitative research in the field of education.

The data collection process involved the research participants being asked pre-determined questions in their preferred language (English or Afrikaans) (please see Appendix __ and __). The interview questions were formulated to be open-ended and non-leading in order to allow the interviewees the freedom to express themselves as to gain results in an inductive manner. The interviewees were assured that they are in a safe and non-judgemental environment in order to allow for deepened conversations and detailed narratives (Aleandri & Russo, 2015; Adams, 2015). It was important for the order of the interview questions to strategically lead its way from general to more personal or possible emotion-provoking ones. Below, I explain how my interview questions were constructed in detail.

The first set of interview questions' purpose was to learn more about the research participant and establish a foundation for making meaning of experiences (Seidman, 2013). Question 1 asked: "Tell me about your teaching qualifications." This open-ended question opens up the conversation for the teacher to freely share information about their teaching qualifications in

the way that they are comfortable with. The second question – "Why did you decide to become a Life Sciences teacher?" – aimed to find out more about the research participant's reasons for teaching Life Sciences. Question 3 asks how long the research participant has been a Life Sciences teacher – thus, exploring their teaching experience. Question 4 - "Did you study the theory of evolution in your undergraduate studies?" – and question 5 – "Did you study the theory of evolution in your teacher education studies?" explored the life history of each research participant, specifically pertaining to learning about the theory of evolution in their tertiary education. The sixth question asks the teacher to talk about their experiences regarding learning about the theory of evolution in their undergraduate and/or teacher education studies. Depending on the research participants' answers, my task as interviewer and researcher, according to Seidman (2013), is to strive to reconstruct the details of the research participant's experiences in the area of study – the experiences of teaching evolution. The seventh question asks: "Could you describe a typical day in your classroom as a Life Sciences teacher?", aiming to explore what the teachers do on the job, as recommended by Seidman (2013). The following question aims for further elucidation and exploration of the topic of study and asks: "Could you describe a typical lesson where you teach the theory of evolution?". After asking such specifically formulated questions, the ninth question, "Tell me about your experiences teaching evolution.", is simply asking the research participant to provide details of their experiences of teaching evolution in an open-ended manner. The research participant has the freedom to share any information that they are comfortable with regarding their experiences of teaching evolution. By this time, rapport has hopefully successfully been fostered, which makes it appropriate to ask more personal questions toward the end of the interview. The tenth question is thus: "Tell me about your religious beliefs.", prompting research participants to share whatever they are comfortable with with regards to their personal religious beliefs. According to Seidman (2013), it is important for the research participants to reflect on what their experiences mean; therefore, question 11 is: "What is it like to be a _____ (*Muslim/Christian*) teacher, teaching the theory of evolution?" This question addresses the emotional and intellectual connection between the research participant's occupation and their personal beliefs of life. Since the research participants are asked in the latter question to explain what it is like to teach the theory of evolution as a teacher of their specific faith, the question allows the participant to

make meaning of how they came to be at their present experience. After aiming to establish a comfortable, non-judgmental environment in the interview, the last question; "When teaching the theory of evolution, how does it make you feel?", focuses on the emotional impact of the research participants' experiences of the phenomenon under study – the teaching of evolution.

3.3.4.4.3. Online interviewing

As previously stated, this research study aimed to explore each Life Sciences teacher's lived experiences of teaching evolution through conducting interviews. In the light of the current COVID-19 pandemic, all five interviews were conducted **online** via Microsoft Teams meetings and were recorded, as recommended by Rabionet (2011). According to O'Connor and Madge (2017), drawing from Krotoski (2010:2), researchers have been experiencing a 'golden age' of online research in the last few decades. In the social sciences, online research has been established a valid and 'legitimate means of data collection' (O'Connor and Madge, 2017:2). There are advantages and disadvantages that come with online qualitative data collection. In this research study's case I am specifically discussing *online interviewing*. The decision-making process of conducting qualitative research that is online involved considerations in relation to administration, population and data collection. Even though O'Connor and Madge (2017) regard online research as a valid and legitimate research method, they cited and acknowledged that Deakin and Wakefield (2014) argue online research to be a 'second choice' to face-to-face interviewing.

In terms of recruitment of potential research participants, a disadvantage of electronic communication is that it can be quite easy for a participant to disregard electronic mail (Seidman, 2013). Once contact has been made, however, I found email and messaging to be useful in "confirming interview appointments", as well as "maintaining contact through the research process" (Seidman, 2013:47). The process of conducting an online qualitative interview started with selecting an appropriate online platform to facilitate the interview. The appropriate video-based technology software chosen for this research project was Microsoft Teams. This platform was chosen as the University of Stellenbosch already uses this platform

for administrative and academic communication. Microsoft Teams is an easy-to-use communication platform that enables one to conduct online video calls that can also be recorded. It is however argued that such an online platform might be perceived as one that requires more sophisticated technological skills compared to the use of email, for example (O'Connor and Madge, 2017). However, I have been familiar with this software, as it had been used for my BEd Hons online interviews as well. Drawing from Deakin and Wakefield (2014), O'Connor and Madge (2017:7) stated that some participants may lack "technological competence, familiarity with online communication, software requirements or regular high-speed internet provision to enable them to participate in a synchronous interview". An advantage of a synchronous interview (one that occurs in real time) is that it closely resembles the nature of a conventional face-to-face onsite interview as it enables interviewees to respond immediately, compared to asynchronous interviews that do not occur in real time. According to O'Connor and Madge (2017), an interview that occurs in real time, whether it is online or face-to-face might generate answers that are more spontaneous and honest in nature, compared to asynchronous interviews (O'Connor and Madge, 2017).

The Microsoft Teams software enabled me to record each interview and to receive an unedited automatic transcript of each interview that could be downloaded – except for the interview conducted in Afrikaans, which I manually transcribed by myself. Editing each transcript and generating word-for-word dialogue (also including pauses, body language and interruptions) was a time consuming, but necessary process. The video calling platform provided me with the opportunity to see and talk to the research participants in real time – synchronous interview. This feature provided me with access to the research participants' verbal and non-verbal cues allowing "an equal authenticity level with face-to-face interviews"; however, there are obstacles in observing all of the research participants' body language as I was only able to see 'head shots' during the interviews (O'Connor and Madge, 2017:9). A benefit of online video interviewing for the research participants is that they are able to choose the level of contact they are comfortable with (O'Connor and Madge, 2017). Thus, they could choose the parts of their location and body that they wish for me to see virtually. For example, one of the research participants chose to use a green screen background to protect their location privacy. In terms of drawbacks of online interviewing,

technological difficulties may occur including issues in sound quality, video quality and internet quality – which might complicate the transcription process, which has unfortunately occasionally happened during some of the interviews.

It is clear that online interviewing has benefits and drawbacks. Some benefits of online video-based interviews include cost effectiveness. Online research provided me with an opportunity to interview each research participant in a cost-effective manner, as the budget only required providing the research participants with a data or internet voucher as compensation for their internet costs. The money for this budget was retrieved by my private bursary (Harry Crossley Foundation). The exact data costs were calculated based on the time of the interviews. Another advantage of online interviewing is that travel time and cost is not only reduced, but completely eliminated for myself, the researcher. In the case of this research project, it has been confirmed that none of the five research participants, nor myself as the researcher/interviewer, had any travel expenses pertaining to their interviews.

In terms of representativeness, O'Connor and Madge (2017) states that the digital divide might be a barrier to the research, as some individuals are less connected to the internet than others; thus, making online research geographically specific. I used email to facilitate initial rapport with the research participants. All prior contact with research participants was electronic, which could complicate the building of initial rapport as "both the interviewer and interviewee are relying on the written word as a means of building rapport" (O'Connor and Madge, 2017:15). I have tried to build rapport with the research participants to my best efforts. The building of rapport entailed explaining the following to the research participants per email: the research study's purpose and aims, what I require of the research participants and what is to be expected of an online interview. I also aimed to foster rapport through explaining why I think the lived experiences of the research participant would be of great value to my study.

3.3.4.4.4. The responsibilities of the interviewer

Throughout the interviewing process, as the interviewer, my task was to listen and encourage

the interviewees to share their experiences. Seidman's (2013) book served as a guideline and reminder that others' stories must be deemed and remain important in my actions as an interviewee. In other words, it is my duty to make the research participants feel heard. Throughout the interviews, I aimed to capture, not only the participants' words, but also their moods and affective components in order to understand their individual contexts and worldviews (Yin, 2009). At times when I wanted to deepen the conversation, I prompted interviewees to elaborate by probing for examples or asking additional questions such as: "Why is that?"; "Could you elaborate on that?" or "Anything else?" (Adams, 2015:502). In other words, iterative questioning was used when clarity was required throughout the interviews. The answers to my interview questions (based on lived experiences) are valued as data that might provide me with insight and understanding with regards to my research question. In order to enhance the interview process, I followed the advice of Seidman (2013:47) to approach the interview process as interviewer with "[s]eriousness but friendliness of tone, purposefulness but flexibility in approach, and openness but conciseness in presentation".

3.3.4.4.5. How the Interviews Unfolded

In order not to repeat the same information in the data presentation of each case, I added this section to discuss how the interviews unfolded. All five interviews started by welcoming the research participant, stating my name, thanking the interviewee for their time and participation and asking if there are any questions before starting the recording. I then proceeded to ask each research participant for his/her permission to start the recording and all five research participants gave their oral consent during their interviews. After starting the recording, I made sure that the session is indeed recording and then commenced to inform the research participant about my study's focus before asking the first official question. To each research participant, I stated the title of my research project:

> *The lived experiences of Life Sciences teachers belonging to different 'religious' beliefs: A focus on the teaching of evolution.*,

and my research question:

How do Life Sciences teachers, belonging to different 'religious' beliefs, experience teaching evolution as a curriculum topic?

I explained to each research participant that I would be focusing on the research question, but that it would be based on their specific context, as I am using a case study approach. Therefore, I also stated the research question based on each research participant's context before starting to discuss the ethical considerations. For Zafir and Saadiq, the question: "How does a *Muslim* Life Sciences teacher experience teaching evolution as a curriculum topic?", was stated. For Michelle, Nandi and Heidi, I stated the question: "How does a *Christian* Life Sciences teacher experience teaching evolution as a curriculum topic?". Due to feeling nervous and socially anxious myself as a first time master's student, I only started recording some of the research participants' interviews at this point. I then started going through my checklist of what I needed to remind the research participants about in terms of ethical considerations in order to establish some rapport. The checklist can be found below, however, for each interview, the checklist was discussed in conversation format.

Checklist of reminders for establishing rapport:

Reminder that your **identity** and **school's identity** will remain **anonymous**.

Safe and **non-judgmental environment** where you may **freely share your experiences**.

There are **no right** or **wrong answers**.

You have the **right to withdraw** at any point of this interview.

To be specific when I speak about evolution, I am referring to **micro-** and **macro-evolution**.

According to **CAPS**, evolution is covered in the:

4th term of Grade 10

3rd and 4th term of Grade 12

Any **questions** before we start the interview questions?

Below, the reader can find an explanation of the steps taken to present and analyse the data.

3.4. Data Presentation and Data Analysis

In this paragraph, I explain the steps that I had planned to take to present and analyse the data, as well as state the codes created in the coding process. In the rest of this section, I explain how the process actually unfolded. The actual process of analysing the data, where these steps were executed, is shown in Chapter 4 in the form of colour coding, highlighting and side notes in the data presentation section. In terms of preparation for the process of qualitative data analysis, a detailed review and evaluation of literature pertaining to the topic of study was the first step. Chapter 2 is the detailed review of literature. As mentioned in Chapter 2, both Aloovi (2016) and Nishizawa (2017) used the process of thematic content analysis to analyse their qualitative data. The second step in preparation for analysing the data was to arrange meetings with researchers who are knowledgeable in the field of interpretive research, as recommended by Rabionet (2011). In an attempt to recruit potential research participants, my supervisor has given me the contact information of a retired subject advisor who assisted me in the recruitment of one of the five research participants. In addition, I arranged a meeting with this subject advisor during which I was provided with useful advice and tips on doing qualitative research – including recommendations on the review of certain policy documents that might enrich my study, such as the Annual Teaching Plan (ATP) (Department of Education, 2021). This meeting was my second step in preparation for the conduction of qualitative data analysis. I have also had a number of meetings with my supervisor, Professor Lesley Le Grange, who provided me with feedback on my chapters, as well as assisted me with uncertainties that I had regarding conducting research and writing up my thesis. I have also attended online post graduate webinars providing advice on doing qualitative research, specifically in the field of education. Lastly, I kept in mind that my own "creativity, experience, knowledge, talents, support and sensitivity" might influence my choices throughout the data analysis process, as stated by Boeije (2002:409). Therefore, I made sure to be sensitive to the matter of bracketing my own experiences and beliefs as much as possible.

Qualitative data was produced where the purposefully sampled research participants shared their lived experiences, through a multiple case study approach to research. However, as the reader would be able to recognise in the following sections, throughout the process of analysing the data, I have slightly changed my methodology from what I had originally

planned to do in my proposal to taking what I have learned regarding qualitative data analysis methods and applying my own take on qualitative data analysis. I realised the significance of each individual case as I went through the data, as well as the importance of compassionate understanding of a research participant's lived experience and therefore, formulated my own unique mode of data analysis by incorporating what I have learned regarding qualitative data analysis and applying my own take on these methods. Thus, I have decided to firstly present the data in order to provide the reader with a clear idea of what each research participant is like, and how their interview unfolded, and then interpret it. Presenting the data in terms of the interview questions might also assist in the compassionate understanding of the teachers' lived experiences. The themes derived from thematic content analysis was not only derived from the data, but was guided by what has been found in the literature, as will be discussed below. Units of meaning recognised through reviewing the data were categorised under the abovementioned themes. Thereafter, as recommended by Maykut and Morehouse (2005), the constant comparative method was used to conduct cross case analysis inductively through applying my own take on coding, recognising convergence and divergence in the data.

3.4.1. Transcription and Coding

Four of the interviews were transcribed through using the Microsoft Teams automatic transcripts that was available after each recording was created. After obtaining the automatic transcripts, these were edited by re-watching the interview recordings multiple times and making sure that the words in the transcript correspond with the words in the recording. Since Heidi preferred to speak Afrikaans during her interview, I manually transcribed her interview, as the Microsoft Teams automatic transcripts could not be created in Afrikaans. Heidi's original transcript is therefore in Afrikaans; however, her words were translated to English in the data presentation in order for the English-speaking reader to gain a better understanding of her lived experiences. The transcripts were created in the form of a dialogue including the researcher's (myself) and the interviewees' spoken words, sounds, body language and any other technical aspect of the interview, since the interviews were conducted virtually on Microsoft Teams. The thematic analysis process actually already started by providing the transcripts with page numbers and making sure that all five transcripts are written in the same

format. This process was all done electronically by placing the transcripts in separate files. All five interview transcript files were coded (named) according to each interviewee's pseudonym. These individual transcripts are the raw data and can be found as Appendices A-E. The files are named (coded):

1. Zafir Transcript
2. Saadiq Transcript
3. Michelle Transcript
4. Nandi Transcript
5. Heidi Transcript

To ensure that the research is trustworthy, before presenting the data in the order of how the interviews unfolded, the research participants were given their transcript back per email and kindly asked to review it to confirm that their words are accurately being represented – also referred to as member checking, further discussed in section 3.6.

Colour coding of the words was used to differentiate between the different interview questions, coding the teachers' answers according to the twelve interview questions in 12 different colours. This letter colour coding can be found in the original transcripts, and it is also shown in the data presentation. Throughout the data analysis process, however, more units of meaning were identified, added and coded. As stated by Rule and John (2011), this process entails a timely process of reading, coding and recoding. Despite coding being a time-consuming process of data analysis, this process was entirely done by myself, the researcher, as it was hoped that it might bring me closer to the data (Rule and John, 2011), which it certainly did. The more I read through the raw data and re-watched the recordings, the more I came to understand the Life Sciences teachers' experiences, and the more I realised how important it is to present how the interviews unfolded in ample detail in order to provide the reader with a deep understanding of the research participants and their lived experiences.

3.4.1. Data Presentation

A way in which I had used my creativity and intuition in the data analysis process was to

present the data in ample detail in the form of a data presentation showcasing how the interview unfolded. This might foster a compassionate understanding of the Life Sciences teachers and their experiences without having to review the entirety of the raw transcripts. Initially, the codes created in order to organise and present the data according to the interview questions, were planned to be the essence of question 1 to 12; however, additional codes were added as the data was reviewed and analysed. The final codes created for presenting the data, after reviewing the raw data multiple times, was the following:

1. **Teaching qualifications**
2. **The reasons why and how the research participant became a Life Sciences teacher**
3. **Experience in teaching Life Sciences: time being a Life Sciences teacher and time being in the career field of education**
4. **Learning about the theory of evolution in the teacher's undergraduate studies**
5. **Learning about the theory of evolution in the teacher's teacher education studies**
6. **Experience in engagement with the theory of evolution in the teacher's undergraduate and/or teacher education studies**

6.1. **Experience in engagement with the theory of evolution while teaching in practice and personally**

7. **Teaching experience in relation to the teacher's general teaching style (typical day in the teacher's classroom)**

7.1. **How has COVID affected the teacher's teaching and schedule**

8. **Teaching evolution in their classroom (how they approach teaching the topic to their learners)**

8.1. **How the teachers applied the Life Sciences curriculum in their classrooms, with regards to having to teach the theory of evolution**

9. **Experience in teaching evolution in their classroom (lived experiences of teaching the topic of evolution)**

9.1. **Misconceptions regarding evolution held by parents, teachers, colleagues or learners**

10. **Personal religious beliefs**
11. **What it is like being a Muslim/Christian person, teaching the topic of evolution**
12. **How teaching the topic of evolution makes the teacher feel**

These codes were identified and colour coded within the transcripted interview answers on the original transcripts (Zafir Transcript; Saadiq Transcript; Michelle Transcript; Nandi Transcript and Heidi Transcript) and is also shown in the data presentation in Chapter 4. Most of the time, the research participants' answers matched the codes organised according to the interview question; however, a number of times, what they have explained or discussed may have fallen under more than one code, a different code or a new code that emerged from the data. The new codes that emerged from analysing the data are the ones in bullets below code 6, 7, 8 and 9, as shown above. As the data was reviewed for presenting, certain coding changed. Therefore, some of the colour coding in the data presentation differs from that of the original transcripts. The latter was kept as is, so that the reader could witness the mumble jumble that is qualitative data analysis. The data is deliberately presented in terms of how the interviews unfolded in Chapter 4 in compelling detail in order to foster an understanding of the Life Sciences teachers' personalities, communication styles and of course, the content, which is their lived experiences of teaching the theory of evolution.

Before discussing the steps taken to find themes, it is also worth mentioning that throughout the process of presenting the data in terms of the codes (derived from the interview questions, as well as the additional four codes mentioned after reviewing the raw data), a physical journal was also kept with additional thoughts and patterns, connections and questions. This had already been the first step in executing an inductive cross case analysis, as most of these patterns were about similarities and/or differences detected across the different cases.

3.4.2. Thematic Content Analysis

The thematic content analysis process entailed a long process of reviewing the data and finding units of meaning by making physical notes of the essence of the units of meaning. I had originally planned to conduct data analysis electronically; however, after reviewing the data multiple times, I had realised that conducting qualitative data analysis electronically would not be as straight forward as I had imagined. I had then opted for doing the thematic analysis by making physical notes as I was reviewing the data. After reviewing the data multiple times and making ample notes about units of meaning emerging from the data, I had

also realised that most of the units of meaning I had taken note of correlated with what was found in the literature. Finally, instead of deriving the thematic content analysis themes inductively, I derived themes guided by the themes found in the literature. I then took the units of meaning I had recognised and made notes of through reviewing the data and categorised these meanings under their relevant themes in order to still let the data speak for itself. In other words, the realisation that most of the units of meaning I had taken note of correlated with the themes found in the literature caused me to change my methodology from an inductive thematic content analysis to using the literature as a guide to form the themes for the analysis of the five individual case studies. After generating all the different themes guided by the themes found in the literature, I reviewed them, making sure that the identified themes are appropriate and sufficient for the research objectives. Thereafter, the themes were finally named and defined, which helped to set boundaries and make distinctions between the data. Five themes were created guided by this process. Essentially, naming and defining the themes helped with the organisation of the thematic content analysis process. Even though all lived experiences were taken into consideration and could be found in the data presentation presenting how the interviews unfolded, only data containing essential meanings (that fit under a created rule of inclusion) was categorised into these themes (Maykut and Morehouse, 1994), which also helps the data speak for itself. Each individual case was then interpreted through a detailed discussion of each theme in terms of the case. Where applicable, the literature was also connected to the findings.

3.4.3. Constant Comparative Method

Together with a thematic content analysis approach to analyse my data case by case (Rule and John, 2011), I also used the process of the constant comparative method in an inductive manner to analyse the data across all five cases (Maykut and Morehouse, 2005). This means that throughout the cross case analysis of the data, a process of inductive reasoning was used to discover important material in the data where the data could speak for itself. In the case of this research study, the units of analysis are the five Life Sciences teachers, each holding their own religious beliefs, and the social phenomenon being investigated involves each teacher's lived experiences of teaching evolution as a curriculum topic. These lived experiences can be

found in the data presentation, where data that was too vague or ambiguous (Maykut and Morehouse, 2005), lacked explication or was not relevant to the research objectives were taken out, making the cross case analysis process more manageable. However, throughout the data analysis process, the original transcripts were referred to if context was ever needed for understanding and interpretation, as well as to remind myself of the totality of each teacher's experiences. Cross case analysis was conducted through taking the thematic content analyses' coding into consideration, but adding new analysis coding techniques, through creating side notes where Z stands for Zafir, S for Saadiq, M for Michelle, N for Nandi, and H for Heidi. Together with the coding of each research participant, convergence across cases was highlighted in yellow and divergence between cases was highlighted in blue. This entire process is shown in Chapter 4 in order for the reader to review the cross case analysis process, as well as to recognise and understand the complexity of qualitative data analysis. Furthermore, I have specifically underlined the teachers' experiences of teaching the topic of evolution with dotted lines in order to distinguish data that focuses on the research question from the rest of the data that provides context and understanding. This does not mean that the underlined data is more important than the rest of the data, but that it is what is most relevant in terms of the research objectives and research question.

After all the lived experiences were taken into consideration and new themes were created inductively based on the cross case analysis, the data analysis was once again reviewed for overlaps, ambiguity and relevance. Finally, after the analysis has been reviewed, each theme was discussed in terms of the cases that were relevant to that specific theme. When the process of data analysis was completed, articulation of meanings, understandings, findings and recurring concepts occurred (Maykut and Morehouse, 2005).

3.5. Ethics

The *Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects of Research* (The National Commission for the Protection of Human Subjects of Biomedical and Behavioural Research, 1979) establishes three important basic ethical principles for research with human beings: respect, beneficence and justice. The first principle states the

importance of respect and protection of the autonomy of the research participants (Seidman, 2013). Secondly, the Belmont Report advocates for maximum benefits and minimum risk to research participants. Thirdly, research participants must be selected equitably. I have taken a number of measures – with respect, beneficence and justice in mind – to ensure ethicality for this research project. The appropriate research paradigm for the type of study has been chosen; the interpretive paradigm, in order to ensure the integrity of my research. A formal letter was sent to the Western Cape Education Department to apply for the conduction of research with Life Sciences teachers teaching in the Western Cape. Permission was given by the Western Cape Education Department – Mrs Wyngaard, followed by Mr Kanzi – in the form of a formal permission letter sent per email (Please see Appendices F and G).

Since human subjects were required to be interviewed for this research project, I have formally completed an online application for ethical clearance to the Stellenbosch Ethics Committee in the Human Research department (Please see Appendix H). As recommended by Ramrathran, Le Grange and Shawa (2017), all five research participants were provided full disclosure on the intentions of the research, their value to my study and how and by whom the findings will be made public in a formal consent form that were read and signed by the research participants. This consent form also contained information of the research participants' rights to confidentiality, anonymity and withdrawal from the study, as required by the Ethics Committee and recommended by researchers such as Ramrathran, Le Grange and Shawa (2017). In addition, the consent forms contained a full disclosure of my research intentions, the research process and possible implications that might arise. As recommended by Shenton (2004), potential research participants were guaranteed that they can withdraw from the study or refuse questions and explanations at any point of the interview. This was also mentioned during the actual interview before the questions were asked. I ensured the participants that no answer is right or wrong aiming to ensure the free sharing of experiences in an honest and comfortable manner. Throughout the process of trying to maintain ethicality, Professor Le Grange has been available for questions or uncertainty regarding my ethical clearance application at Stellenbosch University. It is acknowledged that even though in-depth interviewing does not pose the same risks as biomedical research, it is not risk free (Seidman, 2013). Thus, informed consent aims to minimise such risks. The online application

process for ethical clearance entailed the approval of the informed consent form before it was sent to the research participants. Ethical clearance was granted on the 8th of April, 2021. Before the interviews commenced, after ethical clearance has been granted, the formal consent form (Appendix I) was sent to each research participant to read, complete and sign.

With regards to maintaining ethicality throughout the process of interviewing each research participant, I tried my best to keep the participants' best interests in mind. After transcription, member-checking did not only provide credibility, as discussion in the following section, but also ensured that the research produced is ethical. Regular reflections of the research ensured that there was a clear understanding of the ethical implications associated with social and educational research, as Burgess (1989) recommends. Potential ethical dilemmas were not only avoided and kept in mind before and during the research process, but also after. Throughout the research process, the research participants' religion, belief systems, professional contexts and the effect that the interviews and research results might have on them were taken into consideration.

3.6. Trustworthiness

A study's trustworthiness depends on the extent to which the researcher can place confidence in the outcomes of their study, as well as whether what the researcher has reported is believable (Maykut and Morehouse, 2005). Before discussing the steps I had taken to ensure the trustworthiness of conducting this research study, it is necessary to mention what had been done even before the data had been collected. Credibility was ensured through a detailed review of past literature that related to my research topic. This thorough review of literature that pertains to my study can be found in Chapter 2. According to Maykut and Morehouse (2005), the obvious steps to take in ensuring that one's study is trustworthy is to provide clear and detailed information about the study's purpose, sampling of research participants, context of the research participants, research setting, data collection, data analysis and of the findings and outcomes. This has been done in detail in this chapter. To ensure credibility, I have made sure to use well established research methods for my interpretive study. Such well established research methods are discussed below.

Throughout the process of conducting this study and writing my thesis I focused on transferability, dependability, conformability and credibility to ensure that my study is valid (Shenton, 2004). By providing detailed descriptions of the process of research design, including the data collection process, data analysis and the findings, dependability is ensured (Shenton, 2004). I have used Durrheim's four dimensions of research design to plan, describe and conduct my study. As mentioned in Chapter 1, as well as in my Research Proposal, the purpose of the study was to explore the lived experiences of Life Sciences teachers, belonging to different religious beliefs, as well as to understand the complexity of teaching evolution as a curriculum topic in the teachers' respective contexts. As recommended by Shenton (2004), my study's credibility was increased and irresponsible transferability was avoided through providing detailed descriptions of the context of each research participant, including their religious, personal and school contexts. The interpretive paradigm was the most appropriate paradigm under which my research ought to be done, as my aim was to learn more about and *understand* the Life Sciences teachers' lived experiences of teaching evolution through conducting semi-structured interviews to provide me with qualitative data. Well established modes of data collection were chosen for this study, such as aiming to understand the complexity of each teacher's lived experiences of teaching evolution through a case study approach. It is also extremely important to note that the findings of this study cannot be generalised, as each teacher's case is unique and based on their respective contexts. As each teacher's case is different, a multiple case study method was used. Another well established method used in this study was the process of sampling the research participants – purposive sampling, which is discussed in detail in this chapter. As explicated in section 3.3.4.4.2., I used the book of Irving Seidman (2013), a professor of qualitative research and secondary teacher education, as a guide to construct my interview questions for semi-structured interviews. Researchers such as O'Connor and Madge (2017) regard online research as a valid and legitimate research method. Conducting online interviews was an appropriate choice of data collection in the light of the government's ever-changing COVID-19 pandemic restrictions.

Shenton (2004) also recommends that the study's shortcomings, boundaries and implications be discussed to maintain validity, which are explicated in the 5th Chapter. Furthermore, dependability is also ensured through a disclaimer at the end of the thesis, where I make reflexive comments on the research process. Providing detailed descriptions is beneficial to other researchers to easily repeat similar research in future studies (Shenton, 2004). Confirmability refers to the degree to which other researchers might confirm my study's findings. Thus, it refers to the objectivity of my study. Even though an interpretive study such as this one is impossible to be entirely objective, I have tried my utmost best to refrain from researcher bias through processes of triangulation, member-checking and regular reflections upon the data (Shenton, 2004). These processes aimed to ensure that the study's findings are not influenced by my own beliefs, opinions or preferences, but that they are are based on the research participants' lived experiences.

Maykut and Morehouse (2005) drew on the advice of Lincoln and Guba (1985), who recommended several aspects of qualitative research that ensure trustworthiness. Firstly, they recommended using "multiple modes of data collection" (Maykut and Morehouse, 2005:134). I applied this by collecting data through conducting interviews, observing the teachers' body language, as well as examining documents that the research participants mentioned during their interviews. In other words, triangulation was used for ensuring credibility through examining those documents and resources that the research participants mentioned during their interviews as it helped me to gain a deeper understanding into their lived experiences (Shenton, 2004). Unfortunately, I was not able to observe the teachers in their classrooms as an additional mode of data collection due to the COVID-19 pandemic. In addition, I did not deem it necessary to also add observations to my data collection modes, as I was more interested in the teachers' lived experiences to which they had to reflect on, which they did in their interviews. "Building an audit trail" was the second recommendation I had taken to ensure trustworthiness (Maykut and Morehouse, 2005:134). A permanent audit trial of my research efforts includes the research proposal, the original interview transcripts (Appendices A-E), the presented data, as well as my research journal notes. These documents allow me to take the reader through my work in the exact path that I had taken to conduct my research. The third recommendation was to work with others to increase the trustworthiness

of my study. This had been applied through working with my supervisor, Professor Lesley Le Grange, who provided me with constant guidance and feedback on my research. Lastly, member-checking was recommended by Maykut and Morehouse (2005). Member-checking was implemented by sending the interview transcripts back to the research participants for them to review and verify whether their words were accurately being represented in the raw data transcripts.

Together with Maykut and Morehouse's (2005) recommendations, which were drawn from and inspired by Lincoln and Guba (1985), I have also turned to Seidman (2013) for increasing trustworthiness, specifically pertaining to the conduction of interviews. According to Seidman (2013), no matter how diligently the interviewer works toward minimizing the effect of themselves and the interview itself on the way in which the research participants construct their experiences, the interviewer is still involved in the interviewing and research process. As an interviewer, it was my responsibility to establish rapport, ask the interview questions and respond to the research participants. Therefore, I am part of the meaning-making process, as I engage with the research material, "select from it, interpret, describe and analyse it" (Seidman, 2013:22). Since I am part of the meaning-making process as interviewer, it is also important to acknowledge that, to some degree, the participant's interaction with me is connected to the meaning (Seidman, 2013).

Qualitative research does not only focus on formulaic approaches to ensure validity and trustworthiness, but also focuses on an understanding of and respect for the underlying issues of validity and trustworthiness (Seidman, 2013). This process involves grappling with the concepts of validity and trustworthiness of qualitative research, increasing ways of knowing regarding the topic of study and avoiding ignorance that might influence the validity or trustworthiness of the research. In this paragraph, I discuss how issues of reliability, validity and generalizability that I was confronted with during the research process. Firstly, drawing on Kvale (1996:241-244), the study's validity depends on the quality of my "craftsmanship" as a researcher, as I make knowledge claims based on the research conducted (Seidman, 2013). Asking the interview questions in the order of the three-interview structure recommended by Seidman (2013), aimed to enhance the obtainment of validity through

checking for consistency in the research participants' words throughout their interviews. Validity was further established by the interviews' structure that allowed the research participants "to make sense to themselves", as well as make sense to the interviewer – myself (Seidman, 2013:24).

CHAPTER 4: DATA ANALYSIS & DISCUSSION

4.1. Introduction

Now that the reader has an understanding of what has been done to analyse the data as elucidated in the previous chapter, this chapter consists of what has been found. Firstly, an example is provided of how the data was presented for each case, organised according to how the interview unfolded, and how the data was analysed in terms of codes and convergence and divergence. Then, the data is categorised and interpreted according to themes that emerged (guided by the literature). Lastly, the data is also interpreted through an inductive cross case analysis conducted through the constant comparative method. The findings are also discussed and a concluding summary is provided.

4.2. Data Presentation

The essential data from each interview is included in the data presentation (full version in Appendix J) for the reader to get a sense of how the interviews unfolded, as well as what the research participants are like, in order to understand their lived experiences. It is hoped that the reader reads the entire Appendix J to immerse themselves in the experiences of the five Life Sciences teachers. When these experiences are discussed and interpreted in the data interpretation section, the data presentation with its coding will hopefully have fostered a compassionate understanding of each research participant and their lived experiences *before* the data interpretation is reviewed. It is acknowledged that this chapter is longer than the conventional master's thesis; however, the data presentation is an essential part of this thesis, as it might bring the reader closer to the data and illustrate how the data was analysed as well. The data presentation is also an essential part of the data analysis process, as it brought me, the researcher, closer to the data and allowed me to present how the interviews unfolded and how the teachers reflected upon their lived experiences. A focus was placed on *how* each research participant experienced particular incidents, rather than the actuality of the incidents (Van Manen, 1990). Based on the requirements made by Van Manen (1990), the difficulty of representing the five Life Sciences teachers' lifeworlds from my own perspective is acknowledged (Nishizawa, 2017); however, as Van Manen (1990) recommended, I, the

researcher, let the research participants narrate their experiences freely during their interviews. As researcher, it was my responsibility to present the lived experiences of the research participants in compelling enough detail and sufficient depth to connect the readers to the experiences. In Appendix J, each case is individually presented in the order: Zafir, Saadiq, Michelle, Nandi and Heidi; however, for this section, a few examples from each of the interviews are given (in the same order), specifically focusing on code 9, the teachers' experiences of teaching evolution as a topic.

As a reminder, the final codes created for presenting the data, after reviewing the raw data multiple times, was the following, where the teachers' lived experiences were mostly mentioned in code 8, 9, 11 and 12 as it pertains most to the research question. This colour coding is shown in Appendix J.

1. Teaching qualifications

2. The reasons why and how the research participant became a Life Sciences teacher

3. Experience in teaching Life Sciences: time being a Life Sciences teacher and time being in the career field of education

4. Learning about the theory of evolution in the teacher's undergraduate studies

5. Learning about the theory of evolution in the teacher's teacher education studies

6. Experience in engagement with the theory of evolution in the teacher's undergraduate and/or teacher education studies

6.1. Experience in engagement with the theory of evolution while teaching in practice and personally

7. Teaching experience in relation to the teacher's general teaching style (typical day in the teacher's classroom)

7.1. How has COVID affected the teacher's teaching and schedule

8. Teaching evolution in their classroom (how they approach teaching the topic to their learners)

8.1. How the teachers applied the Life Sciences curriculum in their classrooms, with regards to having to teach the theory of evolution

9. Experience in teaching evolution in their classroom (lived experiences of teaching the topic of evolution)

9.1. Misconceptions regarding evolution held by parents, teachers, colleagues or learners

10. Personal religious beliefs

11. What it is like being a Muslim/Christian person, teaching the topic of evolution

12. How teaching the topic of evolution makes the teacher feel

The manner in which cross case analysis was executed is showcased through side notes where Z stands for Zafir, S for Saadiq, M for Michelle, N for Nandi, and H for Heidi. Convergence across cases is colour coded with yellow highlight and divergence between cases is colour coded with blue highlight. This step was the first step to analyse the data across cases. In addition, in order to further analyse the data, the teachers' experiences specifically were underlined in order to distinguish data that focuses on the research question from the rest of the data that provides context and understanding. Please note that, for the sake of keeping this section concise, only code 9 is used as an example; however, the qualitative nature of the study means that convergence and divergence do not only occur within the same questions, but sometimes they emerged during unexpected times of the interviews where the interviewees' words flowed freely. The examples below will focus on **code 9**, the **teachers' experiences of teaching evolution**; however, for easy reading purposes, the code colour coding and underlining of experiences are both removed.

4.2.1. The case of Zafir: Data Presentation

After I had asked Zafir: "**Tell me about your experiences teaching evolution.**", he firstly emphasised how important it is to be in the classroom, to be well prepared, to be focused and to engage the students in the content. Zafir answered that he experiences teaching evolution as "probably the most interesting section of the work". He has experienced that "a lot of questions [are] being asked in this section of the work". In terms of how Zafir has experienced the reactions of his learners and their parents learning about evolution, he has noticed that evolution is being regarded as a "controversial topic". He explained:

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M

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S

> "You know, they come from their religious backgrounds so when they go home and they talk about the evolution… you know… Parents are also going: 'Why? Why are you being taught about evolution and all that nonsense?' Uhh and so, that is what makes it more interesting… is that when they are being taught a topic that is seen to be a controversial topic, when in fact it's not a controversial topic, uhh, it's been made to be a controversial topic by your Imams, and your shakes and your ministers and so on… your religious ministers… They made it a controversial topic. It's not a controversial topic. And as long as you can distinguish between what is religion and science, there shouldn't be any problems."

N

In terms of his experiences teaching evolution, Zafir also explained that he tries to teach the "youth" about "tolerance". He explained:

> "when a child puts up his hand in the class and says: "Sir, that's a lot of nonsense. I don't believe that." Now, you've got to engage that young man or that young girl with that concept [*nodding head*] and that is where the whole concept of inclusivity comes […] and this is how we develop citizens in our country".

S

4.2.2. The case of Saadiq: Data Presentation

To question 9, "**Tell me about your experiences teaching evolution.**", Saadiq answered that "it's easier to teach it with a group of the same religion, because [they] could go into various discussions and […] compare: this is what you need to learn for the exam, and this is what the Quran says, and you can see how they differ, while they're even similar." He stated:

H

> "So, teaching evolution to a Muslim group allows me as as as a Muslim teacher, uhm, to go beyond the syllabus, beyond the curriculum and have thoughtful discussions, because they can relate to what I'm saying in a better way than somebody from another faith. […] So, you have to be very careful when you have a mixed group how you do your discussion, and you have to make it very clear what is examinable and what is not examinable."

N

Saadiq explaining that having a matric class since the start of the 30 years of teaching "was quite tough", focusing on his experiences of teaching evolution. With regards to teaching the topic of evolution to matric learners, Saadiq stated that "[i]n matric, they are focused so much

N

on assessment and marks, they really don't want to have discussions". In his experience, he has found that the "first thing they will ask" is: "Sir, is this for marks? Why are you discussing this? Is this for marks?", and if he informs his learners that what they are discussing is not for marks, "they switch off". He explained:

> "So, this… this is just part of the education system that we have. Everything is geared towards writing exams. So, the problem you have with engaging in a discussion in evolution, they firstly want to know: "Am I getting marks for this?" And if they're not getting marks, they they won't be interested. So, now you have to replan. […] How am I gonna get them interested? You've now gotta plan an activity that's going to involve them to get them interested, to get them into a discussion."

He discovered that the "main problem has always been time", as there is "not a lot of time for […] real life discussions on how do children feel about this topic", since they are more concerned about whether they are "getting any marks for this". Saadiq has noticed that when he uses "hands-on activities" "to explain evolution", he has his learners' attention; however,

N

when he tells his learners that there will be "an open discussion about evolution, there would be some that would prefer to join in, but most of them will only be interested in: is this for marks?". Therefore, Saadiq feels that one of the problems in grade 12 is that "the matric year is too much geared towards exams and marks" that one cannot really have "open discussions". Another problem that he has experienced is the "time factor in matric", where

H

there is not really "lots of time to have open discussions", since "Life Sciences is a very bulky subject to teach". From his experience, he said:

> "Uh, I can tell you this much; as matric teachers in Life Sciences, we are always the last people to complete the syllabus. All the other subjects, most of them they finish off here by June, July. Life Sciences teachers, right up to the mock exam in September, we still teaching… right before the exam, because we have such a bulky subject to teach; lots of content and lots of assessments. They've now reduced the assessments. [due to the pandemic] So, that helps a little bit, but it's very bulky to teach. So, we don't have a lot of time for open discussions which would have been valuable, especially concerning a topic like evolution."

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4.2.3. The case of Michelle: Presentation and Analysis

The next code focuses on Michelle's **experiences teaching the theory of evolution**, to which Michelle stated that she has "had positive experiences teaching evolution" and "could not think of one opportunity where a kid has ever challenged [her] with regards to it", even though she has "heard of shock stories [*laughing and smiling*] from other teachers and parents that just don't want their children to be told the, the content, but [she's] never experienced that". Michelle was asked to elaborate on what she means by having "positive experiences" and explained that it is "positive in the sense that" she has "never had a confrontation" or a "negative experience with regards to evolution". Michelle only experiences learners "wanting to understand, but why?" and then she helps them by linking previous topics with the current topic. She further explained that her "experiences have been positive", because of the way her learners respond: "they're laughing, they're enjoying it, they're taking part in the conversation". The type of questions that they ask, tell Michelle "that they're actually thinking about it" and that "[t]hey're discussing it outside class" and "coming in with new questions", "asking [her] about the things that they were talking about". She concluded:

S

> "So, so that tells me that they're thinking about it and that to me is a positive experience."

Michelle also compared what she experiences currently as a Life Sciences teacher teaching the theory of evolution, to previous years:

> "just in terms of this year, […] It's probably different for every group of kids that you have, but this year they've been quite… […] critical in their thinking. So, I'm finding that they're asking very interesting questions this year […] You can see that they're trying to formulate the links between the topics, which is something that I've not really experienced [*shaking head*] in previous years… trying to understand how, for example, […] Why would there be a selection for a smaller jaw or a larger brain, etc. […] They're a little bit more challenging in the types of questions that they're asking."

Z

4.2.4. The case of Nandi: Presentation and Analysis

M, H

Question 9 asks Nandi to discuss her **experiences of teaching the topic of evolution**. She stated that "the first year was a bit shaky", as she was "not sure [her]self"; however, fortunately, she was interested and "did a lot of research around the topic". Nandi said that

Z, S

the "issue of […] speciation in… into human evolution" was a "big issue with even the teachers". When she started, evolution was a "difficult concept for them to comprehend". However, she believes that when evolution is approached "from the natural selection point of view, the learners do not have that much issue". She explained:

M

> "Because when you teaching the bipedalism because bipedalism is there, you're looking at the change, maybe in the environment. Why were these characteristics selected? Because they were advantageous. So, you teaching it from a natural point… selection point of view. They were selected because they were advantageous. Those who had this characteristic survived. Hence they were passed on. Hence now we are bipedal."

Nandi believes that "when you tell them as a story to the kids, it's actually interesting to them instead of doing it as an abstract"; thus, she stated:

Z, M

> "So, I really don't have a problem with my learners when […] I teach from that point of view. They never question it, because from the beginning of the term, they know that we're dealing with science and science have evidence. We saying this because there is evidence that this has happened."

Nandi stated that the way in which she explains the concept from a natural selection point of view puts it into context for the learners so that "they can picture it happening". Nandi does not believe that learners only be told that they "need to know this for the exam, whether you believe it or not". She believes that the latter is a "dangerous issue" or a "dangerous thing to say to the learners".

S, M, H

Nandi was asked why she thinks the abovementioned approach is a dangerous issue, to which she replied:

> "[Y]ou're running a risk of losing them. You're running the risk of them not making the links in Life Sciences."

Nandi proceeded to explain that she believes "the whole Life Sciences is about evolution" and it has to be taught "from that context". For example:

> "When you're teaching about the reproductive strategies in paper one; it's in paper one in grade 12, the kids will always come up with the idea of who came first between the egg and the chicken… So, you need to explain that from the evolution point of view,

> that in order for the egg to be invented, it was a reproductive strategy that was selected that was best suited for that environment for that particular species. Hence, they survived because this reproductive strategy… So you see? It's paper one, but I'm dealing with evolution that is in paper two. So, if you close the thing and say you need to learn this for…, then you've lost the learners for the whole Life Sciences concept. That's what I believe in."

4.2.5. The case of Heidi: Presentation and Analysis

Drawing on lived experiences of teaching evolution (**code 9**), Heidi explains why she approaches the subject in this manner.

> "And my previous experiences of presenting evolution at the beginning... especially when I had to start doing it, it was almost as if I had pulled the rug out from under them [*nodding*] when I bring up the subject of evolution and teach them about it. Then they're totally confused, and and they... [*shaking head*] They just can't make sense of it."

This led Heidi to "struggle" with how she should "tackle" the topic. She went on to explain:

> "And I've been struggling with that for a very long time regarding: how do I present it to them so that they can learn it uhm... know what it's about, have the knowledge of it, but not that I completely confuse them with it? And I myself had a whole struggle to come to terms with how do I tackle it now and where do I start and so on?"

After explaining her approach, she goes on to describe her lived **experience** of how the learners perceive the topic. Heidi explained that at this point, she usually starts to see "the 'question mark' faces in front of [her]". Some learners would say to her: "But teacher, we believe as it is written in the Bible."

Based on her lived experiences, Heidi stated that her grade 12 learners experience "the most doubt, because they're a bit bigger now". Therefore, Heidi is "struggling quite a bit" with teaching her learners "critical thinking" according to the CAPS prescriptions. She explained:

> "And now we come to evolution and then they are not allowed to think critically. Because now I have to tell them yes you can think like that, but that's what you have to know and that's what you have to learn and that's what you have to write. Uhm, so then

> it's as if there... You teach them all the time to think critically... critically about stuff, but now that they think critically, now they're not allowed to do it. [*smiling*] […] Then it's a bit like it's in conflict with each other."

Thereafter, Heidi was asked to clarify what she meant by the above statement: in the sense of questioning evolution or their religious beliefs? Heidi answered that they "question the evolution" and continued:

> "Because […] most of them have a Christian background, they question the evolution... which I understand, because they... Yes, they have been getting along with the faith for longer than with evolution. So, they question evolution."

Heidi provided an example and stated that when she teaches "human evolution" and the characteristics of the hominids, some of her learners, referring back to what they have learned in DNA and meiosis, would say:

M

> "Yes, but wasn't it just with just humans and that it's just variations of features […] So, is it just variation or are they really different species?"

Heidi explained that the above question "feels like a critical question". Heidi was then asked to elaborate on what she would answer to such questions to which she replied that she tells her learners that "we have to think about these things". She explained her reasoning:

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> "because I feel on the one hand we have to teach them to think critically. So, you can think critically about it, but this is the stuff you have to write in the exam in the end. So, you can think of those critical questions to form your own opinion, but what you have to answer in the final exam paper is this other stuff that is here in front of you. So, you just have to write about it. Now that's where […] there's conflict. You cannot integrate your critical thinking with what you have to do in the end. You just have to do it and be done. [*smiling*] And in matric we are a bit rushed for time, because the... the academic year is actually shorter now than the other grades. So, you often just have to focus and say okay: you need to know these now […] for the exam and so on. If you get this question you must write this. That's what they give marks for. They give a mark for that fact and that fact and that fact... So, yes, you can think critically. You form your own opinion with that, but *that's* what you need to know and *that's* what you need to write."

The ninth question asked: "**Tell me about your experiences teaching evolution.**" Heidi answered that she finds it "hard" to present the topic and spoke about her experiences when she "had to start to […] offer it in the curriculum":

S

> "the WCED gave us training of what was needed, but for example also, we were told we were not allowed to ask questions at that time. We just have to... 'this is what you have to do, that's what CAPS says, this is what you have to do. Full stop. You're an employee of the WCED. If you don't want to do that, you should take your stuff and go. That's what you have to do.' [*nodding*] Uhm, so, we also didn't get a chance to ever have an... an opinion or a questioning of what we teach learners to do. You just have to keep going."

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Heidi also spoke about "something that strikes [her] pretty much every year, is that learners don't do very well in this section of the work". She spoke about a specific occurrence:

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> "I talked about it the other day with my matrics this year and when the one boy - and he is one of my top candidates - the learners I teach are not... are not... I am not going to say they are not uhm academically strong… There are sometimes learners who are good academically, but they are more... more from a backward community. So, uhm, it's struggling as far as the sciences are concerned in a way. [*nodding*] But *this* one is now an open-minded boy, and he just said to me: "Teacher, it's very difficult to write down a lie." [*smiling*] And and and... I comprehend that. I say, 'yes, but we lie easily every day when we talk'. Then he said "Yes, but if you have to write it, it's very bad." [*smiling*] So... So, it's sort of more the experience of the learners, but I mean I comprehend that. Uhm... And my own children. I have two sons. They themselves also said that it was very difficult for them to have to write the stuff and you... you don't agree. Uhm, so, yes, for me... Now it's okay that I know how to tackle it, but those first few years were terribly bad for me to have to do it. [*smiling*]"

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When asked whether Heidi wanted to add anything else about her experiences of teaching evolution, she stated that what was "quite interesting sometimes to see" was that "learners who watch more TV and who especially watch more of your Discovery channel […] type programs", find it "easier to learn the things". She explained:

> "It's like they... They just see a lot more and hear a lot more about it."

With regards to "learners who are not […] outspoken in terms of their faith", evolution is also easier to learn about, "whereas you can see that the learners who you know and who talk to you about faith-related things; for them it is more difficult", Heidi concluded.

In her response to **question 12**, Heidi describes her **lived experiences of teaching the topic** as she stated that "[e]very class group you find has a different experience of it and some years then it's sort of easier", where the learners "understand easier" and other years "you get groups […] where it's more difficult", where it is "almost like you don't progress… through the work that you have to do". Heidi explained that the in such times, the learners "keep getting stuck on these questions that they ask", which makes it "hard" for Heidi. She explained:

> "I have to finish this job that we have to finish now, but I see you are struggling... So, now... then... then I struggle too. Then it's difficult for me."

Heidi explained that she had an experience that at one point she decided to "leave" the evolution part in order to "work on the other topics", and then continue again with evolution. This gave her "time again to find a […] plan to get them back there and they also have a little time to let it sink in to them that they can now just finish the rest of the part". She said:

> "But yeah, so, some years we go through it easier, but yeah, for me… it's hard for me. [*smiling*] Uhm, I just have to 'compose' myself and get myself together every year to be ready to present this topic to them."

When Heidi was asked whether she wanted to add anything to her answer, she said that because she has been teaching the topic "for quite a few years now", it has become "sort of easier, because one has more experience" and that she knows "a little better how to tackle it […] with the learners", but that it depends on "the group of learners and how they also experience it", which will determine the difficulty level of Heidi's own experience.

The process of presenting, organising and analysing the data, as well as going through the raw data multiple times, allowed me to analyse, interpret and understand the teachers' lived experiences in terms of the research question, add extra coding, as well as make notes about convergence and divergence across cases. Below, the data is interpreted in terms of themes of

which the construction was guided by a review of the literature, a review of the raw data and a review of both the literature and raw data together.

4.3. Data Interpretation (themes)

This section entails how themes were recognised and constructed, what the themes entail, as well as how the research participants' individual case studies connect to the themes. The literature review played a large part of the analysis process in finding themes, as it provided me with the opportunity to review what has been done in research in terms of the topic of study, as well as what the gaps are. Throughout the review of literature on the topic of evolution in education, certain themes emerged. The final thematic content analysis themes were derived from the emerged themes in the literature review, as well as from reviewing the raw data and data presentation. The literature focused on factors such as the importance of evolution in Life Sciences, background, religion, belief systems, worldviews, knowledge of evolution, understanding of evolution and/or external pressures (from the community, learners and/or parents), as well as pedagogical and governmental pressures (curricular pressures). Based on the themes that emerged from the literature and the codes and commonalities that emerged from analysing each case individually, it was found that several themes are relevant to the data of this research project. Even though the themes emerged from literature and data presentation, and are discussed in terms of the case studies, not all themes are relevant to each research participant's case. Thus, each case is analysed separately. At the end of this chapter, a cross case analysis (discussing the convergence across and divergence between cases, derived in an inductive manner) is executed. But first, aiming to answer the main research question; "**How does a *Muslim / Christian* Life Sciences teacher experience teaching evolution as a curriculum topic?",** the following themes are discussed in terms of each individual case:

Theme A: The importance of evolution in Life Sciences

This theme entails the importance of learning about the topic of evolution in the Life Sciences subject, as well as the connection between the understanding of evolution and the

understanding of the nature of science (or the 'big picture' in science). In the literature, I firstly emphasised the importance of the theory of evolution in Life Sciences and biology, where authors, such as Dobzhansky (1973), Paz-y-Miño C. and Espinosa (2009), Dunk, Petto, Wiles and Campbell (2017), Haury (1996), Mathews (2001), Rutledge and Mitchell (2002), Nehm and Schonfeld (2007), Moore and Kraemer (2005), Dempster and Hugo (2006), Cavallo and McCall (2008), Schroder (2012), as well as Mpeta, De Villiers and Fraser (2014) emphasise the importance of understanding and learning about evolution in biology in different ways in their research. Chiappetta and Fittman (1998) recommended evolution as an important topic that unifies the content in biology and provides learners with meaning and relevance to improve their understanding of biology. In other words, if the "big picture" is understood in the light of the theory of evolution, biology in general is more easily understood (Chiappetta and Fittman, 1998:16). In a South African educational context, if the big picture is understood in the light of evolution, Life Sciences is more easily understood. Not only does evolution provide the diverse life on earth with context, but it organises the teaching of biology in general (Rutledge and Warden, 2000). Dunk, Petto, Wiles and Campbell (2017) claim that the nature of science is not emphasised enough in science education, which denies individuals of essential understandings of science. When an emphasis is placed on the nature of science, critical evaluation of evolution might occur, according to Mpeta, De Villiers and Fraser (2014). Throughout the discussions of Theme A in terms of each research participant, as well as in the cross case analysis (section 4.5), the importance of evolution in Life Sciences (as established in the literature) is kept in mind.

Theme B: Background, worldviews, religious beliefs and evolution

Theme B entails discussions of the data in terms of the research participants' backgrounds, worldviews and religious beliefs. As the study focuses on Life Sciences teachers, belonging to different belief systems, and their experiences of teaching evolution, literature on religion and evolution was consulted. It has been found that religion can influence the acceptance of the theory of evolution by authors such as Rutledge and Mitchell (2002), Paz-y-Miño C. and Espinosa (2009), Mpeta, De Villiers and Fraser (2014), Coleman, Stears, James and Dempster (2015) and Stears, Clement, James and Dempster (2016). Research has also shown

that religious beliefs are able to interfere with people's understanding or acceptance of scientific concepts, such as evolution, and vice versa (Rutledge and Mitchell, 2002; Trani, 2004; Chinsamy and Plagányi, 2007; Abrie, 2010; Mpeta *et al.*, 2014; Coleman *et al.*, 2015, Stears *et al.*, 2016). In other words, a teacher's background, worldviews and/or their religious beliefs may have an influence on their personal views on evolution (acceptance, neutrality or rejection of the theory of evolution). Thus, the teacher's personal views of evolution or their acceptance of evolution might have an impact on the teaching of evolution in terms of how the topic is approached in the classroom. Based on the research participants' backgrounds, worldviews and religious beliefs, the relationship between the abovementioned aspects and their lived experiences of teaching the topic of evolution, are discussed for each Life Sciences teacher. In sections 4.3.1-4.3.5, the research participants' backgrounds, worldviews and religious beliefs are discussed, based on their answers to the interview questions (the raw data). The units of meaning were identified through the creation of the data presentation. The Life Sciences teachers' lived experiences of teaching the theory of evolution are also discussed in this section, as well as their opinions regarding the topic, how they approach teaching the topic, as well as how they experience teaching the topic, all while keeping their backgrounds, worldviews and religious beliefs into consideration.

Theme C: Knowledge and understanding of evolution and the teaching thereof

This theme has been selected due to what has been found in the literature, as well as the data in terms of Life Sciences teachers' teaching of evolution in the light of their knowledge and understanding of evolution. Here, the teachers' exposure to, knowledge of and understanding of evolution is discussed, as well as their personal views on evolution, their approach to teaching evolution and their lived experiences of teaching evolution. Specifically, depending on what the research participants have shared, this theme pertains discussions of learning about evolution when the research participants were attending school and university, as well as learning about evolution while in practice or out of personal interest or obligation. For each case, the teacher's experiences of learning about evolution in their undergraduate studies, teacher education studies and post graduate studies are discussed. Some of the research participants also discussed their experiences of learning more about evolution in

their own time, as well as for preparation to teach the topic as the curriculum requires. In terms of what has been found in the literature, Korte (2003) and Rutledge and Mitchell (2002) suggested that a teacher's level of knowledge of evolutionary theory corresponds with their personal acceptance of evolution. Paz-y-Miño C. and Espinosa's (2009) intra-institutional comparisons, as discussed in the literature, showed that exposure to upper-division courses containing evolution-related content can gradually increase the acceptance of evolution. Peker, Comert and Kence (2010) found that an interest in learning about evolution has a positive correlation with the acceptance, as well as understanding of evolution. It has also been found in a study by Rutledge and Mitchell (2002:24-25) that teachers who accept evolution are able to produce the most elaborate, detailed, mechanistic and evidential maps, explaining the theory of evolution in terms of concepts such as "speciation", "natural selection", "genetic variation" and "competition for limited resources". Thus, teachers who accept evolution and regard it as a well-supported scientific theory are able to cite the evidence more easily (Rutledge and Mitchell, 2002). According to Rutledge and Warden (2000), understanding evolution may impact the teaching thereof. Furthermore, the literature suggested that a lack of understanding of evolution and its supporting evidence might foster discomfort for teachers when teaching the topic (Rutledge and Mitchell, 2002). A teacher's understanding of the nature of science and evolution may influence the way they teach evolution, which might influence the way that their learners understand the concepts (Coleman *et al.*, 2015). According to Goldston and Kyzer (2008), a teacher's own acceptance of evolution may influence their pedagogical decisions regarding teaching the theory of evolution.

Theme D: Misconceptions about evolution

This theme focuses on how misconceptions regarding evolution and/or the nature of science may influence the lived experiences of teaching evolution. Misconceptions of learners and teachers are discussed, as well as teachers' acceptance of evolution, their approach to teaching evolution, as well as how they experience teaching evolution in the classroom. According to Mpeta, De Villiers and Fraser (2014), if teachers hold misconceptions against evolution, the acceptance of evolution might be influenced, as found by Rutledge and

Mitchell (2002), Chinsamy and Plagányi (2007), Nehm and Schonfeld (2007), Moore (2008), Sanders and Ngxola (2009), Rice and Kaya (2010) and Schroder (2012). Teachers holding misconceptions regarding evolution means that such misconceptions will likely be taught to their learners, creating educational challenges, said Mpeta, De Villiers and Fraser (2014).

Theme E: The external, pedagogical and governmental pressures of teaching evolution

Theme E entails discussions of each case in the light of pressures faced by the Life Sciences teachers regarding the teaching of evolution. Some of the research participants discussed external and pedagogical pressures such as parents opposing the teaching of evolution or the challenge of keeping learners engaged in evolution in the classroom (Sanders and Ngxola, 2009; Holtman, 2010). Some examples of pressures found in the literature are pressures of getting through a content-dense curriculum, teacher autonomy, state standards, as well as assessment pressures (Goldston and Kyzer, 2008). Teachers' perceptions of the community and their learners' belief systems and perceptions of evolution play a role in the experience of pressure, according to Goldston and Kyzer (2008). Chiapetta and Fittman (1998) found that an overwhelming curriculum that is content-dense can influence teachers' teaching of evolution causing pressure to get through the curriculum and not being able to focus on other important pedagogical factors. The compulsory nature of teaching evolution might put pressure on teachers to teach it effectively to obtain good results (Stears *et al.*, 2016).

Below, each theme (that is relevant to the case) is discussed under each case study.

4.3.1. The Case of Zafir:

Theme A: The importance of evolution in Life Sciences

Reflecting upon his university years learning about evolution, Zafir stated that starting off with the origins of life, "and the way scientists view the origins of life", is how one builds on one's knowledge regarding evolution. He said that this method is "probably the best way

[*smiling*] to study science, to study any subject." In response to the 10th question, Zafir stated his opinion on the importance of evolution in Life Sciences:

> "You know? As far as biodiversity is concerned, plant life, animal life: it's currently happening, and students need to understand that when they learn about evolution, […] and, you know, how species evolve, uh… and the impact, you know, and biogeography, the biodiversity, etcetera… They are all interlinked with each other, and so, as a Life Sciences teacher, evolution is a very important component of them understanding of what happened in the past, and where we are currently going to."

Zafir's explanation represents a clear understanding of the importance of evolution in the subject of Life Sciences, as he describes how essential evolution is to the understanding of the big picture of biology, and to the interconnectedness of living organisms. Referring to the literature stating that evolution is the "unifying theme of all biology" (Dunk, Petto, Wiles and Campbell, 2017:1), Zafir's explanation of the importance of evolution in Life Sciences confirms this understanding. When Zafir discussed his approach to teaching the topic of evolution, he spoke about how he emphasises the importance of evolution in Life Sciences to his learners by telling them: "listen here; further along the line, we're going to deal with the concept of evolution and we're gonna deal with concepts of variation and so on… And it's important and they understand where the changes in our makeup happens.". Zafir's understanding of evolution in Life Sciences coincides with Chiappetta and Fittman's (1998) understanding, as mentioned in the literature review, that evolution as an important unifying topic, since it provides learners with relevance and meaning to understand biology.

In response to the question asking about his experiences teaching evolution, Zafir emphasised the importance of being present "in the classroom", "well prepared", "focused" and to "engage the students in the content". Furthermore, in response to the last question asking Zafir how he feels when he teaches evolution, he stated that "it's a chapter [that he looks] forward to teaching", since "evolution is a concept that you can apply to all aspects of life", and that teaching and learning is about engagement. This statement also coincides with the literature's explanation of the importance of evolution in biology. Thus, in Zafir's interview, there was a clear sense that he had a good understanding of evolution and the nature of science, and therefore, also enjoys and advocates for the teaching of the topic.

Theme B: Background, worldviews, religious beliefs and evolution

Zafir regards Islam as a "way of life" and provided explanations of what it is like being a Muslim teaching the theory of evolution, reflecting on how he was raised. He stated that when growing up, his family was "probably only about one of two Muslim families in that neighbourhood". Zafir mentioned that his father, a teacher and religious minister who "translated the Quran to Afrikaans", taught him to be tolerant of others with differences in beliefs. The reason why Zafir also says that being a Muslim teaching the theory of evolution is "not a problem, is because of the fact that [his] foundations in [his] opinions were solid, from a religious side of things." As emphasised and quoted in the data presentation, Zafir explained that his father taught him "religious tolerance", through fostering an accepting environment whereby he respected his Christian neighbours. He stated:

> "So, so, when you asked me about my beliefs, and how that impacts, you know, I would say that it's about tolerance."

As described in detail in the data presentation, Zafir's views on evolution are that it is not a controversial topic and that "it has been made to be a controversial topic by your Imams, and your shakes and your […] religious ministers… […] It's not a controversial topic. And as long as you can distinguish between what is religion and science, there shouldn't be any problems." Zafir's opinion on the separation of religion and science coincides with the scientists in Stahi-Hitin and Yarden's (2022) study who recommended that the boundaries between science and religion should be made clear. In Zafir's past, he had listened to a professor who provided him with the "necessary confidence as a Muslim […] to be teaching the topic of evolution". He explains: "because as I have made it clear from the start; there's my religion and there's science. […] As a science teacher, […] it hasn't really been for me a problem being a Muslim teaching the topic of…of evolution." Zafir's understanding of the clear distinction between science and religion, therefore, aids in his acceptance of evolution. He explained how some of his colleagues, who question the teaching of evolution, might just not understand how the evidence for evolution was presented to them. Furthermore, Zafir does not see himself as a "Muslim teacher", but only as a "teacher" or "science teacher", since he teaches learners from different faiths. He believes that he is "a teacher first", and that

one's religion is between oneself and one's maker, whereas the "Constitution of a country is what you have to uphold as a citizen of your country". Thus, as a science teacher, Zafir upholds and explores science in the name of democratic education, based on the findings of Long (2012). In terms of his approach to teaching the topic of evolution, Zafir starts his first lesson on evolution by "firstly get[ting] students' opinions" on religious beliefs, as well as how the learners understand evolution and the origins of life. Thereafter, Zafir would provide his own understanding to the learners and say:

> "[N]ow listen, I come from the Muslim faith. And this is […] how I would understand the interpretation of the Quran… uhh, in terms of where life started. And it's it's very clear; God created life. And I tell them that as a Muslim I do not question and I do not doubt that in any way."

Zafir shares his confidence in his religion with his learners, as well as the importance of evolution and how evolution is scientifically connected to the science of life, which indicates that his religious beliefs do not influence his teaching of evolution, and that his background of being taught tolerance, helped him in his teaching of evolution.

Theme C: Knowledge and understanding of evolution and the teaching thereof

Zafir's educational background before he became a Life Sciences teacher, deputy principal and now principal consists of a BSc, PGCE and BEd Honours. With regards to Zafir's high school education, Zafir stated that he had "been blessed when [he] was at high school" with "arguably [two] of the best biology teachers", who inspired him to "develop a passion for the subject". At university, Zafir had also been "blessed with having wonderful lecturers […]: people who are leaders in their field". In his own time during university and as a teacher, Zafir read many articles about the latest science discoveries keeping himself up to date with the current scientific news. In his teacher education studies, Zafir had also been "very blessed with a very good […] method lecturer" who taught him "Philosophy of Science" as well as discussed and debated various theories, which helped with his understanding of evolution. He added that his "development into the understanding of evolution […] obviously also came through reading", relating to the code of personal engagement with the theory of evolution: "I used to sit in the library and I used to read up the papers on uhm… you know, these latest

discoveries as far as the Science, well, scientific American science journals" and he continued saying:

> "And one continues with that as you are teaching. You read newspaper articles and obviously now with the internet, you know, you Google and you read and you read up a little bit more about […] Craig Venter, and the work that they are doing in the Sargasso Sea… and going down, deep down, [*pointing and looking downward*] you know, in the Pacific Ocean and trying to locate microorganisms there and getting some understanding of possibly how life started. And, you know, studying the DNA of your microorganisms; your bacteria, thermophiles, living…".

In "those early years" of learning about evolution, he was aware of what he believed in, as well as "what scientists are saying". Zafir described seeing "pictures of an ape and then you see this […] transformation to an adult man walking upright" in the "life books" that he had at home, as his father was also a teacher. Before Zafir had even studied in university, he asked himself: "Really? Is this how we've evolved? From being an ape to a human"; however, "through reading [he] began to try and make meaning of what was going on and [he] gradually [started] to formulate ideas in terms of what [he was] dealing with". Zafir began to realise that "[y]ou have your beliefs" and that "you have your scientists trying to make meaning of what they observe and what they see and try to explain through their theories […] how life originated […] and how life evolved". Thus, as he increased his knowledge on evolution and learned more about it, he began to formulate an understanding that religion and science do not have to be mutually exclusive. So he came to believe that:

> "there's your religious belief and there's your scientific beliefs and, you know, scientists are trying to explain what they observe, but it doesn't mean that you can't believe, you know, you know when God says I created life; I believe God created. You know, when scientists talk to me about mutations and they talk to me about variations, as a person of the Muslim faith, I believe that God had a hand in it and so God has a hand, God is, you know, that super being and what scientists are saying in my opinion is the work of God and that's the way I look at it. [*nodding*]"

Thus, Zafir's exposure to evolution by his teachers, lecturers, as well as himself, aided in his understanding of evolution, which helped him to accept the theory and not see evolution and

religion as mutually exclusive, but that they could be incorporated into his views of life. In his experiences of teaching evolution, Zafir has been confident in teaching the topic.

With regards to the "Teacher Biology Project" where teachers would obtain education on topics such as evolution, Zafir stated that "[e]volution, in [his] opinion, is a conversation, because it's a concept that students find very difficult to grasp". "Fortunately", he said: "resources are being made available" and referred to the "Teacher Biology Project, TBP, which, in [his] opinion […] revolutionised [*grinning*] the teaching of Life Sciences in the Western Cape". According to Zafir, this project, funded by a distinguished professor, "equipped, in [his] opinion, Life Sciences teachers in the Western Cape well with […] having to teach the concept of evolution." He added: "And believe it or not, we started having teachers coming from [other provinces in South Africa] to be part of this program over the […] holiday period.", which indicates that teacher training programs do assist teachers with the tools to teach topics like evolution. In accordance with the findings of Keke's (2014) study, and Zafir's experiences, it would appear as if the Teacher Biology Project, which is a professional development programme, is beneficial to teachers in terms of increasing their knowledge on evolution. In addition, Zafir's experiences with the TBP and acceptance of evolution also corresponds with Paz-y-Miño C. and Espinosa's (2009) intra-institutional comparisons, which found that exposure to upper-division courses containing evolution-related content can gradually increase the acceptance of evolution. In addition, Paz-y-Miño C. and Espinosa (2009) also found that individuals' acceptance of evolution is influenced by their interactive familiarity with evolutionary processes and how they understand the essence of science.

Zafir also discussed a teaching approach that he uses in his classroom which entails asking the learners to present the theories that relate to evolution, such as Lamarckism, Natural Selection and Punctuated Equilibirum. Thereafter, there is usually an "interesting debate" happening in Zafir's classroom. Then, he "[puts] up [his] slide on natural selection, which is the way […] how scientists view how life evolved." Zafir also discusses changes in the environment and the "variation that happens" with his learners. Zafir's explanation of natural

selection indicates a clear understanding of evolution and the nature of science, as well as his confidence in his knowledge on the subject:

> "The ones with the favourable variation are the ones who will survive. The ones with the unfavourable variation, they die. Over many generations, the population of the ones with the favourable variation, they are the ones who survive […] and that is how we find that the phenomenon of microevolution happens. And over longer periods of time, we find that macroevolution occurs. And so, it's a journey. And then what I've just mentioned to you now, a bit about micro- and macroevolution, that would have been three or four periods down the line. And so I tell them: 'You see this one slide here. If you understand that particular slide, which describes… uh, how natural selection happens or how species have evolved all the time. If you understand that slide, then you won't have any problems with when we deal with […] the evidence for evolution… or when we deal with how variation happens, or when we deal with the phenomenon of speciation.'"

Zafir learned from his experiences of teaching evolution that "[o]nce students begin to grasp" the concept, "they enjoy it", when they have "a better understanding of it". He also believes that it is important to provide the learners with "visual stimulus". An example of how Zafir provides his learners with visual stimuli is by playing a "short clips" on human evolution and how it connects with changes in the environment. He teaches them about "the situation of continental drift", the "Out of Africa Hypothesis", "where our ancestors found themselves in an environment where it was mainly a boreal forest". Zafir explained that he wants his learners to understand that "as continental drift happened, and the environment started to change", "natural selection happens", which will help them to understand "human evolution". He further explained that he wanted his learners to grasp that evolution is about environmental change:

> "And so it favoured from being a quadruped to being a biped. Bipedal. And so they understand that the environment changed from […] forests to grasslands, and it favoured being bipedal, and then obviously the diet, also, how that changed… […] And the fact that with *Homo habilis*, the toolmakers and then the fire makers… uhh and so how the facial features started to change… So, it's a combination of a lot of those factors that contributed to […] the study of… of evolution."

Once again, Zafir displays a clear understanding of how evolution is essential to the nature of science and how it is dependent on environmental change. Zafir's explanations of evolution, coincide with what the CAPS intends for learners to understand in terms of topics such as natural selection and speciation (DoE, 2011: 61-62).

Zafir makes his learners aware of the importance of evolution in Life Sciences, as he does not only talk about evolution when the curriculum requires it, but also mentions it when handling topics such as meiosis in genetics:

> "The teaching of meiosis is crucial… […] because, obviously as we all know that one of the vehicles, besides the fact that the environment changes, is also variation. And […] that is why when you teach meiosis, you know, when you talk about crossing over and you talk about random arrangement of of chromosomes, which brings about the variation, uhm… it's important that you… you give them a sense, there already, that listen here; further along the line, we're going to deal with the concept of evolution and we're gonna deal with concepts of variation and so on… And it's important and they understand where the changes in our makeup happens. You know, that is why it's important, there also that you make students understand that when you look at their faces in the classroom… Yes, we all have the same basic structure, but we all look different from each other. Now, how did that come about? It came about because of genes and the fact that, uh, we all have different variations of a particular gene… and that is how we become different. So, you know, you already plant the seed when you deal with the chapter of meiosis in genetics and you need to make sure that you deal well with it before you get to the section on on evolution."

The connection that Zafir makes between topics such as genetics and evolution is in accordance with what the CAPS requires of him to do. For example, the above explanation coincides with how "variation" can "link with natural selection" (DoE, 2011:57). In terms of teaching the topic of human evolution, as the CAPS requires, Zafir mentioned that he wants his learners to understand "how the environment changed […] from forest environment to a grassland", which favoured humans "being upright". He stated that if learners can grasp that, then the learners are able to understand topics such as the "differences between a chimpanzee and an Australopithecus and the homo species".

In response to the last question of his interview, asking him what he feels when he teaches evolution, Zafir stated that "evolution is a concept that you can apply to all aspects of life". As a biological concept, Zafir is excited to teach the topic of evolution, as "there's gonna be debate, there's gonna be discussion and that, for [Zafir], is what teaching and learning is about". The way in which Zafir describes what teaching the topic of evolution entails coincides with the CAPS, as it recommends that the teacher has a "class debate and discussion" (DoE, 2011:61). Zafir believes that teaching and learning is about engagement. He proceeded to describe his experience of teaching evolution:

> "And so the concept of evolution is a topic that I […] enjoy teaching, and uhm.., as long as it's in the syllabus, I'm sure I will always look forward to teaching the concept"

Therefore, it would appear that Zafir's clear understanding of evolution does influence his attitude toward teaching it in a positive manner, as well as how he feels about teaching evolution – excited. Throughout this theme, it has also been shown that Zafir's knowledge and understanding of evolution, expressed in his teaching, correlates with what the CAPS intends for learners to understand.

Theme D: Misconceptions about evolution

Zafir had mentioned that "misconceptions happen so easily". When he was asked to elaborate on the misconceptions in relation to evolution, Zafir answered:

> "students battle to understand that, uh, when we talk about natural selection, when we talk about changes that happen to the environment… uhm… that is what drives evolution. Now, the biggest misconception that we have in the study of evolution is […] 'to adapt' or 'adapted to'. That is the biggest misconception, because students see it as organisms adapt… and not as: adapted to… That they have the variation that enables them to adapt to the changing environment."

The latter sentence illustrates Zafir's understanding of evolution, which helps him to detect misconceptions when learners hold them. The connection between Zafir's ability to detect misconceptions and his knowledge and understanding of evolution is in accordance with the

findings of Rutledge and Mitchell (2002), where the teachers in their study who accepted evolution were able to describe evolution and cite the evidence for evolution well.

With regards to Zafir's matric marking experience, he also believes that "with all due respects to [his] colleagues, it's because of how the teachers [teach] the concept of 'to adapt' and 'adapted to'" that could cause learners to have misconceptions. Another misconception Zafir had noticed was regarding the theory of Lamarckism, also found by Mpeta, De Villiers and Fraser (2014:19), stating that learners hold misconceptions regarding animals undergoing evolutionary change "out of choice" and found by Hartelt, Martens and Minkley (2022) who emphasise the importance for Lamarckism to be taught from a historical perspective. He realised that as he teaches different theories, the learners soon "start to confuse" Lamarckism and natural selection with each other. Zafir also added that "youngsters seem to battle with [the] particular concept" of "homologous and analogous structures", referring to the former being animals having a common ancestor and latter, animals having different ancestors. In terms of misconceptions around human evolution, Zafir added that it also "has to do with how it is taught to our children.", relating to Moore (2008) stating that when evolution is presented in the wrong light, learners are deprived of an adequate understanding of the theory of evolution.

Theme E: The external, pedagogical and governmental pressures of teaching evolution

In terms of how Zafir has experienced the reactions of his learners and their parents learning about evolution and viewing it as a "controversial topic", he said:

> "You know, they come from their religious backgrounds so when they go home and they talk about the evolution… you know… Parents are also going: 'Why? Why are you being taught about evolution and all that nonsense?' Uhh and so, that is what makes it more interesting… is that when they are being taught a topic that is seen to be a controversial topic, when in fact it's not a controversial topic, uhh, it's been made to be a controversial topic by your Imams, and your shakes and your […] religious ministers… They made it a controversial topic. It's not a controversial topic. And as

> long as you can distinguish between what is religion and science, there shouldn't be any problems."

This experience of Zafir relates to the study of Holtman (2010), where teachers face the challenge of dealing with parents reluctant for their children to learn about evolution. Thus, also relating to Theme D, Zafir describes how misconceptions from parents can influence their response to his teaching of evolution.

4.3.2. The Case of Saadiq

Theme A: The importance of evolution in Life Sciences

Saadiq described that "since 2008", when evolution was introduced into the curriculum, he was "sort of forced to teach it", which indicates a reluctance to teach evolution. The consensus reached by Saadiq and fellow teachers before it had been officially introduced into the curriculum, was that evolution should be left "at university level" and not be taught at school in Life Sciences. Irrespective of Saadiq's personal beliefs though, he tries to foster a more positive situation with his learners' futures and marks in mind. He argued that "at the end of the day, the learners have to write a test or an exam on it". He further explained:

> "So, that is how I think I got around to teaching it with a focus that the child at the end of the day, no matter what I say about evolution, or what the child says about evolution; the end of the day, the the final thing you need to look at is: that child needs to get good marks in the subject. That's the bottom line [*shaking head*] irrespective of what I think about evolution. So, that sort of gave me the strength to teach it purely for getting good marks in the subject."

As found by Stears and colleagues, the compulsory nature of teaching evolution might put pressure on teachers, such as Saadiq, to teach it effectively to obtain good results (Stears *et al.*, 2016).

Saadiq explained that what makes evolution "very difficult to teach" is that "there's no clear evidence that [he] can show" his learners. He said:

> "You can show them what's in the books and what you have electronically, etc. and what's on YouTube etc., but there is no real concrete evidence that you can show them, you know, in terms of school… at school level, perhaps university, so you'd have fossils and stuff that you could have a look at and so forth."

Rutledge and Mitchell (2002:24) stated teachers may believe evolution to be "only a theory" that is "weakly supported" and may regard science and religion as mutually exclusive. Thus, Saadiq's reluctance to teach evolution and his understanding of evolution as a theory with "no real concrete evidence", as discussed in the data presentation, could possibly indicate the understanding that his religion and evolution are mutually exclusive. His views are further discussed in Theme B.

Theme B: Background, worldviews, religious beliefs and evolution

Saadiq is a Muslim, he believes in the Quran and is thus committed to Islam. At a young age, Saadiq has studied the Quran and has attended Islamic lectures "given by local scholars and also by international scholars that come […] to Cape Town or South Africa". In terms of Saadiq's role in schools, he started the "Muslim Student Association" for learners in one of the schools he taught at. Saadiq emphasised his commitment to Islam by saying:

> "So, in terms of my religion, I would say that, uhm, I'm fully committed to Islam and the Quran and the example set by our prophet."

In Saadiq's personal life, he does not restrict himself to only engaging with people of his faith. He wishes to engage with others, learn from them and find "commonalities and share [their] humanity with each other". In Saadiq's response to the eleventh question asking him what is it like to be someone belonging to the Islamic faith teaching the theory of evolution, he replied with: "evolution contradicts all aspects of the Quran" and provided some examples which can be found in more detail in Appendix B and J. Saadiq believes that the basis of evolution is wrong and the foundation is weak. He follows the Quran which gives him the information of how creation started and said: "And you will not find that when you study the […] theory of evolution." He continued:

> "Evolution doesn't have a beginning. Neither does it have an end, whereas in the Quran there's a beginning. The Quran tells that the beginning started with our prophet Adam or Adam [*Arabic pronunciation*], as we say. So, there was a beginning and there's going

> to be an end; the day when the world will be destroyed, the day of resurrection. So, the Quran teaches us that there's a beginning and an end, and evolution doesn't say that. Evolution is still looking for that ancient fish swimming in the ocean… that they're still looking for and they don't know where they're going. [*smiling*] They're still looking for the end."

The above argument and Saadiq's views about evolution, as also stated in Theme A, that it is a theory with "no real concrete evidence", indicate that he regards evolution as mutually exclusive from Islam. Saadiq emphasises the differences in evolution and what is in the Quran that he picked up from learning about evolution in university, reading through the evolution content of the curriculum and reiterated that: "This doesn't click". Saadiq's difficulty in distinguishing between the scientific validity of evolution and his religious views might indicate that a thorough understanding of the nature of science is lacking, supported by the conclusions of Rutledge and Mitchell (2002), who connected a thorough understanding of the nature of science to an increased ability to avoid confusion with evolution and religion. Furthermore, a lack of understanding of evolution and its supporting evidence might contribute to teachers finding the teaching of evolution uncomfortable (Rutledge and Mitchell, 2002). The latter relates to Saadiq talking about teaching evolution:

> "So, that makes it very difficult to teach a a topic like this, because there's no clear evidence that you can show them."

Saadiq explained that realising the differences between evolution and the Quran guided him in preparing for how he was going to approach teaching the topic of evolution. As quoted in the data presentation, Saadiq stated that a "typical lesson […] will be determined by the student that sits in front of [him]", referring to the faith of the learners in his classroom. Saadiq explained that he has to approach teaching the topic of evolution based on the religious beliefs of the learners who he needs to teach. For example, when Saadiq taught at a Muslim school, he discussed some faith-based information with his learners as all of them were from the Muslim faith:

> "If it's a Muslim school, as I say, then we will talk about the Quran and we talk about the the traditions of the Prophet. And does it fit in with what evolution says, you know?"

Saadiq relating evolution to religion in his classroom coincides with 10 of the religious teachers in Stahi-Hitin and Yarden's (2022) study. Furthermore, when he teaches only learners that are from the Muslim faith, "to provide variety", he shows them "small clips" of "Professor Harun Yayha from Turkey" on YouTube who talks about "how the Quran differs from the theory of evolution". These videos entail "statements of evolution", "what evolution is saying about creation" and then "statements out of the Quran", where the professor "compares them with each other". Saadiq explained:

> "But he gives you a live video, you know, of nature, of animals and whatever and their adaptations etcetera. And he shows you how evolution and the Quran differ from each other. […] So, that made the lessons also very very interesting in the Muslim faith schools, 'cause I could do it. But in the mixed groups, I would say, it was a bit more difficult to do that, because you do not want to offend anyone. [*shaking head*]"

When Saadiq teaches learners of different faiths, he makes use of presentations of the content and class discussions of their views on their faiths and evolution. Saadiq said that it is important for his learners' understanding to discuss the latter; however, he makes it clear to his learners during such discussions that it is not examinable and they will not get marks for it. He also mentioned that, in terms of teaching evolution to his learners, he feels that there is "no real concrete evidence that [he] can show them", which could also be categorised under Theme D, as a possible misconception of evolution held by the teacher, as the evidence for the theory is stated in the CAPS document, such as the "fossil record", "modification by descent". "biogeography", "genetics", "other forms of evidence", as well as "evidence of common ancestors for living hominids" in the human evolution section (DoE, 2011:61, 63).

Saadiq viewing evolution as having an "abstract nature" causes him to try "to make it as simple as possible", by discussing the meaning of theories, hypotheses and facts and then he continues to talk about natural selection and human evolution. He provides his learners with an overview of what is required in the curriculum, he then has discussions "based on the type of faith they belong to"; thus, as the 10 religious teachers in Stahi-Hitin and Yarden's (2022) study, he relates evolution to religion. Saadiq also uses these discussions as ways to make the learners aware that there are similarities between the different religions, which "creates understanding between children". He further uses these discussions of evolution and religion,

as the CAPS requires under the section regarding "different cultural and religious explanations for the origin and development of life on Earth", as an opportunity or platform to have discussions where information that would not otherwise have been discussed, are done so to realise commonalities and similarities, which, according to Saadiq, "other controversial topics wouldn't have done that" (DoE, 2011:65).

In the light of his experiences, comparing teaching evolution to learners only of the Muslim faith, and teaching learners from different faiths, Saadiq felt that "it's easier to teach [evolution] with a group of the same religion". He regards himself as a "Muslim teacher" and stated:

> "So, teaching evolution to a Muslim group allows me […] as a Muslim teacher, uhm, to go beyond the syllabus, beyond the curriculum and have thoughtful discussions, because they can relate to what I'm saying in a better way than somebody from another faith."

In his experience, teaching learners from different faiths is "a bit more difficult" for Saadiq as he explained that he needs to be more careful of what he is saying and how he is saying it, as well as to make it clear "what is examinable and what is not examinable".

Theme C: Knowledge and understanding of evolution and the teaching thereof

Saadiq stated that evolution was briefly mentioned in his first year of university, but that he learned about evolution in his third year of his BSc degree. In his third year Zoology, he was taught about evolution in detail. The lecturer who presented the topic of evolution to Saadiq "taught it to [him] in an open minded way". Reflecting on his experiences, this lecturer divided the students (with different religious backgrounds) into smaller groups and had them discuss the theory of evolution. Saadiq talked about this learning experience:

> "But the way he presented it, he gave us the theory in a very explicit, very good way […]. And he allowed us to share our ideas with our peers, and then once we're done discussing it with our peers, he would ask us […] what we want to share with the group regarding our opinion about the particular theory, so it was a very uh open discussion…

> Very free… you could speak freely. You didn't feel uneasy to talk about it, but uh he made it very clear that it is a theory; it's not fact."

Saadiq's experience with the lecturer taught him how to engage with and deal with "controversial material", and not to "push" his religious beliefs aside, but to "read what other people are saying" and then decide if this material is to be believed or not. The above experience made Saadiq "think of evolution […] not to be something to be afraid of". From this lecturer, Saadiq learned that open discussions can remain respectful even if there is disagreement, as well as "not to regard evolution as a threat". In Saadiq's university experience learning about evolution, he also felt that he was "properly guided as to how [he was] going to be examined on the topic of evolution". Therefore, he did not deem evolution to be threatening or that it would cause him to "leave [his] religion". Because of the way Saadiq's lecturer presented the topic of evolution to him, it was easier for him to understand and to "write exams on it". He had also obtained a BEd Honours and MEd thereafter and at the time of his interview, he was busy with his Ph.D. Reflecting upon his university experiences of learning about evolution, Saadiq reiterated that the open-minded way in which his lecturer presented the topic, "gave [him] some idea how to teach it". He said:

> "So, from that point I felt if evolution would actually become a topic to teach in in the schools, I wouldn't be threatened to teach it, because he he actually trained us how to handle the material."

The way in which Saadiq approaches teaching the topic of evolution, through learners having discussions, therefore, seems to be inspired by his university lecturer's teaching style. The CAPS asks of teachers to have debates and discussions about the "origins of ideas about origins", which Saadiq executes in his classroom (DoE, 2011:61). As a result of taking inspiration from this professor, Saadiq also does not feel threatened by the topic of evolution. Thus, his taking inspiration from his professor indicates that academic background does have an influence on the teaching of evolution, as also found by Rutledge and Warden (2000). Even though Saadiq is not "threatened to teach it", he felt like he was "sort of forced to teach it"; therefore, the latter and Saadiq's discussion about evolution having "no clear evidence" might relate to Rutledge and Mitchell's (2002) findings, stating that a lack of understanding of evolution and its supporting evidence might cause teachers to find teaching evolution uncomfortable. Furthermore, Nehm and Schonfeld (2007) found that commonly held

misconceptions regarding the nature of science included that the theory of evolution cannot be proven (Nehm and Schonfeld, 2007), which relates to his statement about evolution having "no clear evidence".

Theme D: Misconceptions about evolution

In response to the question, "What is it like to be someone belonging to the Islamic faith teaching the theory of evolution?", Saadiq added that he has experienced that there are misunderstandings and misconceptions among the staff members, his friends and his colleagues. As a science teacher, Saadiq felt like he was "looked at as if [he was a] monster". Saadiq and many of his colleagues objected the addition of evolution into the curriculum at a "Cape region" workshop before the introduction of evolution into the curriculum; however, the following year, Saadiq had to teach evolution, despite his personal beliefs and reluctance to teach it. He said:

> "And then, especially people who haven't studied evolution, especially our peers or colleagues, we had some friction. They were on top of us: 'Why are you gonna teach this to our children? Huh? This is not what we want in schools.' But […] they do not understand that we… there was great objection, but we couldn't get through to national and to actually get them to get it out of the schools."

As discussed in the previous themes, Saadiq felt that there is "no clear evidence that you can show [learners]" for evolution, which partly relates to Nehm and Schonfeld (2007) who found that commonly held misconceptions regarding the nature of science included that the theory of evolution cannot be proven. Saadiq's view that evolution cannot be proven is only true in the sense that it cannot be experimentally tested, since micro-evolution can be observed through artificial selection and the development of resistance to pesticides and antibiotics. The strength of evidence that supports evolution as a plausible explanation to what exists now is based on inductive reasoning from, to name a few, fossils, comparison of anatomy, embryology and nucleotide sequences and biogeography.

Theme E: The external, pedagogical and governmental pressures of teaching evolution

Saadiq experiencing pressure being regarded as a "monster" by many of his colleagues, connects to Zembylas (2003) who mentioned that how not conforming to emotional rules, such as being reluctant to teach a certain pedagogy, might make a teacher feel isolated or make them feel like the subject of attention. Due to Saadiq's "peers and colleagues", "especially people who haven't studied evolution", causing friction due to the addition of evolution into the curriculum, there is an indication of misconceptions regarding evolution held by fellow teachers. Saadiq spoke of occurrences where parents had phoned the schools and complained about their children having to learn about evolution – which relates to Theme E as well. Saadiq mentioned that such parents were "especially staunch religious people". He explained that the parents did not understand what was happening, what he was going through and "that [he] had no option, but just to teach it". Because of these pressures from parents Saadiq's experience of teaching evolution also has some negative aspects, influencing his experience of teaching evolution:

> "So, in some respects I feel it was sort of forced onto the schools, because most of our recommendations in the workshops was: Let people decide what they want to study and leave it at university, but do not bring it back down to the schools where you sort of forcing it onto the children, especially if they choose Life Sciences. Leave it at university level… […] was the consensus reached, but there were decisions made that is way above our heads that we have no control over. So, in my personal opinion is that since 2008, we were sort of forced to teach it. 'You teach it or your child gets naught, so make up your mind.' So, you had to now adapt and you had to create… uh… good lesson plans to present this in such a way that you can get the child's attention. So, we had to adapt and we had to do it. So, that was another thing that we had to face regarding evolution. I personally feel it was forced upon us [*nodding*] and we we… our objections went through, but it wasn't taken seriously. [*shaking head*]"

The abovementioned instance where Saadiq personally felt that evolution was "forced upon [them]", as their "objections went through, but [weren't] taken seriously" also links to Theme E, since Saadiq experienced governmental pressure to teach evolution, despite his personal beliefs and objections against teaching the topic. In addition, when Saadiq's colleagues looked at him as if he was a "monster", emotional rules such as being expected to teach evolution no matter cultural and religious background, influenced Saadiq's lived experiences

of teaching evolution, as his perceptions of the community's perceptions on evolution influenced his experience of powerlessness after his opposition to the addition of evolution into the curriculum was "not taken seriously", as also found by Goldston and Kyzer (2008).

Saadiq spoke about many external pressures he had experienced regarding the teaching of evolution, for example, he spoke about the focus on assessment and marks in grade 12 Life Sciences. He spoke about his matric learners:

> "The first thing they will ask: "Sir, is this for marks? Why are you discussing this? Is this for marks?" And if once you say it's not for marks, they switch off. [*shakes head*] So, […] this is just part of the education system that we have. Everything is geared towards writing exams. So, the problem you have with engaging in a discussion in evolution, they firstly want to know: "Am I getting marks for this?" And if they're not getting marks, they they won't be interested."

This experience of a strong focus on marks in grade 12, led Saadiq having to "replan" his lessons to make them interesting. If an open discussion is optional and not for marks, most of his learners would not be interested in taking part. He wanted his learners to be involved and to take part in discussions, and therefore, planned hands-on activities to do so. Saadiq was successful in getting his learners' attention with hands-on activities, according to his lived experiences. The above instance is a clear example of how external pressures can influence a teacher's experience of teaching evolution.

Another pressure that Saadiq had experienced was the "time factor in matric", as there is not a lot of time to have open discussions with grade 12 learners. Furthermore, "Life Sciences is a very bulky subject to teach". Saadiq stated that time is the main problem in Life Sciences and explained:

> "I can tell you this much; as matric teachers in Life Sciences, we are always the last people to complete the syllabus. All the other subjects, most of them they finish off here by June, July. Life Sciences teachers, right up to the mock exam in September, we still teaching… right before the exam, because we have such a bulky subject to teach; lots of content and lots of assessments."

Saadiq believes that more time for open discussions "would have been valuable, especially concerning a topic like evolution".

Saadiq and his school, tried to eradicate some of the problems that they had experienced regarding the topic of evolution. Saadiq had experienced that evolution is covered "too late in the year", as learners displayed "poor results" for the topic. In response, Saadiq "swapped evolution with human reproduction", because of evolution's "abstract nature". When evolution was moved to the second term, "then it gets tested over three exams", referring to June, September and final examinations. Saadiq discovered that "it works", as they "got better results out of the children by moving evolution into the second term." The school later had to move evolution back to the third term after a discussion with a subject advisor. The reflection upon this occurrence led Saadiq to say:

> "So, you see? So, we feel that this is a lot of restrictions placed on the teaching of evolution, guided by what the exam wants. You know? So, it restricts it more to… to uh… knowing your facts, than to actually understand the concepts in evolution."

The above experience is another experience of Saadiq where external pressures have had an influence on his experience of teaching evolution.

According to Goldston and Kyzer (2008), state standards, assessment pressures and teacher autonomy influence biology teachers' pedagogical decisions regarding the teaching of evolution. Many biology teachers claim that their subject matter is overwhelming, which stifles engagement if too much content needs to be covered in a limited amount of time (Chiappetta and Fittman, 1998). Saadiq spoke about Life Sciences being a "bulky" subject to teach, as it leaves limited time for meaningful class discussions. With having to teach such an overwhelming content-rich curriculum, the instruction of evolution might become more challenging. Thus, the content-dense curriculum of Life Sciences might influence learners' ability to truly engage with topics such as evolution. The process of teaching the "big picture" in biology might be implicated by an overwhelming content-rich curriculum (Chiapetta and Fittman, 1998:16).

Saadiq does not only focus on the problems, but he also looks at the "positive" side of teaching evolution. He uses the opportunity of teaching evolution to tell his learners:

> "Look. In your life […] post matric, you're going to come across controversial material… […] you don't agree with [*shaking head*], but you have to read through it. You have to understand it. You have to be able to read through the lines. You have to do critical and analytical thinking. […] This is actually practice for later in your years when you're going to study. […] This is sort of a training ground […] just to make you aware that you're going to meet material like this that's going to be controversial and you need to be able to use your brain to understand what is going on here. […] You have to get good marks. I have to teach it. So, let's carry on"

In this way, Saadiq looks at the topic from a positive viewpoint, as he has to teach it and cannot control the teaching of it. He tries to make it clear to his learners that learning about evolution is "good training ground" for when they enter university in order to make up their own minds and deciding whether they agree on a certain topic. He tells his learners:

> "This is regarded as training in handling controversial material, because once you get to university, you will know […] how to identify it. You see? So, in terms of my feelings, I felt that made me feel a bit stronger and more relaxed and easy about teaching it… uhm, because we looked at it from a positive viewpoint and not only just harp on what is negative about the topic."

Thus, Saadiq teaches his learners that evolution is a compulsory and controversial topic, but that they need not be afraid of it, which links to Abrie's (2010) prediction stating that some teachers might treat evolution as a compulsory topic, rather than the unifying theme of modern biology.

4.3.3. The Case of Michelle

Theme A: The importance of evolution in Life Sciences

Talking about her reasons why she became a Life Sciences teacher, Michelle stated that she "always just enjoyed the subject" and that "[i]t's one of the […] few subjects that [she finds] you take at school that actually prepares you for life after school." She also stated that a lot of the skills that learners are taught in Life Sciences, "can be applied to later life." Michelle added that she also decided to be a Life Sciences teacher "to take […] complex processes and

to simplify it so that children understand it and actually find it interesting." Her approach to teaching evolution, connecting it to other areas of Life Sciences, is in accordance with the literature stating that evolution is the "unifying theme of all biology" (Dunk, Petto, Wiles and Campbell, 2017:1). Michelle stated that she teaches natural selection in order to "lay a foundation for them to understand the principles regarding how evolution happens". As the CAPS requires Life Sciences teachers to teach learners about the "origin of ideas about origin" and evidence for evolution (DoE, 2011:61), Michelle emphasised the importance of teaching learners how evidence is collected for a scientific theory, as well as the difference between a theory and hypothesis. She links the topics of DNA, Genetics and meiosis as a "preface to the concept of evolution in grade 12", as they provide learners with an understanding of "what mutations are, how genes are transferred, how variation is introduced into a species through meiosis and reproduction, happening over millions and millions of years'". Michelle's way of connecting genetics to the topic of evolution is in accordance with what the CAPS aims for teachers to do, where "useful mutations link to natural selection" (DoE, 2011:57). Furthermore, Michelle explains to her learners that "natural selection is happening as [they are] sitting in [the] classroom", which indicates that she has a clear understanding of the importance of evolution in Life Sciences and everyday life. By explaining to her learners that "evolution doesn't happen in individuals", but in populations, Michelle provides them with an understanding of "genes and the idea that there's variation in a population", that evolution is not linked to an internal drive, but a "whole population of organisms changing". Michelle's approach to teaching evolution through connecting the topic to other Life Sciences topics, indicates a clear understanding of what the theory entails and how it relates to the nature of science, as emphasised in the literature.

Theme B: Background, worldviews, religious beliefs and evolution

Michelle was raised in a "Christian household that was very strict in terms of Bible study and going to church on Sundays". She stated that she had always had "a very uneasy feeling about the way that [she] was being forced to love God and the way that God has set a lot of… conditions for His love." Michelle calls herself "technically a Christian", but prefers to think of herself as "spiritual". Her full personal understanding of God can be found in her original

transcript. She stated during her interview that she is not a "textbook 'read the Bible, go to church' Christian" and that there are many aspects of the Bible she does not necessarily agree with. Michelle stated that the "God that [she] believes in is not necessarily the God that the Bible is telling [her] exists." She explained that she has a "very personal relationship with God" and that her perception of a "Bible fixed Christianity" changed to a "more personal understanding of what God is to [her]" because of people that she has met in her life and books that she has read. She came to this new understanding through reading books about a "God of love and a God of understanding, a God who wants to experience physical life, physical reality through [her]". She explained her beliefs stating that she believes God "created this world and he gave us free will to make choices in our lives that will either help us to remember who we are, which is him, or maybe forget for a little bit longer." She stated that she does not "believe in a vindictive God", as she reasoned that a God would not punish her if he gave her the "option of choice". Michelle concluded discussing her beliefs:

> "I believe in a God who wants to experience life through me, whatever that experience might be… and whatever that experience might be is okay. It's okay, because all of it stems from him. I don't know if that's too philosophical. [*laughing*]"

In response to the question asking about her approach to teaching evolution, she explained how she introduces the topic, which includes what her own beliefs are of how God created life:

> "Uhm, I think that there's a lot more beauty to a process where God created the universe with physical principles like natural selection, like cause and effect, etc. that then over millions of years created this top species, than, you know, Genesis going God went boom [*hand gestures to one side*] Eva [*pronouncing in Afrikaans*], boom [*hand gestures to other side*] Adam [*pronouncing in Afrikaans*] and then magic, you know? That that to me [*smiling*] is less magical than this beautiful process of… of life. And that's why I still believe in a God even though I believe in evolution."

In terms of teaching evolution, Michelle stated that she has had "positive experiences teaching evolution" and could not "think of one opportunity where a kid has ever challenged [her] with regards to it." Michelle thinks that these positive experiences are due to the way she introduces the topic of evolution, which entails telling her learners that she is a Christian and believes in evolution and then she states:

> "And those two things aren't mutually exclusive, and I want you to understand as a student that they shouldn't be, uh, mutually exclusive."

Michelle's approach to introducing the topic of evolution also entails laying a foundation for her learners, by discussing what a theory and hypothesis is and what the difference is between the two, as stated in the previous theme. Then, she discusses theories that contributed to an understanding of evolution, mechanisms of evolution, speciation, reproductive isolation and current examples of evolution happening in terms of natural selection. It would appear from Michelle's description of how she introduces the topic, that she follows the order in which the CAPS document recommends. Before Michelle starts the section on human evolution, she has a "talk" with her learners, as she knows that evolution is a sensitive topic and "religious thing". As previously stated, she has never had a problem where her students don't take kindly to the topic, and believes that it is because of how she introduces it. She stated that her learners "usually seem very keen to understand what it is, especially when [she tells] them that evolution is not the typical picture of an ape changing into a man." The talk that she typically has with her learners before going into human evolution goes as follows:

> "So, I kind of tell them that you are not allowed to have an opinion about it [*shaking head*] until you know the facts. So, you can sit here and you can believe what you like, but I'm telling you that you're not allowed to give me an opinion until you actually have all the facts of it. So, you're going to listen and learn, and then you can form an opinion about it; when you can form an argument about it."

She tells the learners that if their concept of evolution is the typical picture of an ape changing into a man, their concept is flawed and therefore, they cannot yet make an argument. Michelle tells her learners:

> "So, you need to first understand the theory before you can have an argument."

Furthermore, Michelle thinks that because she has introduced the topic as a Christian, "as someone who can kind of bring these two concepts together and it doesn't threaten [her] Christianity", she is able to "disarm the situation". She hopes that with her explanation and introduction of evolution, as described above, a learner who is reluctant to listen and learn, has a new insight. The last thing Michelle tells her learners is:

> "and if nothing of this matters to you, then at least you should know you are tested on this at the end of the year. Whether you like it or not, it's 70 marks out of your paper. So, you're going to have to listen [*nodding*] and you're going to have to absorb whether you believe it or not. You're going to go into many situations in your life where you're going to be confronted with traditions and principles and ideas that you might not enjoy."

Lastly, Michelle refers to a saying by Aristotle:

> "An educated mind can entertain a thought without having to accept it. So, be educated. So yah. [*laughing*]"

Answering what it is like being a Christian teaching the theory of evolution, Michelle said that it has not made any difference in her life. Instead, she has spent a lot of time trying to help students to "understand that the two concepts shouldn't be mutually exclusive". She brings up her own beliefs into the discussion by saying:

> "And if you think about the way that I've just explained God and the idea of life being a series of choices, then evolution […] kind of fits perfectly into that idea. [*shrugging shoulders*] It's just a series of choices that led to our evolution that led to our change. It is *Homo habilis* sitting with a rock in his hand and going: "What shall I do with this? Shall I hit a bone with it? Yes, I shall." [*nodding head*] And then he eats bone marrow and over many years that allows brain development. I mean choices, [*laughing*] so yeah."

Theme C: Knowledge and understanding of evolution and the teaching thereof

Michelle has always enjoyed the subject of Life Sciences, and was inspired by a "very good Life Sciences teacher when [she] was at school", who inspired her to study science and become a Life Sciences teacher. Michelle feels that "going into the teaching career", evolution "was just not a subject matter that [she] had studied in depth and when [she] was at school it was also not part of [their] curriculum" at that time. Michelle's educational qualifications consist of a BSc degree and PGCE. Thereafter, she started teaching Life Sciences and has since been teaching for "8-9 years". Michelle spoke about some of her

experiences of learning about evolution in her undergraduate studies. In her first year of BSc, evolution was touched on, occupying two weeks of her time, but it was not a main part of her study field. She described the lecturer who taught evolution to her as "very good", as he gave her a basic idea of the concepts regarding evolution such as natural selection. She did not learn about human evolution in her first year and said:

> "I mean if *Homo habilis* was mentioned, that would have been a lot."

Michelle had not learned about evolution during her PGCE, and was quite shocked that she felt like it taught her "very little of how [she needs] to teach, or rather, what [she] needs to teach." In her Life Sciences subject, "there was no point instruction about specific topics or content":

> "I think it was literally just: in term three and four you cover human evolution, bla bla. That was about it."

Michelle's experience of her PGCE, indicates that the recommendation of Rutledge and Mitchell's (2002) to elucidate the manner in which evolution needs to be taught might benefit teachers such as Michelle, who needed to do her own research on evolution in order to teach it proficiently. Michelle said that in terms of what she is teaching to grade 12 learners at the moment, she "had no prior exposure to changes in the skull, changes in the diet, changes in the pelvis". As a teacher, Michelle had to learn in practice "how the educational system works". She explained how she had to do her own research on evolution, using "whatever textbooks [were] available" in order to feel prepared to teach it to grade 12 learners and "figure it out" as she went along. Michelle reflected back on her exposure to evolution in her undergraduate studies and connected them to what she now knows:

> "This was something that I had to teach myself as I'm teaching the curriculum. Was never exposed to it in my BSc. I don't even know if there is a particular BSc strand in the Life Sciences department that actually focuses on that type of evolution. So, I think that's why I was maybe just touched on microevolution, macroevolution, basics regarding natural selection…"

Michelle also spoke about a negative university experience with a guest speaker in her undergraduate studies that relates to Theme B (since religion and evolution is mentioned) and C (since she speaks about different understandings of evolution):

> "And then also very unpleasant experience where they […] invited a very famous speaker [who] came to speak with us during our first year […] He was very off putting with the way that he discussed evolution. Uhm. In fact, […] he barely touched on the concept of evolution. He used it as a platform to discuss his own atheism, uhm, and how the belief in evolution for him has made him an atheist, and how he's trying to basically tell us that that's what we need to do in order to believe in this [*laughing*] theory (and I remember vividly him going into a segue about female castration, which I don't quite understand how it fits into the whole theme of evolution), but I remember leaving there with like a very bad taste in my mouth and not quite understanding why I had an hour of my life wasted listening to someone telling me why he doesn't believe in God instead of actually explaining the theory of evolution to me. […] That to me was a very negative experience with regards to the topic."

This experience of Michelle is in accordance with Mpeta, De Villiers and Fraser's (2014) findings where some learners sensed that their educators attempted to convince them that evolution should be accepted and their religion, abandoned.

In terms of Michelle's teaching experiences, as mentioned in Theme B, the way in which she introduces the topic eradicates any problems that she might experience in the classroom. She has never had a confrontation or negative experience with regards to teaching the topic. She has even noticed that in the year of 2021, her learners are starting to ask "very interesting questions", aiming to "formulate the links between the topics", which is something that Michelle has not really experienced before. She stated that "They're a little bit more challenging in the types of questions that they're asking."

Michelle also explained how she would approach teaching evolution by linking other topics to it, as recommended by the CAPS, as well as how she aims to foster critical thinking and help learners to "recognise patterns" (DoE, 2011:18). Below is an example of her explanation:

> "'So, in the previous chapter we learned about environmental pressures that cause natural selection. So, let's think of pressures that could have caused humans to evolve. Uhm, talking about changes in climate that caused us to favour… or that caused the

> environment to favour organisms that could stand on two legs rather than four. What's the advantage of having two legs? Uhm, if you have a change in diet, because you've discovered fire, now your food is less… it needs less processing, it's cooked, etc. That is another selective pressure… a change in diet and therefore selection is applied as a result of it.' So, depending on where we are in the work you would link the principles to whatever you're discussing now to help open up that content for the kids."

With her knowledge of evolution, she explains to her learners that "[t]here are some pieces of evidence that you can't argue with", such as "genetic evidence" and "biogeography", where she said:

> "I mean; why would you find exactly the same fossil in two completely different continents? I mean, did the organism pick up its boots across the ocean and die and get fossilised on two different…? [*interrupting herself*] You can't argue with that.

She also states to her learners that:

> "you can't argue with the principle of natural selection, regardless of whether you believe it actually leads to evolution. That's up to you. But natural selection is happening as you're sitting in this classroom. Some of you are gonna sink, and some of you are going to swim. That's just basic natural selection. [*nodding*] So, you can't argue with that. And if you at least understand that, I'm happy. Whether you believe that apes or… or rather chimpanzees and humans shared a common ancestor, that's up to you, but the point is: the picture of an ape changing into a human… that's not evolution. You can take a chimpanzee. You can look at it for as long as you like. It's never going to evolve into a human, because the fact of the matter is this whole, beautiful process of evolution, if you change one thing, you change one meteorite, you change one climate change event, you change one predator, one choosy female, and we wouldn't have evolved. That's the magic of evolution. It's all just about applying the right pressure at the right time and affording enough time for the changes to accumulate."

Michelle's explanation about the evidence for evolution is in accordance with the findings of Rutledge and Mitchell (2002), where teachers who accept evolution are able to produce the most elaborate, detailed, mechanistic and evidential maps for evolution. There is however, one problematic issue, as Michelle expresses teleological misconceptions. A teleological

explanation, a fundamental stance on how people interpret the world around them, describes a process or entity to be appealing to a particular consequence or result that might involve purpose, goal-directness, individual organisms' internal needs or an external designer (Hartelt, Martens and Minkley, 2022). A cognitive bias might be present in her teleological explanations used in conjunction with her scientific explanations. Hartelt, Martens and Minkley (2022) explain the illegitimacy of Michelle's teleological conceptions, as her explanations might be perceived to include an underlying purpose of evolution. Specifically in the context of evolutionary conceptions, teleological conceptions are commonly held and are particularly problematic when such conceptions have an underlying design stance (Hartelt, Martens and Minkley, 2022).

Michelle uses her knowledge of other topics in Life Sciences to connect it to evolution to foster an understanding of evolution. She explains that evolution does not happen in individuals, but in populations. Therefore, her learners need to "have an understanding of genes and the idea that there's variation in a population". She explains to her learners that evolution is not an internal drive, but it is a "whole population of organisms changing". Her explanation is in accordance with what the CAPS requires of her, where "natural selection […] depends on variation" (DoE, 2011:61).

A reason why Michelle enjoys teaching the topic of evolution is that it provides her with the opportunity as a woman to talk to her learners about "selective breeding" and explaining that their reproductive choices "is an example of a selective pressure that [they're] applying". Therefore, they need to make those choices carefully. She stated that "it leads to very good classroom discussions and interactions", where she is able to teach the "unseen curriculum a lot more than necessarily just the seen curriculum". Michelle stated:

> "So, I think for me, I like teaching evolution. It's one of the chapters that I look forward to, similar to human impact in grade 11. […] I like teaching the content. I spend a lot of time trying to find images and videos and things that make interesting for them to understand and my, uhm, own understanding of it and my own teaching of evolution has definitely evolved over the years, so, that it makes it easier for them as well. Yeah."

Thus, Michelle's own understanding of evolution impacts how she experiences teaching the topic, as well as how she experiences her learners' reactions to her teaching the topic.

Theme D: Misconceptions about evolution

Because of the way Michelle introduces the topic of evolution, it would seem that misconceptions are eradicated for the most part, since she has not had negative experiences in her classroom. She talked about only having positive experiences and explained that she has never had a confrontation or negative experience with regards to evolution. From Michelle's experiences, the learners in her classroom seem to be wanting to understand the reasons for the topics that she is teaching them:

> "The only experiences I've ever had is kids wanting to understand, but why? And then me helping them link something that we learned in maybe genetics, something that we learned in reproduction… linking that to what they're not understanding at the moment. And in that sense, I haven't had any negative experiences. My experiences have been positive, uhm, because I think the way the kids sometimes react, they're laughing, they're enjoying it, they're taking part in the conversation. Uh, the questions that they ask tell me that they're actually thinking about it. Uhm, so, in that sense it has been positive. It's not like they're running around: "Ah, ma'am, I believe in evolution…" but they're discussing it outside class, because they're coming in with new questions and, you know, asking me about the things that they were talking about. So, so that tells me that they're thinking about it and that to me is a positive experience."

Michelle enjoys teaching evolution and looks forward to teaching it:

> "I like the challenge of teaching it. Uhm. I like teaching it to kids and helping them to actually understand it and to not have obstinate ideas about evolution, because they were told this is what it means and rather understanding what it actually means."

4.3.4. The Case of Nandi

Theme A: The importance of evolution in Life Sciences

Nandi started learning about evolution when it was still a "disconnected theory"; however, she later "connected the dots" when she had to start to teach it. Since Nandi teaches Natural Sciences to grade 8 and 9 students as well, she stated that evolution starts in grade 8, where natural selection and variation is discussed. She connects the history of life on earth to evolution, as well as real life scenarios that are relatable to her learners. Referring to the FET level, Nandi, connects the topic of evolution to DNA, Genetics and mutations. From the beginning of the term, Nandi teaches her learners that "[they're] dealing with science and science [has] evidence". Because of the way Nandi explains the topic and brings it into context, her learners "can picture [evolution] happening". Nandi explained how she helps her learners to make the links in Life Sciences through the teaching of evolution:

> "I believe the the whole Life Sciences is about evolution. You teach it from that context. When you're teaching about the reproductive strategies in paper one; it's in paper one in grade 12, the kids will always come up with the idea of who came first between the egg and the chicken… So, you need to explain that from the evolution point of view, that in order for the egg to be invented, it was a reproductive strategy that was selected that was best suited for that environment for that particular species. Hence, they survived because this reproductive strategy… So you see? It's paper one, but I'm dealing with evolution that is in paper two."

Nandi tries to connect other topics to evolution and aims not to "lose" her learners through "closing" the conversation by just telling them what they need to learn for assessment. When Nandi was asked how she feels when she teaches evolution, she said:

> "Excited. [*smiling*] Actually, that's the topic I like the most as it ties in everything in Life Sciences."

Nandi reiterated that she does not only teach evolution when it is in the curriculum, but that she brings it across as she goes along. She further explains how teaching evolution makes her feel, describing how evolution "ties up everything in Life Sciences":

> "Whatever you […] teach, let's say in grade 12 syllabus, you you teach DNA; the code of life. Then you go into meiosis. You go into reproduction. You go into genetics. You see? It's building up up to this climax that is, that is evolution at the end. So, it's it's not about evolution as such, but it's about the whole […] curriculum, whole content that is

> tying up together into this climax that is evolution at the end. So, I'm I'm just excited in teaching every topic in Life Sciences as long as it's science for me."

Nandi 'connecting the dots' of the importance and relevance of evolution in Life Sciences illustrates a clear understanding of the theory that is being shared with her learners. Her understanding of the importance of evolution in Life Sciences coincides with Dunk, Petto, Wiles and Campbell (2017:1) who regard evolution as the "unifying theme of all biology".

Theme B: Background, worldviews, religious beliefs and evolution

Nandi grew up in a Christian home; however, she is not sure whether she believes in God. She married into a traditional home; however, she is not sure whether she believes in ancestors. Somewhere, somehow however, she has faith that there is a supernatural being. Nandi is certain that this supernatural being did not "create the world". Nandi said:

> "I don't think I believe in the Bible. Although, I believe in a supernatural being, but I don't believe in the Bible itself."

She explained that she does not believe that her faith is "linked to science", "is linked to who we are today" and "is linked to the diversity of the species out there." *That*, she believes is science. In other words, Nandi believes that her faith is not linked to science. Nandi therefore defines her religion as a mixture of both part Christian and part traditional.

When she teaches evolution, Nandi tells her learners that Darwin did not explain "how life started on Earth. But he said when life was on Earth, how did it become what it is now?". She goes on to explain to her learners that there are theories or ideas and hypotheses being researched. Now that "life is here", "it has changed over time genetically and phenotypically. This is what Darwin is trying to explain." In order to prevent the perpetuation of the educational inequalities of South Africa's past, Dempster and Hugo (2006:112) recommend the explicit "teaching of Darwinian evolution at school[s]", which is clearly well executed by Nandi based on her explanations of how she approaches teaching evolution. Nandi brings up religion in her classroom by talking about the differences between science and religion in order for her learners to understand that religion is faith based and science "relies on evidence and it's supported". She also discusses the history of Darwin, as he went to study theology

and to be a doctor. Nandi uses the story of Darwin being "discarded in class" and later becoming the father of evolution to inspire learners who think "that they are not brilliant".

When Nandi was asked to describe what it is like being a Christian teaching the theory of evolution, she said that she had "never thought about it being a problem", since religion and evolution do different things in her life. She said that evolution is science and is based on evidence, whereas her religion is personal, faith based and cannot be tested. She sees her faith as something that is there "for moral and […] ethical living". Because of the fact that she separates religion from science, and tells her learners that: "you're not wrong to have a faith and understand science because […] they've got different directions in your life", in her experience as a Life Sciences teacher, her learners have "never ever had a conflict with" religion and evolution.

Nandi discusses the differences between science and religion with her learners, including informing them about her views:

> "Do I believe Jesus was on Earth? Yes, I do. [*nodding head*] But do I believe Jesus was […] the son of an Angel? No, I don't. [*shaking head*] Because I believe Jesus was born of a man and this is science. Science say a sperm cell has to… [*interrupting herself*] So, something is missing. […] I believe that there was a Jesus who was a Mandela in our lifetime, because for me he was not a holy kind of person, but he was probably a preacher. […] The Bible made him to be a holy person. […] Those will be my views when we're discussing the issue"

Nandi does not have these types of discussions when she is about to teach evolution, but she has those debates with the learners "right at the beginning" in order for them to understand the distinction between science and religion "right from the start". She explains that she does not only bring up such issues when she is "about to teach evolution", as then she might "sound dogmatic" – as "if you want them only to take this side instead of this" – but she believes that when discussions about science are embedded along the way, "then it's much easier for them to understand the science behind evolution." Nandi's understanding of evolution in terms of the nature of science is in accordance with the findings of Rutledge and

Mitchell (2002), as a thorough understanding of the nature of science allows teachers to avoid confusion with evolution and religion.

Theme C: Knowledge and understanding of evolution and the teaching thereof

In terms of Nandi's education, she obtained a BSc, majoring in Physiology and Biochemistry, a Higher Education Diploma, as well as a BEd Honours. Nandi has been a teacher for 24 years. As discussed in Theme A, the data indicates that Nandi has a wide range of knowledge on Life Sciences and understands the importance of evolution in Life Sciences, as well as the big picture of Life Sciences. In her undergraduate studies, Nandi had learned about evolution, but "not really in detail". In Zoology, she learned about the "phylogenetic trees and […] the evolution of species". In Physiology, she learned about "the cells and the effect of cancer". What she had learned in undergraduate studies "never came together as a theory of evolution" as it was a disconnected theory for her at that time. Evolution was not taught in Nandi's HED. Only after obtaining some experience, Nandi was able to "connect the dots".

Since evolution has not been explicitly taught in South African schools before 2008, many teachers such as Nandi faced the challenge of becoming familiar with evolutionary concepts that were new to them (Holtman, 2010); however, Peker, Comert and Kence (2010) found that the individuals in their study who were interested in learning about evolution had better acceptance and understanding thereof compared to those who were not interested. When evolution was introduced into the curriculum, Nandi "went into 2008 with no experience at all, with no content at all in teaching the topic". Nandi did her own research on the topic, since she was interested in learning about evolution, as well as to teach the topic as a Life Sciences teacher. Nandi described the first year of teaching evolution as "a bit shaky" as she was quite new to the concept, but fortunately, she was interested and "did a lot of research around the topic." Her interest and acceptance of evolution also coincides with the results of Holtman (2010), as mentioned above.

As a teacher, Nandi describes her class as "chaotic" as many discussions happen at the same time. She focuses on training her learners to have the skill of writing examinations, as well as

societal skills. When she teaches the history of life on Earth to grade 10 learners, she starts from what the learners are familiar with and then brings in the theory of natural selection. An example of what they know is some cockroaches possibly becoming resistant to insect repellent. Thereafter, she asks the learners what they think is causing that and then discusses natural selection, as well as the "changing nature of science", by bringing up the rejected theory of Lamarck. In her experience, Nandi has found that the learners accept micro-evolution and speciation, but ask questions about human evolution and find it difficult to comprehend concepts around human evolution. She approaches teaching the topic from the point of view of natural selection, and therefore, fortunately "the learners do not have that much issue". She discusses how she explains the natural selection point of view:

> "Because when you teaching the bipedalism because bipedalism is there, you're looking at the change, maybe in the environment. Why were these characteristics selected? Because they were advantageous. So, you teaching it from a natural […] selection point of view. They were selected because they were advantageous. Those who had this characteristic survived. Hence they were passed on. Hence now we are bipedal."

Nandi realized that when she teaches the content in the form of a story to her learners, "it's actually interesting to them instead of doing it as an abstract". She stated:

> "They never question it, because from the beginning of the term, they know that we're dealing with science and science have evidence. We saying this because there is evidence that this has happened…"

Nandi aims for her learners to make "the links in Life Sciences". Thus, as she believes that the whole of Life Sciences is about evolution, she teaches it from that context. When she teaches the topic of evolution, Nandi feels excited, as evolution is "the topic [she likes] the most as it ties in everything in Life Sciences". Her understanding and manner of teaching of evolution coincides with evolutionist; Dobzhansky (1973) who stated that biology only makes sense in the light of evolution. Nandi brings evolution across right through her teaching of Life Sciences. She spoke about her excitement when teaching evolution and said:

> "For me, it's just like any other topic; the genetics, the DNA, the meiosis, because the… Those topics are building up to what you going to… talking about in evolution at the end. So. the whole curriculum, for me, it's a very interesting and exciting."

Whatever she teaches, whether it be DNA, reproduction, genetics, she says that all those concepts build up to the "climax that is evolution at the end".

Theme D: Misconceptions about evolution

Nandi tries to eradicate misconceptions by bringing in societal skills into her teaching when she teaches Life Sciences. She "always teach[es] in relation to science", starting from grade 8. By emphasising the "processes of science" in order to try and eradicate possible misconceptions, she explains that she emphasises scientific processes throughout her teaching of Life Sciences. Nandi stated that because of the way she emphasises science her learners "never question it, because from the beginning of the term, they know that we're dealing with science and science have evidence. We saying this because there is evidence that this has happened." Her emphasis on the evidence for scientific knowledge connects to Rutledge and Mitchell's (2002) research which found that teachers who accepted evolution were able to cite the evidence, as her learners "never question it".

4.3.5. The Case of Heidi

Theme A: The importance of evolution in Life Sciences

Heidi feels like she is a successful teacher in terms of teaching learners how to apply what they have learned in real life. Heidi connects other Life Sciences topics to evolution, but finds it "hard" to present evolution. She explained that she was not given the opportunity to voice her concerns regarding teaching evolution when it was introduced into the curriculum and was not allowed "to ask questions at that time". She said:

> "Uhm, so, we also didn't get a chance to ever have an... an opinion or a questioning of what we teach learners to do. You just have to keep going."

Teaching evolution as a creationist makes Heidi experience "conflict within [herself]", as she explained that it is hard for her to reconcile herself with what she has to teach. However, she tried to teach it by creating perspective for herself and for her learners by arguing that she needs to know what evolution is about in order to discuss it in her classroom:

> "we teach it so that we know what it's about and that we know what I agree with and what I don't agree with, um, because […] I can't express an opinion about something I don't know anything about. So, it's […] also just my way of keeping myself okay [*smiling*] ... uhm with the subject of evolution. I can't talk about it if I don't know something about it."

Heidi experiencing conflict within herself relates to the Theory of Cognitive Dissonance discussed in Lovely and Kondrick's (2008) study, where it was expected that teachers might experience inner conflict between their religious or personal beliefs and what they ought to teach. Furthermore, her cognitive dissonance might be difficult to overcome if she is not prepared to relinquish her essentialist understanding that "species are timeless God-given entities" (Evans, 2000:250).

Theme B: Background, worldviews, religious beliefs and evolution

Heidi describes herself as a Christian, who grew up in a "Christian home environment". Even though she does not regard the Bible as a science textbook per say, as the Bible describes things, she believes them. Therefore, to her, God is the Creator, and *how* He created is not important, but *who* he created. Heidi chooses not to believe in evolution based on specific arguments against evolution, as she rather chooses to "follow the Bible's version word for word, instead of following the theory of evolution". Thus, Heidi perceives evolution and her religion as two mutually exclusive concepts. She does not feel completely convinced "whether the […] dating used in the theory of evolution […] is really such a decisive factor". Here, Heidi does not display an accurate understanding of radiometric dating nor its importance in establishing life's long history. Hartelt, Martens and Minkley's (2022) findings correlate with Heidi's misconceptions of evolution, as the found that alternative conceptions of evolution are held by some biology teachers because they choose to hold scientifically inaccurate explanations instead of scientific evolutionary explanations. Furthermore, she believes that the Bible's explanation for the "great flood" could be a possible explanation for all the found fossils. Based on Heidi's understanding of creation, she explained that the "great flood" might be an explanation for the different layers in the earth, which "is not only described in the Bible, but that is also described in many other cultures". She explained that

the “smaller species” died first, and “this is why you find them in the […] layers that lie deeper”, and that the “larger plants/animals died out later and that they now appear in the higher layers and the more recent layers of the earth”. She explained that it could “actually give an explanation of why it seems to us that some organisms are much older than others because they are found in deeper layers of the earth”. She questioned the evidence for evolution asking:

> “Aren't the fossils we find the fossils of that flood?”

Heidi teaches evolution based on the religion of her learners. Most of her learners are Christian, and therefore she puts the concept into perspective for them in her teaching approach. In terms of her school context, she stated:

> “[T]he Christian faith in this community […] I consider as the maintaining factor within the community.”

Based on her previous experiences of presenting evolution, when Heidi had to start teaching it,

> “it was almost as if [she] had pulled the rug out from under them [*nodding*] when [she brought] up the subject of evolution and [taught] them about it. Then they're totally confused, and and they... [*shaking head*] They just can't make sense of it.”

This led Heidi to “struggle” with how she should “tackle” the topic, not to “confuse” her learners with it. After contemplation, she came to the point of talking to the learners about a universal question that everyone asks: “Where do I come from?”, which is her starting point. She explains to them that “for some people” the answer suffices in reproduction; however, some people, “who want to know more”, wonder where their parents come from, to which the answer is one’s prehistory, such as ancestors. She continues that some people are still not satisfied and ask where do *people* come from. Heidi tells her learners that people get their answers in different places; for some people, the answer is in the Bible, “which says God made people”, and for others “evolution is an option”. Heidi continues where she tells her learners that “there may be other creation stories” and says:

> “So, that's where we start to differ a bit with how we now explain where people come from. And then I always say, then there are still people who want to go further and say: “Yes, but it's not just about where people come from. Where does life come from?” And

> then for some people, again, it's the Bible's creation story and for others it's evolution. For others it is other creation stories. And then there are some people who are still not satisfied and say: Where does the earth come from? And then you go back to... okay, again, the Bible's creation story of the creation... of the earth or the Big Bang or whatever... So, then I'll tell them different people have different levels of satisfying this universal question, uhm, but that we can actually find our answers in different places."

Heidi's explanation also connects to Theme D, as Moore (2008) and Schroder (2012) found that a common misconception is that evolution is regarded as a belief system rather than a scientific theory. When she arrives at this part of her lesson, she usually starts "to see the 'question mark' faces" in front of her. The "question mark faces" that Heidi has experienced after introducing the topic of evolution relates to a statement made by Coleman, Stears and Dempster (2015), stating that teachers' understanding of evolution may influence the way they teach evolution, which might influence the way their learners understand evolution. From her lived experiences, some learners have told her: ""But teacher, we believe as it is written in the Bible." Heidi then responds to such comments by saying:

> "Yes, for some people the answers are in the Bible, so we stick to that, but there are also others... there are also other explanations and evolution is now, I just tell them, is one of the other explanations and we learn from it that we can know how those people think, but you don't have to agree with it. Now, I'm probably deviating a bit from the CAPS document that says it's a theory and it's proven and that's all and it's just like that... Uhm, but it feels to me that I have to give the children the perspective within which they must learn it."

Heidi's approach to teaching evolution, as described above, coincided with Goldston and Kyzer's (2008) research, which suggested that teachers' own acceptance of evolution might influence their pedagogical decisions regarding the theory of evolution.

When having to teach evolution, Heidi has found that the grade 12 learners have the most doubt, as "they're a bit bigger now", which makes her struggle as a teacher, as she feels like the curriculum prevents her learners from thinking "critically". Heidi explained her reasoning for the latter statement stating that the learners have more experience in learning about

Christianity than of evolution; therefore, they question evolution. Heidi explained learners' trouble with evolution:

> "if we now come to human evolution and we learn about the characteristics of the... […] hominids, then they will say, for example: Yes, but wasn't it just with just humans and that it's just variations of features, because now in meiosis we've learned about the variations, in DNA we've learned about variations... Uhm, what to me it feels like a critical question... and then there would be... We don't know... [*smiling*] So, is it just variation or are they really different species?"

In response to such questions, Heidi tells her learners that such things need to be thought about, as on the one hand, she wants her learners to think critically, and on the other hand, she wants them to be able to write an exam in the end. Here is where Heidi sees conflict:

> "You cannot integrate your critical thinking with what you have to do in the end. You just have to do it and be done."

In her experience of presenting evolution, Heidi states that it is "hard" for her to present the topic. Her learners "don't do very well in this section of the work". A specific experience that made it hard for her to teach evolution was a "top candidate" "open-minded" boy, who told her: "Teacher, it's very difficult to write down a lie.", to which Heidi resonated with. She responded by saying that "Yes, but we lie easily every day when we talk.", to which he responded: "Yes, but if you have to write it, it's very bad." This instance connects to the literature from Coleman, Stears and Dempster (2015) where students struggle to align their existing beliefs with newly presented views when they learn about evolution, as their religion might influence their experience of learning about evolution. She described the first few years to be "terribly bad" to have to teach evolution. Moreover, Heidi added that she had noticed that learners who watch more "Discovery channel" type programs, find it easier to learn about evolution, since they "see a lot more and hear a lot more about it", as well as learners who are not outspoken in terms of their faith. She has experienced that learners who are outspoken in terms of their faith, find learning about evolution more difficult. Heidi's experience with religiously outspoken learners in her classroom, such as the boy mentioned above, provides a reminder of Chinsamy and Plagányi's (2007) study, where students

expressed their feelings regarding evolution, where the ones that were deeply religious rejected the theory of evolution.

For Heidi, it is "hard to present" the topic of evolution, since she "always [has] to build up courage […] not to pull the rug out from under" her learners completely. Heidi's approach to teaching evolution, as elucidated above, connects to the results of Schroder (2012) and Mpeta, De Villiers and Fraser (2014) who found that a barrier to learning about evolution is the misconception that the acceptance of evolution and religion is an either-or decision (which could also be categorised under Theme D). Heidi tries her best not to pull the learners' "steadfastness in their beliefs from them", but to get them to understand the topic and be able to form an opinion about it. Heidi's view indicates, as stated above, that evolution and religion is regarded as mutually exclusive or that evolution is a belief system. Despite her difficulty teaching the topic, Heidi tries to look at the positive side of evolution by seeing it as an opportunity for her to teach learners to form their own opinion, as they would be able to be confronted with a topic which they need to form an opinion around.

Theme C: Knowledge and understanding of evolution and the teaching thereof

Heidi's educational background consists of a BSc degree in Botany and Zoology, as well as an HED. Thereafter, she became a qualified teacher, and has been a teacher for 17 years, with 10 years not teaching, working in tourism. The first time Heidi was introduced to evolution was through the concept of "survival of the fittest" in school. During her undergraduate studies, Heidi learned about how evolution works for the first time in subjects such as Zoology and Botany. Her experience of learning about evolution during her BSc was "quite difficult" for her. She participated in many discussions about evolution with fellow students about: "How does it fit in with our religious convictions and such?". It was hard for her to learn about evolution when she did not quite agree with it, as it was presented to her. Learning about evolution was where she also noticed that people have different views and opinions. She felt "almost as if [she] didn't know where [she] fit[s] in with regard to evolution and the theory and what is in your background around the origin of... of creation and of people". Therefore, it was difficult for her. Even though there are parts of evolution,

such as microevolution, that Heidi could more easily "quite see that it happens", because of "contemporary examples" that it is happening in "reality"; however, when it came to macroevolution, she found it more difficult to accept "that this could have been the way in which uhm animal groups, plant groups arose and how the changes came about". A fellow student made her feel more at ease by saying that if they "get to Heaven one day, then the Lord is going to say: 'Just sit quietly back on these soft chairs and then you are going to see this video of how it finally happened.'" After the friend had said the latter, she felt more at peace and thought:

> "Oh, well. One day we will know exactly how it happened. [*smiling*] Uhm. So, I don't have to worry too much about it."

Furthermore, Heidi found the example of the "pepper moths" interesting and is able to understand their adaptations to their environment, while learning about evolution. She stated that she had a "very good lecturer" who explained the vertebrates and changes in the skull to her, and she found it interesting and quite believable.

From her experience, she does not remember whether she had learned about evolution in her teacher education studies, but said that: "If we had done it, it wouldn't have been a big deal." In her third year of guidance, Heidi decided to become a teacher, as she could go to work in any town in the country. Heidi became a teacher in a small town, as she regards herself as a "rural person" who wanted to work in the countryside. When evolution was introduced into the curriculum, Heidi "just had to drop in and get to know and learn" about evolution. She did some reading of her own in order to form an opinion on the topic. When she first had to start to offer evolution in the curriculum, the WCED gave her "training of what was needed"; however, Heidi stated that they were told they "were not allowed to ask questions at that time" and just had to do "what CAPS says", as employees of the WCED. Therefore, Heidi felt like she did not get a "chance to ever have an […] opinion or a questioning" of what she had to teach her learners. She said: "You just have to keep going." Being a creationist Christian person, teaching the topic of evolution, creates a "conflict within [her]self". It is hard for Heidi to reconcile herself with what she has to teach, so she just tries to create perspective for the learners. The perspective that she created for herself to make it easier to teach evolution is:

> "we teach it so that we know what it's about and that we know what I agree with and what I don't agree with, um, because I can't... I can't express an opinion about something I don't know anything about. So, […] it's also just my way of keeping myself okay […] with the subject of evolution."

She explained why it is hard for her as her views do not reconcile with evolution. Heidi believes, in contrast to natural selection, that "death came with the fall of sin". Therefore, before the fall of sin, there was no death, so there could not have been evolution before death. She explained her understanding:

> "So, from my understanding from the Bible is that death came when people uhm sinned... Before people were on earth, there could not have been evolution. […] That's the only thing that makes sense to me as to why I can't go along with it."

Heidi's understanding also connects to the misconception that the acceptance of evolution and religion is an either/or decision (Schroder, 2012; Mpeta, De Villiers and Fraser, 2014); therefore, it also connects to Theme D.

In her approach to teaching Life Sciences, as a "mother to children" herself, Heidi tries to "put into perspective the events that children experience", as "they do learn from an adult how to approach a situation". Heidi also stated that the curriculum does not specifically distinguish between micro- and macro-evolution, which she regards as a "gap" in the curriculum. She explained that micro-evolution and natural selection can be researched, whereas she understands macro-evolution to be a "bigger idea", and that the curriculum does not include "what are all the changes that had to happen to change from a fish to an amphibian".

In terms of her lived experiences of teaching evolution, Heidi has noticed that "every class group [she] find[s] has a different experience of it", where some years the learners understand it more easily, and other years, there are groups that find it difficult to get through the work. She explained:

> "It's almost like you don't progress... through the work that you have to do, because they keep getting stuck on these questions that they ask and then it get it's hard for me, too. Uhm, because then it's like: I have to finish this job that we have to finish now, but

> I see you are struggling... So, now... then... then I struggle too. Then it's difficult for me."

During 2021, she had the latter experience and decided to pause the evolution topic in order to get to the other topics and continue with it later. Heidi felt that she would then at least "have time again to find a […] plan to get them back there", and it also provides them "time to let it sink in". She explained that when she experiences this, she just has to "compose" herself and "get [her]self together every year to be ready to present" evolution to her learners. As Heidi has gained more experience over the years, it becomes "sort of easier" and she knows "a little better how to tackle it"; however, it mostly depends on the "group of learners and how they also experience it". Heidi's experiences with having freedom to adapt the curriculum content to the locational context, might have affected her experiences of teaching evolution, as she found it difficult to evaluate and apply the content (Abrie, 2010).

Theme D: Misconceptions about evolution

With regards to Heidi's own views on evolution, she holds misconceptions about the theory of evolution and its evidence, such as radiometric dating, as explained in Theme B. In her experience of presenting the topic of evolution, Heidi's learners "don't do very well in this section of the work". A specific experience that made it hard for her to teach evolution was a "top candidate" "open-minded" boy, who told her: "Teacher, it's very difficult to write down a lie.", which Heidi resonated with. She responded by saying that "Yes, but we lie easily every day when we talk.", to which he responded: "Yes, but if you have to write it, it's very bad." This instance connects to the study of Sutherland and L'Abbe (2019:2), where the way in which evolution is taught might result in "misconceptions and distrust in evolutionary theory". Heidi described the first few years to be "terribly bad" to have to teach evolution. This instance related to Schroder's (2012) study where it was found that one of the concepts that learners found most conflicting was human evolution, as the notion held by creationists (that God created the Earth in 6 days and humans in his own image) is challenged by the evolution of humans from primitive primates over millions of years.

Theme E: The external, pedagogical and governmental pressures of teaching evolution

In terms of COVID, Heidi has more classes and describes the experience as "very different now", as she has to "fit everything in" and do "a lot more things than before". In terms of teaching of evolution, she keeps it "very focused" and tells her learners what they need to know for the examinations, "especially when it comes to matric". Her approach to teach evolution to grade 12 learners connects to Goldston and Kyzer's (2008) study where teachers' pedagogical decisions regarding the theory of evolution were influenced by state's standards and their accountability regarding examinations. The limited time in matric also plays a role in her decision to focus on assessment, as she is not able to spend a lot of time on topics, but added "not that I really want to [*laughing*] […] teach them more about evolution". She stated that evolution is "actually a much broader topic which is only briefly delineated" and that "there is not […] that separation between micro-evolution and macro-evolution in the […] curriculum". In terms of matric examinations, Heidi explains some limitations that her learners face:

> "And I also now see just like with matric papers, they are actually quite limited with the questions. There is always a question about natural selection. There is always a question about speciation. Then there's a question about the difference between the uhm skulls and the skeletons of the humans and the hominids and the uhm primates... So, it's sort of the same."

4.4. Inductive Cross Case Analysis: Themes (convergence and divergence between cases)

As the reader would have derived from the data presentation and the discussion of each case in terms of the themes above, the research participants' views, backgrounds, religious beliefs, knowledge of evolution, understanding of evolution, approach to teaching evolution and experiences of teaching of evolution are of different nature depending on each research participant's own specific context; however, there were also some similarities detected in the different cases. Throughout the inductive cross case analysis process, I went through the original transcripts and thereafter data presentation and looked for convergence and divergence between cases, while aiming to answer the research question: ***How do Life Sciences teachers, belonging to different 'religious' beliefs, experience teaching evolution as a curriculum topic?***

As the data presentation already includes ample amounts of information of the research participants' contexts, information such as commonalities and differences between the teachers' religious backgrounds, teaching qualifications or years of teaching experiences are not compared. The reason for the latter is that each case is unique, and such factors cannot be compared, as every teacher's psychological, social, domestic, academic and religious background is different which has a unique influence on their experiences of teaching evolution, and cannot be applied to any other individual's case. If Michelle, for example, would have had exactly the same background experiences as Heidi, her experiences of teaching evolution might have still been completely different, as they are not the same person and every human being is unique. The information focused on in this section is the *teachers' experiences of teaching evolution*, taking their individual contextual backgrounds into consideration. In the discussion of the teachers' experiences relative to one another, their backgrounds are referenced to in order to provide the reader with context and understanding. The Life Sciences teachers' experiences are discussed below in the order of which the themes emerged inductively through the cross case analysis:

4.4.1. The Relationship between Religion and Evolution/Science

Throughout analysing the five cases, it has been found that a concept emerged where the teachers talked about how they perceive the connection between their religion or belief system and evolution in relation to how they experience teaching evolution. As stated in the data presentation, Zafir emphasised the distinction between religion and science by stating: "there's my religion and there's science". Commonality was detected in the way in which Zafir describes his beliefs in relation to science and the way in which Michelle talks about her beliefs in relation to evolution. Zafir stated that as he developed, he began to formulate an understanding "there's your religious belief and there's your scientific beliefs" and that when scientists talk about "what they observe", "it doesn't mean that you can't believe […] God created". He elaborated on his views and stated that mutations, variations and other scientific occurrences are the work of God, "as a person of the Muslim faith". Just as Zafir describes that "God had a hand in it", Michelle described her beliefs stating that "there's a lot more

beauty to a process where God created the universe with physical principles like natural selection" compared to the creation story of Adam and Eve. She said: "And that's why I still believe in a God even though I believe in evolution". Michelle poses to her learners that she is Christian and believes in evolution and that "those two things aren't mutually exclusive", and Zafir also provides his understanding of his religion and "how he understands the interpretation of the Quran in terms of where life started", to his learners and that "what scientists are saying […] is the work of God". Similar to the findings of Stears , Clément and Dempster (2016), who found that a large group of South African teachers are "theistic evolutionists", which means that they accept evolution in the light of their respective religions, the personal views and beliefs of Zafir and Michelle relate, as Zafir believes that "that God had a hand in it and so […] God is […] that super being and what scientists are saying in [his] opinion is the work of God" and Michelle believes that "God created the universe with physical principles like natural selection". Their beliefs as they describe them seem to be similar to the beliefs of the famous evolutionist, Dobzhansky (1973:127), who acknowledged that he himself is a "creationist and an evolutionist", since he believed that God or Nature created life through evolution. With regards to the teaching of evolution, Moore (2008), as well as Mpeta, De Villiers and Fraser (2014) suggest that biology teachers make learners aware of the fact that many scientists include evolution into their religious beliefs; thus, that one does not need to reject evolution to hold religious beliefs. It would seem as if Zafir and Michelle abide by such suggestions in their teaching of evolution, as discussed above. Zafir and Michelle's beliefs described above relates to the concept of theistic evolution and might benefit from a reference to the concept of nonoverlapping magisteria, discussed in the literature review (Gould, 2014).

Similar to Zafir and Michelle, Nandi has never had a conflict between her faith and science, but her reasoning is that as they take different directions in her life. Her beliefs, which she also shares with her learners, in terms of creation differ from that of Zafir and Michelle, as she stated that she is not sure whether she believes in God; however, she said she believes there to be a supernatural being; however, this being did not create the world, as she does not believe that faith is linked to science. Zafir and Michelle's ability to realise the possible mutual inclusivity of religion and evolution, or Zafir and Nandi's ability to clearly distinguish

between religion and science might be influenced by their understanding of the nature of science, as Zafir and Nandi both emphasised the scientific method and all three teachers produced clear explanations about evolution during their interviews linking evolution to other Life Sciences topics, such as genetics.

Even though Zafir and Saadiq are both of the Islamic faith, their views on evolution differ from one another, where Zafir does not experience conflict between his religion and evolution, but Saadiq believes that "evolution contradicts all aspects of the Quran". Even though evolution does not threaten Saadiq's faith, he believes that evolution contradicts what is written in the Quran about creation, and provided some examples (as displayed in the data presentation). Even though Saadiq and Heidi belong to different religions, Heidi, similar to Saadiq's beliefs about the Quran, feels that evolution contradicts the creation story of the Bible, and also provided examples. Interestingly, both teachers, Saadiq and Heidi, whose religious beliefs align with some sort of creationism (whether their faith be Islam or Christianity) are reluctant to teach evolution, even though they still teach it as required by the curriculum, but feel "forced" to teach it or find it "hard" to present. Their personal rejection of evolution in the light of their religions aligns with Rutledge and Mitchell's study, as well as Paz-y-Miño C. and Espinosa's (2009) research, which found that individuals' personal religious convictions may influence their acceptance of evolution. Saadiq and Heidi's personal views of evolution (rejection of evolution) are thus possibly related to their religious understandings (Rutledge and Mitchell, 2002) that both align with creationism. Creationism refers to the assumption that a Creator created the universe and all forms of life (Paz-y-Miño C. and Espinosa, 2009).; however, different kinds of creationism exist (Mpeta, De Villiers and Fraser, 2014). As stated by Sanders (2018), Christianity and Islam are two of the religions that might contradict with the theory of evolution, mainly because of the story of the Earth's creation. This phenomenon seems to be true for Saadiq (Islam) and Heidi (Christianity); however, not for the other three teachers who are also of the Islamic or Christian faith. When they teach evolution, Heidi and Saadiq discuss religious creation with their learners. Zafir, Michelle and Nandi also discuss their views of religion in relation to evolution; however, Michelle emphasises to her learners that evolution and religion need not be mutually exclusive and Zafir and Nandi emphasise a clear distinction between science and

religion. Heidi aims to put evolution into "perspective" for her learners by stating that evolution is an alternative way of understanding how life started. As she talked about Christianity being the "maintaining factor" within her community and her learners being mostly Christian, Heidi's experiences relate to the findings of Goldston and Kyzer (2008), who found that teachers' decisions regarding teaching evolution are influenced by the impact that evolution might have on their learners' religious views. Saadiq shares (only with his learners of the Muslim faith) YouTube videos of the differences between the Quran and evolution in terms of creation and discusses it. Even though Cooper (1996) believes that the discussion of creation cannot be avoided, since learners raise the issue if not raised by teachers, Abrie (2010) states that discussing creationism might create a perception that creationism is an alternative to evolution.

Mpeta, De Villiers and Fraser (2014) recommended that using religious beliefs or worldviews as scaffolds when teaching evolution might help deeply religious learners who experience conflicts with their religious beliefs and evolution. Interestingly, all five teachers mention their own religious beliefs when they teach learners about evolution. Zafir asks his learners' opinions on the topic, shares his own beliefs and states the distinction between religion and science. Depending on the religion of the learners that Saadiq teaches, he changes his teaching approach; when he teaches learners of the Muslim faith about evolution, he discusses with them how evolution differs from the Quran, whereas when he teaches a mixed group of learners (belonging to different belief systems), he uses a similar approach to the one used by his university professor – to divide the learners into smaller groups and discuss their beliefs and evolution. Michelle shares the fact that she is a Christian with her learners when teaching evolution, and explicitly tells them that religion and evolution need not be mutually exclusive. Nandi shares her beliefs with her learners, as well as the ways in which she questions the Bible; although, she explicitly emphasises the separation between religion and science. Heidi's teaching approach seems to be from a Christian perspective, since most of her learners are Christian. She tells them that evolution is another way of looking at how life started.

As shown in the international, as well as South African literature, as well as the data, teachers' backgrounds and belief systems may influence their experiences of teaching evolution. As shown in the data discussed above, and as also picked up by Reddy (2012), there is an interconnectedness present between the research participants' worldviews, belief systems, emotions and their acquired knowledge and information in the light of the teaching of evolution. According to the data presentation, Saadiq and Heidi experienced conflict between their religion and evolution, whereas Zafir, Michelle and Nandi did not. Thus, regardless of the type of religion an individual is committed to, their acceptance of evolution cannot necessarily be determined. Thus, it has to do more with how they understand evolution, regardless of religion. Chinsamy and Plagányi (2007:253) recommend that teachers create a supportive classroom atmosphere in order to ensure that evolution is well understood, even if challenges may arise, such as conflicts with learners' belief systems, as "evolution often challenges pre-existing conceptual ideas". However, based on the data, it would appear as if all five teachers create a supportive classroom atmosphere, even the teachers who experience conflicts with evolution and their own religious beliefs.

Another interesting concept noticed in all five teachers is that none of the teachers, irrespective of their religious beliefs, were willing to abandon the concept of a creator or supernatural being in charge of forces such as evolution. A useful concept for the teachers to explore might be concept of theistic evolution, which is the acceptance of evolution but under the control of God, a very common viewpoint held even by agnostic or atheist individuals, as shown in Stears, Clément and Dempster (2016). Gould's (2014) concept of NOMA might be useful to explore for the teachers such as Zafir and Nandi who separate religion from science. The reconciliatory approach, discussed in the literature review, suggested by Tolman, Ferguson, Mann, Maskiewicz Cordero and Jensen (2020) might also be a useful recommendation.

4.4.2. Reluctance or Excitement to Teach Evolution

Saadiq and Heidi both found it difficult to accept the addition of evolution to the curriculum. When evolution was introduced into the curriculum, Heidi felt that she could not express her reluctance to teach it to the WCED, and Saadiq felt like his objections went through, but were

not taken seriously. Both teachers stated that they had no option but to teach it. Saadiq wished for evolution to be covered rather at "university level"; however, he had no control over the decision. Irrespective of his own "personal beliefs", Saadiq teaches evolution with the learners' marks and futures in mind, which gave him the "strength" to teach the topic. Having to teach evolution has created a conflict within Heidi; however, she tried to inform herself of the topic anyway in order to teach it to her learners, as the curriculum requires. Heidi experiencing conflict within herself serves as a reminder of Lovely and Kondrick's (2008) study whereby individuals experienced cognitive dissonance when having to teach evolution. When she teaches evolution, especially when it comes to matric learners, Heidi keeps is "very focused" and informs her learners: "that's all you need to know for the exam". When Heidi spoke about the "limited" time in matric, she stated that she is unable to spend a lot of time on the topic, but added: "not that I really want to [*laughing*] – that I want to teach them more about evolution". Heidi also experienced the external examinations to be "quite limited with the questions", as the questions asked are of the same nature every year. When Saadiq has discussions with his learners about religion and evolution, he makes it "very clear what is examinable and what is not examinable". Focusing on the learners' marks gives Saadiq the "strength" to teach evolution. Based on what they have shared about their experiences of teaching evolution, both Saadiq and Heidi use the teaching of evolution as an opportunity to teach learners how to form an opinion on controversial topics, which gives Saadiq the "strength" to teach it and is a way for Heidi to keep herself "okay" with the subject of evolution. Thus, Heidi and Saadiq are still in a state of cognitive dissonance regarding evolution; therefore, they resort to extrinsic motivation (assessment) to get their learners to study evolution, which might appear to be poor pedagogy. According to Abrie (2010), and supported by Downie and Barron (2000), Rutledge and Mitchell (2002) and Trani (2004), religion might be a stumbling block to evolutionary acceptance. Therefore, according to Mpeta, De Villiers and Fraser (2014), deeply entrenched religious beliefs may interfere with individuals' objectivity towards appreciating or acknowledging the scientific validity of topics such as evolution. Thus, based on Heidi and Saadiq's data, it would appear as if their commitment to creation might create a barrier with which they are influenced to reject evolution, which might contribute to their experience of feeling reluctant to teach evolution. Rutledge and Mitchell (2002) stated that teachers who lack a thorough understanding of the

nature of science, may struggle to distinguish between evolution's scientific validity and strong religious views, which may confuse their teaching of evolution. This might be the case for Heidi, as she finds it "difficult" to teach evolution, as well as Saadiq, viewing evolution as an "abstract" and "controversial" topic. Saadiq and Heidi's situation where they experience reluctance to accept and teach the theory of evolution might be improved through Tolman, Ferguson, Mann, Maskiewicz Cordero and Jensen's (2020) recommended reconciliatory approach where acceptance of evolution can be fostered through an increase in knowledge of the nature of science, knowledge of evolution and the reconciliatory approach which suggests that the nature of religious beliefs and the nature of evolution are compatible with one another, which might assist with their cognitive dissonant states of mind without decreasing their religiosity.

Zafir, Michelle and Nandi have had different experiences regarding teaching evolution, compared to Saadiq and especially Heidi. When asked how he feels when he teaches evolution, Zafir answered that "it's a chapter [that he looks] forward to teaching". Michelle stated that she likes teaching evolution and that it is also "one of the chapters that [she looks] forward to". Nandi shared that she feels "[e]xcited" to teach evolution "as it ties in everything in Life Sciences", but that she enjoys all topics in Life Sciences, "as long as it's science". A common quality of all five Life Sciences teachers, regardless of evolution, was the expression of a great passion for the subject of Life Sciences.

4.4.3. Engagement with Evolution (Secondary, Tertiary Education, Personal Interest)

An aspect that three of the teachers had in common was that Zafir, Saadiq and Michelle mentioned that they had good Life Sciences teachers when they were at school. Zafir "develop[ed] a passion for the subject" of Life Sciences, as he mentioned that he had "been blessed when [he] was at high school" with "arguably [two] of the best biology teachers". Saadiq stated that his love for the subject was brought about by the influence of the teachers who taught him biology in high school. Michelle "had a very good Life Sciences teacher when [she] was at school, and [she's] always just enjoyed the subject".

In accordance with Peker, Comert and Kence (2010), who found that the individuals in their study who were interested in learning about evolution had better acceptance and understanding thereof compared to those who were not interested, Zafir considers evolution as "probably the most interesting section of the work" and Nandi views it as an "interesting" and "exciting topic". Zafir considering himself as "someone who's always been interested in the latest research happening in the sciences", had read many academic articles about the latest science discoveries keeping himself up to date with scientific studies. He added that his "development into the understanding of evolution" also came through "reading", where he would spend his time in the library reading up on scientific papers. Since Nandi was interested in evolution, she did "a lot of research around the topic". For her, evolution is an "interesting topic" and "it's exciting", as she "bring[s] it across as" she works through the Life Sciences curriculum. Based on the elaborate discussions of evolution in the light of the nature of science by Zafir, Michelle and Nandi, the study of Rutledge and Mitchell (2002) resonated, as it was found that teachers who accepted evolution produced the most elaborate, detailed, mechanistic and evidential maps of evolutionary concepts.

4.4.4. Evolution is Compulsory and/or the Basis of Science

Despite his reluctance to teach evolution, Saadiq had no choice but to teach it, as he had "no control over" the decisions being made about the introduction of evolution into the curriculum. Heidi also felt like she was not provided an opportunity to voice her opinion regarding her reluctance to teach evolution. Thus, state standards and assessment pressures had an influence on Saadiq and Heidi's experience of having to teach the theory of evolution (Goldston and Kyzer, 2009). Even though Saadiq and Heidi are reluctant to teach evolution, they do not refuse to teach it. Both teachers still accept that it is their duty as a teacher to teach the topic of evolution, since it is part of the curriculum and they work for the Western Cape Education Department. Based on their explanations of how they approach the topic, both Saadiq and Heidi, who are reluctant to teach evolution, treat evolution as a compulsory topic in their classrooms, as predicted by Abrie (2010). However, both teachers try to look at the positive aspects of teaching evolution as well, which relates to another commonality

between Saadiq and Heidi. Both teachers use the teaching of evolution as an opportunity for learners to form opinions about "controversial" topics such as evolution and to have discussions about it. Michelle also tells her learners that the topic of evolution is compulsory for the examinations, "whether [they] like it or not" and communicates to them that even though they might not enjoy certain situations they are confronted with, they need to entertain new thoughts to become educated. Zafir discusses the connection between micro- and macro-evolution with his learners, and also emphasised the importance of evolution in Life Sciences and explained to his learners that they need to understand how evolution is interlinked with other topics in Life Sciences. He explained that the interconnectedness of all Life Sciences topics, including evolution, will help his learners to understand the past. Michelle explains to her learners that evolution does not happen in individuals but in populations, and also links other topics in Life Sciences to evolution. Together with Zafir and Michelle's explanations, Nandi's explanation that the "whole Life Sciences is about evolution" shows an emphasis on evolution as the basis of science. Since Dunk, Petto, Wiles and Campbell (2017:1) regard evolution as the "unifying theme of all biology", it would appear as if Zafir, Michelle and Nandi understand the importance and relevance of evolution in Life Sciences. All three teachers, regardless of their beliefs, were able to understand the importance and relevance of evolution in the subject of Life Sciences, as they portrayed a clear understanding of what evolution entails and how it connects to other Life Sciences topics. Based on the elaborate discussions of evolution in the light of the nature of science by Zafir, Michelle and Nandi, as also stated by Rutledge and Warden (2000) who found that an understanding of evolution impacts the acceptance thereof, this statement could be made for the three teachers who accept evolution.

4.4.5. Misconceptions about The Nature of Science and/or Evolution

As supported by Rutledge and Mitchell's (2002) findings, and discussed in 4.4.1, Saadiq and Heidi's rejection of evolution might be related to their religious convictions. Their rejection might be related to their inability to view religion and evolution as mutually inclusive, as Rutledge and Mitchell (2002) connected a thorough understanding of the nature of science to an increased ability to avoid confusion with religion and evolution. Thus, based on the

literature describing the importance of evolution in the nature of science and Life Sciences, mutually exclusive views of evolution might be regarded as a misconception held against evolution. According to Mpeta, De Villiers and Fraser (2014) and Coleman, Stears and Dempster (2015), teachers' understanding of the nature of science and evolution may influence the way they teach the theory of evolution, which could have a consequential influence on the way their learners understand the nature of science and evolution. As a result, some misconceptions may abound (Coleman, Stears and Dempster, 2015). Such mutually exclusive views of evolution and religion is in contrast with Zafir and Michelle's approach to teaching evolution where they make sure to teach their learners that science and religion do not need to be mutually exclusive. Similarly, Nandi informs her learners that science and religion play different roles in her life and in that way, avoids misconceptions relating to the confusion between religion and evolution. As expected that there might be differences in beliefs concerning micro-evolution and macro-evolution, Heidi regarded micro-evolution and natural selection to be information that can be researched, whereas macro-evolution is only a "bigger idea". Zafir explicitly distinguishes between macro- and micro-evolution in his explanations of evolution, as discussed in the data presentation.

A commonly held misconception of the nature of science is that a theory is only a fact if it is scientifically proven with well-supported evidence and that the theory of evolution cannot be proven (Rutledge and Mitchell, 2002; Nehm and Schonfeld, 2007). Nandi stated that her learners "never question" evolution, as she teaches them from the beginning that when one deals with science, it has evidence and the content that one is learning about is supported by evidence that it had happened. As elucidated in previous sections, Michelle stated that certain evidence for evolution cannot be argued with and she elaborated on some examples, such as genetic evidence, biogeography and fossils. In contrast to Nandi and Michelle, Saadiq spoke about how there is "no clear evidence" that he could show to his learners regarding evolution. This is a misconception about evolution, as evolution cannot be experimentally tested, but inductive reasoning from sources, such as fossils, comparative anatomy and embryology, biogeography and comparison of nucleotide sequences, all support the theory of evolution as a plausible explanation for the life that exists now. Heidi's questioning of radiometric dating also indicates that she holds misconceptions regarding the evidence for evolution. Rutledge

and Mitchell (2002) made a statement that teachers who find teaching evolution uncomfortable might lack an understanding of the supporting evidence for evolution, which is a plausible explanation for their misconceptions about evolution. Such misconceptions held by Saadiq and Heidi regarding the theory of evolution might also be attributed to poor content knowledge and pedagogical content knowledge and could consequently affect their ability to diagnose their learners' potential misconceptions about evolution (Hartelt, Martens and Minkley, 2022).

4.4.6. Experiencing Pressure from Parents

Saadiq and Zafir had similar experiences with regards to pressure from parents who oppose to them teaching evolution to their children, as also found in Holtman (2010). Zafir experienced parents insinuating that evolution is "nonsense" and Saadiq spoke of occurrences where parents had phoned the schools complaining about their children having to learn about evolution, "especially staunch religious people". He explained that the parents did not understand what he was going through and "that [he] had no option, but just to teach it". The difference between the two teachers' experiences is that Zafir is pro-evolution and Saadiq against the teaching thereof.

4.5. A concluding summary of findings

This section entails a summary of the findings in terms of all five Life Sciences teachers, as well as a summary of the interpretations based on the cross case analysis. The lack in literature regarding the lived experiences of Life Sciences teachers, who belong to different belief systems, teaching evolution, led to the research question: ***How do Life Sciences teachers, belonging to different religious beliefs, experience teaching evolution as a curriculum topic?*** Even though the research focus was also inspired by a personal experience and guided by a personal interest in the topic, my personal beliefs and experiences that motivated the conduction of this study were bracketed focusing on a compassionate understanding of the five Life Sciences teachers' lived experiences. In my research proposal,

I stated that the individual experiences of teachers teaching evolution might be influenced by many different aspects, and the purpose of my study was to find out what those aspects are, and what their experiences are. Therefore, the aim of my study was to find out how Life Sciences teachers of different religious beliefs experience teaching evolution in order to understand the complexity of teaching evolution in their respective contexts. A case study approach was used in order to explore the uniqueness of each Life Sciences teacher's experiences. The aim to learn more about and understand the teachers' lived experiences of teaching evolution (taking their individual contexts into consideration) falls under the interpretive paradigm, as discussed in detail in Chapter 3. The multiple realities based on the research participants' subjective experiences were explored and produced qualitative data through the conduction of semi-structured interviews that provided adaptability to the teachers' individual contexts and personalities. The qualitative data produced did not only provide words of meaning, but also the affective components of the teachers' experiences.

The Life Sciences teachers' broader contexts provided their experiences of teaching evolution with depth and a better understanding of their complex lived experiences, respectively. The results, which are discussed below, cannot be uniformly applied to all contexts and cannot be associated with all Life Sciences teachers belonging to the specific religious beliefs focused on in this study. As the reader might infer from the findings in Chapter 4, even within a certain religion, an individual's beliefs of the religion itself and of the theory of evolution differ dramatically, depending on various factors. As inductively derived in the cross case analysis, the themes that emerged from the teachers' experiences were: the relationship between religion and evolution or science, a reluctance or excitement to teach evolution, engagement with evolution, evolution as a compulsory topic or the basis of science, misconceptions about evolution or the nature of science and pressure from parents.

As the literature indicates (Dobzhansky, 1973; Haury, 1996; Chiappetta and Fittman, 1998; Mathews, 2001; Rutledge and Mitchell, 2002; Moore and Kraemer, 2005; Dempster and Hugo, 2006; Nehm and Schonfeld, 2007; Paz-y-Miño C. and Espinosa, 2009; Schroder, 2012; Mpeta *et al.*, 2014 and Dunk *et al.*, 2017; Tolman *et al.*, 2020), the topic of evolution is essential to the understanding of the history of life on earth, as well as to the understanding of

the subject of Life Sciences. Evolution provides the diverse life on earth with context and organises the teaching of biology in general (Rutledge and Warden, 2000). As discussed in Chapter 4, Zafir, Michelle and Nandi conveyed this view of evolution in Life Sciences based on their descriptions of evolution in terms of Life Sciences, regardless of their religious beliefs. In Zafir's interview, he talked about the theory of evolution in detail and the interconnectedness of the different topics in Life Sciences, presenting a clear understanding of the importance of evolution in Life Sciences, as well as of the nature of science, as he discussed how essential evolution is to the understanding of Life Sciences and how he enjoys the teaching of evolution since for Zafir, "evolution is a concept that you can apply to all aspects of life". Michelle's approach to teaching evolution indicates a clear understanding of what the theory entails and how it relates to the nature of science, since she connects the topic of evolution to other Life Sciences topics in her teaching. She emphasises that evolution happens in populations and "is not linked to an internal drive", but a "whole population of organisms changing". Nandi believes "the whole Life Sciences is about evolution" and that evolution "ties in everything in Life Sciences", as she connects the history of life on earth to evolution, as well as other topics in Life Sciences, such as DNA, Genetics and mutations. A focus is placed on science and scientific evidence in Nandi's teaching of evolution, which helps her learners to make the links in Life Sciences. Nandi mentions evolution as she goes along the subject of Life Sciences, as she believes that evolution "ties up everything in Life Sciences". Thus, she presents a clear understanding of the importance of evolution in Life Sciences. Saadiq displays a reluctance to teach evolution, as he was opposed to the teaching thereof on school level. He sometimes finds it "very difficult to teach" evolution; however, despite his personal beliefs, he presents the theory of evolution with a focus on the learners' marks and their futures, while also teaching them how to deal with "controversial material" and that different belief systems have commonalities. Similar to Saadiq, Heidi teaches evolution with the learners' marks in mind, while also teaching them how to form an opinion about evolution, despite the experience of "conflict within [herself]" around teaching the topic and finding it "hard" to present it. In conclusion to Theme A, Zafir, Michelle and Nandi show a clear understanding of the importance and relevance of evolution in the subject of Life Sciences based on their elaborate discussions of evolution in light of the nature of science. Saadiq and Heidi expressed their reluctance to teach evolution; thus, did not want it

in the curriculum, however, irrespective of their personal beliefs, they teach the topic with the assessment in mind, as the curriculum requires them to do so. In order to foster some positivity within themselves and the topic of evolution, both teachers use the teaching of evolution as an opportunity to teach learners how to form an opinion on or deal with controversial topics. Thus, teachers' lived experiences of teaching evolution *might* be impacted by their understanding of the importance of evolution in Life Sciences.

The literature found that religion might influence the acceptance of the theory of evolution (Rutledge and Mitchell, 2002; Paz-y-Miño C. and Espinosa, 2009; Mpeta, De Villiers and Fraser, 2014; Coleman, Stears, James and Dempster, 2015 and Stears, Clement, James and Dempster, 2016) and that religious beliefs may interfere with people's understanding or acceptance of scientific concepts, such as evolution (Rutledge and Mitchell, 2002; Trani, 2004; Chinsamy and Plagányi, 2007; Abrie, 2010; Mpeta *et al.*, 2014; Coleman *et al.*, 2015, Stears *et al.*, 2016). It was expected that the results would indicate that a teacher's background, worldviews and their religious beliefs may influence their personal views on evolution, and might in turn have an impact on how a teacher experiences teaching evolution. Based on the lived experiences of the five research participants, the above statements are discussed.

Zafir and Michelle's experiences of teaching evolution indicate the belief that religion and science need not be mutually exclusive. These beliefs might be influenced by their understanding of the theory of evolution and its connection to the nature of science. Based on the data, Zafir, Michelle and Nandi abide by the suggestions of Moore (2008) and Mpeta, De Villiers and Fraser (2014) that biology teachers make learners aware that evolution need not be rejected in order to hold religious beliefs. Zafir and Saadiq, both belonging to the Islamic faith, have different views regarding evolution (where Zafir displays an acceptance of evolution and Saadiq a rejection thereof); however, both teachers do not allow evolution to threaten their faith. Similar to Saadiq's beliefs that evolution contradicts all aspects of the Quran, Heidi, belonging to the Christian faith, feels that evolution contradicts with the Bible, similar to the work of Sanders (2018). Both teachers spoke about the contradictions between their religious scripts and evolution, specifically referring to how evolution is an alternative

to creation. Saadiq and Heidi are reluctant to teach evolution; thus, their rejection of evolution might be influenced by or be related to their personal religious convictions (Rutledge and Mitchell, 2002 and Paz-y-Miño C. and Espinosa, 2009), as both teachers discussed the contradictions between evolution and their religion during their interviews. In Saadiq and Heidi's classrooms, the teaching of evolution is used as an opportunity for learners to form opinions about evolution, which they consider to be an abstract or controversial topic.

According to Mpeta, De Villiers and Fraser (2014), using religious beliefs as scaffolds when teaching evolution might help deeply religious learners who experience conflicts with their religious beliefs and evolution. Interestingly, all five teachers mention their own religious beliefs to their learners when teaching the topic of evolution. An interconnectedness between the five teachers' worldviews, belief systems, emotions and their acquired knowledge and information in the light of the theory of evolution is present, as there were many overlaps found in the data. Saadiq finds it "easier to teach [evolution] with a group of the same religion", whereas teaching learners from different faiths is a bit more difficult. Even though Michelle was raised in a "strict" Christian household, her beliefs had changed to "spiritual" (but "technically Christian") after she had come to read a series of books during university changing her perception of God. Similar to Nandi, there are many aspects of the Bible that Michelle does not agree with. According to Michelle, because of the way she introduces the topic of evolution, her learners usually seem keen to learn about it and she has not had any negative experiences with regards to teaching the topic. Michelle stated that being a Christian teaching evolution has not made "any difference" in her life. Nandi defines her religion as both part Christian and part traditional. Nandi had never thought about the teaching of evolution to be a problem, as she enjoys teaching all topics in Life Sciences, "as long as it's science for [her]", and also clearly separates religion from science, as they play different roles in her life. Based on how she teaches evolution to her learners, Heidi perceives evolution to be an alternative to creation; thus, regarding evolution as a belief system, rather than a scientific theory (Moore, 2008 and Schroder, 2012). Heidi describes teaching evolution as being "hard" and her learners "don't do very well in this section of the work". Based on Heidi's data, a statement by Coleman, Stears and Dempster (2015) resonated, stating that

teachers' understanding of evolution may influence the way they teach evolution, which in turn might influence the way their learners understand evolution.

In terms of the literature, it was expected that a teacher's level of knowledge of evolution corresponds with their personal acceptance of evolution (Rutledge and Mitchell, 2002 and Korte, 2003). Thus, in terms of this study's research question, it was expected that the teachers' experiences of teaching evolution would be influenced by their knowledge and understanding of evolution. The five teachers' understanding of evolution, specifically its importance in Life Sciences, had already been discussed and such connection has thus been established. However, since the interview questions had not specifically focused on the teachers' knowledge of evolution, and the data produced regarding their knowledge of evolution came organically, it was difficult to make conclusions regarding the connection between knowledge of evolution and the experience of teaching evolution. For example, Zafir, Michelle and Nandi had shared elaborate discussions about evolution and its connection to Life Sciences – which could connect to Rutledge and Mitchell's (2002) research talking about the connection between teachers' acceptance of evolution and their ability to produce elaborate discussions about the evidence for evolution – however, they shared this information organically and not by answering a question asking about their connection between knowledge of evolution and their experience of the teaching thereof. Saadiq stated that evolution had "no clear evidence" to show his learners and Heidi spoke about evolution making less sense compared to her beliefs of creation. Thus, a conclusion that could be made for this theme was that the teachers who accept evolution and regard it as a well-supported scientific theory (Zafir, Michelle and Nandi) cited the evidence for the theory of evolution (Rutledge and Mitchell, 2002).

Throughout the discussion of Zafir's knowledge and understanding of evolution, Zafir produced elaborate explanations of how the theory works and expressed excitement and interest in the topic. With regards to his educational background, Zafir stated that he had been taught about evolution by "wonderful" lecturers "who are leaders in their field". In his free time during university and while teaching, Zafir read articles about the latest science discoveries, as he found it personally interesting. Zafir's elaborate explanations of evolution

and his interest in the topic is in accordance with Peker, Comert and Kence's (2010) research, which found that individuals who are interested in learning about evolution had better acceptance and understanding thereof. Nandi's interest in the topic, as well as her excitement regarding teaching it, is also in accordance with this statement, as her personal interest led to her doing "a lot of research around the topic", and being able to understand the importance of evolution in Life Sciences. Even though Michelle learned about evolution in general in her undergraduate studies, she had to teach herself about human evolution concepts when it was introduced into the curriculum. During her interview, she was able to produce elaborate discussions about evolution connecting the importance of evolution to Life Sciences and the nature of science. Thus, Michelle's own research on evolution enabled her to form a clear understanding of the theory of evolution, not necessarily her formal education of evolution. Saadiq reflecting upon his university experiences about the way in which his lecturer presented the topic of evolution "gave [him] some idea how to teach it". This experience helped Saadiq not to feel threatened by teaching the topic, as he felt like this experience trained him to know how to "handle the material". Thus, based on the latter reflection of Saadiq, his academic background had an influence on his experience of teaching evolution (Rutledge and Warden, 2000). Heidi's experience of learning about evolution in university was "quite difficult" for her, as it made her feel "almost as if [she] didn't know where [she] fit[s] in with regard to evolution" and her background. When evolution was introduced into the curriculum, Heidi had to attend a training course; however, she experienced that she was not allowed to express her opinion. Heidi did some reading of her own on the topic; however, she still experienced presenting the topic of evolution to be hard.

With regards to the teaching of evolution, all five teachers described how they taught evolution, as well as how they experienced teaching evolution. The three teachers who provided elaborate discussions of evolution, and found the teaching of evolution to be exciting or enjoyable were Zafir, Michelle and Nandi. On the other hand, Saadiq and Heidi (who mentioned a personal rejection toward evolution), despite portraying knowledge of evolution, found the teaching of evolution to be "hard" or "difficult" or did not want it to be taught in schools. Despite their experiences with regards to teaching evolution, Saadiq and Heidi attempted to remain positive regarding the topic by approaching teaching it with the

learners' marks in mind, as well as the opportunity that the topic of evolution gives their learners to form their own opinions (Heidi) and that different beliefs can have certain similarities (Saadiq). Thus, the teachers' own feelings toward evolution influenced their experience of enjoyment or reluctance regarding teaching evolution.

It was expected that misconceptions regarding evolution and/or the nature of science may influence the lived experiences of teaching evolution. In addition, the literature guided an expectation that misconceptions against evolution might influence the acceptance of evolution (Rutledge and Mitchell, 2002; Chinsamy and Plagányi, 2007; Nehm and Schonfeld, 2007; Moore, 2008; Sanders and Ngxola, 2009; Rice and Kaya, 2010 and Schroder, 2012). Furthermore, it was expected that teachers holding misconceptions regarding evolution might lead to them teaching those misconceptions to their learners (Mpeta, De Villiers and Fraser, 2014). This also connects to the teachers' understanding of evolution, intertwined with their religious convictions and backgrounds, as well as their teaching of evolution, which establishes the complexity of lived experiences.

With regards to misconceptions that learners might hold, Zafir, based off of his reflections of marking matric examination about evolution, explained that the "biggest misconception that we have in the study of evolution is […] 'to adapt' or 'adapted to'", as learners struggle to understand that the environmental changes drive evolution, "because students see it as organisms adapt" and not that "they have the variation that enables them to adapt to the changing environment". In accordance with Mpeta, De Villiers and Fraser (2014:19), stating that learners hold misconceptions regarding animals undergoing evolutionary change "out of choice", Zafir had noticed that another misconception that learners hold are of Lamarckism, where the latter is confused with natural selection. Zafir explained that such misconceptions might be held due to the way in which the topic has been taught. Zafir's experience of parents being reluctant regarding their children learning about evolution as they regard it to be "nonsense" – in accordance with Holtman (2010) – indicates that misconceptions from parents can influence a teacher's experience of teaching evolution. Michelle uses her knowledge and understanding of evolution to try and eradicate any misconceptions that her learners might hold regarding evolution. As a result, Michelle's experiences of teaching

evolution have “been positive”, since her learners’ reactions include laughter and enjoyment, as well as taking part in class conversations. Similarly, Nandi uses her knowledge and understanding of evolution to try and eradicate misconceptions that her learners might hold regarding evolution, since she “always teach[es] in relation to science”, explaining that: “So, that when we get into those things that they think they are misconceptions, in fact they are not misconceptions for them.” Thus, because of the way that Nandi emphasises science in her teaching of evolution, her learners “never question it”. Saadiq’s experience of isolation with staff members looking at him “as if [he was a] monster”, since he had to teach evolution, made him feel misunderstood, since he explained that even though there was great objection against the addition of evolution into the curriculum, he could not “get through to national”. Thus, Saadiq’s experience is an example of “friction” being a result of misconceptions, or rather misunderstandings, regarding the theory of evolution. Parents phoning the school also made Saadiq feel as if evolution “was sort of forced onto the schools”, as “[their] objections went through, but it wasn't taken seriously”. Heidi’s experience with the boy in her class who struggled with “writ[ing] down a lie”, referring to evolution, and describing having to write about evolution as “very bad”, related to Schroder’s (2012) conclusion stating that one of the concepts that learners find conflicting is human evolution, as the notion is held that God created the Earth in 6 days and humans in his own image is challenged by the evolution of humans from primitive primates over millions of years.

A commonly held misconception of the nature of science is that a theory is only a fact if it is scientifically proven with well-supported evidence and that the theory of evolution cannot be proven (Rutledge and Mitchell, 2002; Nehm and Schonfeld, 2007). Such misconceptions could be connected to Saadiq’s experience where he states that there is “no clear evidence” for evolution, as well as Heidi’s experience where she explains how evolution does not coincide with her creationist beliefs and is “hard” to present. Thus, teachers who find it uncomfortable might lack an understanding of the supporting evidence for evolution (Rutledge and Mitchell, 2002). On the other hand, Michelle stated that certain evidence for evolution cannot be argued with and Nandi focuses on the scientific evidence for any topic when dealing with Life Sciences. As discussed in Theme D in Chapter 4, mutually exclusive views of evolution and religion might be regarded as a misconception held against the theory

of evolution. Ideas regarding the mutual exclusivity of religion and evolution complicate teachers' experiences, as the rejection of evolution might be related to the inability to view religion and evolution as mutually inclusive (Rutledge and Mitchell, 2002). A common misconception, as shown in Heidi's case, is the view that evolution is regarded as a belief system rather than a scientific theory. Such a misconception, that the acceptance of evolution is an either-or decision is regarded as a barrier to learning (Schroder, 2012 and Mpeta, De Villiers and Fraser, 2014). Thus, teachers' understanding of evolution and the nature of science may influence their experiences of teaching evolution.

The literature found that teachers experience pressure such as assessment pressures, state standards, teacher autonomy and a content-dense curriculum (Goldston and Kyzer, 2009), thus such pressures were expected. Zafir experiencing parents of learners complaining about their children learning about evolution, relates to the study of Holtman (2010), where teachers face the challenge of dealing with parents reluctant for their children to learn about evolution. The pressure that Saadiq experienced from staff members regarding him as a "monster" since he had to teach evolution, influenced his experience of teaching evolution in a negative manner, as it made him feel like evolution was "forced upon [the Life Sciences teachers]" and caused "friction". Another manner in which the teaching of evolution was a complicated experience for Saadiq was parents phoning the school and complaining about their children having to learn about evolution. Therefore, the expected findings regarding pressure to teach evolution as it is compulsory, were established by Zafir and Saadiq's experiences of parents and colleagues opposing what they have to teach (Stears *et al.*, 2016).

Teachers such as Saadiq and Heidi, mentioned pressures specifically related to their grade 12 classes. Heidi experienced that the limited time in matric plays a role in her decision to focus on assessment, as she is not able to spend a lot of time on topics, but added "not that I really want to [*laughing*] […] teach them more about evolution". As a Life Sciences teacher, Heidi also feels like her grade 12 learners are limited with regards to the topic of evolution as the same type of examination questions are asked. Another pressure experienced by Saadiq was the focus on assessment in grade 12, which caused his learners to be disinterested in any discussion that is not for marks; thus, he had to adjust in planning hands-on activities in

engaging his learners in evolution. Therefore, assessment pressure experienced by Saadiq is in accordance with Goldston and Kyzer's (2008) findings. The "time factor in matric" was another pressure experienced by Saadiq, which is in accordance with Chiappetta and Fittman's (1998) results stating that teachers complain that the subject matter is overwhelming. It also relates to Goldston and Kyzer's (2008) findings of the pressure of a content-dense curriculum, since Saadiq described Life Sciences to be a "bulky subject to teach". Such a content-dense curriculum leaves little time for Saadiq to have open discussions with his learners "especially concerning a topic like evolution". Due to the abovementioned pressures, Saadiq and colleagues attempted to improve the poor marks regarding evolution by "swapp[ing] evolution with human reproduction", because of evolution's "abstract nature"; however, subject advisors advised them to return evolution to the third term. This experience caused Saadiq to feel that "this is a lot of restrictions placed on the teaching of evolution, guided by what the exam wants." With a focus on the learners having to achieve good marks for the topic of evolution, Saadiq tries to look at the topic in a positive manner by making it clear to his learners that learning about evolution is "good training ground" for when they enter university as it helps them to make up their own minds regarding a certain topic, as well as recognise similarities in beliefs.

CHAPTER 5: CONCLUSION

5.1. Introduction

The final chapter of this thesis contains the contributions of this study based on the findings. Thereafter, recommendations for future studies based on the results and interpretations are discussed. Lastly, a reflexive comment to round the thesis off is provided.

5.2. Contributions (based on findings and reflection on limitations)

By referring back to the problem statement, I discuss ways in which my research helped to "solve" the problem at hand below. The problem statement pointed out that most studies focusing of the teaching of the theory of evolution were empirical studies (Abrie, 2010; Asghar, 2013; Chinsamy & Plagányi, 2007; Coleman, Stears and Dempster, 2015; Korte, 2003; Long, 2011; Rice & Kaya, 2010), and the studies that focus on teachers specifically do not highlight their lived experiences of teaching evolution. My study succeeded in the contribution of filling such a recognised gap in the literature, since five Life Sciences teachers' lived experiences of teaching evolution were explored through the research question: ***How do Life Sciences teachers, belonging to different religious beliefs, experience teaching evolution as a curriculum topic?*** In the problem statement, a reason for resistance with regards to the teaching of evolution was mentioned, namely the concern for the controversial nature of evolution, especially its controversy with regards to religion (Sutherland & L'Abbe, 2019). Saadiq's case where he objected against the teaching of evolution and spoke about the controversy of the topic, is in accordance with the above reason. Michelle spoke about evolution as a sensitive topic. Zafir, however, did not regard evolution to be a controversial topic. Abrie's (2010) results, mentioned in the problem statement, which found that evolution will mostly be avoided or briefly mentioned in Life Sciences classrooms, were not in accordance with the findings of the study, since all five teachers still taught evolution, despite their personal feelings toward the topic. However, the manner in which the topic is taught by the teachers differed, where evolution was not treated as the foundation of modern biology by all five teachers (Abrie, 2010). An interest in witnessing how Life Sciences teachers' religious beliefs contribute to their experiences of

teaching evolution as a topic in the classroom, was fulfilled, since all five teachers explained what it is like being a person of a particular faith teaching the theory of evolution. In the problem statement, an interest was also mentioned regarding the possible cognitive dissonance that might arise due to teachers experiencing inner conflict between their religious or personal beliefs and what they ought to teach (Lovely and Kondrick, 2008). Saadiq objecting to the teaching of evolution in the high school curriculum and Heidi experiencing conflict within herself relate to the Theory of Cognitive Dissonance discussed in Lovely and Kondrick's (2008) study, where it was expected that teachers might experience inner conflict between their religious or personal beliefs and what they ought to teach.

Many parts of the data were in accordance with Van Manen's (1990) statement that lived experience can only become apprehended upon reflection of the past and cannot be fully understood at presence, as all five research participants reflected upon their past experiences while speaking about their lived experiences of teaching evolution. Thus, the mumble jumble of the data presentation establishes the full "richness and depth" of the participants' lived experiences (Van Manen, 1990:36). Therefore, as stated, the Life Sciences teachers' lived experiences were interpreted in relation to the totality of their lives, as each particular lived experience instance is "part of a system of contextually related experiences" (Van Manen, 1990:37).

As mentioned in the literature review, an expected limitation of my study was the subjective nature of the research participants' experiences, as well as the number of participants interviewed, as the lived experiences explored are limited to the five particular research participants and their contexts (Goldston and Kyzer, 2008). In an empirical sense, such subjective experiences are limiting; however, subjective lived experiences in interpretive research, such as my study, highlight the interconnectedness of individuals' personal contexts and their lived experiences. My study thus shows the strength and significance of qualitative analysis, as ample detail is provided. Therefore, my research emphasises the uniqueness and humanness of each individual teacher's lived experiences of teaching evolution, which are influenced by their personal contexts, as also found by Nishizawa (2017:82). Since the case study approach achieved the latter, it is suggested that further research also take more holistic

approaches to science and educational research, focusing on individuals' lived experiences in the light of their contexts. Furthermore, such a holistic approach to research highlights, not only the uniqueness, but the situatedness of lived experiences, since the experiences occur in a particular space and time (Aloovi, 2016). It has been shown in the literature that studies that focus on biology and/or Life Sciences teachers' lived experiences (Goldston and Kyzer, 2008; Reddy, 2012; Aloovi, 2016 and Nishizawa, 2017) do not specifically focus on their lived experiences of the teaching of evolution. Thus, it is acknowledged that my study brought about unique qualitative data regarding the lived experiences of teaching the theory of evolution of two Life Sciences teachers of the Muslim faith and three Life Sciences teachers of the Christian faith.

5.3. Recommendations (based on findings and reflection on limitations)

I had originally planned to organise the following section in the order of the themes discussed in Chapter 4; however, the overlapping nature of the results led to the following intertwined recommendations for future studies, based on the findings and reflection upon the limitations of the study. Many studies reviewed focused on pre-service or teachers' acceptance of and attitudes toward the theory of evolution (Korte, 2003; Chinsamy & Plagányi, 2007; Rice & Kaya, 2010; Abrie, 2010; Long, 2012; Coleman *et al.*, 2015), where most were of empirical nature or are based on the controversy between evolution and religion. Others also focused on the acceptance of evolution, teachers' attitudes toward teaching evolution, their concerns regarding teaching evolution or misconceptions regarding evolution (Rutledge and Warden, 2000; Rutledge and Mitchell, 2002; Korte, 2003; Trani, 2004; Moore and Kraemer, 2005; Chinsamy and Plagányi, 2007; Nehm and Schonfeld, 2007; Moore, 2008; Paz-y-Miño C. and Espinosa, 2009; Abrie, 2010; Peker *et al.*, 2010; Rice and Kaya, 2010; Long, 2012; Schroder, 2012; Baker, 2013; Mpeta *et al.*, 2014; Stears *et al.*, 2016; Coleman *et al.*, 2015; Dunk *et al.*, 2017). It was found that there is a lack of research regarding the individual lived experiences of teachers teaching the theory of evolution, nationally, and internationally. Therefore, my study aimed to fill the gap in the literature regarding teachers' lived experiences of teaching evolution. Even though the influence of religious beliefs on the experiences of teaching evolution was researched quantitatively by authors such as Rutledge and Warden (2000) in

the USA and Abrie (2010) in South Africa, a qualitative gap was recognised by Baker (2013). A lack of qualitative studies focusing on the individual lived experiences of Life Sciences teachers holding different belief systems, and the influence that their religious beliefs might have on their experiences of teaching evolution, was recognised. Thus, my research aimed to make contributions to the field of educational research and generate meaningful qualitative data through asking open-ended questions to five Life Sciences teachers belonging to specific religious beliefs. As the reader could derive from the data presentation, meaningful qualitative data was generated regarding Life Sciences teachers' experiences of teaching evolution and how their backgrounds, religious beliefs, knowledge and understanding of evolution and external pressures of teaching evolution influenced their experiences of teaching evolution. The fact that the five Life Sciences teachers participated voluntarily contributed to the qualitative value of the study. However, the study's conclusions are thus limited to only the contexts of the specific individuals that were interviewed (Moore and Kraemer, 2005); so, generalisations cannot be made. Nevertheless, meaningful qualitative data was produced that aided in the understanding of how teachers experience teaching the topic of evolution, in the light of their backgrounds and religious beliefs. The voluntary nature of the five teachers' participation in the research could be also be regarded as a limitation to the study in the sense that only Life Sciences teachers who are willing to speak about the topic took part in the study; however, based on the diversity of the results, taking Saadiq and Heidi's objections to adding evolution to the curriculum into consideration, it would seem that the voluntary participation was not only done by teachers who advocated for the teaching of evolution, but also by teachers who reject the theory of evolution. A limitation to my study could be that only semi-structured interviews were used for the final data collection; however, such types of interviews are an accepted approach in interpretive studies of this kind (Reddy, 2012).

Based on the diverse, context-specific and meaningful qualitative data produced in this study, the importance of understanding teachers' lived experienced (regarding teaching evolution) is acknowledged, also emphasized by Sanders (2018). As shown through the difference in lived experience of the teachers from the same religion (Zafir and Saadiq belonging to Islam; Michelle, Nandi and Heidi belonging to different forms of Christianity), the problematic

nature of stereotyping people's views regarding evolution based on religion is brought to light. Therefore, based on the diversity in results, one cannot assume that all Muslim teachers experience teaching evolution in the same manner, nor can one assume that all Christian teachers experience teaching evolution in the same manner. It is reiterated that the results of my study cannot be generalised and that each research participant's data is unique to them and their context. What can be learnt from the individual case studies is that the uniqueness of each individual's experiences is as a result of their specific life context and background. Therefore, the conclusions made based on each individual case might enrich the value of the issue under scrutiny, as well as enrich and inform future qualitative studies through highlighting the importance of understanding in the interpretation of lived experiences. The importance of the results of an interpretive study being context-dependent is thus emphasised (Sanders, 2018). Thus, once again, based on the unique, diverse and context-dependent results of my study, the gap as recognised in my literature review – the lack of the interpretive investigation or compassionate understanding of individual teachers that experience the teaching of evolution – was addressed and filled in terms of five Life Sciences teachers' respective lived experiences.

In the literature review, recommendations were expected to be made based on what was found in the international and South African studies. These recommendations were applied to the results of my study and are discussed in the following paragraphs. With regards to Theme B, based on the challenges faced by teachers such as Zafir, Saadiq and Heidi where parents or learners object to the teaching of evolution, it is recommended that teachers be provided with instructional material and development strategies in order to deal with issues pertaining to evolution conflicting with belief systems, as also recommended by Abrie (2010). Such instructional material needs to have been prepared by well-informed professionals who are aware of the challenges of the teaching of evolution, and needs to be easily accessible to teachers (Abrie, 2010).

Based on the results of Saadiq and Heidi where "conflict" between their religion (specifically referring to creation) and evolution was experienced (regarding the two concepts as mutually exclusive), it is recommended that Life Sciences teachers be made aware of the possibility of

religion and evolution to be mutually inclusive; thus, scientists do not need to reject evolution to hold religious beliefs or vice versa (Moore, 2008; Mpeta *et al.*, 2014). Gould's (2014) concept of NOMA and Tolman, Ferguson, Mann, Maskiewicz Cordero and Jensen's (2020) reconciliatory approach are recommended to be explored in this case. Making not only learners aware of the possible mutual inclusivity of religion and evolution, but also teachers through teacher-training, might foster better acceptance of evolution, especially for deeply religious individuals who experience conflicts with their religious beliefs and evolution (Mpeta, De Villiers and Fraser, 2014). In accordance with Stears, Clément and Dempster (2016:8), it is also recommended that a better understanding is fostered regarding the relationship between teachers' religious beliefs and their positioning on the "creationist-evolutionist continuum", which might reduce some conflict that deeply religious teachers experience when teaching evolution. Such an understanding might be fostered through evaluated pre-service education, as well as in-service professional development programmes (Stears *et al.*, 2016). With regards to this issue, as well as Theme A and C relating to the importance of understanding evolution in Life Sciences, and the comprehension of the nature of science, it is recommended that in such training programmes or professional development programmes, an emphasis is placed on the nature of science when dealing with the topic of evolution. This might improve the understanding of evolution by Life Sciences teachers, as well as possibly foster greater acceptance of evolution (Mpeta *et al.*, 2014; Coleman *et al.*, 2015). As Zafir's experience with the Teacher Biology Project aided in his teaching of evolution, it is recommended that evolution-based workshops be implemented and/or evaluated in order to equip teachers to understand and teach evolution (Chinsamy and Plagányi, 2007). Referring to examples such as Heidi and Saadiq finding it "difficult" and "hard" to teach evolution based on their lived experiences, evaluated teacher-education courses focusing on the nature of science in relation to evolution might combat some of the challenges that teachers face regarding teaching evolution, as well as possibly promote biology teachers' appreciation for and responsibility towards their teaching of evolution as the foundation of biology (Rutledge and Warden, 2000; Rutledge and Mitchell, 2002). Abrie's (2010) recommendation that biology-focused teacher training be critically evaluated, specifically regarding evolution and the nature of science, is worth mentioning at this point. Such evaluated courses might also generate greater scientific literacy, an appreciation for and

the acceptance of science and technology, including the theory of evolution (Paz-y-Miño and Espinosa, 2009). Based on the results of Korte (2003) who found that one in eight secondary Life Sciences teachers in Ohio reject the theory of evolution, it was recommended that how teachers' personal and religious convictions could negatively impact their teaching of evolution be assessed. However, based on Saadiq and Heidi's rejection of evolution influencing their personal experiences of teaching evolution in a negative manner, as they found it sometimes "hard" and "difficult" or "forced" upon them, it is recommended that how teachers' personal and religious convictions could negatively impact their experiences of teaching evolution be further assessed. Even though teacher training courses are recommended by authors such as Korte (2003), it is also recommended that teachers educate themselves on the theory of evolution. Self-education could be fostered through universities and schools providing additional sources of information regarding evolution and its relation to the nature of science. In accordance with recommendations made by Korte (2003), it is also recommended that national and state standards be revised to ensure that proper emphasis is placed on the education of the nature of science and that teachers are being clearly made aware of the expectations of science teachers regarding the teaching of evolution. Based on Saadiq feeling that such expectations already place "restrictions" on the teaching of evolution, and Heidi feeling that the curriculum is limited in terms of grade 12 assessment, it is highly recommended that governmental standards for Life Sciences teachers regarding the teaching of evolution be revised. Strategies discouraging the teaching of creationism and encouraging the nature of science could be considered (Plutzer *et al.*, 2020). Such strategies to improve the teaching of evolution, such as treating the topic of evolution as "the guiding theoretical lens in interpreting and explaining biological phenomena", provides students with their democratic right to learn about the science of the origins of life (Peker, Comert and Kence, 2010:754). Since Heidi spoke about the grade 12 examinations placing limitations on her learners, as the questions remain the same for the most part, it is recommended that the big ideas of biology be better emphasised in the curriculum, rather than placing great focus on specific topics (Chiappetta and Fittman, 1998). Based on the objection from parents experienced by Zafir and Saadiq, and the challenges in Heidi's classroom dealing with learners who are "outspoken" in terms of their religion, it is also recommended that teacher

education in terms of the topic of evolution places an emphasis on the challenges that may arise in the classroom when teaching evolution (Chinsamy and Plagányi's, 2007).

5.4. Reflexive Comments

A reflexive comment is helpful in rounding this thesis off, and making it more trustworthy. I feel a great sense of gratitude that I was given the opportunity to do this research project. Doing this research project has taught me various life lessons; some about academic research and others about my own life. I have learned a great deal about how to conduct qualitative academic research, as well as how much of a complex process the study of lived experiences is. Van Manen (1990) has suggested that in the process of gathering and exploring human experiences, the researcher (myself) might become more experienced myself. I can with certainty say that this project has given me the opportunity to enrich my knowledge and understanding of the nature of evolution in the curriculum and about lived experiences; however, I was also humbled by this project, as things are not as straightforward as they sometimes seem. This project has taught me that the world cannot be viewed in black and white, but that everything exists within a grey space. Even though I had initially felt personally disappointed in the Life Sciences teacher, mentioned in the motivation of my study, who refused to teach evolution because of her religious beliefs, I have now come to understand her. Even though she was not the one being interviewed, I have grown compassionate understanding toward this teacher that I had once not understood. There are reasons why people feel the way that they feel and do the things they do, and now, because of the opportunity to conduct this study, speaking to five different Life Sciences teachers, belonging to different religious beliefs, teaching evolution, I have learned that each person's background and context has an influence on how they experience life. From Zafir, I have learned the importance of tolerance for others' beliefs and decisions, as I listened to and reflected upon his words. Since Saadiq still taught the theory of evolution to his learners with their marks in mind, despite his personal feelings toward it, I have learned how rewarding it can be to put others' needs before mine and therefore, be selfless. From Michelle's experiences, I have learned that I need not be afraid to make the wrong choice, as every choice in life is an opportunity to learn a valuable lesson. From Nandi, I have learned the

importance of respecting and honouring science. Heidi's case has taught me the importance of compassionate understanding in qualitative research. Reflecting on the five teachers speaking proudly of their academic qualifications, their teaching careers and their passion for Life Sciences and the environment, I have learned the importance of incorporating one's passion into one's career. In addition, reflecting upon the latter, I was reminded of my own passions. I am proud to be an academic. I am proud to be a student and graduate at Stellenbosch University. I am proud to be an advocate for science. I am proud to be in the field of education. I am proud to be a part of the Curriculum Studies department. I am proud to have had the opportunity to learn the importance of compassionate understanding toward others and oneself. I am proud to be part of this complex but fascinating world, and lastly, I am grateful for all that I have learned and excited for what is still to come.

"*Education is the most powerful weapon which you can use to change the world.*"
– Nelson Mandela –

PLAGIARISM DECLARATION

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Date: October 2022

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APPENDIX A: Interview with Zafir

Leila: So, just going over the focus of my study. It's the lived experiences of Life Sciences teachers belonging to different religious beliefs: A focus on the teaching of evolution. My research question is: How do Life Sciences teachers, belonging to different religious beliefs, experience teaching evolution as a curriculum topic? And throughout the interview, I will be focusing on the research question, but based on your specific context. So, since, uhm, I will be using a case study approach, I'll be asking: How does a *Muslim* Life Sciences teacher experience teaching evolution as a curriculum topic? And just a few reminders that your identity and your school's identity will remain anonymous, uhm, and it is a safe and non-judgmental environment… where you can freely share your experiences and there is no right or wrong answer and you also have the right to withdraw at any point of the interview. And to be specific when I speak about evolution, I'm referring to the micro- and macro-evolution, specifically in the CAPS document the fourth term of grade 10 and the third and fourth term of grade 12. Uhm… also keeping in mind that background knowledge is needed for evolution, such as genetics. And are there any questions before we start? (*smiling*)

Zafir: No questions absolutely. I think you've explained everything. You've explained the context and I'm fully fully informed about it. So, you may go ahead [*nodding*].

Leila: Okay, thank you. So the first one is just: **Would you tell me about your teaching qualifications?**

Zafir: Okay, so I… firstly my academic qualifications is I've got a BSc degree: [redacted]… uh, that was in 1986, and then I did my PGCE (post grad educator course) and also at the [redacted] and then I started teaching in 19… in 1988. I also completed a BEd in

education. Uh, I think it was 94 95 round about that time, I completed BEd. So, also at the [redacted] and so, yah, those are my formal studies.

Leila: Thank you. I'm just muting my microphone every time I've finished speaking just so that the sound is more clear when I transcribe the interviews later.

Zafir: No problem.

Leila: The second question is: **Why did you decide to become a Life Sciences teacher?**

Zafir: Okay. Uh… I think I've been blessed when I was at high school. I was at the school that I'm currently principal at; [redacted]. Uh… and I had probably, in my opinion, arguably one of the best biology teachers. In fact, two of them: [redacted] and [redacted]; two excellent Life Sciences teachers and I think that is where I developed a passion for the subject. Uhm, I think also that just one's love for the environment, one's love for nature… Those are all contributing factors. Uh, I was hoping to… to go into medicine, but I don't think that my grades were good enough and then also I think also family circumstances… uhm… also persuaded me in the sense that I needed a bursary and so I got a bursary from the Department of Education and uhm… Well, good enough to get in at [redacted] for a science degree and, uh, haven't looked back on that. I must say I was also blessed with having wonderful lecturers at the [redacted]: people who are leaders in their field. I'm thinking of Professor [redacted] and you know… Have you seen the book: [redacted] He was one of my lecturers. I had a fantastic lecturer in Zoology, also third-year professor [redacted], uhm, excellent Physiology lecturer; [redacted], Professor [redacted]. Professor [redacted]…

So, I was just blessed having very good, excellent teachers at high school and then also lecturers at university even in the field of Genetics; professor [redacted], Microbiology, professor [redacted] who became the vice chancellor of [redacted]… These were my lecturers. So, I was blessed. I was probably being lectured by people who are the leaders in their field and who gave one excellent insight… you know, and it wasn't… It was just coincidental, you know, that professor [redacted]… I was part of a team… uhm… by… organised by, uhm, Walmart James. He was the DA shadow minister for education and he somehow got some funding from the Norwegian… uh, I think an NGO in Norway and so he had these tons of… uh… pounds and he… in 2000… between 2008 and 2014 needed qualified teachers to assist new teachers in IT, as well as in the teaching of evolution. Uh, and so myself, [redacted] and one or two teachers… We then started this IT program for teachers every holiday; every March, June and September holiday, I think from 2009 to 2014… uh where every location for about a week and a half we ran a program to assist teachers. So, yah. I think I've given you more than what what you actually asked for.

Leila: [*smiling*] Thank you. Uhm… the third question is: **How long have you been a Life Sciences teacher?**

Zafir: Wow! [*smiling*] Okay, so, this is my thirty-fourth year that I'm in the teaching profession. Uh, I started out in 1988 and uh… yah. 34 years. [*nodding*]

Leila: Okay [*smiling*]. That's a very long time.

Zafir: [*laughing*]

Leila: The fourth question is: **Did you study the theory of evolution in your undergraduate studies?**

Zafir: Yes [*nodding head*], I studied evolution.

Leila: Could you elaborate a bit more on what specific topics? And…

Connection between religion and Evolution (not mutually exclusive)

Zafir: Well, I think that there was an introduction to evolution by [redacted]; Professor [redacted], in my first year at university. And uh… you know, when you study the origins of life and so on… and then yah, that's… that's your first exposure to, to evolution. And then in my second-year, obviously we branched out a little bit more, you know, more on diversification also. I mean, I think as we all understand, when you study Zoology, when you study Botany and Microbiology, you basically start off with the origins of life and the way scientists view the origins of life and that is how you then build on that and so uhm… which is probably the best way [*smiling*] to study science, to study any subject. And so yes; it started in my first year and I must say, at that particular point in time… I'm from the Muslim faith. So, you know, you already beginning to grapple… you know, the Quranic… you know, all the Quranic verses you know where God says: "Be and it shall be.", God created… life and then all of that and so already you're beginning to, you know, ponder and you're beginning to question… uhm, at that particular age… So, I'm 18/19 years old at that particular point. Uhm… and, you know, my… my development into the understanding of evolution uhm… obviously also came through reading. And uhm… you know, it was… it was also still in case I would stay in those early years of: this is what I believe in and this is what scientists are saying. Uhm… and then obviously, you know, you would see pictures of an ape and then you see this trans… transformation to an adult man walking upright and so those are the books that I had in my home also, which my dad was a school teacher… those life books. Uhm… and and, you know, so so you also…

Earlier than that, before you've even studied in university, you're asking yourself: "Really? Is this how we've evolved? From being an ape to a human, but what was also happening was that because through reading one began to try and make meaning of what was going on and, you know, gradually you start to formulate ideas in terms of what we're dealing with here, you know? You have your beliefs; you have your religious beliefs, and then you have your scientists trying to make meaning of what they observe and what they see and try to explain through their theories, you know, how life originated… and how life evolved through fossil evidence etcetera and and and uh… other evidence and biochemical evidence and, you know, anyone develops your knowledge, you know, genetics and how DNA profiling happened and, you know, polymerase chain reactions and… you know, as you develop, you begin to have an understanding that there's your religious belief and there's your scientific beliefs and, you know, scientists are trying to explain what they observe, but it doesn't mean that you can't believe, you know, you know when God says I created life; I believe God created. You know, when scientists talk to me about mutations and they talk to me about variations, as a person of the Muslim faith, I believe that God had a hand in it and so God has a hand, God is, you know, that's super being and what scientists are saying in my opinion is the work of God and that's the way I look at it. [*nodding*] And I do understand that within my community… uhh and I'm not saying that my community is illiterate or I'm not saying that my community… uhh… doesn't understand, you know, and don't want to understand, you know, all that I can do is but educate people into understanding how things work and in my 16 years that I've taught evolution, because I think it was introduced [*looking up*] in 2005/2006… I think the first group of matrics of 2008; they wrote on evolution… uhm at a matric level. 2008. Uhm, I must say since 2005/2006… Oh, sorry, 2006 upwards, that engagement started to happen with students and uhh… I mean, I won't forget this one girl in my first year… 2008… She said: "Sir, how can… how can scientists say that we originated from apes?" And

before I could answer to tell her: “Listen, it’s not that way.”, a student put up their hand in the class and said: “No, Tracy, that is not what it is. This is what it is. What scientists are saying is that we have a common ancestor. We share a common ancestor. It doesn’t mean that we evolved from apes as such.” You know, you engage the students in the topic and importantly; whenever you start evolution… start the teaching of evolution, you have to bring religion in. You have to tell them: “Listen here, there’s some of us in this room; we are from the Christian Faith. There are some from the Hindu faith. There are some from the Muslim faith. We all have our beliefs on how God created life, because we all believe that God created life. And there’s also… in the Bible and in the Quran, they would clearly state also… God states the sentence: “It took me so many days to do it.”. The Quran said this was the time period. Now, we also know that as far as that time period is concerned, it's… it's seen in a certain context, uhm… and so you gotta firstly start off there. And then… and then bringing what scientists are saying. And uhm… You know, I have to be really clear about it, also. I mean, I have to tell them: “Listen here, I’ve studied Evolution at university and this has been my full journey of coming to grips with what evolution is.”, and one comes to the realisation that there is scientists… And you also need to get them to understand what science is about. They need to understand how science works and and and and, you know, one very important aspect of it is getting students to understand how the scientific method works so… so that they can see when that scientist talks about the theory of evolution, or the theory of gravity, they need to understand how these scientists derived their theories. And so, the scientific method is important. It's crucial in getting students to understand how scientists: your paleontologists, your archaeologists… how they could come up with their various theories on evolution.

Leila: [*smiling*] I agree. Then the fifth question is: **Did you study the theory of evolution in your teacher education studies, so specifically referring to PGCE and your BEd.**

Zafir: Ok. Yes, I did very… [*thinking facial expression*] well again very blessed with a very good uhm… method lecturer… Uhm… I had two of them… Please forgive me… Uhhh… the name… Oops oops oops, my apologies. I'm getting old now: 57 years old. [redacted]: Australian educational academic [*looking upwards*]. Came to South Africa… Uhhh… Professor [redacted]. And then I also had a Professor [redacted]… And so, I did Philosophy of Education… Oh, sorry, Philosophy of educ… [*correcting himself*] Philosophy of Science in my method also for my BEd. And and and it was a lot of these theories that were debated and discussed in that area, but I had also Professor [redacted] in my method for PGCE and and and that also… all… It all helped in ones understanding… [*interrupting himself*] But just remember this; when I taught… when I started teaching, evolution wasn't really in the curriculum. It only came around in 2005/2006. But one's understanding of how one *taught* [*with an elevated tone*] the subject, was based on an evolutionary line. [*nodding*] You know, when you taught biodiversity, you know, when you've been taught the plant kingdom, you had to use your understanding of how life evolved and how planti evolved; you needed to use that in your style of teaching. When you dealt with genetics, you need to bring that into your teaching. So, it is a very important component of any Life Sciences teacher that you give good grounding in evolution, because it's the foundations of how one understands Zoology, Botany, Microbiology.

Leila: [*nodding and smiling*] Yes, I also agree. Question 6. You already mentioned some, but… if you would like to talk more about it, the question is: **Tell me about your experiences regarding learning about the theory of evolution in your undergraduate and your teacher education studies.**

Anything else that you would like to add with your experiences learning about evolution?

Zafir: Yah, I think that… you know, I think I've already said this before, Leila, is the fact that I was just blessed to have excellent uhm… lecturers at university and people who are leaders in their field. And also the practical part of it, you know, in the practical components of your study, your readings… I think that all helped to develop one's understanding of the theory of evolution. And uhm… Yah, you know, it it it went a long way in getting me to understand evolution. And and and and also also also came in my first few years of teaching is that… where I… would uhm… you know, pick up through newspaper articles that there's a visiting lecturer coming through to the Baxter Theatre. The one I'm thinking of is Craig Venter and I'm sure you heard of Craig Venter. Professor Craig Venter, who's considered to be one of the leaders in Genomic studies and I think he was he was the one who came up with the human genome. I think that happened probably about… probably about 20 years ago or slightly more than 20 years ago… and I attended a few lectures of his. He was invited by [redacted] … sorry [redacted] from the [redacted]. And so I've been privileged to attend lectures also. Uhm… and so, you know, the whole issue of COVID now… and, you know, all the uncertainty about the vaccine… Uhm, you know, I would consider myself to be someone who's always been interested in the latest research happening in the Sciences, happening in the Life Sciences, especially with regard to Genetics and Genomics and… And you must also remember this, Leila, that when I studied at university in the 1980s, HIV was… as we have with COVID-19 now, HIV was going through that same journey. Does it come from the ape? Does it come from humans? You know? Where in Africa did it… was it transmitted to America… You know? And I think there was an Institute somewhere in Paris… uhhh… that was doing a lot of work at that particular time. Early 1980s: 1983/84… uhm… 85 and and that is where I really also

developed this passion for the Sciences. I used to sit in the library and I used to read up the papers on uhm… you know, these latest discoveries as far as the Science, well, scientific American science journals… and so… Uhm… And one continues with that as you are teaching. You read newspaper articles and obviously now with the internet, you know, you Google and you read and you read up a little bit more about uhm… uhm… Craig… Craig Venter, and the work that they are doing in the Sargasso Sea… and going down, deep down, [*pointing and looking downward*] you know, in the Pacific Ocean and trying to locate microorganisms there and getting some understanding of possibly how life started. And, you know, studying the DNA of your microorganisms; your bacteria, thermophiles, living… and so yes, Leila, it's about building and acquiring and understanding the knowledge so that when you are confronted within the classroom you're able to deal with those issues. And so the whole issue of COVID, you know… Uhm… at [redacted], we… you know… we looked at the curriculum. We always look at the curriculum. And even before the new curriculum, uhh… standard 9 biology genetics other schools were skirting genetics, because no, no that's… that's too difficult for students. So, they are mainly focusing on, you know, the plant kingdom and the animal kingdom and, you know, the… for students to understand that we decided: 'No. We'll do bit of evolution in terms of the plant kingdom and then projectise the animal kingdom, but we focus on genetics and human reproduction. So, we did that with the old syllabus… and we gave our kids a good grounding in genetics and… we also used that to sift our higher grades from our standard grades. You know? So, we gave them an intensive higher grade paper in standard… in standard 9 that time; grade 11, on genetics and we would get a sense as to who can cope [*gesturing to one side*] and who can't cope [*gesturing to the opposite side*] and so the ones who battled, with all due respects, we did our own bit of Natural Selection… [*correcting himself*] in biology. [*laughing*] and the ones who couldn't cope with genetics, we'd rather encourage them to do biology on a

standard grade. But the majority of our kids did biology in higher grade because we had excellent teachers at the school at the time. Uhhh… I'm not including myself [*smiling*]…

Leila: [*smiling*]

Zafir: So, so, yes. Uhm… Yah it's it's it's… [*looking down*] I think I've drifted again. I've gone off the topic. In fact, please don't ask me what was the question, 'cause I wouldn't know what your question was. But yah. [*nodding*] That is basically it.

Leila: Uhm… I actually encourage if you go off-topic, because Prof Le Grange told me that it's very important for my research participants to be able to express themselves and usually the most meaningful… uhm… knowledge that I'm acquiring comes from the when the research participant, uhm, goes off topic. [*nodding and smiling*]

Zafir: [*laughing*]

Leila: The seventh question…

Zafir: Okay, how many questions are there, Leila?

Leila: Twelve.

Zafir: Okay. All right. Okay. Could we maybe just carry on for maybe another 3 or 4 minutes then I just need to get into the hall and then would we be able to continue in about 15 minutes?

Leila: [*nodding*] Okay.

Zafir: Are you gonna set a new link or… or how are we gonna operate or are we just gonna keep it on and then I'm just gonna go to the hall and come back again?

Leila: [*nodding*] We can do that. That's fine.

Zafir: Okay. All right.

Leila: Uhm… Would you like me to ask the question now?

Zafir: Okay, yes, you may ask the next question.

Leila: **Could you describe a typical day in your classroom as a Life Sciences teacher?**

Zafir: Okay. I'm the principal at this very moment in time and I've been… I was deputy principal from 1999 through to 2016… Uhhh, but I've always tried to have as full a load as possible. Unfortunately, since I've been principal for the past four years, I've been limited to about 2, maximum 3 classes… Uhm, but as a deputy had about four classes that I taught. Uhm, and obviously before that, uhh, much more. But yah… So, so, my typical day is a busy day. Uhm… I'm a firm believer in that when you're a science teacher, you have a box with you. Uhm. Even if you don't have a lab and then that's the unfortunate situation for the most of my teaching is that we didn't have a lab and we shared classrooms. So, I'm a firm believer in that… uhm… in a subject like science, students must see. And so my box would be filled with whatever… uhhh… material… that was needed for the content to be covered. Uhhh… We had models. We had skeletons. We had models of the eye etcetera… and then that is what you would walk around with… Uhm… transparencies was the order of the day for most of my teaching until data projectors, uhh, were introduced roundabout 2006/2007

where we started using the data projector, but prior to that my transparencies was my main source of making my lessons as interesting as possible. Uhm… But I think importantly also… the… one of the… I would say success stories of our school, is the fact that our students have been involved in extra for young scientists, uhh since 2004/2005 and I've even served on the committee for Expo for Young Scientists… [redacted]. And… for me, that has formed the foundations of my teaching of Life Sciences… is making sure that my students understand the scientific method when we enter our students for Expo for Young Scientists. And I just want to say that our school was amongst the… the top achieving schools as far as Expo for Young Scientists is concerned, together with the Stellenbosch region… Uh… where you have a a a very well organised lady… uhm… organising the Expo for Young Scientists in the Stellenbosch area and obviously [redacted] obviously our region. So, Expo and the teaching of scientific method, we've embraced it. We have our own mini expo and that is… also… it contributes a lot to kids' understanding how science works until you find that for the first six months of the year, where we initially have workshops for our Grade 8 students when they come to [redacted]. Uhhh… We get into… we get them to understand the scientific method. We spend that first term a lot in the class also with the scientific method so they start working on their own expo projects, and we have a mini expo in our hall for over 2 weeks; one week for the grade 8's and 9's and one week for the 10's and 11's and so we have all these wonderful projects and these ideas in the hall and that is how you *develop* [*nodding head*] scientific thinking. And so when you teach evolution, the students firstly… they understand how the scientific method works. And that is why you don't have so many issues, because students at [redacted] will know that when we teach evolution, we are teaching what scientists have discovered as far as how possibly life evolved. And so yes. How's my day? It's a busy day. [*laughing*]

Leila: [*laughing and smiling*]

Zafir: And we don't have lab assistants at [redacted]. You need to get into that storeroom. You've gotta prepare your experiments for your students. Whatever you're going to demonstrate, *you* have to see that that happens… Leila, I need to get to the hall. Are we just going to just… Should I just minimize and then open up again possible in the next 15 minutes?

Leila: Yes, you can just uhm… turn your camera off and mute and then it should be fine. [*nodding*]

Zafir: Okay. See you in about 15 minutes, Leila! All right. You can have some coffee or something. [*laughing and smiling*]

Leila: Okay. [*nodding*] Yes.

Zafir: All right. [*smiling, turning camera off and muting*]

19 minutes later

Leila: Welcome back. [*laughing and smiling*]

Zafir: Ahh! Thank you, thank you, thank you. Okay, there may be a little bit of a disturbance, because the question… the scripts have to be placed in my office, so there may be a little bit of an interference, but I'm sure we'll be done by then. [*smiling*]

Leila: Okay, that's no problem. Uhm… [*looking at the questions*] The eighth question is: **Could you describe a typical lesson where you teach the theory of evolution, specifically?** Uhm, the question after that is uhm…

just: Tell me about your experiences teaching evolution. So, that's more of a general question, but uhh question 8 is just a typical lesson where you teach evolution.

Zafir: Okay… uhm… It could either be an introduction, or it could be a lesson further down the line… I can maybe just talk a little bit about both. Uhhh, I think that with a topic like Evolution, uhhh firstly, number one, as a teacher, you have to be well prepared. You need to know your content… very well, because students will pick it up pretty easily whether you are reading from a book, or uhh you have memorised certain things and that is what you are giving over to them. Uhh… Evolution, in my opinion, is a conversation, because it's a concept that students find very difficult to grasp. Fortunately, uhh… resources are being made available and I'm… I alluded to it earlier on; the Teacher Biology Project, TBP, which, in my opinion, was… uhh, it revolutionised [*grinning*] the teaching of Life Sciences in the Western Cape and we were very fortunate that we had professor [redacted] making these… uhhh, uhhh… funding available, which equipped, in my opinion, Life Sciences teachers in the Western Cape well with… uh having to teach the concept of evolution. And believe it or not, we started having teachers coming from the Eastern Cape, teachers coming from the Free State… uhh from Kwazulu-Natal… to be part of this program over the… over the holiday period. So, the question is… uhm… a lesson on evolution…

Leila: [*nodding*]

Zafir: Even if it's an introduction, even if it's my first lesson, before… there's an introduction to evolution, which I will firstly get students' opinions, you know? We talk about… uhh… you know, we talk about beliefs, those who come from the Christian faith, the Muslim faith… We'll allow them to talk about how they understand evolution or how they understand the origins of life. Uhm… And, uh, you would then maybe give *your* understanding and I

would say now listen, I come from the Muslim faith. And this is what… I understand, my belief, uhh or or or what I… how I would understand the interpretation of the Quran… uhh, in terms of where life started. And it's it's very clear; God created life. And I tell them that as a Muslim I do not question and I do not doubt that in any way. Then I would talk to them about the various theories; how over a period of 250 to 300 years, how scientists have tried to make meaning of where life originated from and how life evolved and so we go to the theories of evolution, you know, Lamarckism, which is in the textbook, uhhh and and then you have the theory of Natural Selection, Charles Darwin, and more recently also now coming into the syllabus is Punctuated Equilibrium… and so, yes. There's this whole discussion that happens and I tell you, it takes about two to three periods and, most importantly, what we've done at [redacted] is… What we've done is, when it comes to the theories, we've asked the students to read the theories and then we ask them to present. So, now you get them focused. They now have to prepare the Lamarckism. They've got to prepare uh, you know, Natural Selection, Punctuated Equilibrium… and they do their presentations. Once they've done that, once we've had this… Now, there's this interesting debate that's also happening in the classroom. Now, I put up my slide on natural selection, which is the way we view… how scientists view how life evolved. You know, and so obviously we talk about the fact that uhm… the environment changes. There's variation that happens. The ones with the favourable variation are the ones who will survive. The ones with the unfavourable variation, they die. Over many generations, the population of the ones with the favourable variation, they are the ones who survive and… and and that is how we find that the phenomenon of microevolution happens. And over longer periods of time, we find that macroevolution occurs. And so, it's a journey. And then what I've just mentioned to you now, a bit about micro- and macroevolution, that would have been three or four periods down the line. And so I tell them: "You see this one slide here. If you understand that particular slide, which

describes… uh, how natural selection happens or how species have evolved all the time. If you understand that slide, then you won't have any problems with when we deal with uhh the evidence for evolution… or when we deal with how variation happens, or when we deal with the phenomenon of speciation. And so, yes, you can't rush through it and what we do at our school is, we provide our students with the PowerPoints on our lessons, so that when they make their notes at home, and especially during this COVID period, is one thing we've learnt also, is you can't teach evolution online. It's got to be face-to-face. It's got to be in the classroom, uhm, because misconceptions happen so easily…uh if these youngsters have to grapple and grasp the spectacle… And I want to say one thing, Leila, and that is that… uhm… Once students begin to grasp it, they enjoy it. And that is when they become… you know the inquiring mind, you know, it starts to wonder and wonder even more, and then you have a better grasp and a better understanding of it. So, that is basically how I would maybe introduce and teach the the topic. And importantly, as I said, you've got to provide them with the visual stimulus. Uhm… The whole topic of how humans evolved, you know, I mean there's my famous little video that I play, where… It's about two or three videos. Short clips that I play on human evolution. And, uh, again we sketch the situation of continental drift and, you know, we are looking at the Out of Africa Hypothesis, and so we look at, you know, where our ancestors firstly found themselves in an environment where it was mainly a boreal forest… Uhm… and and what happened was that, as continental drift happened, and the environment started to change… So, you know… They understand how natural selection happens about the environment changing and and and the ones with the favourable variabl… [*interrupting himself*] So, now they understand also human evolution. It has also to do with a situation where the environment changed. And so it favoured from being a quadruped to being a biped. Bipedal. And so they understand that the environment changed from from Forests to grasslands, and it favoured being bipedal, and then obviously the

diet, also, how that changed… Uhm… And the fact that with *Homo habilis*, the toolmakers and then the fire makers… uhh and so how the facial features started to change… So, it's a combination of a lot of those factors that contributed to… uhm… the study of… of evolution.

Leila: Uhm, you mentioned that there uhm… it has to be in the classroom, because otherwise misconceptions can happen easily… Could you provide me with some examples… of misconceptions?

Zafir: [*gesturing to someone behind the camera not to speak*] Okay, Leila, can you just give me 5 minutes. I've got the monitor for the WCED in my office. Can you just give me 5 minutes and, uh, I will continue with the uh interview after that?

Leila: [*nodding and smiling*] No problem.

Zafir: I'm just going to mute… uhh [*muting and turning camera off*]

5 minutes later

Zafir: Sorry, Leila! I'm really sorry about this, but unfortunately man it's uh, I didn't think before I set the time, for 11 o'clock today, and there was an Afrikaans exam and then the monitor pitched… Uh, you know, where I could normally just break away, I needed to just be there with the monitor also. So, anyway, let's continue.

Leila: No problem. Uhm… My question was… uhm… just could you provide some examples of misconceptions uhm… with the online teaching or just in general?

Zafir: Uhh, when you say misconceptions…

Leila: …uh with regards to evolution.

Zafir: Okay. I would say [*looking up*] … firstly… Uhm… students battle to understand that, uh, when we talk about natural selection, when we talk about changes that happen to the environment… uhm… that is what drives evolution. Now, the biggest misconception that we have in the study of evolution is adapted… [*correcting himself*] "to adapt" or "adapted to". That is the biggest misconception, because students see it as organisms adapt… and not as: adapted to… That they have the variation that enables them to adapt to the changing environment. And I can tell you now that, you know, and I'm thinking back to my marking period also, where I was a marker… I was a marker for more than 20 years… Uhm… and when we had our first debates at the marking centre and that was in 2008 and 2009 and 2010 where we picked up and I can tell you now, with all due respects to my colleagues, it's because of how the teachers taught the concept of "to adapt" and "adapted to" and so for *me*, that was the biggest misconception that we started off with as far as the teaching of evolution is concerned. Uhm… I think that, you know, Lamarckism is also a concept that youngsters battle to to to grasp. You know, and obviously there we're talking about the fact that… uhm… we talk about inheritance of acquired characteristics. We talk about… uhm… where we talk about organisms changing in their lifetime, you know? We talk about the concept of the law of use and disuse. Uhm… I think students also… What happens is that… as you… as you teach the different theories, soon they start to confuse the two theories with each other. Lamarckism and that of natural selection. Uhm… And so, yes, I would say that in terms of the concept of Natural Selection, which is basically the first part of the teaching of evolution at a matric level, it's those theories that seem to be giving students problems: the concept of "to adapt" and "adapted to": that is… that is an issue… Uhm… And then… Yah, furthermore, I think it's more a case of, you know, when

you talk about homologous structures and analogous structures… Uhm… and, you know, where we talk about organisms having a common ancestor: they… they differ in terms of their structure… uh, and function… as opposed to analogous, where we would talk about the fact that they have different ancestors. Youngsters seem to battle with that particular concept also. Uhm… The teaching of meiosis is crucial… genetics, but meiosis is crucial also, because, obviously as we all know that one of the vehicles, besides the fact that the environment changes, is also variation. And if… and if students can master… and that is why when you teach meiosis, you know, when you talk about crossing over and you talk about random arrangement of of chromosomes, which brings about the variation, uhm… it's important that you… you give them a sense, there already, that listen here; further along the line, we're going to deal with the concept of evolution and we're gonna deal with concepts of variation and so on… And it's important and they understand where the changes in our makeup happens. You know, that is why it's important, there also that you make students understand that when you look at their faces in the classroom… Yes, we all have the same basic structure, but we all look different from each other. Now, how did that come about? It came about because of genes and the fact that, uh, we all have different variations of a particular gene… and that is how we become different. So, you know, you already plant the seed when you deal with the chapter of meiosis in genetics and you need to make sure that you deal well with it before you get to the section on on evolution. Uhm… human evolution misconceptions… uh, I think that it also stems from the way in which it gets taught. Uhm, you know, I think some teachers, they have slides of a chimpanzee and Australopithecus and and homo species and they teach that. What students need to understand is that whole story about how the environment changed, you know, from forest environment to a grassland. And it favoured being upright. If they can grasp that, that then when you teach, differences between a chimpanzee and an Australopithecus and the homo species, then they understand much

better. So, I think that, when we talk about misconceptions, in my opinion, and a lot has to do with how it is taught to our children.

Leila: I agree. [*smiling*] Question 9 is… It was basically almost the same, but… it's just: **Tell me about your experiences teaching evolution.** So, is there anything else that you would like to add? Interesting experiences when you taught evolution?

Zafir: Uhm… [*looking away*] I think the most important thing is that when you teach evolution, is, uhm… don't get sick. [*nodding*] See that you are at school every day. See that you are in your classroom on time and that you maximise the period that you're having, an engagement period, which is basically for any subject. All teachers. Most importantly is that you as a teacher, you need to understand that when you teach evolution, you… uh, as a teacher, also have to be well-prepared, you've gotta be focused… Uhm… and because questions can come anytime and I'll tell you one thing; the students really, when it comes to evolution, and when it comes to reproduction, oh well I would say the entire paper 2… uh genetics also, it's probably the most interesting chapter or series of chapters in the Life Sciences syllabus. And it's important that teachers are well prepared… uh, for that. Uh, so you're asking me about some of my other experiences… [*looking up*] Uhm… I would say that uhm… uhm… it's probably the most interesting section of the work. You have a lot of questions being asked in this section of the work, and it's all about students grappling and it's also a case of students… You know, they come from their religious backgrounds so when they go home and they talk about the evolution… you know… Parents are also going: 'Why? Why are you being taught about evolution and all that nonsense?' Uhh and so, that is what makes it more interesting… is that when they are being taught a topic that is seen to be a controversial topic, when in fact it's not a controversial topic, uhh, it's been made to be a controversial topic by your Imams, and your shakes and your ministers and

so on… your religious ministers… They made it a controversial topic. It's not a controversial topic. And as long as you can distinguish between what is religion and science, there shouldn't be any problems. I don't think I've answered the question, but yeah. [*laughing and smiling*]

Leila: [*nodding and smiling*] Uhm… Question 10. Speaking about religion; **tell me about your own religious beliefs.**

Zafir: Well, I mean, you know, my own religious beliefs… uhm… you know, is based, uhm on the Shahada, which is our our doctrine as far as our belief is concerned and that is that uh, I believe that there is only one God… Uhm… and that the prophet Muhammad uh… is the final messenger of my God… and then there are five sort of… uhm… principles on which our religion is based, and that is uhm, you know, to perform your five daily prayers, which I try my best to do, [*smiling*] and I battle every day… uhm… and, you know, obviously… uhhh, so it's fasting during the month of Ramadan, uh… to give, uhh, charity… uhh, is another aspect of our religion, and when I'm by the mains and which I hope to do one day and that is to perform my pilgrimage to Mecca. So, that's the foundations of of my religion, and then obviously it's the Teachings in the Quran, uhm… and then also the Teachings of the Prophet Muhammad, which is referred to as the… uh, we talk about the Sunnah, the actions of our prophet… uhh we talk about the Hadith which is the sayings of our prophet. Uhh, and those are the foundations that I would uphold and I would think I am upholding. Uh, Islam, like I would say probably any religion, is seen as a way of life, and so to the best of my ability, I try to uphold those uh values; uhm, Islamic values, and I want to say that when I engage with my colleagues from other faiths, we share those values. We're dealing here with children… uhh, the upbringing of children and I might, I might have mentioned this to you, which I don't know if you… [*smiling*] you can include it or not, but currently we have in one of our corridors, you know, the LGBT flag. And

that has now created a big issue at my school. Now, you see, there now we have the issue of what does the Constitution of the country say about freedom of choice, freedom of religion, freedom of expression… Uhm… and so, now you have a situation where people say: "No, I'm from the Muslim faith. We don't believe in that nonsense!" Uhh, people from the Christian faith: "We don't believe. Why is that flag up at your school?" Now again there; when you're in a public school, uhh, you gotta uphold the Constitution of your country. Uhh, and so, now we're grappling with those ideas. Now, I believe that the school environment is the best place also. [*nodding head*] You know? And we… what we're trying to teach our youth is also tolerance and when I talk about the concept of evolution, especially when a child puts up his hand in the class and says: "Sir, that's a lot of nonsense. I don't believe that." Now, you've got to engage that young man or that young girl with that concept [*nodding head*] and that is where the whole concept of inclusivity comes. Uh and and and this is how we develop citizens in our country, you know? And so, you know, Leila, this is… We find ourselves in interesting times. We come from an apartheid system where there was lot of exclusion, where there was a lot of… how can one say now… intolerance if I may use that word, uhm… and we now have the complete opposite. And now parents are also worried, you know; "you're teaching evolution, uh… you uh… have a flag, LGB flag, you have a flag of Palestine in your corridor also." Now, aren't learning institutions places where you expose students to these concepts and you allow them to grasp and to grapple and to… You make them aware and you allow them to debate… Aren't these the places where this must happen? Imagine… uhm… You know, I had a group of students coming to me and say: "Sir, LGB etcetera." Now imagine I go then and say: "No, sorry sorry sorry, I want to see your parents regarding this." You now build a situation where they don't trust you anymore… you know? So, that is how one has to deal with situations currently. And so, in the next few days, there will be uh… the amnesty flag also going up, and Greenpeace flag will also go up. And

so, you know, Leila, that is what Life Sciences is. And when we talk about the evolution of the sciences, we need to… I mean the whole topic of renewable energy… Uhm… and how do you make students aware of this particular concept? You know? Uh, where we find that we are going to be the cause of… is it the fifth extinction, or is it the fifth mass extinction… It's currently happening! You know? As far as biodiversity is concerned, plant life, animal life: it's currently happening, and students need to understand that when they learn about evolution, uhm… and, you know, how species evolve, uh… and the impact, you know, and biogeography, the biodiversity, etcetera… They are all interlinked with each other, and so, as a Life Sciences teacher, evolution is a very important component of them understanding of what happened in the past, and where we are currently going to. Uhh, and so, yah. I don't think I answered the question.

Leila: But I think it was necessary to mention… Or it was very interesting and I think, or in my opinion, I think that's the right way to do it: to expose the students and to educate them and to teach them acceptance and yah, I wouldn't even actually want to say tolerance; acceptance. [*nodding head*]

Zafir: Yah. [*nodding head*]

Leila: Uhm. Question 10. Oh no, question 11, the last two questions: Specifically, **what is it like to be a Muslim Life Sciences teacher teaching the theory of evolution?**

Zafir: Uhm… There's a… There's a professor at the [redacted], Enver Mall, E N V E R M A L L. Uh, Professor Enver Mall. I'm not too sure whether he's still at at [redacted], or whether he has retired, uhm… and uhm, I've listened to one or two of his talks… Uhm, and I must say that also provided me with the necessary confidence as a Muslim… uhm, to be teaching the topic of evolution, not that at any stage I doubted being a

Muslim teaching the topic of evolution, because as I have made it clear from the start; there's my religion and there's science. And, uh, when we talk about evolution, we're talking about how scientists are trying to explain how life originated and how species evolved over time and they spelled it out very clearly that the… you know, that the driving force was obviously the change in the environment, which was brought about by continental drift. Uhh, and so, and so yes. As a science teacher, I mean that is for me the departure point in terms of how one… [*interrupts himself*] So, it hasn't really been for me a problem being a Muslim teaching the topic of…of evolution. Although, I know that I've got quite a few colleagues of the Muslim faith, uhh who… would still question the teaching, but in my opinion, you're questioning it, because you don't understand… how the information, the evidence was presented uhm… and and and and and that is a worry when you teach evolution and you still have that philosophy or that way of thinking. So, for me it's not a problem.

Leila: Okay. [*nodding*] Thank you. [*smiling*] Uhm… and the last question…

Zafir: And… Sorry Leila, sorry…If I could say this: It's not a problem also, because of the fact that, uh, my foundations in my opinions were solid, from a religious side of things. And there's one thing that my father also taught me: He taught us tolerance. Uh, I lived in a neighbourhood where we were the only Muslim family in the road… uh, I would say for a… possibly a 400-meter radius. We were probably only about one of two Muslim families in that neighborhood. I grew up in [redacted] and my father was a religious minister. He translated the Quran into Afrikaans in the late 1960s. Uhm… [*buffering*] He taught us tolerance. He taught us religious tolerance. He was persecuted by certain members of the Muslim community, but he taught me tolerance. And every Sunday morning, I always wondered, you know, you would be standing on the stoop. We had a long stoop in [redacted] and he would be standing on the stoop and our Christian

neighbours would be passing by and he'd be greeting all of them and they were all on their way to church. Now, that is how he was. He respected my neighbours. They were all of the Christian faith, and that's what I was taught and so all my friends, when I grew up, were all from the Christian faith. They respected my father, my family, my mother. I respected them. When when it was time for prayers in the evening, you know, you'd find that the road was quiet, because they would hear the Adhan, and the road is quiet, because they respected my faith. The same way, as on a Sunday morning when they go to church, my dad respected them. And uhm… Also, when it came to religious festivals or religious gatherings, you know, the neighbours would go out of their way to… you know, for Eid, to ensure that, you know, there's something from their home for our home and the same when it came to Christmas, my Mom would make about five or six fruit cakes. I'll tell you this, one of the best fruit cakes… and I would then have to go over to my neighbours. And when it was Eid, when she made her Breyani, uh, with the chicken or or the roast beef, I would go over to their place and we'd also give them some food and so, you know… So, that is the environment that we grew up in. Tolerance. Uh… and that is crucial in terms of how one… So, so, when you asked me about my beliefs, and how that impacts, you know, I would say that it's about tolerance. And so when you see things happening, you know, with Isis and the Taliban and, you know, that is not Islam. That is not my religion. Yes, you have fanatics and unfortunately uh… the West would want to portray that that is Islam. When you see what's happening in Afghanistan, when you see what's happening in Syria, the West, the Western world would want to portray that is Islam, but that is not Islam. That's not the way I read my Quran. Our prophet was someone who had a lot of empathy and a lot of respect, and he was spat at… You know, stones were thrown at him during his lifetime… uhm… and he did not respond. When the body of a Christian person or person of another faith passed by his place, he was outside and he would stand there and he would show his respect. Now, those are the values, uhh, that I

believe is Islam about. And so, when you see what's happening in Palestine and you have the uhm… the persecution of your Palestinians happening, and again, Palestine is not Muslim. There are Christian Palestinians, there are Jewish Palestinians also. So, when you see that happening there, uhm… and unfortunately you find that, you know, Israel wants to portray them as terrorists and so on, uh, one has to, you know, you gotta, you gotta also try and make meaning of what is currently happening. And there's no doubt that the politics in the world, you know, the the the the polarisation… It seems as if, you know, there's superpowers and these these leaders; they want that, because that is how they accrue their wealth. And so, yes, [*nodding*] as a teacher, you need to understand all these things so that when you teach concepts… you know, and I don't see myself as a Muslim teacher at [redacted]. I'm a teacher at [redacted], uhm, because I have students of the Christian faith, I have kids of the Muslim faith, of the Hindu faith… So, you are a teacher first. And also, importantly there is a constitution that, as South Africans, we have to uphold and uhm… You know, some people want to say: "No, my religion comes first, then the Constitution of the country." Nah ah [*shaking head*]. It doesn't work that way. Your religion is between yourself and your maker. That is your religion. The Constitution of a country is what you have to uphold as a citizen of you country. And you need to promote that Constitution, because we have laws in our country that protect that constitution, you know? There's the, uh, Human… Rights Commission that will uphold your values and your rights and uh one has to be careful with how one deals with those issues.

Leila: Thank you.

Zafir: And I'm not a terrorist. [*laughing*]

Leila: [*laughing*] I would say that… uhm… I have never had a negative encounter with an Islamic person. I would say there are… The ones that I have… or

that I'm friends with or that I know, uhm are the most respectful people. So, I don't agree with the terrorist stereotype at all. [*laughing*]

Zafir: [*laughing*]

Leila: Uhm… The last question is: **When teaching the theory of evolution, how does it make you feel?**

Zafir: [*looking away*] Uhm, okay. If you have asked me that 15 years ago, uhm… I would have said excited. Uhm, it's a chapter, I must say that I look forward to teaching, uhm, because, uhm, you know, evolution is a concept that you can apply to all aspects of life. Uhm, and if you Google the term evolution, uhh, it gives you some definitions and there are differing interpretations of the definition, but teaching evolution as a biological concept, biological sciences concept, uh, I would say it's it's it's it's something that you look forward to, because you know that there's gonna be debate, there's gonna be discussion and that, for me, is what teaching and learning is about. That is what education is about is the engagement that needs to to happen in the classroom, because, you know, children learn from each other. And, you know, when I listen to my English teachers at the school, my colleagues teach English or Afrikaans for that matter, and the discussions that they have; Life Orientation: the discussions that happened; History, you know, uhm… That is what… gets students to understand, uh, concepts, but also they begin to understand each other. And that is what teaching and learning is about. And so the concept of evolution is a topic that I enjoy… uh, I enjoy teaching, and uhm.., as long as it's in the syllabus, I'm sure I will always look forward to teaching the concept and I'm very disappointed that the, you know, the topic of the human impact on the environment, you know, when we look at pollution, when we look at our carbon emissions and water pollution and… uh, the whole concept of biodiversity and etcetera… The fact that that's been taken out of the grade

12 syllabus, uhm, I'm disappointed about that, because I think it's also gonna happen at a grade 11 level is that you're gonna find that some schools are gonna teach the concept and others are not. And so when you at this whole cop 26 and, you know, this climate change and etcetera… Uh, I'm a bit worried, [*nodding*] but I also understand that it was COVID. Teachers had to decide which sections of the work they're going to cover, which sections of the work they won't be able to cover. One hopes that when we return to normality, that concept of human impact will be taught well in the schools.

Leila: [*nodding*] Thank you. Thank you very much for your contribution and for, I feel like you mentioned a lot of meaningful things and definitely things that I will quote. [*smiling*] Yah, thank you very much.

[*Personal question out of interest about Lamarckism.*]

Leila: Do you have any questions for me before we end the interview?

Zafir: Leila, do you require one or two other teachers of the Muslim faith?

Leila: That would be very helpful. [*nodding*]

APPENDIX B: Interview with Saadiq

Leila: So, firstly I have a checklist that I need to go through and just to give you some more information about the project. So, the research project is the lived experiences of Life Sciences teachers belonging to different religious beliefs and the focus is on the teaching of evolution. And then the research question is: How do Life Science teachers, belonging to different religious beliefs, experience teaching evolution as a curriculum topic? And since… Uhm… I'm going to interview different Life Sciences teachers who belong to different religions and my questions throughout *your* interview specifically would be: How does a Muslim Life Sciences teacher experience teaching evolution as a curriculum topic? … And then I'm just reminding you that your identity and the school's identity will remain anonymous and that this is a safe and non-judgmental environment where you can freely share your experiences and there are no right or wrong answers, and you have the right to withdraw at any point of this interview. And then just to specify when I speak about evolution, I'm speaking about micro and macro evolution or my questions will refer to micro and macro evolution. And specifically… Uhm… if you look at the CAPS document and if you have any further questions on uhm what exactly I'm referring to, it's the fourth term of Grade 10 and the third and fourth term of grade 12, where evolution is covered… mostly. Okay, so are there any questions before we start?

Saadiq: No, no. Nothing yet. As we go through the interview and something comes up, you will allow me to ask a specific question? I assume.

Leila: Yes. [*nodding*]

Saadiq: Yah. [*nodding*]

Leila: Okay, so, the first question is… or it's not really a question [*smiling*]… Uhm, **tell me about your teaching qualifications**.

Saadiq: Teaching qualifications… I have a BSc degree obtained at [redacted]. Following that, I obtained an 8 stage (they call it an HED: Higher Education Diploma) which qualifies you as a teacher, through [redacted]. Then, after that I did a BEd Honours, also through [redacted]. After that, I did MEd, also through [redacted] and at the moment I'm busy with my Ph.D. [redacted]

Leila: [*nodding*]. Okay. Thank you and is there anything else you would like to add?

Saadiq: Uh, regarding qualifications? Uh… In terms of the teaching of Life Sciences, mostly that. And obviously Life Sciences, you attend quite a lot of workshops and… and training, especially training workshops and stuff like that. Uhm… So, that's a part of qualifications, but it just helps you in the development of the subject that we had to go through a lot in previous years.

Leila: Mmm. [*nodding*] So, was Life Sciences one of your specialisation subjects when you did your HOD?

Saadiq: My HED? Yes, yes. Life Sciences and Natural Sciences. [*nodding*]

Leila: Okay. [*nodding*] So, second question is, **why did you decide to become a Life Sciences teacher?**

Saadiq: Uhm… [*looking away*] Man, that's a long story, but okay. Let's give you some idea… Uhm… I was at [redacted], as you've heard before, doing my BSc. But I actually re-routed back to BSc. I did my first year BSc; got into

Dentistry. Those years… those were tough years: we're talking about the 1985s, when the country was in turmoil. So, I did my first year at BSc, I got into Dentistry. We had a very tough year. A lot of oddly lectures for most of the year, and we were supposed to write exams. The end of that year, and then I just decided: "No. This is totally unfair." And then I went back to complete my BSc. So, that's how it got back to BSc and I always had a love for nature, for the outdoors, you know, and what is happening in the outdoors. And then I decided to choose Zoology and Botany as my two majors with Microbiology, also as sort of a sub major up till second year. So, I went with that BSc. I did Zoo. 3 and Bot. 3 and Microbio. 2 to finish that BSc. So, you can see there's a good mixture of content related to the teaching of Life Sciences that I did in a BSc. You see? So, that's how I got back into BSc. But I always had a love for the outdoors and for nature and to care and to conserve and to… and to see how we can protect the environment. That love was always there. That's why I went back to BSc and then continued with my BSc.

Leila: Yeah. **And why did you decide to become a Life Sciences *teacher* specifically?**

Saadiq: Uh, I think the influence probably comes from the teachers who taught me, uh, the exact time it was called biology in previous years. He taught me Biology at the high school. I think the… the stimulus came from the type of teachers I had. I had fantastic teachers teaching me the subject or brought about a love for the subject. And then, while I was doing my BSc and thinking which direction I should go, and obviously the majors I had steered me towards Life Sciences and I felt that this is where I… I want to be at that specific moment in time. Because of the good teachers ahead at high school, which created a love for the particular subject. [*nodding*]

Leila: Mm. [*nodding*] Okay, thank you. Third question… Uhm… is: **How long have you been a Life Sciences teacher?**

Saadiq: Uh, we're talking about approximately 30 years. Thirty years since 1988, but not continuous service. Dur… [*interrupting himself*] from 1988, there were years during which I had to study. And sometimes I used to take off for a period to study. And I wasn't teaching. So, in total it added up to about 30 years of teaching. And it was teaching Life Sciences from grade 10 up to matric, for the 30 years, every single year of that 30 years, I had a matric class. So, it was quite tough. And then also, uhm, what made me, I think, a bit stronger in Life Sciences for 18 years, I have been appointed as a matric marker in Life Sciences. So, I'm very involved and uh… and that also helped me to to actually develop the subject better, because when you mark matric as well, you actually learn more from… from other centres, what mistakes learners make and you take that back to your own institution the following year and you improve your school through mistakes that others make. So, it is a very good learning experience. It was. It always is a good learning experience to be a marker in that particular subject, Life Sciences. The other advantage also of that is that, uhm, sorry I'm going off the point probably. The other advantage is that your network, when you mark with teachers from other schools, and that is… That is great in any subject. You know, where you can share resources, ideas, even electronic information, electronic lessons, uh… PowerPoints and whatever. So, the the the years I've been teaching is 30 and about 18 years of matric marking. [*nodding*]

Leila: Wow. [*nodding*] Okay, that's a long time. But it's definitely good… [*smiling*] The marking… It's definitely a good learning experience.

Saadiq: Yes. No. Definitely. [*nodding*]

Leila: The 4th question is uhm: **did you study the theory of evolution in your undergraduate studies?**

Saadiq: Yes, very late… if I can recall now… probably in 3rd year Zoology, only third year Zoology they taught us evolution. It was mentioned in your first year, but uh uhm… very briefly and very concise, but in third year Zoology they did quite a lot of detail. So, in the undergraduate studies, it was done… It was taught to us at university level, but when I started teaching it wasn't part of the curriculum in high schools. I started in 1988 and the teaching of evolution was not in high schools. It only appeared in 2008. 2008 was the first year we had to teach evolution, but we were taught the theory of evolution at university in undergraduate. That's correct. [*nodding*]

Leila: Okay, and **did you study the theory of evolution in your teacher education?**

Saadiq: Uhm… [*looking up*] No, no, not specifically, no. [*shaking head*] Not in HED. No, not that I can recall, no. [*shaking head*]

Leila: [*nodding*] Okay. Probably because it wasn't in the curriculum back then.

Saadiq: Yes, and they had specific modules you had to pass, but there was no particular reference to evolution or that evolution is a prerequisite for any of the modules to pass an HED at that time. So, it… it wasn't present in that part of the… in that diploma.

Leila: Okay. And the next question… **Tell me about your experiences regarding learning about the theory of evolution in your undergraduate studies.** [*smiling*]

Saadiq: Uhm… [*looking away*] Very uh uh… The lecturer we had first year was an excellent lecturer. I can still remember his name, Prof [redacted]. Fantastic lecturer! We had a very good lecturer. He taught it to us very in an open minded way. Uh, he gave us the theory, the taught us the theory, and after teaching the theory to us, he would divide… divide us sort of into smaller group and uh we had to discuss the theory amongst ourselves and we were from different religious background, I can remember at the time, and uhm… But the way he presented it, he gave us the theory in a very explicit, very good way, presented the theory. And he allowed us to share our ideas with our peers, and then once we're done discussing it with our peers, he would ask us if if… what we… what we want to share with the group regarding our opinion about the particular theory, so it was a very uh open discussion… Very free… you could speak freely. You didn't feel uneasy to talk about it, but uh he made it very clear that it is a theory; it's not fact. So, and he's trying to teach us… He told us at that time, I still remember the two words he told us. He said: 'It's all about uh critical thinking.' He said: 'I'm trying to teach you critical analytical thinking. It's a controversial piece of material. I'm throwing it in your lap and I want to see what you do with it. What you think about this… What comes out of your mind? How you've been reared… Wha… what is in your… in your mind? You know, what can you share with us once I share this theory with you?' So, the discussion, I feel, was done in a very good way. I feel it was a very good lecturer we had and I think that also sort of made me think of evolution, uh, not as something to be afraid of. [*nodding*] Uh… People can talk about it, but be open minded about it and respect others: others' views and their opinions. So, that is something Prof Leonard at that time made very clear to us. We respect one another, even if they disagree with you. Even if they have a different viewpoint regarding their religious beliefs… Respect. He taught us respect… by teaching evolution, uh at the end of the day, I… I really think what I learned from it is: respect other people's viewpoints. [*nodding*] That was my… [*interrupting himself*] At university level, that is what he instilled

in us; respect what other people's opinions are, you know… that there will be people that will differ from you. Let them speak, but do not, sort of, you know, oppress people and not allow people to say what they need to say. So, he was very open about it and that sort of uh… uh… allowed me to regard evolution not as a threat, but to teach it in such a way that… Tell, your learners, one day, when you go into the schools, he said to us that uhm… we'll always, uh, pick up controversial material. And he actually taught us how to read actually between the lines. 'When you get a piece of controversial material', he said to us, 'don't be afraid of it. Pick it up. Read it', but… where he says: 'Think about it and think about your religious beliefs… especially religious beliefs', he said: 'Never, sort of, shun back or push that aside for something that you're reading. So, he said: 'always keep your religious beliefs close to you, but read what other people are saying and then you decide if you want to agree with it or not, based on… on the knowledge you have about your religion, and and about life in general.' So, I think the way it was presented to us at university level, was in in such a way that I felt: this is not going to be a threat to teach, because he actually gave us some idea how to teach it, because he was such a good lecturer at the time. I regarded… [*interrupting himself*] I still regard him as one of my best lecturers in Zoology. And I still remember his name after so many years; [redacted]. So, from that point I felt if evolution would actually become a topic to teach in in the schools, I wouldn't be threatened to teach it, because he he actually trained us how to handle the material. Okay. [*nodding*]

Leila: That's very interesting. [*smiling*] Uhm… Is there anything else that you would like to add about your experiences regarding learning about evolution in your undergraduate studies?

Saadiq: Uhm… [*looking away*] in undergrad, uhm… Let me just think… You're taking me very far back, [*laughing and smiling*] if you could just give me a

moment to think. [*laughing and looking away*] Uh… [*still looking away*] Mmmm… I really don't so… also in the exams as such… I mean, we were, we were properly guided as to how we're going to be examined on the topic of of evolution, so we didn't really feel that this is threatening and this is going to sort of cause me to to leave my religion and to join another uh… uhm ideology. So, there was nothing like that, so it wasn't threatening as such that, that you felt 'I don't want to write an exam on it, because of being so controversial.' Because, as I said before, it's the way he presented it to us and how to handle a topic like that, especially if you have to teach it to others, and I think that made it so much easier to understand that the… what it's about, and to write exams on it. You see? And I think the bottom line, as I… I'm emphasizing all the time, is the way it was presented.

Leila: [*nodding*] Okay, that's well put. Uhm… **The seventh question is: could you describe a typical day in your classroom as a Life Sciences teacher?**

Saadiq: Based on teaching evolution?

Leila: Uhm, the next question is about a typical lesson where you teach the theory of evolution, but... uhm… the, question 7 is: could you describe a typical day in your classroom as a Life Sciences teacher? So just uhm… a typical day, regardless of evolution.

Saadiq: Oh okay… [*nodding and looking away*] Uhm… A typical day in Life Sciences. Uhm… I was regarded as very funny teacher. I was called the… [*interrupting himself*] They called me all sorts of names, but they love my lessons. Uhm… I made my lessons very humorous, very, very humorous. The… the children would sometimes run to my class, because they know they're getting me next and there's going to be fun. There's going to be laughter and it's gonna be excitement. I always try to make my lessons very very exciting. I always try to provide variety every single day. My lessons;

the previous lesson, and the lesson to follow would never be the same. They would link most definitely, because you have to revise what you've done the previous day, but there would be so much different variety or different methodology that I'm using in the next lesson, it just keeps them on their toes and it keeps them excited all the time. You know? And uhm… [*looking away*] the approach most of the time, at most schools (we were very well equipped) was, children don't want to sit in a desk all the time. [*shaking head*] So, when they come in, the first thing they would look, what is on my table for today? Is there something set up? Is there some equipment on the table? Is there something lying there that's going to be dissected or something? So, they would come up… The first thing they would… they would do is: 'What is on that table? What are we getting today?' And then they would go in and they would get ready to to to to start the lesson as such, and I would always try not to keep them in their seats. I would present them with an introduction, provide them with the core of the lesson of what it's all about, and always try to start with the hands on approach like something that needs to be dissected, like uh… uh something that takes them out of their seats. You know, something where there's movement, and then, once they're excited and we've done that part of the lesson, the lesson phase would change and I would get them back into their seats and then I would say: 'Unfortunately, now you've learned… What have you learned? And we would assess what we've learned. And they would tell me this [*pointing one way*] and they've enjoyed this so much and so much and enjoy it so much according to the different approaches that I'm using just by not writing on the board or just by switching on a project or something like that. And then, unfortunately, I would take all that fun and turn it into, but unfortunately: 'There is an exam at the end of the day or test to be written. So, this and this and that of what you've just learned in that dissection, for example, is important now for the test. And do you still remember the function of this part and the function of that part?' Etcetera… So, my methodology was always to keep them excited so that they would

love to come to my class and they would, uh… and they knew that they're not gonna be sitting, unless they're writing a test, they would sit in this seat for a period. They knew they're not gonna be sitting still in this… in this lab, 'cause I was always in a lab, and in a lab you can do so much. There would be microscopes… a lot of things that we'll have done. It takes a lot of preparation, but it it just builds the love for the subject, because it's very.... It's not always that you find that when children walks out of your classroom that they say: 'Thank you, Sir. But I really enjoyed that today.' Because it takes so much effort to get them to that point and it just creates love for the subject. So, a typical day for me in the Life Sciences classroom is to provide so much variety that the children… [*video and recording buffering for a few seconds*] Fun activities… But at the end of the day, also remind them that there is a test and an exam after all of that, and to keep movement in the classroom all the time, because you can lose them if they have to sit for some of our periods were something like an hour long. It's a very long session to let a child sit in a seat for an hour. Vary your lessons. And that movement was always part of my lessons. They would know: 'When are we getting up? When do we get to the front? When are we getting the scope? What is under that microscope? What do you have set up for today?' [*buffering for a few seconds*] So, they they, they, they they, they they called me a funny guy, but that is how they perceived me; the funny teacher, you know? They loved my lessons, because I always had… from 99% of my learners very good, uh, feedback as to how lessons were presented and how they enjoyed the teaching of Life Sciences, and I even had… I can tell you: when I walk into a mall or some public place, I meet some of my past pupils and some of them are doctors and still up to today, they will recognise me and they will shake… shake my hand and say: 'Thank you, Mr Surname! I really enjoyed your classroom', etcetera... I I even had, one year at the marking centre, I remember, we were sitting around the table eating, a few, uh, markers, and this guy came blindly up to us; 'Mr Surname!', he said to me, 'You are the one who made a difference

in my life!' I said: 'Who are you, firstly?' [*laughing*] I can't remem… [*interrupting himself*] He gave me his name and then gave me the school etc. and then he told me he's actually doing… some uhm… technical work for the department on the computers recording marks, and this is the type of feedback I get whenever I meet these students in public places. They would never shy away or run away. Their first instinct was not to go or go the other way. They want to meet up with me, ask me how am I doing, what am I doing, etc. And it's always been like that and maybe I think it's it's it's part of… they regard… They regarded my lessons as something which stuck… stuck to them. They could see there's planning. They could see every day there's something different, there's excitement and they could see that it was a man who loves his subject because, it takes a lot of preparation to get it to that level. So, a typical day in the Life Sciences classroom, I would say, is to provide all that variety, just to make the subject as excitable as possible. Yah, thanks. [*slightly nodding head*]

Leila: That was very inspiring to hear. [*smiling*]

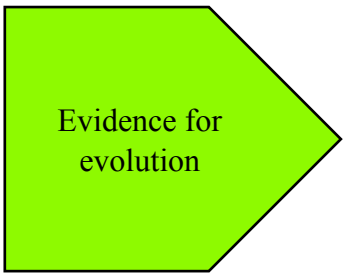
Saadiq: [*smiling and laughing*] Comes from the heart.

Leila: Yeah, definitely. [*nodding*]. And uhm… quest… [*interrupting myself*] Is there anything else that you would like to add?

Saadiq: No, not really. I think that's the essence. Yah, that's the essence. [*nodding*]

Leila: Okay. Uhm, question 8 is, **could you describe a typical lesson where you teach the theory of evolution?**

Saadiq: Uhm… Evolution, you have to start at the beginning. And uh the beginning of evolution you you need to touch on the religious background of what sits in front of you, because I taught at many schools, and some of the schools I



taught at were… most of the children were from the Christian faith. Some of the schools I taught at were mixed; different faith. Some of the schools I taught at were only Muslim students. So, this now changes your lesson plan. For example, if I was at a Muslim school, then I know now the lesson plan to start evolution, I have to start bringing in some faith information, some… something about the Quran. I have to speak to them about that and ask them what do they know about it and how it fits in with evolution. If it was from a place where most of the learners are from the Christian faith, I would shy away from that. I would not put that into the lesson. I would rather then focus on what the curriculum is asking me to teach, but I would ask them: 'How do you feel about this? What does your faith say about this?' and so forth… You know? If it was a mixed sort of group, then I would probably… what I would have probably done with them is divide them into smaller groups of different faith and let them discuss it. I would first give them a presentation, a brief presentation about what the topic is all about and why people are saying it's controversial, etc. and if they agree with it and what do their religions say about it, and then we can discuss it in their their groups, and then afterwards we can have report back from each group. So, it's the way I tackle evolution… it depends a lot on my audience, the type of student that sits in front of me. If it's a Muslim school, as I say, then we will talk about the Quran and we talk about the the traditions of the Prophet. And does it fit in with what evolution says, you know? But we would make it clear that the discussion that we're having, will not be examinable. You're not going to get any marks for it. You know? But it is important for your understanding of of what we're discussing at the moment. So, a typical lesson, then, will be determined by the student that sits in front of you. So, now I need to go sit and work on that; how I'm going to present it so they do not… so that I do not offend anyone when I speak to… to my learners. You see? And evolution, because it is so abstract and there's clear evidence about it, and learners would always like to see… they like to see evidence. Give me the proof. I want to see… If you tell me

the the the the sky is blue, I wanna see the evidence. Show me the sky is blue, then I believe you. So, that makes it very difficult to teach a a topic like this, because there's no clear evidence that you can show them. You can show them what's in the books and what you have electronically, etc. and what's on YouTube etc., but there is no real concrete evidence that you can show them, you know, in terms of school… at school level, perhaps university, so you'd have fossils and stuff that you could have a look at and so forth. You know? So, a typical lesson then… would first be specially be determined by the audience in front of me, how am I going to present it, and the abstract nature of evolution, I will try to make it as simple as possible. First start off perhaps: What is a theory? What is an hypothesis? What is a fact? You know, start off from the basics and then go on to the two main sections that are tested in evolution, the… theory of the the theory by natural selection and in human evolution… You know? I would give them an overview of what is required and then you will have discussions based on the type of faith they belong to, and they would actually tell me also what the Bible is saying and what the Torah is saying etc. And if there are some Muslim children, and they couldn't perhaps add a lot to the discussion, I would say the Quran, also says something about this and this and that, and it gives them sort of a better perspective that uhm different faiths have something in common when you discuss this topic. They realise; 'Oh, but there's something in common here. We're ticking some boxes here.' You know? So, when you have that discussion in a very varied, uh, group, uhm, you start seeing the similarities between the groups. So, in that way evolution could actually be a way of understanding that there are similarities between religions that the children are not even… might not even be aware of. And now it comes out. 'Oh, we also think like that! We also…' And now? All three major groups, they agree on one thing. You know? So, it creates understanding between children. So, that could perhaps be a positive, if if… because of the topic of evolution. Uhm… So, things comes out, that are never shared and evolution, I think, also provides the

opportunity that comes up also provides the opportunity or the platform for these things to to be… to surface, because children don't also want to talk about what's written here and what's written there. They might have a private discussion with their parents, but now you opening up a can of worms and things come out and now they hear what other people are thinking, and now they see all these commonalities, similarities, and now… It's just… this is just because of something controversial that you brought up, they start seeing similarities and they realise: Oh, but in some regards, we are the same. We believe the same, you know? We differ at certain aspects, but at some aspects we… we all agree on. So, evolution also brings that out, which, I think, other controversial topics wouldn't have done that. You know? So, uh… Evol…. [*interrupting himself*] As I say: So, a typical day teaching evolution, I would start off with the basics. I'd give them an overview of what the curriculum requires, go into group discussions and have feedback from different, uh, religious groups. Yah. [*nodding*]

Leila: [*nodding*] Thank you. And then question 9 is sort of similar. It's just: **Tell me about your experiences teaching evolution.**

Saadiq: Uhm, as I've said before, it's easier to teach it with a group of the same religion, because we could go into various discussions and… and compare: this is what you need to learn for the exam, and this is what the Quran says, and you can see how they differ, while they're even similar. [coughing] So… Excuse me. [*coughing*] The teaching to a… to a student of the same faith, I would regard it as easier, because we could go into more discussions that would be of value to the learner… uhm… not in a… in a, in an assessment way, but it would have value to the learner as a person throughout his life, but he's not going to get any marks for it. It's not going to be assessed. So, teaching evolution to a Muslim group allows me as as as a Muslim teacher, uhm, to go beyond the syllabus, beyond the curriculum and have thoughtful discussions, because they can relate to what I'm saying

in a better way than somebody from another faith. Uh, whereas when you have a mixed group, you've gotta be careful what you're saying and how you are saying it, because everyone does not want to hear about the Quran, 'cause that's not his faith. He wants… If he's a Christian, he wants to hear about the Bible. He wants to speak about the Bible. Why are you talking about the Quran? You know? So, everyone doesn't want to hear about other people's books. They have been reared from a child, whatever, or the case of a specific religion; that is our scripture. That is what we believe in. So, you have to be very careful when you have a mixed group how you do your discussion, and you have to make it very clear what is examinable and what is not examinable, because evolution is a matric topic. In matric, they are focused so much on assessment and marks, they really don't want to have discussions. The first thing they will ask: "Sir, is this for marks? Why are you discussing this? Is this for marks?" And if once you say it's not for marks, they switch off. [*shakes head*] So, this… this is just part of the education system that we have. Everything is geared towards writing exams. So, the problem you have with engaging in a discussion in evolution, they firstly want to know: "Am I getting marks for this?" And if they're not getting marks, they they won't be interested. So, now you have to replan. What are… [*interrupting himself*] how am I gonna get them interested? You've now gotta plan an activity that's going to involve them to get them interested, to get them into a discussion. You know? I remember one year we had uhm… [*looking away*], an activity… [*looking away*] can't remember now, with the… I think it was something with beads. I know it was something that you had to build with beads and we had an activity with a dragon that you had to build or something like that. We had so many things that were hands-on activities, and once we used those activities to explain evolution or a concept of evolution, we have their attention. But once we say to them, we're going to have an open discussion about evolution, there would be some that would prefer to join in, but most of them will only be interested in: is this for marks? So, now you've got to

create an activity that accounts for marks to get them interested in to get them into discussing or be part of the discussion of the topic. You see? So, this is this is one of our problems that we had; the… the matric year is too much geared towards exams and marks, that you cannot really have really open discussion. And also, the other problem is your time factor in matric. You don't really have lots of time to have open discussions because your time… [*interrupting himself*] in life… Life Sciences is a very bulky subject to teach. Uh, I can tell you this much; as matric teachers in Life Sciences, we are always the last people to complete the syllabus. All the other subjects, most of them they finish off here by June, July. Life Sciences teachers, right up to the mock exam in September, we still teaching… right before the exam, because we have such a bulky subject to teach; lots of content and lots of assessments. They've now reduced the assessments. So, that helps a little bit, but it's very bulky to teach. So, we don't have a lot of time for open discussions which would have been valuable, especially concerning a topic like evolution. But then also another problem that I've picked up teaching evolution is we found that it's too late in the year. So, to teach matrics, its third term. They go into mock exam after teaching evolution in the third term. So, what I've did one year and with a couple of schools; we swapped evolution with human reproduction. We shifted evolution into the second term and we push down human reproduction into the third term and another another topic I think… I think, but not meiosis… uh, genetics further down. No, no, sorry, no, it was something else, not genetics. So, we tried something different just because of the system that we are in, teaching Life Sciences, to shift the topic of evolution from third term to second term, because of its abstract nature. Because if we teach it in the third term, we discovered, it gets tested only in the mock exam, for one exam and then it gets tested again in the final exam for two exams. But we discovered if we push it earlier into the second term, then it gets tested over three exams. It gets tested in June. You can make up for it now after that in September, and then you reach your finals. So we discovered the teaching

of… the uh, evolution is a topic, because of its abstract nature, rather teach it earlier in the year and let the children get tested on it three times in an exam instead of two times. So, that is something that we also… we also tried and… and it works. We got better results out of the children by moving evolution into the second term. You know, just to get away from that abstract nature of it etcetera. So, this is just to give you some idea of what we've done with evolution and how we sort of try to make it presentable to the children. Uhm, but our main problem has always been time. [*nodding*] Teaching Life Sciences: time. There is no… [*interrupting himself*] not a lot of time for… for this real life discussions on how do children feel about this topic? Because they are more concerned really about: "Is this for marks? Am I getting any marks for this?" And that's the focus in matric, unfortunately. So, these are the problems that we're sitting with, you know, how the system has been created not to allow evolution to be discussed fully in order to give more time to discussions on evolution to the children. Yeah, that's when I think about it. I hope I answered your question.

Leila: Yeah, definitely. You answered my question. Just: why did you move it to the second term? What was the reason?

Saadiq: Uh, poor results. We discovered that teaching it in the third term and going immediately after that into a September mock exam, the children performed poorly, especially in the exam paper on evolution, because of, as I say, it's abstract nature. They don't really understand what it's all about, because there's hardly any time to discuss it properly out of… out of this curriculum, out of the syllabus, you know? So, poor results caused us to decide to move it earlier and see if… if it works and it did work, I can tell you, because perhaps the mistakes that they made in June, they never repeated those mistakes in September. They improved on it, because what happens now; when we do revision, that whole topic of evolution must be

revised again for the September exam, which would have… would not have been the case if we taught it in the third term. So, now they get sort of extra exercise and extra exam practice on writing on such abstract concepts and… and it worked in terms of the results that we have achieved. So… I know a couple of schools, we've done that, uhm… But then later, I remember, after discussion with one of the subject advisors, they actually asked us to keep it in the third term and we asked them for the reason, because, you know, schools… some schools write the common exam in September. Common paper. They say the reasons could probably be that they want schools to write all this… this common paper, so you have to follow the sequence that they give you to teach for the year, and not move or shift topics around. You know? So, then I think after a couple of years we just stopped it and just be continued into the third term, because of the common paper that came up. So, you see? So, we feel that this is a lot of restrictions placed on the teaching of evolution, guided by what the exam wants. You know? So, it restricts it more to… to uh… knowing your facts, than to actually understand the concepts in evolution. [*nodding*] Okay.

Leila: Yeah, makes sense. Uhm. Question 10 is: **Tell me about your religious beliefs.**

Saadiq: My religious beliefs related to evolution? Or… or the faith I belong to?

Leila: The faith you belong to. [*nodding*]

Saadiq: I'm a Muslim. I practice Islam. I believe in the Quran and I believe in our Prophet Muhammad who is the… [*interrupting himself*] we believe is the last prophet that was sent down to the earth and we believe in the message of that comes with the Quran and the… We believe that our prophet came down as a practical example for humans to follow what we should do on the earth. So, from a religious viewpoint… Uhm, I've done studies in uhm,

Quran at a younger age. Uhm… I attend a lot of Islamic lectures… given by local scholars and also by international scholars that comes to Cape Town or South Africa. Uhm… In terms of my role in schools, uh, related to Islam, I started at… the school, I started the MSA, you know, the Muslim Student Association. I was the liaison teacher at one school I came, there was no MSA, and the students wanted to start an organisation and they… they confronted me and they asked me if I could be the liaison teacher between our school and other schools. So, I've been involved with the MSA for learners. Uhm… In terms of my religion, also, I've traveled already to the holy sites; Mecca, Modena, couple of times myself and my wife. So, and we regard that sort of… in our religion as… as as very sanctimonious if you have the opportunity to go there, because it's very expensive to visit the holy site. So, we regard that as sort of the pinnacle in our life if we could go there, and we managed to go there a couple of times and in future we want to go there again numerous times. So, in terms of my religion, I would say that, uhm, I'm fully committed to Islam and the Quran and the example set by our profit. Uhm, and that I have... uhm, an open… because I… [*interrupting himself*] most of my friends are not Muslim. Uhm, most of my friends at university also, and at the high school were not Muslim. We were only few in our peer group who were Muslim. So, I have lots of diversified friends. I have friends from all faiths. We we uhm… We get along very very well.  So, in terms of my religious belief, it is Islam and Muslim. But I mix a lot with people from other faiths and uhm… And I choose my friends based on character. I do not choose my friends based on their faith. I have a lot of friends in my faith and that I will pray with and so forth. Yes, most definitely. [*nodding*]

But I would latch onto people or… based on their character, irrespective of their faith. You know, because once we start engaging, actually the commonalities: 'You are exactly the same as me. You… We just differ at… somewhere we differ.' But it's a lot of… [*interrupting himself*] We have more similarities than differences. You see? So, my philosophy is that as a Muslim, as such, uhm, I do not restrict myself to my faith and my own people. I engage with others as well, so that I can learn from them and, in reverse, perhaps they could learn from me, and so that we can find the commonalities and share our humanity with each other. You know? So, this is my philosophy that, uhm, I don't draw the line. Unfortunately, some people do… that they would not engage with people of other faith, because then you're being narrow minded, because you can learn from them and vice versa, they can learn from you. So, my basis is Islam [*nodding*] and I'm a Muslim, but I am not shy to engage with others of other belief systems. [*nodding*]

Leila: Okay, thank you. [*smiling*] Uhm. Question 11: **What is it like to be someone belonging to the Islamic faith teaching the theory of evolution?**

Saadiq: Uhm, firstly, evolution contradicts all aspects of the Quran. Do you mind if I give a few references?

Leila: [*nodding and smiling*]

Saadiq: Yes, you don't mind. For example, the Quran says that man was created from a clot of blood. Evolution doesn't say that. [*shaking head*] For example, the Quran says that man was created from dust, from soil particles. Evolution doesn't say that. [*shaking head*] For example, the Quran says that man was created from, we call it nutfa; sperm. Evolution doesn't say that. So, when we started the origin of creation, the Quran gives you

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already the information: how did Creation start. And you will not find that when you study the evolution, the theory of evolution. So, automatically, the basis is already wrong. The foundation is weak. You know? Evolution doesn't have a beginning. Neither does it have an end, whereas in the Quran there's a beginning. The Quran tells that the beginning started with our prophet Adam or Adam [*Arabic pronunciation*], as we say. So, there was a beginning and there's going to be an end; the day when the world will be destroyed, the day of resurrection. So, the Quran teaches us that there's a beginning and an end, and evolution doesn't say that. Evolution is still looking for that ancient fish swimming in the ocean… that they're still looking for and they don't know where they're going. [*smiling*] They're still looking for the end. So, the basis of evolution and what is in the Quran about creation differs dramatically. Dramatically. [*shaking head*] And as as a Muslim, you obviously pick this up immediately, because you read through what you had to study at university. You read through what you have to teach to the children and you pick it up immediately: 'But this does not click. This doesn't click. This doesn't click.' [*shaking head*] So, that, as a Muslim, sort of uh… guides you or prepares you as to how you're going to approach the teaching of this… of the topic. As I said before, based on what sits in front of you. Is it a Muslim audience? Is it a mixed audience, etc. But as a Muslim, you already know… uh, how the theory of evolution differs with the Quran and what I've also done quite a lot… Let me just see. I've written something down… [*looking down and away from the screen*] one second, one second… Uhm… Now what was this...? Yeah. [*nodding head*] What we've also done quite a lot. Uhm… I don't know if you heard about Professor Harun Yahya from Turkey. Professor Harun Yahya is all over YouTube, Harun Yahya. He's got small clips on evolution as to how the Quran differs from the theory of evolution. So, he takes the statements of evolution, what evolution is saying about creation, and then he takes statements out of the Quran and then he compares them with each other. But he gives you a live video, you know, of nature, of animals and whatever

and their adaptations etcetera. And he shows you how evolution and the Quran differ from each other. So, this is what we've done quite a lot also, especially at the Muslim faith schools. Uh, in between, to provide variety, we would show them clips of Professor Harun Yahya from Turkey, how he actually shows how the Quran differs from evolution. You know? Uhm. In a mixed group, it's a bit more difficult, because he makes a reference to… uh, to verses of the Quran, which is not part of their religion. [*shaking head*] So, you have to be very sensitive and very careful how… if you want to show it to a mixed group, but in the Muslim faith group, we could do it easily. I could show them a 3 minute clip in between, especially when I'm doing… uh trying to teach a certain concept, a 3 minute clip in between of Harun Yahya; what he says how the Quaran differs from what the concept I've just been teaching. So, that made the lessons also very very interesting in the Muslim faith schools, 'cause I could do it. But in the mixed groups, I would say, it was a bit more difficult to do that, because you do not want to offend anyone. [*shaking head*] You know? You want your student to always be your student, and it's difficult to get them back once they they they decide: 'No, no… This is... I have to switch off.' So, you have to be very careful not to lose them. You know? So, as I said before, the type of group that is in front of you determines your approach. So, this is what we… what we've done with professor Harun Yahya's videos and it helps… conceptualise… It helped the children out with conceptualisation, because now they really understood. But uh, there's not only one story here. There's something else that I need to listen to to make up my mind what is really the truth here. You know? So, that made it a small interesting and, especially in the Muslim faith schools, it is something we could do, that we could not do in other schools. [*nodding*]

Leila: Okay, thank you. Oh and is there anything else you would like to add to: what is it like to be a Muslim teacher at a, uhm, school and teaching the theory of evolution?

Saadiq: Uhm… Misunderstandings and misconception also among your staff members, your friends, you're your colleagues at schools. Because I remember in 2008, when we had to teach the theory, the science teachers were looked at as if we were monsters. "What are you doing to our children? What are you teaching our children?" And we said to them, the previous years we were called to workshops and they asked us how do we feel about the teaching evolution? Ninety-nine percent of people in the workshop, they said they do not want to teach this to children and they told us in those workshops we going to take this to national and we're going to tell them that the Cape region will… uh, they do not want to discuss topics like this with with young children. And they must keep it at university level rather, that they can rather have a choice to choose to do something in the sciences, than forcing it onto them in the schools, especially if they're doing Life Sciences. So, we attended workshops before 2008, I remember, and most of us objected, and they told us it's going to be taken to national and they're going to try and scrap it that we do not teach this…And the following year, we get the documents and everything is in black and white, we just have to teach it. And then, especially people who haven't studied evolution, especially our peers or colleagues, we had some friction. They were on top of us: "Why are you gonna teach this to our children? Huh? This is not what we want in schools." But we… [*correcting himself*] they do not understand that we… there was great objection, but we couldn't get through to national and to actually get them to get it out of the schools. You know? So, we had that sort of problem, also, that we even have parents… Parents phoning the schools and complaining, especially staunch religious people: "Why is my child coming home with this – inverted commas – nonsense? Why must my child study this? My child is a staunch Christian. My child doesn't have to be learned all this rubbish" – and sorry in inverted commas, you know? So, we have that sort of problem also that parents also didn't understand what was happening… that our peers… our colleagues

didn't understand what was happening and what we were going through… that we have to teach this and we had no option, but just to teach it. Either teach it or your child gets naught for the test or for that particular exam based on evolution. So, in some respects I feel it was sort of forced onto the schools, because most of our recommendations in the workshops was: Let people decide what they want to study and leave it at university, but do not bring it back down to the schools where you sort of forcing it onto the children, especially if they choose Life Sciences. Leave it at university level… was was was the consensus reached, but there were decisions made that is way above our heads that we have no control over. So, in my personal opinion is that since 2008, we were sort of forced to teach it. You teach it or your child gets naught, so make up your mind. So, you had to now adapt and you had to create… uh… good lesson plans to present this in such a way that you can get the child's attention. So, we had to adapt and we had to do it. So, that was another thing that we had to face regarding evolution. I personally feel it was forced upon us [*nodding*] and we we… our objections went through, but it wasn't taken seriously. [*shaking head*] Okay.

Leila: Okay, thank you for that one, Sir. Uhm, it actually is related to the next question. The last question… [*smiling*]

Saadiq: Okay…

Leila: Uhm. **When teaching the theory of evolution, how does it make you feel?**

Saadiq: Uhm… [*looking away*] I teach it from the… with the approach that at the end of the day, the learners have to write a test or an exam on it, especially in matric. And that child needs to get good marks in matric to one day either get to university or one day going into a certain career. So, I teach it with

that in mind. This child, irrespective of what I think of what my religious belief is, that child still needs to get good marks in Life Sciences, irrespective of my personal beliefs. So, from that viewpoint, that sort of made me very strong as to rather focus on… uh, pushing the child to a level where the child gets good marks in that section of the work, but not uh uh… sort of enforcing my personal viewpoint onto the child and refocus rather on the final exams, because this is a matric topic that is being discussed. So, that is how I think I got around to teaching it with a focus that the child at the end of the day, no matter what I say about evolution, or what the child says about evolution; the end of the day, the the final thing you need to look at is: that child needs to get good marks in the subject. That's the bottom line [*shaking head*] irrespective of what I think about evolution. So, that sort of gave me the strength to teach it purely for getting good marks in the subject. But if time allowed it, we had discussions and we had different discussions depending on what was sitting in front of me. You see?

Leila: Okay. Yah, I understand. Uhm. Is there anything else that you would like to add to: How does it make you feel?

Saadiq: Uh… [*looking away*]

Leila: …when you teach the theory of evolution?

Saadiq: Uhm… [*looking away*] Let me just think. Uhm… I think also… Uh… let me just go a bit positive here. Uhm, what I do with evolution, because everybody when they hear the topic evolution, automatically people think negative. So, I go the positive way and I say to them: "Look. In your life… after this… after [*interrupting himself*] post matric, you're going to come across controversial material… [*nodding head*] material you don't agree with [*shaking head*], but you have to read through it. You have to understand it. You have to be able to read through the lines. You have to do

critical and analytical thinking. So, this is not the first time… This is actually practice for later in your years when you're going to study. So, you need… [*interrupting himself*] This is sort of a training ground just to… just to make you aware that you're going to meet material like this that's going to be controversial and you need to be able to use your brain to understand what is going on here." So, I say to them from a positive viewpoint: "It's good. Let's do it. We can't control the teaching of it. We have to teach it. You have to get good marks. I have to teach it. So, let's carry on. But at the end of the day,", I make it quite clear to them, "maybe this is good training ground for you that when you get to university, you will be able to see when you read material, but this doesn't make sense." [*buffering for 2 seconds*] to research this further. I don't agree with what this person is discussing. So, it's sort of training ground for uh… uh reading controversial with the relating on life, so that you can make up your own mind and decide if you agree or disagree with what a certain person has written or or said, about a certain group or a certain topic, etcetera. So, from a positive viewpoint, uhm, I feel, and I said to them: "Let's go ahead. There's nothing we can do, but let's go ahead in such a way that it's training. This is regarded as training in handling controversial material, because once you get to university, you will know what… [*interrupting himself*] how to identify it. You see? So, in terms of my feelings, I felt that made me feel a bit stronger and more relaxed and easy about teaching it… uhm, because we looked at it from a positive viewpoint and not only just harp on what is negative about the topic. [*nodding*] Okay.

Leila: Okay. Okay, thank you very much. [*smiling*] Is there anything else just overall that you would like to add?

Saadiq: Uhm, let me just look at my papers and see everything I've written down… Uhm… Can I ask you a question that I need to learn from you something… from your interview?

Leila: Yes.

[*unrelated discussion below*]

Saadiq: [redacted]

Leila: [redacted]

Saadiq: [redacted]

Leila: [redacted]

Saadiq: [redacted]

Leila: [redacted]

Saadiq: [redacted]

Leila: [redacted]

Saadiq: [redacted]

Leila: [redacted]

Saadiq: [redacted] I hope that answered your questions according to your satisfaction. I tried to give you an idea from a Muslim teacher perspective how we taught the subject at the topic is specially. So, I hope I've done justice to your interview and that you that you can make use of this recording to write up your thesis.

Leila: Definitely, I feel like you mentioned a lot of meaningful things that I would like to add in my thesis.

Saadiq: Okay, now good, good. Glad to be of help.

Leila: Thank you very much. Have a lovely evening.

Saadiq: No, same to you and it was a pleasure to assist you.

Leila: I have to stop the recording.

APPENDIX C: Interview with Michelle

Leila: Okay. Uhm… So, I just have to run over a few things on my checklist. Uh there's a reminder that your identity and your school's identity will remain anonymous. Uhm, uh a reminder that it's a safe and non-judgmental environment. So, you can freely share your experiences. Uhm, and there are no right or wrong answers. You have the right to withdraw at any point of the interview if you feel uncomfortable and uhm, just to clarify, when I speak about evolution, I'm specifically referring to micro and macro evolution and uhm, specifically according to the CAPS document, and I'm sure you are familiar, with the fourth term of grade 10 and the third and fourth term of grade 12.

Michelle: Yeah.

Leila: So, the questions will be around those grades. Are there any questions?

Michelle: Nope, I'm good. [*smiling*]

Leila: So, the first question, or it's not really a question, **tell me about your teaching qualifications.** [*smiling*]

Michelle: So, I studied at [redacted] of BSc Human Life Sciences, which I completed 2011 [*looking up*] 20… not 2011. No, 2010. And then I went onto my PGCE, which I then completed the next year and I haven't studied any further than that, so I just have my BSc and then my teaching diploma.

Leila: Okay, thank you. [*smiling*] I'm just turning off the mic, because I want the video to be clear… the sound to be clear.

Michelle: Cool.

Leila: Uhm. The second question, **why did you decide to become a Life Sciences teacher?**

Michelle: Uhm… So yah, just I think a natural inquisitiveness that I have for myself for just life. And then obviously, I think, as with many teachers, it starts with the teacher that inspires you. So, I had a very good Life Sciences teacher when I was at school, and I've always just enjoyed the subject. It's one of the subjects… the few subjects that I find you take at school that actually prepares you for life after school. Uhm, and a lot of the skills that we teach you, both the intentional and unintentional ones, uhm, can be applied to later life. So, I find that it's just… it's the study of life and I mean that's something that's very interesting to me. Uhm, and that that wanting to transfer that knowledge and that love for natural things to other people, I think, is what what made me decide to be a teacher… to take these complex processes and to simplify it so that children understand it and actually find it interesting.

Leila: Okay, and would you like to elaborate on the intentional and unintentional things that you want to teach the learners?

Michelle: Yeah, so intentional, meaning the stuff of the curriculum that we have to teach them. Something as simple as you do a chapter on population dynamics and you teach them how overpopulation leads to, for example the spreading of disease… and lack of resources… And then you also kind of segue into more moral and ethical questions about overpopulation and how we as a species, for example, as a result of the choices we're making, how it affects the world around us as well, because we are a species that's impacting our environment. Uhm, so that… that kind of drawing from natural principles and then applying it to just the way of thinking about life, I think, uhm… I find that a lot of times I have a very big passion for

speaking about just women's rights and the ideas with regards to… [*looking away*] the options that there are available to women in life. So, when I do the chapter on, for example, reproduction, we often have class discussions relating to the choices that there are for women. Uhm, choices about abortion, choices about having children, not having children, and I think that's part of the unintentional curriculum where you kind of educate girls about them as individuals rather than just their bodies, uhm, and then just skill… skill based. Uhm, you have this intentional teaching of the scientific method and thinking like a scientist and kind of having this methodical way of writing a hypothesis, considering variables, but unintentionally also teaching kids to critically analyse situations. So, when you teach them about variables that might affect your experiment and you're assessing them on it, you're also giving them practice into thinking like that on a daily basis. You know? Uhm, variables that could affect other sectors of their lives and that it… then yah, that it affects them. So, I thinking more critically about life situations rather than just prepared exam examples. So, that's that's kind of what I mean with intentional and unintentional curriculum. Yeah. [*nodding head*]

Leila: Makes sense, I understand. [*nodding*]

Michelle: [*laughing*]

Leila: Anything else on the question: Why did you decide to become a Life Sciences teacher?

Michelle: Uhm… [*looking away*] Well, just personally, wanting to make a difference. Uhm… necessarily, maybe that relates more to just wanting to be a teacher than just the Life Sciences teacher, uhm, although I do personally find a lot of my own inspiration in my own spirituality from the subject matter. So, nature as a whole to me is is very much a fantastic spiritual thing. So, uhm,

I draw a lot from that to motivate and inspire students. And I've… I've found that that's a big part of who I am is inspiring other people and seeing that they're actually… [*hands gesturing inward*] they're taking something away from what I'm sharing with them.

Leila: Okay, thank you. [*smiling*] Uhm, question 3: **How long have you been a Life Sciences teacher?**

Michelle: So, since 2012.

Leila: [*nodding*] Okay.

Michelle: So, there was just the one… there was just the one year that I, that I skipped, but basically since 2012. Yeah. So, what? That's like 8? Yeah, 8-9 years basically.

Leila: [*nodding*] Okay. And question four: **Did you study the theory of evolution in your undergraduate studies?**

Michelle: Yes, we did in my first year of BSc, but it was not a very big part of the modules that we did. Uhm. So, going into the teaching career I was… I was very… I won't say unprepared… It was just not a subject matter that I had studied in depth and when I was at school it was also not part of our curriculum. So, I mean the last time that we really did evolution on school level was like in Grade 7 when it was part of a completely different syllabus. So, yes, but it was not [*shaking head*] the main part of my study field.

Leila: Okay, and **did you study the theory of evolution in your teacher education studies?**

Michelle: [*looking away*] Again, no, I think… [*laughing*] I think people who actually go into a PGCE, depending on where you take it, you're quite… I don't know if the recording has stopped now or if it's still going, hey? 'Cause like the little screen around my… thingy has disappeared.

Leila: It shows it's still recording. [*nodding*]

Michelle: Okay. Right. So, I think people who go into PGCE, depending on where you take it, you're quite, uhm, shocked to find that [*laughing*] it teaches you very little of how you need to teach, or rather, what you need to teach. Uh, with the PGCE that I did at [redacted], we had a lot of subjects that actually meant nothing to me, [*shaking head*] to be quite honest. We had Educational Philosophy. Uh… We had Curriculum Studies where the… the lecturer rarely actually gave us any information about the content of the subject. He literally talked about himself for 45 minutes period after period after period. So, it made absolutely no impact on my life. We had Educational Discipline subject, which again made no difference [*shaking head*], because there was just this discussion about how we would handle certain situations that did not apply to the real life scenarios at all. Uhm, and then we had the two curriculum studies. So, if I… if I give Life Sciences and Natural Sciences, I had one 45 minute period per day for Life Sciences where we would sit in a classroom and we would actually just work through the CAPS document. So, we would look at what do we need to teach and what are some of the things that learners need to be able to do and then we would discuss maybe what type of practical activities we could do. But there was no point instruction about specific topics or content. Uhm… Those were the two subjects that I obviously gained the most from, even though it was a little kind of like [*scratching head*] wishy washy as well, because they were actually directed to what I was supposed to do as a teacher. I mean, we weren't even taught how to moderate a paper. We didn't know what moderation was, uhm, which I think there there are massive

massive gaps in the way PGCE's are presented… uhm, for certain universities, anyway, uhm, because as a teacher you go in and you kind of have to have someone to teach you how the educational system works… Uhm, and, as a new teacher teaching grade 12, if you haven't done evolution in depth and you haven't gotten any instruction about the content of it in your curriculum study, then you kind of have to study that up yourself. You… you have to use whatever textbooks are available to you and kind of… figure it out as you go along and hope the kids don't realise you don't know what you're talking about. [*laughing*] So…

Leila: Okay, and would you like to elaborate on, uhm, where you said one of your curriculum subjects, Life Sciences, when you went through the CAPS document, did you ever, uhm, study evolution when you went…

Michelle: [*shaking head*]

Leila: Or did you ever handle evolution when you went through the CAPS document?

Michelle: So, we… we obviously touched on the main topics. I cannot for the life of me at this point recall whether we actually spent time on specific topics. Uhm. I actually want to tell you: no. Uhm, it might have been something like: Okay, so, in term 1 you're supposed to cover this and this and this topic and there should be a test and a practical. So, we kind of did the gist of it. Uhm, I might be lying now, because it's been awhile, but I can't remember having ever actually sat with any of the topics for that matter in grade 10, 11 or 12, and actually going through the content of that topic. It was literally: this is what the CAPS document looks like, this is the content that needs to be taught so that you understood the layout of the… of the policy… uhm, and you kind of had to… [*interrupting herself*] When I went for teaching practice, for example, then I would refer to the CAPS

document for whatever the teacher was teaching at that time, but in terms of actually going through for evolution, you need to do differences and similarities between humans and apes, you need to… [*gesturing steps with her hands*] step by step. [*shaking head*] No, we did not. So, I think it was literally just: in term three and four you cover human evolution, bla bla. That was about it.

Leila: Okay. [*nodding*] And question 6, also, not really a question, [*smiling*]: **Tell me about your experiences regarding learning about the theory of evolution in your undergraduate studies.**

Michelle: So, again, obviously I took this at [redacted]. It was my very first year, uhm, doing a BSc, and it was in the first semester module of biology… I think 124 or something like that. So, it was like one of six other topics that we discussed that semester. So, it occupied maybe two weeks or so of our actual time. The teacher who taught it, I think he… if I remember correctly, was an him… it was a he. He was very good. [*looking away and nodding*] Gave us kind of a basic idea of the concepts regarding evolution… uhm, natural selection… I clearly remember his uh description of how the giraffe picture getting its long neck. Uhm. So, it was kind of basic stuff, but nothing [*shaking head*] about human evolution. So, I mean if *Homo habilis* was mentioned, that would have been a lot. So, in terms of what I'm teaching to grade 12's now, I had no prior exposure to changes in the skull, changes in the diet, changes in the pelvis… This was something that I had to teach myself as I'm teaching the curriculum. Was never exposed to it in my BSc. I don't even know if there is a particular BSc strand in the Life Sciences department that actually focuses on that type of evolution. So, I think that's why I was maybe just touched on microevolution, macroevolution, basics regarding natural selection… And then also very unpleasant experience where they got a guest speaker that I think the university had been doing this for quite some time, where they

actually invited a very famous speaker and I'm gonna say his name. You can decide to use it or not. [*laughing*] [redacted], uhm, came to speak with us during our first year and as a scientist I have a lot of respect for him and I love listening to him on the radio, but he completely… [*looking away*] urgh, what would be the word? He was very off putting with the way that he discussed evolution. Uhm. In fact, we had like I think an hour session with him and he barely touched on the concept of evolution. He used it as a platform to discuss his own atheism, uhm, and how the belief in evolution for him has made him an atheist, and how he's trying to basically tell us that that's what we need to do in order to believe in this [*laughing*] theory. And I remember vividly him going into a segue about female castration, which I don't quite understand how it fits into the whole theme of evolution, but I remember leaving there with like a very bad taste in my mouth and not quite understanding why I had an hour of my life wasted listening to someone telling me why he doesn't believe in God instead of actually explaining the theory of evolution to me. Uhm. So, I don't know if that was the purpose of the lecture and I remember that the students, afterward, all of us were feeling like maybe that wasn't the purpose of the lecture. That was not what the lecturer had in mind when he asked him to come, but you can't always control what a guest speaker does. But yah. That to me was a very negative experience with regards to the topic.

Leila: Okay, that's interesting. [*smiling and laughing*]

Michelle: I don't know if they're still using him. [*laughing and looking away*] So, yah. [*looking at the camera*]

Leila: Uhm, anything else on your experiences when you learned about evolution?

Michelle: Not anything that comes to mind now. [*shaking head*]

Leila: Okay. Question 7: **Could you describe a typical day in your classroom as a Life Sciences teacher?**

Michelle: Okay, so yeah, [*looking confused*] I don't know exactly what you what you want me to explain here…

Leila: The follow up question is: Could you describe a typical lesson where you teach evolution? So, the first question is basically just your teaching style… about your teaching style.

Michelle: Okay… So, a typical day in my class, [*looking away*] uhm… So, let's take a grade 12 period. They come in. We greet each other. I usually ask absentees. If there was homework, I would actually start by marking it. With grade 12's I rarely actually check homework, because there's just not time and then we would move into the content. So, depending on what content we're doing and how thoroughly we covered it the previous lesson, I would do a recap of whatever we did, just very quickly highlighting the important stuff so that it links to whatever we're doing in that specific period, and then we would cover the content, usually end off by giving an activity, if there is an activity that relates, and then that would be… usually be the end of the period. I hope that answers the question.

Leila: Yeah. [*nodding*] Anything else on a typical day about the learners or the school?

Michelle: Yeah, I don't know how much detail you want in terms of that question now. So, uhm, I mean currently in terms of COVID, the kids are… Well at our school, they're all back at school, so we're not we're not rotating anymore. So, there's quite a lot of learners sitting behind masks, sitting social distanced from one another. So, the classrooms… they… they feel very small at the moment, uhm, for what needs to happen in there. Uhm.

The learners this year I think are a lot more stressed. There is a lot more anxiety amongst them. You can see a clear decline in morale, uhm, as we're going through the year, which is very visible, especially amongst the grade 12's. Uhm, and I think it's just, it's just pressure. Uhm, and a typical day in my classroom usually consists of six periods [*looking away*] of about 55 minutes each. So, it's… it's really long periods. Uh, the idea is that we're supposed to get a lot done, but it's… it's not happening, [*shaking head and laughing*] because we have a a different cycle at the moment. So, we're doing 7-day cycle, so we don't see them every day. So, it's… it's making it a little bit difficult to get through the curriculum. Uhm… Yeah, and for different grades. I work at a different pace because with grade 12's you have an external exam, so I would then usually… the pace is a little bit faster than with the other grades that I actually have control over what, what they are being assessed on.

Leila: [*nodding*] Thank you. Uhm, question 8 is: **Could you describe a typical lesson where you teach the theory of evolution?**

Michelle: Okay, yah, so again this… this will kind of depend on what topic in evolution I'm doing. So, usually when we discuss this particular chapter we start off with the evolution through natural selection. So, we kind of have to lay a foundation for them to understand the principles regarding how evolution happens. Uhm, so we first do what evidence is there for the theory, why is it a theory? Why isn't it a hypothesis? And what is the difference between those two things? Uh, and then we look at the theories that have supported it. So, in terms of Lamarck and Darwin and Stephen Jay Gould, we look at how evolution theory has evolved itself, uhm, and contributed to our understanding of evolution. We also look at mechanisms of evolution, so we go into speciation, reproductive isolation, how species actually become reproductively isolated, uhm, and then we also look at examples of evolution happening today… still, so… evolution in terms of

natural selection; that's still happening. And then we go into human evolution, and usually before I start the whole section on evolution right before natural selection, that chapter, I have kind of a… a talk with the girls about it, uhm… where I know it's a sensitive topic. I know it's a religious thing and there have been students in the past who don't take kindly to the topic, although I've never had a problem in my class to be quite honest. So, I kind of tell them that you are not allowed to have an opinion about it [*shaking head*] until you know the facts. So, you can sit here and you can believe what you like, but I'm telling you that you're not allowed to give me an opinion until you actually have all the facts of it. So, you're going to listen and learn, and then you can form an opinion about it; when you can form an argument about it. Uhm. Yah, I've never had a problem with that. [*smiling*] The girls usually seem very keen to understand what it is, especially when I tell them that evolution is not the typical picture of an ape changing into a man. If you think that is your… If that is your concept of evolution, your concept is flawed, uhm, and therefore you don't know what you're arguing about. So, you need to first understand the theory before you can have an argument. And also what's very important with regards to this is that we do the chapters of DNA, Genetics, meiosis… All of this is a preface to the concept of evolution in grade 12. So, they already have an understanding of what mutations are, how genes are transferred, how variation is introduced into a species through meiosis and reproduction. So, taking all of that into consideration and then giving yourself millions and millions of years, who's to say what variation starts to accumulate and actually causes changes within species, you know? Uhm. So, yah, in a typical evolution lesson it depends on where we are. If it's the start of the chapter, I would kind of introduce the topic and I'm assuming you're going to ask me questions about this more… [*smiling*] Uhm, if we're in the middle of the chapter, I would just continue as if it's any normal theory lesson. Uhm. If it's something like, for example, human evolution, which I'm actually currently doing with the grade twelves, uhm, that chapter we

usually start by first linking the natural selection to it. So, actually explaining, you know, for humans to have evolved something had to change. So, in the previous chapter we learned about environmental pressures that cause natural selection. So, let's think of pressures that could have caused humans to evolve. Uhm, talking about changes in climate that caused us to favour… or that caused the environment to favour organisms that could stand on two legs rather than four. What's the advantage of having two legs? Uhm, if you have a change in diet, because you've discovered fire, now your food is less… it needs less processing, it's cooked, etc. That is another selective pressure… a change in diet and therefore selection is applied as a result of it. So, depending on where we are in the work you would link the principles to whatever you're discussing now to help open up that content for the kids. Yah, I don't know if that answers your question. [*laughing and smiling*]

Leila: Yes, it does. [*smiling*] Uhm, anything else that you would like to add on your…

Michelle: Uh… [*looking up*] No, not in terms of a typical, uh, well, just in terms of this year, I've had… It's probably different for every group of kids that you have, but this year they've been quite… uhm… critical, not critical, as in bad critical, but critical in their thinking. So, I'm finding that they're asking very interesting questions this year, uhm, trying to actually… [*interrupting herself*] You can see that they're trying to formulate the links between the topics, which is something that I've not really experienced [*shaking head*] in previous years… trying to understand how, for example, changes in chromosomes could have contributed to certain mutations, and, you know, why? Why would there be a selection for a smaller jaw or a larger brain, etc. So, yah, something that's that's been unique for me this year. They're a little bit more challenging in the types of questions that they're asking.

Leila: Okay, and the follow up question is actually, uhm, I would like to hear more about that. So, **tell me about some of your experiences teaching evolution**.

Religion and Evolution (not mutually exclusive)

Michelle: Okay, so I've… I've had mostly… I've had… No, I've had positive experiences teaching evolution. I've not… I can't think of one opportunity where a kid has ever challenged me with regards to it. Uhm, I've heard of shock stories [*laughing and smiling*] from other teachers and parents that just don't want their children to be told the, the content, but I've never experienced that. So, I think it has a lot to do with the way that I usually introduce the topic, which is that I am a Christian. I believe in evolution. And those two things aren't mutually exclusive, and I want you to understand as a student that they shouldn't be, uh, mutually exclusive. Uhm, I think that there's a lot more beauty to a process where God created the universe with physical principles like natural selection, like cause and effect, etc. that then over millions of years created this top species than, you know, Genesis going God went boom [*hand gestures to one side*] Eva [*pronouncing in Afrikaans*], boom [*hand gestures to other side*] Adam [*pronouncing in Afrikaans*] and then magic, you know? That that to me [*smiling*] is less magical than this beautiful process of… of life. And that's why I still believe in a God even though I believe in evolution. And there are some things that I say… and I say to them: there are some things that you can't argue with. You can't go into a museum and say that fossil of a T. Rex: "No, that's fake." I mean, seriously. There are some pieces of evidence that you can't argue with. You can't argue with genetic evidence, and that's something that a lot of people back in the day didn't have. So, they would easily refute it, because they didn't have the genetics to base their theories on, or their hypotheses on. Uhm… You can't argue with biogeography. I mean, why would you find exactly the same fossil in two completely different continents? I mean, did the organism pick up its boots across the ocean and die and get fossilized on two different… [*interrupting herself*]

You can't argue with that. And then you can't argue with the principle of natural selection, regardless of whether you believe it actually leads to evolution. That's up to you. But natural selection is happening as you're sitting in this classroom. Some of you are gonna sink, and some of you are going to swim. That's just basic natural selection. [*nodding*] So, you can't argue with that. And if you at least understand that, I'm happy. Whether you believe that apes or… or rather chimpanzees and humans shared a common ancestor, that's up to you, but the point is: the picture of an ape changing into a human… that's not evolution. You can take a chimpanzee. You can look at it for as long as you like. It's never going to evolve into a human, because the fact of the matter is this whole, beautiful process of evolution, if you change one thing, you change one meteorite, you change one climate change event, you change one predator, one choosy female, and we wouldn't have evolved. That's the magic of evolution. It's all just about applying the right pressure at the right time and affording enough time for the changes to accumulate. And then also explaining to them that evolution doesn't happen in individuals. It happens in populations. And therefore they need to have an understanding of genes and the idea that there's variation in a population. So, it's not a case of me sitting and then wishing that I evolve into a bird or have wings to fly away. That's not going to happen. It's not… It's not an internal drive. It's not… just me changing, it's a whole population of organisms changing. And then I kind of sometimes relate it to the idea of evolution in thought. I mean, you maybe start thinking this thing. You discuss it with people. More people start thinking it and that kind of evolves into this general consciousness. I mean, that's kind of the same idea. So, I think because I've introduced it as a Christian, as someone who can kind of bring these two concepts together and it doesn't threaten my Christianity. It doesn't threaten me personally, I kind of… [*looking away*] uhm, disarm the situation. So, if a child was sitting there and thinking that I'm going to not listen and not learn, then hopefully they have a new insight. The second thing that I also tell them, like I've said, is that I tell them you are not

allowed to have an opinion unless you actually know the facts, because your facts are most probably wrong. So, reserve your opinions for later and then the third thing I tell them is: and if nothing of this matters to you, then at least you should know you are tested on this at the end of the year. Whether you like it or not, it's 70 marks out of your paper. So, you're going to have to listen [*nodding*] and you're going to have to absorb whether you believe it or not. You're going to go into many situations in your life where you're going to be confronted with traditions and principles and ideas that you might not enjoy. An educated mind can entertain a thought without having to accept it. So, be educated. So yah. [*laughing*]

Leila: That's very inspiring for me. [*smiling*]

Michelle: [*laughing*] Okay, I'm glad. [*smiling*]

Leila: And you mentioned that all your experiences, uhm, when you taught evolution were positive. Could you elaborate on that?

Michelle: So, positive in the sense that I… I have never had a confrontation. I've never had a negative experience with regards to evolution. The only experiences I've ever had is kids wanting to understand, but why? And then me helping them link something that we learned in may be genetics, something that we learned in reproduction… linking that to what they're not understanding at the moment. And in that sense, I haven't had any negative experiences. My experiences have been positive, uhm, because I think the way the kids sometimes react, they're laughing, they're enjoying it, they're taking part in the conversation. Uh, the questions that they ask tell me that they're actually thinking about it. Uhm, so, in that sense it has been positive. It's not like they're running around: "Ah, ma'am, I believe in evolution…" but they're discussing it outside class, because they're coming in with new questions and, you know, asking me about the things that they were talking

about. So, so that tells me that they're thinking about it and that to me is a positive experience.

Leila: Okay, makes sense. [*smiling*]

Michelle: [*smiling*]

Leila: Question 10 is: **Tell me about your religious beliefs.**

Michelle: So, I am technically a Christian. If I had to classify myself according to uhm… [*looking away*] certain religions, but I prefer to think of myself as… as spiritual. So, I'm not your textbook 'read the Bible, go to church' Christian and there are quite a lot of things within the Bible that I don't necessarily agree with. Uhm. So, to me… [*looking away and grinning*] something stupid like God saying you are loved unconditionally completely [*laughing*] contrasts to then setting rules for my love. So… So there, there are things that I that I do not agree with. So, the God that I believe in is not necessarily the God that the Bible is telling me exists. So, but I do believe in God; the God. So, I am a Christian. I am spiritual, but I do not preach from the Bible, [*shaking head*] I do not read the Bible all the time. I have a very personal relationship with God. Uhm, a lot of it just comes from people that I've met, books that I've read, experiences that I've had that have changed my perception of this very Bible fixed Christianity to a more personal understanding of what God is to me. [*nodding*]

Leila: Could you **elaborate** a bit more on that understanding?

Michelle: So uhm, yah, I was raised in a Christian household that was very strict in terms of Bible study and going to church on Sundays and I always had a very uneasy feeling about the way that I was being forced to love God and the way that God has set a lot of… conditions for His love. Uhm, but also

the idea of being born into sin just never made sense to me, because I don't understand the concept of of sin, because it completely contrasts [*laughing*] with the idea of free choice. Uhm, if you tell me I have free will to make choices, how can my choices then be wrong? Uhm. So, I was introduced to a friend at university and I was introduced through him to a series of books that I read and that changed my perception of God a lot to a God of love and a God of understanding, a God who wants to experience physical life, physical reality through me and that's why I am actually a part of God. So, my spirit is not something different to God. It is God. And when I… [*interrupting herself*] My purpose in life… I believe my purpose in life is to remember where I come from, to remember who I am, which is God, so that when I die I can physically re-member with the whole, because that's where my spirit will go. And in that sense, if I am God, and if I was created from him, then there is no such thing as right and wrong, and you shouldn't judge right and wrong, because if God is everything, then everything is God. If that makes sense. You shouldn't judge black for not being white, because you couldn't understand black without white. You shouldn't judge hate for not being love, because you can't understand hate without love. And that's the whole point of having a physical reality… is that God is this… is this all knowing, all understanding being and it's wonderful to be an all knowing all, understanding, being, but you need to experience yourself as such, experience and thought… Experience and understanding are two completely different things. So, for God to experience himself as loving, he needs to experience it through you and for you to experience yourself as loving, you need to have the opposite of hatefulness as well, otherwise how would you know what loving looks like? So, therefore I believe in my… my sense [*puts right hand on heart*] with regards to God, I believe he created this world and he gave us free will to make choices in our lives that will either help us to remember who we are, which is him, or maybe forget for a little bit longer. And there is no right choice and wrong choice. There are only choices. Some choices take you closer to God, make

you remember him. Some choices make you forget a little bit longer, and the wonderful thing about free will and the wonderful thing about choices is that you can always make a different choice. So, through that understanding, uhm, you kind of let go of regret. Uhm, and that to me was a big problem in my life was the idea of regret, but when you understand that I am the sum of my choices. I am who I am only because of the things that I've done through my life, every choice that I've ever made. And I'm perfect in this moment, I'm perfect. Then it takes the… the fear of regret away, because if you regret it means that you're not a perfect person [*shaking head*] and perfect doesn't mean 'perfect', like the way we use it: "It's such a perfect day!" It means you are exactly who you are supposed to be in this moment, and then you get exposed to someone else and you make a different choice and you change who you are, and that's perfect. That's fine. So, my spirituality has evolved to a more personal understanding of… of God, where… [*interrupting herself*] Urgh, and this is like maybe getting totally off track now. Uhm… That's just one example of my change with regards to my understanding of God. Uhm. There is no right and wrong. There is no God who's going to punish me. Why would he punish me if he give… if he gave me the option of choice [*laughing*] and they said: "Oh, wrong choice, you're going to hell." That's horrible! I don't want to believe in that type of God. That makes me feel like he's sitting there with like a magnifying glass and trying to pinpoint every problem that I've ever made and mistake I've made in my life and I just don't believe in a vindictive God. I believe in a God who wants to experience life through me, whatever that experience might be… and whatever that experience might be is okay. It's okay, because all of it stems from him. I don't know if that's too philosophical. [*laughing*]

Leila: No, I have an idea of what you mean. [*smiling*] Uhm. Question 11 is: **What is it like to be a Christian teaching the theory evolution?**

Michelle: So, like I've said, it hasn't made any difference to my life. Uhm. Instead, I've spent a lot of time, like I said, trying to rather… uhm, help students understand that the two concepts shouldn't be mutually exclusive. [*shaking head*] And if you think about the way that I've just explained God and the idea of life being a series of choices, then evolution kind of… kind of fits perfectly into that idea. [*shrugging shoulders*] It's just a series of choices that led to our evolution that led to our change. It is *Homo habilis* sitting with a rock in his hand and going: "What shall I do with this? Shall I hit a bone with it? Yes, I shall." [*nodding head*] And then he eats bone marrow and over many years that allows brain development. I mean choices, [*laughing*] so yeah.

Leila: [*smiling*] Okay, uhm, is there anything else that you would like to add to that?

Michelle: No, not at the moment.

Leila: Okay. [*nodding*] And we are at the last question. Uhm… The last question is: **When teaching the theory of evolution, how does it make you feel?**

Michelle: I like teaching evolution. It's usually actually one of the chapters that I look forward to teaching, because… [*looking away*] uhm, well for many reasons. One being that it… it brings together a lot of the other concepts that we've been doing with the kids. So, [*online meeting buffering for 3 seconds*] meiosis and how they all come together to facilitate this process. I like the challenge of teaching it. Uhm. I like teaching it to kids and helping them to actually understand it and to not have obstinate ideas about evolution, because they were told this is what it means and rather understanding what it actually means. And I like the opportunity that it gives me as a woman [*pointing to herself*] to talk to other women about the idea of [*laughing*] this is going to sound funny... selective breeding and understanding that if an

animal can do this, like a frikkin' frog, you can do this as well and you need to be… [*looking up and laughing*] cognisant of the fact that your reproductive choices is an example of a selective pressure that you're applying. So, you need to make them carefully. [*laughing*] Uhm, so, it leads to very good classroom discussions and interactions and, like I said, teaching that unseen curriculum a lot more than necessarily just the seen curriculum. Uhm. So, I think for me, I like teaching evolution. It's one of the chapters that I look forward to, similar to human impact in grade 11. I actually… I like teaching the content. I spend a lot of time trying to find images and videos and things that make interesting for them to understand and my, uhm, own understanding of it and my own teaching of evolution has definitely evolved over the years, so, that it makes it easier for them as well. Yeah.

Leila: Okay, and can you elaborate on the (I'm quoting you)… the 'good discussions' that you had.

Michelle: So in terms of… [*looking away and laughing*] just talking about reproductive, uhm… [*looking away*] What would we say? Uhm, just talking about female reproductive choices. Uhm. There is especially this year and last year there's a big movement amongst young children questioning gender stereotypes and things like that. So, it opens up this idea about reproductive choices and breeding selectively and how breeding selectively can also mean not breeding… [*laughing*] not having to breed. [*shaking head*] So, that… that part to me it's… I… As someone teaching young girls, it is very important for me to help them understand that you don't have to fit into a box of what femininity is. You don't have to marry. You don't have to have children, and that it doesn't make you more or less of a woman. Motherhood is an extension of… of womanhood. It is not its definition. [*shaking head*] And if you decide not to do that. If you decide to be a career woman, that is your choice and more women, in my opinion, should be

doing that… actually putting themselves before their families and family choices, because there's the stereotype that has been created by the world that tells us this is the pattern we need to follow and I find that sometimes the pattern leads to more unhappiness, because you're not really thinking about why do I follow the pattern. Do I want to follow the pattern? Or is it but I've been told to follow? So, I think that… that's what I mean with good discussions. [*nodding head*] A segue in… just into… talking about life choices and the choices that are available to them as young women after school.

Leila: Okay, I understand. [*nodding*] And anything else that you would like to add on how does it make you feel to teach evolution?

Michelle: No, not really. I think I've… I've touched on the important stuff.

Leila: Okay. [*nodding head*] Well, thank you very much. It was… Everything you said was very meaningful for me. I'm sure I'm gonna be able to use it in my thesis.

Michelle: [*laughing*] Awesome, thank you so much for involving me.

Leila: Thank you, I'm just going to stop the recording.

APPENDIX D: Interview with Nandi

Leila: It's pending… Okay, it's recording. Uhm, so the research project is the lived experiences of Life Sciences teachers, belonging to different religious beliefs, and the focus is on the teaching of evolution. And my research question is: How do Life Sciences teachers…

Nandi: Uh… Come again?

Leila: Uh… the research question is: How do Life Sciences teachers, belonging to different religious beliefs, experience the teaching of evolution as a curriculum topic?

Nandi: You know, Leila… [*looking away*] I've got it, let me take off this that I can hear you. Can you hear me?

Leila: Yes. [*buffering*]

Nandi: My audio seems to be… Let me check… [*computer sounds*] Can you talk? Hello?

Leila: I can hear you. [*nodding*]

Nandi: You can hear me. Something is… My audio is not… Hello?

Leila: Uh, now it's very soft…

Nandi: [*smiling*] Now I can hear you.

Leila: Okay. Your sound is a bit soft… Could you just say something quickly?

Nandi: Okay. Can you… can you hear me? Can you hear me?

Leila: Mmm… I think. Maybe I should move my computer closer to the internet...

Nandi: Yeah.

Leila: Okay, just hold on a second. [*smiling and moving seating location and laptop*] … Okay, I moved closer to the Internet. Can you hear me?

Nandi: Yeah, I can hear clearly now.

Leila: Okay. [*nodding*] Uhm… So… Yes, let me just repeat the research question. It's: How do Life Sciences teachers, belonging to different religious beliefs, experience teaching evolution as a curriculum topic? So, throughout the interview I will be focusing on the research question but based on your specific context, so I won't generalise anything… uh, since I will be using a case study approach. Uhm, that's why I won't generalise. And so based on *your* religion, I will ask the question: How does a Christian Life Sciences teacher, with African religious values and beliefs, experience teaching evolution as a curriculum topic?

Nandi: Uhm... [*looking up*] For me…

Leila: Sorry?

Nandi: Can I answer? Must I answer?

Leila: Oh, no, just uhm, it's just the main research question. I'll ask more specific questions.

Nandi: Okay. Okay.

Leila: Uhm… So, just a reminder that your identity… uh, is anonymous and it's a safe and non-judgmental environment where you can freely share your experiences, uhm, with no right or wrong answers and you have the right to withdraw at any point of the interview and uhm, just to be very specific when I speak about evolution, I'm referring to micro- and macro-evolution and specifically, uhm, the fourth term of grade 10 and the third and fourth term of grade 12. Uhm, so, are you ready that I can ask the first question?

Nandi: Yes, I'm ready.

Leila: Okay. [*smiling*] So, the first question is: **Tell me about your teaching qualifications.**

Nandi: Uhm, I've got a BSc, uh, majoring in Physiology and Biochem and then an HED on on… biology, method of biology, as well as uh… general sciences. And then I've got a… a BEd Honours. Yeah.

Leila: Is there anything else that you would like to add regarding your qualifications or…?

Nandi: Well… I also started… I also started my masters looking at this same topic that you are doing actually…

Leila: [*smiling*]

Nandi: Yeah, when it started evolution was to be introduced… That was 2008 when the matrics were going to write. So, my topic was about the… the teaching evolution in the South African context comparing it with some states in the United States, but uh I didn't get to finish it.

Leila: Ah okay. But that's very interesting. [*smiling*]

Nandi: Yeah.

Leila: And is there anything else that you would like to talk about regarding your teaching qualifications?

Nandi: Uh… my experience… [*smiling and looking at the camera*] Well, uhm, how many years? Since '98. I've been teaching since 1998. So, that would be how many years now… I can't keep track. But that's how long I've been teaching and I've been teaching grade 8 up to grade 12, actually Life Sciences, as well as Natural Sciences.

Leila: [nodding] Okay. That was also one of the questions, so, I don't have to ask that one. Uhm, the next question is: **why did you decide to become a Life Sciences teacher, specifically?**

Nandi: Why did I decide… I didn't decide… [*laughing*] Uh, honestly, I never thought I'd be a teacher. I went to university, remember those years, I'm from [redacted]… rural areas… So, I applied for pharmacy actually and my second option was dentistry, but with the snail mail at that time I didn't receive my uhm... my acceptance letter until it was very late. So, I went… When I went, the course was full already for both cases. So, I took another stream of of of BSc. So, second year, I was going to change, but some tragedy happened, so I continued with what I was doing hoping for the best. Third year… finished and had nothing to do and I didn't want to do honours, because that would mean I have to do masters in order to get into the research and… and work. I wanted to work. So, HED one year diploma was my best option at that moment. So, that's how I became a teacher. [*smiling*]

Leila: [*nodding and smiling*]. Okay. Uhm… And, yeah. So, the next question is **how long have you been a Life Sciences teacher**, but you said since 1998.

Nandi: Since 1998. Yeah, since 1998. Yes.

Leila: Uhm, the fourth question is: **Did you study the theory of evolution in your undergraduate studies?**

Nandi: [*looking up*] Sort of, yes. Uhm… We did some aspects in Physiology, that… when I was doing my Physio… uh, third year. And my Biochem was mainly doing… dealing with Genetics. So, we we we sort off… Yeah. We sort of touched it, but not in detail, as it should be. And during my second year in Zoology as well. So, it it was there, but not really in in detail. Yes. That's what I would say.

Leila: Could you maybe elaborate on what specifically they touched on regarding evolution?

Nandi: [*looking up*] Well, in Zoology and it was about phylogeny. The phylogenetic trees and and, yeah, the evolution of species. In in in Physiology… What was it about? I I can't remember exactly [*laughing while speaking*], but we were dealing with the… the cells… I think the cells and the effect of cancer and on the effect of nicotine and everything on on on on cancer. So, we touched on it in that… in that specific angle, but I can't remember clearly what was it about.

Leila: Okay. **That's no problem. And did you study evolution in your teacher education studies?** So the HED?

Nandi: No, it was not there. Remember that time it was not even in the… in the curriculum actually, although it was embedded in some of the grade level

curriculum where you deal with firearms and everything in biology, but it was… it was actually, uhm… What would I say? It was… disconnected. So, you couldn't put it together as as as if you're teaching a theory of evolution. You just teaching, uh, the classification in a disconnected way. So, we never did, actually… [*shaking head*] anything in my… in my teaching in my one year. Specifically, not even one year, because six months you spend at school. It's about 3 months that you spend in class. Mmm [*nodding*]

Leila: Okay. The sixth question is: **Tell me about your experiences regarding learning about the theory of evolution in your undergraduate studies.**

Nandi: Pardon?

Leila: Uhm, tell me about your experiences regarding learning about the theory of evolution in your undergraduate studies.

Nandi: Uh, since I said it was a disconnected theory that that never came together as a theory of evolution. So, hence it was… It was not the thing that was uh… that that that you could latch on, because it was taught... [*interrupting herself*] It's only now when I'm teaching… now when I've got experience that I can connect the dots. But at that time it was a disconnected thing and in in… my student days as as as a… as in biology student – learner – it was not there, actually. So, we went into 2008 with no experience at all, with no content at all in teaching the topic.

Leila: Okay. [*nodding*] And uhm… the seventh question is: **Could you describe a typical day in your classroom as a Life Sciences teacher**, just in general. It doesn't have to be regarding evolution.

Nandi: Not not regarding evolution? [*sighing and smiling*] A typical day… [*looking up*] It's it's uhm… How would I say? I always teach in relation to science,

because that's that's what I I I emphasise with my learners starting from Grade 8, actually. Uh, I I emphasise the the science, the the the processes of science. So, that when we get into those things that they think they are misconceptions, in fact they are not misconceptions for them. They they they that that it it it will be a tug of war in there. So, they know that it's science and we've touched on science from the very first topic. [*buffering*] Uhm? Fifty learners maximum. In most cases it's 50 learners from grade 8 up to grade… Grade 12 would be about forty maximum. Uh… We… I usually use the cell phones, the the the… on processes… on things and processes. And uh research collaboration, and we will discuss issues. We put a question and we would discuss. It's sort of… my class is a chaotic class, I would say, because we discussed at the same time. I trained them for the skill of writing an exam that is for an assessment, because you have to have an end product at the end of the day. So, it's sort of a mixture of content. Uh, it's a mixture of of of of of of society… bringing in society… the skills of society as well as the skills of the assessment. That's what I do in my class time.

Leila: Okay. I understand. Uhm, the next question is: **Could you describe a typical lesson where you teach the theory of evolution specifically?**

Nandi: Let's start in Grade 8. Do you know it's in the grade 8 syllabus? Do you know evolution is in Grade 8 syllabus?

Leila: Uh, my project only focuses on Life Sciences and not Natural Sciences.

Nandi: So, I'm saying… I'm just saying it started from grade 8. It doesn't start in grade 12. So, when you're looking at grade 8 syllabus; natural selection, you're talking about variations there. So, my my thing from grade 8 in grade 10, also, you're talking about the history of life on Earth. That is evolution. So, the the the issue for me, is starting from what they know. What they

know is is is cockroaches at home. There are cockroaches and we we've got Doom. There are rats in the… mainly… in most of their houses. We've got Rattax, but the rats will eat the Rattax, but they are not dying and some will die. And some cockroaches, when you put in a Doom they will die and some will not die. They would just get weakened and then they… [interrupting herself] So, you're starting from that point what they know and you ask… you ask them what is causing that. Then you bring in the the theory of natural selection. And then, because you've already talked about the the the genes, the DNA, the mutations and the differences in in in in characteristic, the genetic variation, now you're bringing in the theory of natural selection based on what they know. From there, then I talk about the history of of of this theory, because for for for us to to to understand the changing nature of science, that science is based on evidence, then you bring in the issue of Lamarck. You're bringing in the issue of of, yeah, of of why it was rejected and why… In that case, you're also bringing in… I also talk about religion. In fact, from the start, not only when I'm teaching evolution, about the differences between science and religion, so that they understand one is faith based and one is science; it it relies on evidence and it's supported, somebody else must go and test and… So, those are the typical things that that I go through. And I would talk as well as as as on the history of Darwin; Darwin as a person, now, that was that was a.... went to study religion: theology, went to study being a doctor, but yeah… So, I'll tell them those stories. The story of him getting into… In fact, for that, I'm bringing in the issue of those kids that, uh, that that think that they are not brilliant. What does brilliance mean? What does an intelligent mean and look at Darwin who was discarded in class who was regarded as… but he came and and became… So, those are the things that I'm bringing in class, but I start from where they know to bring in the issue of the theory of natural selection.

Leila: [*nodding*] Okay. That's very inspiring.

Nandi: Hello?

Leila: Can you hear me? [*smiling*]

Nandi: Yeah.

Leila: Uhm, so the ninth question, is: In general, could you **tell me about experiences where you teach evolution.**

Nandi: With the learners?

Leila: [*nodding and smiling*]

Nandi: You know, the first year was a bit shaky, because you still… you, you know, you, you just got into this this this issue. You're not sure yourself, but fortunately, because I was interested, I had uh… I… I did a lot of research around the topic. But you get to question yourself on the issues of macro evolution and then you get questions on on human evolution, because they can accept natural selection. They can accept speciation, because you show them the micro evolution in the everyday life. But the issue of of of speciation in… into human evolution. It's still a big issue with even the teachers, but when you… when you approach it from the natural selection point of view, the leaners do not have that much issue. Because when you teaching the bipedalism because bipedalism is there, you're looking at the change, maybe in the environment. Why were these characteristics selected? Because they were advantageous. So, you teaching it from a natural point… selection point of view. They were selected because they were advantageous. Those who had this characteristic survived. Hence they were passed on. Hence now we are bipedal. Although, it it… when you started it's it's a… it's a… it's a difficult concept for them to comprehend.

But looking at the change in diet… The change in diet led to this, but it's a complicated issue. If if you don't read enough information so that you can bring these issues, these debates that are still happening to the kids that it's still not a conclusive thing, it's still a debate, but this is what is accepted at the moment. Why is… did our brain size increase when we started using fire? Now, you you get into the energy that is expanded that is less expanded on looking up on on on digesting this and more into… So, those kind of things, when when you tell them as a story to the kids, it's actually interesting to them instead of doing it as an abstract. So, I really don't have a problem with my learners when when when I teach from that point of view. They never question it, because from the beginning of the term, they know that we're dealing with science and science have evidence. We saying this because there is evidence that this has happened… This.

Leila: Okay, I understand. So, what I understand from what you've just explained, you tried to uhm... take away any misconceptions or prevent any misconceptions. So, you're teaching natural selection when you speak about evolution…

Nandi: Yes! Yes, and by doing that, by doing that, I have never had a problem. I would be lying… I've never had a challenge from learners who are mostly religious. I've never had a challenge with that, because i… it's it's sort of sometimes for them putting it into a context that they can picture it happening. So, I won't say because I've been in a class of a teacher, because I was subject advisor as well at some point in my life, where did the the the teacher was teaching the curriculum, because it has to be taught, not because, he… he explained to the kids how… how this could have happened. So, that created a resistance for the kids, and understanding. As a result, he said at the end that you need to know this for the exam, whether you believe it or not, it's up to you, but you need to know this for the exam,

which I believe in. It's a, it's a, it's a, it's a dangerous issue. It's a dangerous thing to say to the learners. So…

Leila: Why do you say it's a dangerous think to say to the learners?

Nandi: You you you… you're running a risk of losing them. You're running the risk of them not making the links in Life Sciences. So, because I believe the the whole Life Sciences is about evolution. You teach it from that context. When you're teaching about the reproductive strategies in paper one; it's in paper one in grade 12, the kids will always come up with the idea of who came first between the egg and the chicken… So, you need to explain that from the evolution point of view, that in order for the egg to be invented, it was a reproductive strategy that was selected that was best suited for that environment for that particular species. Hence, they survived because this reproductive strategy… So you see? It's paper one, but I'm dealing with evolution that is in paper two. So, if you close the thing and say you need to learn this for…, then you've lost the learners for the whole Life Sciences concept. That's what I believe in.

Leila: Thank you, I understand. [smiling] The next question, or it's just… **tell me about your own religious beliefs.**

Nandi: [*laughing*] That's interesting! [*smiling*] I grew up in a Christian home. Do I believe in God? I'm not sure. [*laughing*] And, uh, I'm married into a traditional home. Do I believe in ances… ancestors? I'm not sure, but somewhere somehow I do believe there is a supernatural being. For my faith, I believe in something that is supernatural. There is a supernatural being out Although, even when I'm teaching evolution and I will tell the learners that Darwin never said about… anything about when… how life started on Earth. But he said when life was on Earth, how did it become what it is now? So, there are theories about… There are ideas. There are

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hypotheses that are being researched, that is, on the current edge of research; how life started. But now life is here, but it has changed overtime genetically and phenotypically. This is what Darwin is trying to explain. Why? So, for me, my faith is on a supernatural being. However, I don't believe that this faith that I have is linked to science, is linked to who we are today, is linked to the diversity in the species out there. That is science. I'm not sure if you get me…

Leila: I understand, I think? Uh, could you elaborate a bit more about how you define your religion?

Nandi: My religion?

Leila: [*nodding*]

Nandi: That's part Christian and part traditional. So, it's a mixture of both. Yeah, I would say it's a mixture of both.

Leila: Okay. [nodding] Uhm, the eleventh question: **What is it like to be a, as you've just mentioned, part Christian and part African traditional values… uhm, Life Sciences teacher teaching the theory of evolution?**

Nandi: I I I can't hear you. Sorry?

Leila: I'll repeat. What is it like to be a Life Sciences teacher who is… who has the beliefs that you have; Christian and then traditional values… What is it like to be this Life Sciences teacher, teaching the theory of evolution?

Nandi: Honestly, I've never thought about it being a problem. To be honest. Uhm… [*looking up*] because they do different things in my life. One, I have to understand it's science and it's based on evidence. The other one is faith

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based. It's a personal thing I cannot test. I cannot do anything. It's just a faith that is there… that is for moral and ethic living… ethical living that, because, as as I would say to the kids you you you you you're not wrong to have a faith and understand science, because this… this, uh, they've got different never ever had a conflict with with with these two, although I question the Bible. I must be honest. [*smiling*] I've got lots of questions [*laughing*] on the Bible and I will pose it to learners as well. And I'll say this: "Look at this, in Genesis, this happened and this happened and then this guy went to this land. But it's never said that God created another nation, but this one went to this land. So those kind of things you do… [*interrupting herself*] I I I I don't think I believe in the Bible. Although, I believe in a supernatural being, but I don't believe in the Bible itself. So, as I say, these are different directions and they don't conflict in my life at all. [*shaking head*]

Leila: Could you elaborate a bit more uhm of what you've just said regarding telling the learners about the Bible?

Nandi: No, when when we're discussing the issue at the beginning in every start of the year, I'll start with the with the science and versus religion and I will… I will also tell them about my views when we're discussing this… the issue about this… the the the, the science versus religion. That… This is my view: Do I believe Jesus was on Earth? Yes, I do. [*nodding head*] But do I believe Jesus was was was was the son of an Angel? No, I don't. [*shaking head*] Because I believe Jesus was born of a man and this is science. Science say a sperm cell has to… [*interrupting herself*] So, something is missing. Joseph was there and he was engaged to be married to Mary and Mary got pregnant. So, you you bring in these kinds of things, so I don't believe that Jesus was the son of an Angel or whatever or God, but I believe that there was a Jesus who was a Mandela in our lifetime, because for me he was not a holy kind of person, but he was probably a preacher... who was

the… about their living conditions. The Bible made him to be a holy person. That is… Those will be my views when we're discussing the issue of of… [buffering] of this, but that will happen, because if you do it, when you're starting evolution then you seem like, you know…

Leila: Sorry, Miss Mjali… Could we maybe…

Nandi: Yeah, something uh went wrong… something… something went wrong, so something… So, you do it at the beginning… Can you hear me? Hello?

Leila: Yes, I can hear you. Could we turn off our cameras and then I can… the recording will focus more on…

Nandi: Okay. Can you hear me?

[*Teams Meeting connection was lost. Myself and Nandi communicated over WhatsApp that we will start a new Teams Meeting and recording.*]

Nandi: Hello? Yes?

Leila: Mmmm… Just waiting for it to say… Okay, it's recording. So, the last thing you said was about uhm… You didn't see Jesus as a holy person, more like a leader like Mandela?

Nandi: Hello?

Leila: Can you hear me?

Nandi: I didn't get the last part…

Leila: Uhm, the last thing that I heard was you spoke about Jesus as a leader. That you didn't see him as a holy leader, but as a political leader. Like Mandela.

Nandi: Yes. [nodding head] That's what I believe. So, yes, so this this will be the debates right at the beginning and if I'm fortunate to to teach the learners from grade 10 not just grade 12, so they would understand that that distinction between science and religion right from the start. Because when you, when you talk about that when you are about to teach evolution, then you sound dogmatic. You sound as if you want them only to take this side instead of this. But when you… when when you embed it along the way that when we're dealing with science and this is what is being done in science, then it's much easier for them to understand the science behind evolution.

Leila: Yeah, I understand. Uhm… We are at the last question. The last question is: **When teaching the theory of evolution, how does it make you feel?**

Nandi: Excited. [*smiling*] Actually, that's the topic I like the most as it ties in everything in Life Sciences. Uh, you teach grades eleven… If you're looking at the Grade 11 syllabus, people say it's boring. For me it's not boring, because when you're teaching those phylum's, you teach them from the evolution point of view, then it becomes interesting. How did reproduction in those… in in, in, in, in the in the bryophytes… all all those kinds of species evolved as the complexity… the complexity of of the organism became. So, when you teaching from that point of view, then for me it's it's actually an interesting topic. It's it's it's exciting in in… [*interrupting herself*] So, I don't actually only teach it in grade 12. I bring it across as we go along, that this evolution, if you're looking at the differences this is evolution. This is… So, you you bring it across right through then it doesn't become a problem. It's actually for me… It's an exciting topic. It's an interesting topic.

Leila: Mmm… [*nodding*] For me as well. [*smiling*] Is there anything else that you are feeling when you teach evolution? Anything else than excitement?

Nandi: Hello? Hello? I can't… Sorry?

Leila: I'll repeat. Uhm, is there anything else that you feel when you teach evolution? Anything else other than excitement?

Nandi: No. [*shaking head*] It's just exciting [*laughing*] There's there's no other hidden feelings about it. It's… For me, it's just like any other topic; the genetics, the DNA, the meiosis, because the… Those topics are building up to what you going to… talking about in evolution at the end. So, the whole curriculum, for me, it's very interesting and exciting.

Leila: Okay. [*smiling*] I just have one last follow up question. Uhm, **why do you say evolution is your favourite topic?**

Nandi: It's, as as I said, evolution ties up everything in Life Sciences. Whatever you you teach, let's say in grade 12 syllabus, you you teach DNA; the code of life. Then you go into meiosis. You go into reproduction. You go into genetics. You see? It's building up up to this climax that is, that is evolution at the end. So, it's it's not about evolution as such, but it's about the whole whole whole whole curriculum, whole content that is tying up together into this climax that is evolution at the end. So, I'm I'm just excited in teaching every topic in Life Sciences as long as it's science for me. Mmm… [*nodding head*]

Leila: I'm really finding your interest in science inspiring. [smiling] So, thank you very much for…

Nandi: Uhhh wait…

Leila: Can you hear me?

Nandi: Uh, yes, but it's bad. The sound is bad.

Leila: Can you hear me now?

Nandi: Yes.

Leila: Uhm, so I just want to say thank you again for taking part in my study and I really appreciate it. And I hope all the best for you in your career and your health.

Nandi: Thank you, thank you, Leila and uh, I hope I've assisted you in your research. You've got... Yeah, you've got something to think about. [*laughing*]

Leila: Yah, definitely, I enjoy listening.

Nandi: Are you planning on teaching?

Leila: Uhm… I think my personality is, uh, is not really strong enough to uhm discipline teenagers. So, I think I would like to go more into academia if possible.

Nandi: [*laughing*] Trust me, I was… I was like that. I was the quiet one… the most soft, quiet person but… Well, I did manage… 25 years on, I'm still there.

Leila: [*smiling*]

Nandi: Yeah, it's an exciting… It's an exciting thing teaching youngsters. But uh, good luck, good luck with whatever you're going to do.

Leila: [*speaking indistinctively*]

Nandi: I've lost your connection.

[*The Teams Meeting has ended and further communication was done over WhatsApp and email.*]

APPENDIX E: Interview with Heidi

Leila: Hy sê 'pending'… Ek wil… Daarsy. [*nodding head*]. So my… Ek gaan maar net weer oor wat my projek is. Uhm, dit is: 'The lived experiences of Life Sciences teachers, belonging to different 'religious beliefs''. En die fokus is op 'the teaching of evolution'. Uhm, my 'research question' is: 'How do Life Sciences teachers, belonging to different religious beliefs, experience teaching evolution as a curriculum topic?' So, dit gaan oor jou 'experiences' en daar is geen agenda nie en ek mag glad nie 'generalise' nie. Skuus as ek bietjie tale meng! [*laughing*]

Heidi: Dis okay. [*smiling*]

Leila: Ek is nou gewoond aan my akademiese taal wat Engels is. So, ek mag glad nie 'generalise' of, ja, ek mag glad nie veralgemeen nie. Ja, so dis… Dit is 'n 'safe space' en jy kan vry enigiets deel. Daar's geen reg of verkeerde antwoorde nie en uhm dis 'non-judgemental' en jou identiteit en jou skool se identiteit is anoniem. So, ek sal 'n skuilnaam gebruik in my finale tesis. En uhm daar is nog een dingetjie wat ek wil sê. [*looks away at computer*] Jy het die reg om te onttrek as jy ongemaklik raak of as jy nie wil deelneem nie. En uhm, so, as ek spesifiek verwys na evolusie, dan verwys ek na mikro- en makro-evolusie. En in die CAPS dokument (ek weet dit het nou bietjie verander as gevolg van COVID), maar gewoonlik was dit die vierde kwartaal in graag 10 en die derde en vierde kwartaal in graad 12. Dis meestal die evolusie onderwerpe waarna ek verwys. Is daar nou enige vrae?

Heidi: [*smiling*] Nee, nee. Dis als reg. Dankie dat ek in Afrikaans kan praat. [*smiling*]

Leila: Dis reg. [*smiling*] Ek het vir ingeval toe ek my proposal gemaak het, het ek my 'interview questions' in Afrikaans en Engels gemaak – net vir ingeval.

Heidi: Okay, dis reg. [*smiling*]

Leila: Uhm, so daar is 12 vrae. So, nommer een is net: **Vertel my van jou onderwyskwalifikasies.** [*smiling*]

Heidi: Okay, ek het ‘n BSc, uhm, graad, uhm, met plantkunde, dierkunde studeer by [redacted] en toe het ek ‘n HOD diploma gedoen vir ‘n jaar en daarna het ek gekwalifiseer as ‘n onderwyser.

Leila: Okay. En is daar enigiets anders?

Heidi: Ek het... Ag, ek het maar net later op ‘n kol het ek in toerisme gewerk, toe het ek ‘n toerisme kort kursus ook gedoen. Dit is nou nie van toepassing regtig op die... op die onderwys nie. Alhoewel, toerisme is ook maar soos onderwys op ‘n manier. [*smiling*]

Leila: [*smiling*] Uhm, so vraag twee is: **Hoekom het jy besluit om ‘n Lewenswetenskap onderwyser te wees?**

Heidi: [*looking up*] Aanvanklik wou ek in plantkunde studeer, want plantkunde is my... eintlik my groot passie in die lewe. Uhm, en ek wou navorsing gedoen het, en toe ek nou eintlik ‘n student is, toe besef ek as ‘n mens nou in navorsing wil ingaan, dan moet jy gaan tot by ‘n meestersgraad. Finansies was maar vir my ‘n probleem gewees op daai stadium. Uhm, en ek is ‘n plattelandse mens. [*smiling*] Uhm, met plantkunde sou ek seker op die platteland ook kon werk, maar as mens navorsing doen, dan is mens maar aan ‘n universiteit verbonde meeste van die tyd. Uhm, en ek wil net nie by ‘n... in ‘n groot plek werk of bly nie. [*shaking head and smiling*] So, [*buffering*] toe in my derde jaar voorligting... Watter beroep kan ek volg in... in die Lewenswetenskappe wat mens op die platteland ook kon doen, en sê hulle vir my: “Wel, jy kan ‘n onderwyser word en dan kan jy in enige dorp in die land

kan jy gaan werk. En uhm, ja, dit het toe so uitgewerk wat eintlik die beste is, want ek geniet dit regtig om ‘n Lewenswetenskap onderwyser te wees. [*nodding*] So, in die eerste plek die vak wat eintlik my passie is, maar uhm, ja, ek dink nie ek is ‘n gebore onderwyser nie, maar ek het ‘n onderwyser geword deur dit te doen. [*smiling and nodding*] Ja.

Leila: Okay, ek verstaan. Dit maak sin. [*smiling*] Oh, ek het vergeet. Ek moet... as ek nie praat nie, dan moet ek net my mikrofoon afsit sodat die ‘recording’ ‘n bietjie meer... suiwer is.

Heidi: Duidelik is. [*nodding*]

Leila: So, vraag 3 is: **Vir hoe lank is jy al ‘n Lewenswetenskappe onderwyser?**

Heidi: Sjoe, ek moet nou gou tel... [*counting on fingers silently*] ... Dis nou 17 jaar. [*nodding*]

Leila: Sjoe, dis lank. [*smiling*]

Heidi: Ja. [*nodding*]

Leila: Kan jy bietjie uitbrei oor die tydlyn van ‘n Lewenswetenskappe onderwyser wees?

Heidi: Uhm, ek het... Toe ek begin het, was 1994. En toe het ek vir 3 jaar onderwys gegee. Dit was nog op die ou kurrikulum gewees... dieselfde kurrikulum waarop ek skoolgegaan het... waar evolusie nie eintlik regtig deel van die kurrikulum was nie. Dit was net ‘n bietjie rondom ‘survival of the fittest’... die idee gehad het. Uhm, en toe het ek vir 10 jaar lank nie onderwys gegee nie. Toe het ek weer in 2007 begin onderwys gee. Daai jaar was... die matrieks het daai jaar toe nog op die ou kurrikulum... die ou Wes Kaap kurrikulum.... uhm...

ja, onderrig ontvang of of eksamen geskryf en toe; 2008/2009 toe het ons begin... [*looking away*] Nee, ekskuus tog. 2007 toe ek hier begin het, toe... ja, toe't die matrieks nog die ou kurrikulum se eksamens geskryf, maar die ander grade was toe al by die OBE stelsel gewees. Uhm, toe moes ek nou maar inval en dit leerken en alles... en toe was evolusie toe nou redelik ook... wel, by graad 8 en 9 was die idee van natuurlike seleksie was toe daar in hulle kurrikulum gewees, maar dit was baie uhm... 'open' gewees. Jy as onderwyser kon self amper besluit hoeveel daarvan... tot in watter mate... watter graad binne die fase jy dit doen en so aan, uhm, maar graad 10, 11 en 12 het dit toe nou ingekom dat van graad 10 af doen ons dele, en aanvanklik was dit amper meer daarvan in graad 10 en 11 gewees as in graad 12 [*gesturing to one side*] ... en toe na 3 jaar toe't dit weer verander. [*gesturing to the other side*] So, [*looking up*] dit was gewees ek dink daar 2013/14... maar dit het ook so ingefaseer. So, dit was nie al die grade gelyktydig gewees nie. Toe het daar weer veranderinge gekom. Toe het dit meer verander soos wat dit nou is waar ons in graad 10 en meer in graad 12 doen. So, het 'n bietjie geskuif na graad 12 toe, maar met 'n begin in graad 10. In graad 11 doen ons bietjie by die... by die plantgroepe en die diergroepe doen ons net die filogenetiese stambome. Uhm, so ja... Dit is maar... So, ek het al die jare wat ek onderwys gegee het, het ek Lewenswetenskappe onderrig. Aanvanklik was dit nog biologie gewees die eerste drie jaar... uhm, en nou later die Lewenswetenskappe... Uhm, wat... Iets wat nogal vir my goed was van die kurrikulum veranderinge is meer die praktiese... die gerigtheid op die praktiese vaardighede wat nie van tevore daar was nie. Uhm. [*looking away*] Ja, en dan okay, goed, die evolusie gedeelte het nou bygekom.

Leila: Okay. Baie dankie. [*smiling*] Uhm... vraag 4 is: **Het jy geleer van die teorie van evolusie in jou ondergraadse onderrig?** So, die BSc.

Heidi: Ja, [*nodding*] dit was eintlik half my eerste... uhm... kennismaking met evolusie gewees. Ons het op skool ook maar eintlik net die... die beginsel van

'the survival of the fittest' het ons in biologie gedoen. En toe ek op universiteit kom eerste jaar, toe het ek eintlik nou vir die eerste keer te doen gekry met die hele teorie van evolusie en hoe dit dan nou werk en... uhm... alles. So, ek het uhm in my [*looking away*] tweede jaar... derde jaar by dierkunde veral... veral dierkunde tweedejaar... [*interrupts herself*] Ag, van eerste jaar af eintlik. [*nodding*] Bietjie by plantkunde ook, maar meer by dierkunde... uhm, te doen gekry met die evolusie teorie en en waarop dit gesnoei is en hoe dit werk. [*nodding*]

Leila: En wil jy dalk uitbrei op jou ervaringe van... [*looking up*] dit leer in jou ondergraadse studies?

Heidi: [*smiling*] Dit was nogal... [*nodding*] Dit was nogal moeilik gewees. [*laughing*] Uhm, ek onthou ons as klas en en as studente in daai jaar het baie gesprekke daaroor gevoer – [redacted]. Uhm, rondom joh... [*looking up*] Is dit nou? Is dit nou nie? Uhm. Hoe pas dit in by ons geloofsoortuigs en so aan. Uhm. En dit was moeilik gewees. Dit was moeilik om dit te leer en jy, jy's nie heeltemal eensgesind daarmee dat... dat... dat dit is soos wat dit aan jou voorgehou word nie, en dis maar daar wat ek ook eintlik begin agterkom het dat mense het verskillende menings en opinies daaroor, en dit was amper asof jy nie nou lekker weet nou waar pas jy nou in ten opsigte van evolusie en die teorie en dit wat in jou agtergrond rondom die ontstaan van... van die skepping en van mense is nie. So, dit was moeilik gewees. Dit was baie moeilik gewees en al daai gesprekke wat ons gehad het het hoofsaaklik maar oor dit gegaan. Maar ek onthou daar was een uhm student wat saam met ons was, uhm, in my eerste jaar, en hy't net eendag gesê, uhm, ja, hy't net eendag gesê: Hy dink as ons eendag in die hemel kom, dan gaan die Here sê: "Sit nou net rustig agteroor op hierdie sagte stoele en dan gaan hulle nou hierdie video sien van hoe dit uiteindelik gebeur het. En na dit het ek baie vrede gekry en gedink; Oh, well. Ons sal eendag weet presies hoe dit

gebeur het. [*smiling*] Uhm. So, ek hoef my nie te veel te breek daaroor nie, maar dit was moeilik gewees, ja. [*nodding*]

Leila: Ja, ek kan dink. [*smiling*] Uhm, en dan vraag 5 is: **Het jy geleer van die teorie van evolusie in jou uhm onderwys onderrig? So, die HOD?**

Heidi: [*looking up*] Uhm, ek kan nie regtig onthou dat ons dit as ‘n spesifieke onderwerp in my HOD jaar gehad het nie... Uhm, nee. [*shaking head*] Dit was... Dit was uhm... as ons dit gedoen het, was dit nie ‘n groot ding gewees nie. [*shaking head*]

Leila: Okay, so dit... Dit was nie ‘n onderwerp enigsens met daai kursus nie?

Heidi: [*shaking head*] Nee. Nee.

Leila: [*nodding head*] Okay. Uhm, dan vraag 6 is: **Vertel my hoe jy dit ervaar het om van die teorie van evolusie te leer in uhm watookal die onderrig... So, in jou geval is dit die uhm plantkunde. So, vertel my van hoe die ervaringe was... ek het eintlik al dit nounou gevra [*smiling*], maar is daar enigiets anders wat jy wil noem daaroor? Of?**

Heidi: [*looking up*] Uhm... Daar is. Daar’s, daar’s dele daarvan, en as ek nou sê dele dan verwys ek eintlik nou meer na die mikro-evolusie gedeelte wat ‘n mens nogal kan insien... [*nodding*] dat dit gebeur en omdat daar hedendaagse voorbeelde daarvan is en omdat daar uhm spesifieke uhm ondersoeke is wat gedoen is en waaroor daar geskryf is wat jy kan sien, wel, dit gebeur en dit is ‘n werklikheid. Uhm, is... Dis makliker om daai gedeelte te volg en daarmee saam te gaan, maar as dit by die makro-evolusie gedeeltes kom, is dit moeiliker om te verstaan dat dit die manier kon gewees het waarop uhm diergroepe, plantgroepe ontstaan het en hoe die veranderinge gekom het. So... So, ja, maar ek het meer die... [*looking up*] By die plantkunde het ons nie

eintlik so baie gefokus op die... op die ontwikkeling nie. [*looking up*] Bietjie... maar nie so baie nie. Dit was meer by die dierkunde gewees. [*nodding head*]

Leila: En is daar enige onderwerpe wat uitgestaan het in... toe jy geleer het van evolusie?

Heidi: Uhm, ekskuus tog, onderwerpe soos byvoorbeeld...?

Leila: Uhm, ek het nou eintlik verwys na uhm toe jy gesê het dat die mikro-evolusie was vir jou interessant... Was daar enigiets spesifiek interessant uhm... Ek mag nie self goed sê wat in my kop kom nie [*laughing*] maar...

Heidi: [*laughing and nodding*] Okay, okay. Uhm... Ek dink nou maar die ou bekende voorbeeld van die pepermotte... is mos nou maar die ene wat mens in al die handboeke lees en so aan. Dit was vir my interessant gewees om te... om te kan verstaan wel dat die kleur van die pepermotte verander het as gevolg van die veranderinge in die omgewing, wat dan dan nou die gunstige kenmerke bevoordeel het en die ongunstige kenmerke benadeel het of laat uitsterf het. [*looking up*] Uhm, ek probeer nou dink... Wat nogal vir my interessant was by die... by die dierkunde ook het ons in die derde jaar gedoen die vertebrate met die skedels en die die uh waar die uhm... die die die verskillende bene van die skedel uhm vasgegroei is aan mekaar soos wat jy van die een groep na die volgende groep toe gaan. Ons het by Dr van der Heever klas gehad. Dr Jurie van der Heever en hy was ‘n baie goeie dosent gewees en hy het dit baie goed verduidelik ook. So, dit was nogal vir my interessant gewees. Uhm, en ja as mens dit nou so volg dan dan... dan lyk dit of dit skyn dat daar... dat dinge so kon gebeur het. So, ja, daai gedeeltes was vir my interessant gewees.

Leila: Okay, baie dankie. Uhm, en vraag 7 is... Nou fokus ek meer half op die klaskamer en die onderwys. Uhm, **kan jy ‘n tipiese dag in jou klaskamer as ‘n Lewenswetenskap onderwyser beskryf?** Die volgende vraag is spesifiek

oor ‘n les waar jy evolusie aanbied, maar dié vraag gaan maar net oor ‘n algemene dag in die Lewenswetenskap klaskamer.

Heidi: Kan ek net gou seker maak: so, dit gaan meer oor soos in my, as onderwyser, my aanslag ten opsigte van die vak in my klas?

Leila: [*nodding*]

Heidi: Goed. Ek is uhm... Ek het hierdie passie vir my... vir my vak, maar ek het regtig ook ‘n passie vir die kinders met wie ek werk. Uhm, so, ek hou van interaksie in my klas met die leerders... Uhm, so, dis nie... My klas is nie daai stil plek waar niemand [*smiling*] ‘n woord mag sê en net die onderwyser praat nie. So, die, die kinders neem deel aan my klas en ek, ek hou nogal daarvan om hulle deel te maak van die klas ook. So, hulle weet hulle mag enige, enige tyd ‘n vraag vra. Natuurlik moet ons dit nou net ordelik doen, maar hulle mag vrae vra en hulle mag vrae vra wat hulle dink selfs simpel vrae is of so. En ek sal dan nou sê: pas dit in by die les en sal ek dit antwoord of gaan ons dit los vir ‘n ander tyd of watookal... Of of of dis heeltemal onvanpas en ek gaan dit glad nie antwoord of so nie. So, ek hou van ‘n interaktiewe... uh, uhm omgewing. En ek is ook die onderwyser wat hou van die praktiese gedeelte van die vak. So, ek voel altyd as ons leer oor die blare, dan bring ek blare klas toe en as ons leer oor die skelet, dan haal ek my boks met bene uit en dan leer ons van die skelet. So, uhm ja, ek dink die vak leen hom ook daartoe dat ‘n mens amper die heeltyd amper prakties kan gaan. [*nodding*] Uhm, en ja, dit is ook hoekom ek daarvan hou dat die kurrikulum nou die praktiese gedeelte en die praktiese vaardighede insluit, want dit is nou eintlik die gedeelte waarvan ek ook hou. Miskien kom dit uit my... uit my agtergrond uit dat ek eintlik graag uhm navorsing wou gedoen het en met die praktiese goeters besig wou wees. Uhm, so ja. Dis vir my goed as my leerders dit wat hulle leer kan kan beleef en ervaar ook en dat hulle daaroor kan praat en dat hulle daaroor dink en uhm vir my... Ek dink my algemene onderwys ingesteldheid is ook dat dit

gaan nie net oor die kennis nie, maar dit gaan ook oor: hoe maak ek dit deel van my lewe en wat doen ek daarmee vorentoe in my lewe? So, ja. Baie ander onderwysers verskil miskien ‘n bietjie in die opsig dat hulle voel die kinders moet net goeie punte kry en ons... ons merk net daarvoor. Ons kyk na die vrae wat in die vraestel is en hulle moet net dit kan... [*interrupting herself*] Vir my is dit baie meer as dit. Uhm, ja. Ek sou nou nie sê ek is altyd die mees suksesvolle onderwyser as dit kom by punte nie, maar as dit gaan oor die lewe en wat leer ons en wat kan ons daarvan toepas in ons lewe, dan voel ek dan is ek suksesvol. So, ja en die die... Die dag by die skool is maar uhm... Ek onderrig van graad 8 tot graad 12 klasse... Uhm Natuurwetenskap: graad 8 en 9. Lewenswetenskap graad 10, 11 en 12 en dan gee ek op hierdie stadium nou Wiskunde geletterdheid ook vir graad 10 en vir graad 11... En uhm ja met COVID het ons nou baie meer klasse by ons skool. Uhm, elke graad het ek nou half dubbel die hoeveelheid klasgroepe en ons moet nou rondbeweeg na die klasse toe ook, maar vir Lewenswetenskap kom die leerders na my klas toe. [*nodding*] Uhm, so dit is nogal vir my orraait, want mens het baie goed in jou klas wat jy... plakkate en apparaat en goed... Uhm, so... Dis okay. Ons hardloop maar bietjie rond, maar met COVID is dit... is dit baie anderster nou ook. So, ja. Ons moet alles inpas en ons moet baie meer dinge doen as van tevore. [*smiling*]

Leila: Ja, ek verstaan en ek kan dink. [*smiling*] Uhm, en is daar enigiets anders wat jy wil noem oor die tipiese dag in die klaskamer as ‘n Lewenswetenskap onderwyser?

Heidi: [*looking up in thought*] Uhm, nee. Ek het geraak wat ek... moes sê, ja. [*nodding*]

Leila: Oh, en uhm, jy het genoem dat die kinders partykeer onvanpaste vrae vra. Is daar voorbeelde van sulke vrae?

Heidi: [*looking up*] Ag, dis maar... dis maar... Jy kry maar meestal dit by jou laer grade waar kinders nou partykeer vrae vra wat nie van toepassing is op die onderwerp waarmee mens besig is nie... Uhm, ja, of partykeer is hulle sommer net snaaks en hulle vra... half persoonlike tipe goed wat nou niks met hulle te doen het nie, dan... Maar ek het net ‘n reël; jy mag vra. [*nodding*] Ek sal sê as ek dit nie wil antwoord nie. Of ek gaan sê ek gaan dit nie antwoord as dit nie van pas is binne die... die beplanning vir die dag of so nie. [*nodding*]

Leila: Okay, ek verstaan. [smiling] Uhm, en dan die volgende vraag is: **Kan jy ‘n tipiese les waar jy die teorie van evolusie aanbied, beskryf?** So, uhm, dis jou keuse oor hoe jy dit wil beskryf... Graad 10 of graad 12 of altwee. Net ‘n tipiese les oor die teorie van evolusie.

Heidi: Okay, ek dink ek... Ek het bietjie daaroor gedink voor die tyd en ek... ek sien myself ook as... Ek dink dit is ook maar mens se onderwys uitgangspunt wat [*buffering*] uhm... wat ek as self ‘n ma vir kinders sien myself as ‘n persoon wat: jy moet die... jy moet die... uh uhm, nou sukkel ek om die woord te kry... [*smiling*] Jy moet vir kinders die gebeure in hulle lewe moet jy vir hulle in perspektief stel. Dis die woord. Jy moet dit vir hulle in perspektief stel. Uhm, want hulle leer maar van ‘n volwasse persoon af hoe om ‘n situasie te benader. Wat is dit wat met my gebeur? Hoe dit... Hoe kan ‘n mens dit beleef? Wat maak jy daarmee? So, ek... as ek die onderwerp van evolusie aanpak, dan dit is wat ek doen. Ek sit dit vir hulle in ‘n sekere perspektief en natuurlik het my geloofsagtergrond nou ‘n invloed daarop. Nou, die kinders wat ek onderrig is ook meestal Christene. Uhm, en die Christen geloof in hierdie gemeenskap is die... beskou ek as die behoudende faktor binne die gemeenskap en my vorige belewenisse van die aanbied van evolusie aan die begin... veral toe ek dit moes begin doen het, was dit amper soos in: ek ruk die mat onder hulle uit [*nodding*] as ek die onderwerp van evolusie begin en hulle leer daarvan. Dan is hulle totaal verward, en en hulle... [*shaking head*] Hulle kan net geen sin daarvan uitmaak nie. En ek het baie lank al geworstel met dit oor soos in: hoe bied ek

Connection between religion and Evolution (mutually exclusive) – evolution is seen as a belief system

dit vir hulle aan dat hulle dit kan leer uhm... kan weet waaroor dit gaan, die kennis daarvan kan hê, maar nie dat ek hulle heeltemal verwar daarmee nie? En ek self het ‘n hele worsteling gehad om half uit te kom by hoe pak ek dit nou aan en waar begin ek en so aan? En ek het dit op die ou end gekom by die ding dat: dit gaan maar oor die vraag wat alle mense vra is: waar kom ek vandaan? So, dis my vertrek punt. So, as ek begin met die evolusie onderwerp, dan begin ek met hulle vir party mense is dit okay as ek die antwoord kry van voortplanting. En dan is daar mense wat sê: ja maar okay, dit is... Dit sê nou waar kom ek nou vandaan; van my ouers af, maar wat... waar kom hulle vandaan? So, party dan dan gaan ek verder en sê dan: maar party mense wil meer weet. So, hulle wil weet waar kom hulle ouers vandaan... waar jy meer in die rigting van uhm jou voorgeskiedenis en die geskiedenis van jou ouers en waar kom hulle vandaan, maar vir party mense is dit ook nog nie genoeg nie. [*smiling*] Party mense wil meer weet as dit. Hulle wil weet, okay, waar kom... waar kom my voorouers dan nou vandaan? So, dan moet ‘n mens meer in die geskiedenis ingaan. So, dan is dit nou meer genealogie en geskiedkundig, waar, waar jy dalk jou antwoord kry. Maar dan is daar party mense wat nog nie heeltemal tevrede is nie en wat dan vra maar waar kom mense vandaan? [*smiling*] En dan kry mense hulle antwoorde op verskillende plekke. So, vir party is dit: jy kry jou antwoord uit die Bybel uit, wat sê God het mense gemaak. Ander mense sê nee evolusie is ‘n opsie. Vir ander is daar dalk ander skeppingsverhale. So, dis waar ons bietjie begin verskil met hoe ons dan nou verklaar waar kom mense vandaan. En dan sê ek altyd maar, dan is daar nog mense wat wil verder gaan en sê: “Ja, maar dit gaan nie net oor waar kom mense vandaan nie. Waar kom lewe vandaan?” En dan vir party mense, weereens, is dit die Bybel se skeppingsverhaal en vir ander is dit evolusie. Vir ander is dit ander skeppingsverhale. En dan is daar party mense wat nog nie tevrede is nie en sê maar: Waar kom die aarde vandaan? En dan gaan jy terug na... okay, weereens, die Bybel se skeppingverhaal van die skepping... van die aarde of dan nou die Big Bang of watookal... So, dan sal ek vir hulle sê verskillende mense het verskillende vlakke van bevrediging van hierdie

universele vraag, uhm, maar dat dat ons ons antwoorde op verskillende plekke eintlik kan kry. En dan begin ek nou die vraagteken gesiggies sien voor my gewoonlik. Uhm, want dan sal daar van die leerders weet wat sê: "Maar juffrou, ons glo mos soos wat dit in die Bybel geskryf is. [*nodding*]" Dan sal ek sê: Ja, vir party mense is die antwoorde in die Bybel, so ons hou daarby, maar daar is ook ander... daar's ook ander verduidelikings en evolusie is dan nou, sê ek nou maar vir hulle, is een van die ander verduidelikings en ons leer daarvan dat ons kan weet hoe daai mense dink, maar jy hoef nie daarmee saam te stem nie. Nou daar wyk ek seker nou bietjie af van die CAPS dokument wat sê dis 'n teorie en dis bewys en dit is alles en dit is net so... Uhm, maar dit voel vir my ek moet die perspektief vir die kinders gee waarbinne hulle dit moet leer. So, dan pak ek dit maar van daar af aan en dan uhm gee ek net eers vir hulle die breë riglyne van evolusie... uhm dat lewe begin het van die eenvoudige en ontwikkel het na die meer komplekse toe, dat dit ontstaan het in water en uitbeweeg het op land. Uhm, en dan so breë... breedweg ek nou van lewe van die eenvoudigste organismes... bakterieë wat ontwikkel... verder ontwikkel het en dan jou invertebrata en jou vertebrata en dan nou die vyf vertebrate groepe... uhm, waar die evolusie teorie sê van die vis na die... na die amfibieë en so... En dan dan probeer ek nou maar invul met... met bietjie voorbeelde wat ons het, maar in graad 10 het hulle nou nog nie so baie agtergrond voorbeelde nie. So, graad 12 begin ek nou eintlik maar weer op dieselfde punt wat ek in graad 10 begin het, maar dan gaan ons nou net vinniger daardeur, want hulle het dit dan al in graad 10 en so gedoen. En dan... dan kan mens nou terugverwys na graad 11 wat ons die diergroepe en die filogenetiese stamboom en die plantgroepe en die filogenetiese stamboom daarvan gedoen het. Dan... dan dan okay, dan integreer hulle bietjie daai wat hulle als klaar geleer het. Uhm, maar dit is nog altyd... Ek ondervind nog altyd by die graad 12we is daar half die meeste vertwyfeling, want hulle is nou bietjie groter al en dit is ietsie wat ek nou nogal mee sukkel... uhm... Ons leer vir hulle een van die... en van die vaardighede wat die CAPS dokument voorskryf wat ons vir ons leerders moet leer is kritiese denke. [*nodding*] En

nou kom ons by evolusie en dan mag hulle nie krities dink nie. Want nou moet ek vir hulle sê ja jy kan so dink, maar dit wat jy moet ken en dit is wat jy moet leer en dit is wat jy moet skryf. Uhm, so dan's dit half of daar 'n... Jy leer die heeltyd vir hulle krities... krities dink oor goeters, maar nou dat hulle krities dink, nou mag hulle dit nie doen nie. [*smiling*] Dan uhm... Dan's dit bietjie of dit in konflik met mekaar is. Ja. Dalk het ek nou meer geantwoord as wat jy eintlik gevra het. [*smiling*]

Leila: Uhm, kan jy net uitbrei met wat jy bedoel met uhm die feit dat hulle nie krities mag dink nie? Is dit in die sin van uhm evolusie bevraagteken of hulle geloof bevraagteken?

Heidi: Uhm... Okay, meeste... Omdat hulle nou meestal Christelike agtergrond het, bevraagteken hulle die evolusie... wat ek begrip voor het, want hulle... Ja, hulle kom al langer aan met die geloof as met die evolusie. So, hulle bevraagteken die evolusie. Uhm... [*looking up*] Hulle... Hulle sal byvoorbeeld ook as ons nou by menslike evolusie kom en ons leer van die kenmerke van die... van die uhm... die hominide, dan sal hulle byvoorbeeld sê: Ja, maar was dit nie maar met net mense en dat dit net variasies van kenmerke is nie, want ons het nou in meiose het ons geleer van die variasies, in DNA het ons geleer van variasies... Uhm, wat vir my voel dit is 'n kritiese vraag... en dan wil daar... Ons weet nie... [*smiling*] So, is dit net variasie of is dit nou regtig ander spesies?

Leila: Wat sal jou antwoord dan wees op so vraag... as hulle so half verskriklike kritiese vrae vra?

Heidi: Ek... ek sal dan maar vir hulle sê dat ons ons moet dink oor die goed, [*nodding*] want ek voel aan die een kant moet ons hulle leer om krities te dink. So, jy kan krities daaroor dink, maar hierdie is die goed wat jy op die ou end in die eksamen moet skryf. So, jy kan daai kritiese vrae dink om jou eie opinie te vorm, maar wat jy in die eindeksamen vraestel moet antwoord is hierdie ander

goed wat wat hier voor jou is. So, jy moet dit nou maar net skryf. Dis nou waar dit vir my kom... Daar's nou konflik. Jy kan nie jou kritiese denke integreer met dit wat jy op die ou end moet doen nie. Jy moet dit net doen en klaar. [*smiling*] En in matriek is ons maar bietjie gejaag vir tyd, want die... die akademiese jaar is eintlik korter mos nou as die ander grade s'n. So, jy moet maar baiekeer net fokus en sê okay: dié moet jy nou... die moet jy nou weet vir die eksamen en so. As jy die vraag kry moet jy dit skryf. Dis waarvoor hulle punte gee. Hulle gee 'n punt vir daai feit en daai feit en daai feit... So, ja, jy kan krities dink. Jy vorm jou eie opinie daarmee, maar dié is wat jy moet ken en dis wat jy moet skryf.

Leila: [*nodding*] Ja, ek verstaan. Uhm, en dan... Vraag 9 is – dis maar net half 'n uitbreiding op – **vertel my van jou ervaringe wanneer jy evolusie aanbied.** So, enigiets wat uitstaan van jou ervaringe. [*nodding and smiling*]

Heidi: Okay, uhm... Dit is vir my ook moeilik om dit aan te bied. Uhm... Toe ons moes begin het om dit... om dit in die kurrikulum aan te bied, het hulle vir die... die WKOD vir ons opleiding gegee... uhm, ek bedoel wat nodig was, maar hulle het byvoorbeeld ook daai tyd vir ons gesê ons mag nie vrae vra nie. Ons moet net... dit is wat jy moet doen, dis wat CAPS sê, dit moet jy doen. Punt. Jy's 'n werknemer van die WKOD. As jy dit nie wil doen nie, moet jy jou goed vat en loop. Dis wat jy moet doen. [*nodding*] Uhm, so, ons het ook nie 'n kans gekry om ooit 'n... 'n mening of 'n bevraagtekening van wat ons vir leerders moet leer te doen nie. Jy moet maar net aangaan. Uhm, ietsie wat nogal elke jaar vir my tref is dat leerders doen nie baie goed in hierdie afdeling van die werk nie en en en ek het die ander dag met my matrieks van hierdie jaar het ek daaroor gepraat en toe't die een outjie – en hy is nou een van my top kandidate – nou nie... die leerders vir wie ek skoolgee is nie... is nie... Ek gaan nie sê hulle is nie uhm akademies sterk nie. Daar is soms leerders wat akademies goed is, maar dis meer... meer uit 'n agtergedrewe gemeenskap uit. So, uhm, dit sukkel maar wat die wetenskappe aanbetref op 'n manier.

[*nodding*] Maar hierdie een is nou ‘n oopkop seun, en hy sê toe net vir my: “Juffrou, dis baie moeilik om ‘n leuen neer te skryf.” [*smiling*]

Leila: [*smiling*]

Heidi: En en en... ek het begrip daarvoor. Ek sê ja maar ons lieg elke dag maklik as ons praat. Toe sê hy “Ja, maar as mens dit moet skryf is dit baie erg.” [*smiling*] So... So, dit is nou maar half meer die belewenis van die leerders, maar ek bedoel ek het begrip daarvoor. Uhm... En my eie kinders. Ek het twee seuns. Hulle self het ook gesê dit was vir hulle baie moeilik om die goeters te moet skryf en jy... jy stem nie saam nie. Uhm, so, ja, vir my... Nou is dit oraait dat ek weet hoe om dit te aanpak, maar daai eerste paar jaar was vir my verskriklik erg gewees om dit te moet doen. [*smiling*]

Leila: Ja, ek kan dink dit is ‘n aanpassing. Uhm... Enigiets anders wat uitgestaan het van jou ervaringe van dit aanbied?

Heidi: Uhm... [*looking up*] Dit is nogal partykeer interessant om te sien dat leerders wat meer TV kyk en wat veral meer jou Discovery kanaal uhm... tipe programme kyk dat vir hulle is dit makliker [*nodding*] om die goeters te leer. Dis asof hulle... Hulle sien net baie meer en hoor net baie meer daarvan. Uhm, so, ja, dis nou weer ‘n belewenis na die ander kant toe [*smiling*] dat vir hulle is dit baie makliker om dit te kyk. Ook... ook jou leerders wat nie... nie so uhm uitgeproke is ten opsigte van hulle geloof nie. Vir hulle is dit makliker om dit te leer, waar die... waar jy kan nou sien dat die leerders wat jy nou weet en wat jy... wat met jou praat oor geloofsgoeters; vir hulle is dit moeiliker. [*nodding*]

Leila: Okay, ek verstaan. So, soos wat ek verstaan is jou ervaring as onderwyser uhm sukkel... kom jy agter dat die leerders wat gelowig is meer... worstel om die onderwerp?

Heidi: [*nodding*] Ja. [*nodding*]

Leila: En uhm enigiets anders spesifiek oor jou ervaring as die onderwyser?

Heidi: [*looking up*] Nee. [*shaking head and smiling*] Ek dink die... die goed wat ek gesê het is, is soos wat dit is, ja. [*nodding*]

Leila: Uhm... dan vraag 10 is... **Vertel vir my van jou godsdienstige oortuigings.** So, jou geloof.

Heidi: Okay. [*nodding*] So, ek is 'n Christen. Ek het uhm eintlik maar grootgeword in 'n Christelike huisomgewing. En ja [*nodding*] Uhm... Soos wat die Bybel dinge beskryf is soos wat ek dit glo. [*nodding*] Ja.

Leila: Okay, so uhm... soos kan ek maar die woord gebruik: kreasionistiese Christen?

Heidi: Ja. [*nodding and smiling*]

Leila: Okay.

Heidi: Uhm, ek moet miskien net kwalifiseer... nie dat ek die Bybel as 'n wetenskaphandboek beskou nie, maar vir my... uit my oogpunt uit is die uhm... God is die skepper en uhm hoe hy geskep het, is nie die belangrike nie, maar dat dit Hy is wat geskep het is die belangrike ding. En daar is... daar is spesifieke goed wat ek nou sal kan... wat ek half soos argumente wat ek sal hê hoekom ek sê nie evolusie nie... So, daarom kies ek om eerder woord vir woord die Bybel se weergawe te volg as wat ek die evolusie teorie sal volg.

Leila: Mmm, ek verstaan. [*nodding*] En uhm ek is nie doodseker of ek eintlik mag vra nie, maar die tydlyn... Wat glo jy in terme van die tydlyn?

Heidi: [*smiling*] Okay, wat ook nogal interessant is is dis amper daai ding wat maak dat ‘n mens nou... wonder... stem jy saam of stem jy nie saam nie. So, die tydlyn wil ek amper sê pla my nie te veel nie, maar as ek die die Bybel se gebeure navolg en as ‘n mens nou... as jy meer in kreasionistiese skrifte ingaan, dan is daar verskillende dinge wat hulle sê soos as jy nou al die jare optel soos wat dit uit die ou testament geskryf is met al die geslagte en goeters, dan kom jy beslis nou nie by die miljoene jare uit wat mense dan al op die aarde is nie... [*shaking head*] Uhm, dat dit in duisende eerder is... 5000/6000... Maar ja, ek ek ek is ook net nie altyd heeltemal oortuig of die... of die daterings wat gebruik word in die evolusie teorie, of dit nou werklik so ‘n deurslaggewende faktor is nie. Vir my is dit maar meer... Dit dui aan in terme van... meer ‘n relatiewe verstaan van wie was voor wie gewees, behalwe as ‘n mens nou ook weer kyk na die Bybel se verhaal van die groot vloed wat ‘n moontlike verklaring kan wees van al die fossiele wat ons vind. [*nodding*]

Leila: Okay, ja, ek het al so iets gehoor van die vloed.

Heidi: Moet ek uitbrei daarop?

Leila: As jy wil? As jy gemaklik is daarmee? [*smiling*]

Heidi: Ja... uhm... Ek kan nogal... Ek het nogal begrip daarvoor met die groot vloed wat nie net in die Bybel beskryf word nie, maar wat in baie ander kulture ook beskryf word... uhm... kan ‘n mens dan indink dat daar moet soortvan ‘n massa-uitsterwing van spesies gewees het, en dat jou... jou kleiner spesies heel moontlik eerste uitgesterf het of gesterf het as gevolg van die water oor die hele aarde en dat dit is hoekom jy hulle in die... in die lae kry wat dieper lê en dat jou groter plante/diere later uitgesterf het en dat hulle in die hoër lae en die meer onlangse lae van die aarde dan nou voorkom. Uhm, wat dan nou eintlik soos ‘n verduideliking kan gee van hoekom lyk dit vir ons asof party organismes baie ouer is as ander omdat hulle in dieper lae van die aarde

gevind word... die fossiele gevind word in die ander hoër lae... Uhm... [*looking up*] en ja, omdat dit eintlik uit... uit kultuur vertellings kry ‘n mens dat hierdie verhaal oor die vloed kry jy regoor die wêreld. So, dit... Dis nie net ‘n Bybelse verhaal eintlik nie. En dat ja, daar moes mos fossiele gevorm het tydens daai vloed ook nou, so, waar is hulle nou ten opsigte van die fossiele wat ons dan nou wel vind? Is daai fossiele wat ons vind nie juis daai vloed se fossiele nie? Uhm, so, ja, dit is nogal enetjie waaroor mens kan dink, maar ek gaan maar eerder saam met soos in... soos wat die Bybel dit dan beskryf, sal ek dit dan aanvaar. [*nodding*]

Leila: Okay, ek verstaan wat jy bedoel. Uhm, en dan die tweede laaste vraag is: **Hoe is dit om ‘n kreasionistiese Christen te wees wat die teorie van evolusie aanbied?**

Heidi: Ja, ek dink soos wat ek al van tevore gesê het, dit... dit is konflik binne in ‘n mens self. Dit is uhm... Dis moeilik om jouself te versoen met dit wat jy moet aanbied en dan probeer ek maar, soos wat ek sê, soos ek vir die kinders probeer perspektief skep, moes ek maar eers vir myself probeer perspektief skep soos in: ons leer dit dat ons weet waaroor dit gaan en dat ons weet op grond waarvan stem ek saam en waarvan stem ek nie saam nie, uhm, want ek kan nie... ek kan nie ‘n mening uitspreek oor iets waarvan ek niks weet nie. So, dis maar... dis maar my manier om myself ook okay te hou [*smiling*] ... uhm met die onderwerp van evolusie. Ek kan nie daaroor praat as ek nie iets daarvan weet nie. So, ek leer dit wat ek... [*interrupting herself*] Ek lees ook daaroor dat ek... dat ek meer kan weet en dat ek meer kan weet waar verskil my opinie [*nodding*] van die opinie van evolusie, en miskien kan ek op hierdie punt uitlig dat my opinie verskil eintlik op daar waar dit betref dat daar is in in... As mens nou kyk na natuurlike seleksie, dood is eintlik ‘n dryfveer vir evolusie in die opsig dat jou ongewensde kenmerke is die kenmerke wat uitsterf, terwyl die gewensde kenmerke is die kenmerk wat oorleef en wat oorgeërf word, en as Christen glo ek dat die dood het met die sondeval gekom.

So, voor die sondeval was daar nie dood nie. So, daar kon nie evolusie voor die dood gewees het nie. Uhm... So, uit my verstaan vanaf die Bybel dan nou is dat dood het gekom toe mense uhm sonde gedoen het... Voordat mense op die aarde was, kon daar nie evolusie gewees het nie.

Leila: Sjoe, ek het nog nooit dit gehoor nie. Dis baie interessant. [*smiling*]

Heidi: [*smiling*] Dis die... Dis die enigste ding wat vir my sin maak van hoekom ek nie daarmee kan saamgaan nie.

Leila: Mm. [*nodding*] Uhm, enigiets anders oor hoe is dit om ‘n Christen te wees wat evolusie aanbied?

Heidi: Uhm... [*looking up*] Nee. Uhm... Ek dink net ook dat aan die positiewe kant is dit vir my ‘n geleentheid om vir kinders te leer om ‘n eie opinie te vorm wat miskien positief is... uhm... dat ‘n mens hulle kan konfronteer met iets waar hulle regtig ‘n opinie moet vorm. [*nodding*] Uhm... of nie noodwendig hulle moet nie, maar hulle... hulle besef... Wel, ek moet nou in hierdie ding moet ek my eie opinie vorm en ek moet dit uitleef. Die kurrikulum het ‘n bietjie verander ook daar, want aanvanklik was daar heel op die einde gewees oor die verskillende opinies oor dit, maar hulle het dit later gesê wel hulle gaan dit nie eksamineer nie. Ek dink dis... Uhm, ek dink dis maar net bietjie moeilik om dit te bepunt op die ou end. So, hulle fokus nie eintlik meer daarop dat jy nou half die verskillende opinies rondom evolusie hoef te onderrig nie, maar ek dink dis tog iets wat met die leerders gebeur soos wat hulle met die onderwerp gekonfronteer word... dat hulle besef... hulle... Jy kan jou eie opinie daaroor ontwikkel. [*nodding*]

Leila: Ja, ek verstaan. Uhm, en dan die laaste vraag is: **Wanneer jy die teorie van evolusie aanbied, hoe laat dit jou voel?** [*smiling*]

Heidi: [*looking up*] Ooogh, dis altyd soos in ek uhm... Ek moet nou altyd mooi moed skep... [*smiling*] om om hulle... soos ek vroeër gesê het, om nou nie die mat heeltemal onder hulle uittrek... uhm hulle geloofs... hulle geloofsstandvastigheid onder hulle uit te trek nie, maar om hierdie onderwerp tog by hulle tuis te bring sodat hulle dit op die ou end verstaan en leer en dan op die ou end hulle eie opinie daaroor kan vorm, maar dit is nogal... Dit... Elke klasgroep wat 'n mens kry het ook maar 'n ander belewenis daarvan en sommige jare dan's dit half net makliker. Hulle... hulle verstaan makliker kom ons leer die ding. Kom ons gaan daardeur. Ander jare kry jy groepe wat... waar dit moeiliker is... Dis amper asof jy nie gevorder kry nie... deur die werk wat jy moet doen nie, want hulle bly heeltyd vassteek by hierdie vrae wat hulle vra en dan raak dit vir my ook moeilik. Uhm, want dan's dit soos in: Ek moet julle nou net hierdeur hierdie werk wat ons nou moet afhandel, maar ek sien julle sukkel... So, nou... dan... dan sukkel ek ook. Dan's dit vir my moeilik en ek het nou hierdie jaar het ek daai ervaring dat ek toe op 'n kol besluit het kom ons... nou los ons nou gou net eers die gedeelte dat ons net eers met ander werk wat ons nog moet doen vinniger kan klaar maak en dan sal ons weer... Dan gaan ek nou weer... Dan het ek darem net weer tyd om bietjie half... weer 'n plan te kry om hulle weer daar te kry en hulle het ook 'n bietjie tyd om om dit te laat insink by hulle dat hulle nou net die res van die gedeelte... die laaste gedeelte daarvan kan klaarmaak. Maar ja, so, party jare gaan ons makliker daardeur, maar ja, dit is vir my... dit is vir my moeilik. [*smiling*] Uhm, ek moet maar elke jaar mooi myself 'compose' en en myself agtermekaar kry om gereed te wees om vir hulle hierdie onderwerp aan te bied. Ja. [*nodding*]

Leila: Ja, ek kan dink. Uhm, enigiets anders oor hoe dit jou laat voel om dit aan te bied?

Heidi: [*looking up*] ... Nee, dit is uhm... ek dink dis nou... omdat ek dit nou al 'n hele paar jaar doen raak dit ook half makliker, want 'n mens het meer ervaring... Jy weet 'n bietjie beter hoe om dit aan te pak met jou... met die leerders... Maar

ja, dit hang maar af van, soos ek sê, van die groep leerders af en hoe hulle dit ook beleef en hoe hulle dit ervaar... uhm... wat dit dan nou vir jou makliker of moeiliker maak om... om dit te doen. [*nodding*] Uhm, ek kan maar net ook sê; ek dink die meeste mense in die algemene breë gemeenskap praat maklik oor evolusie, maar hulle weet nie eintlik regtig waarvan hulle praat nie. [*smiling*] Uhm... So, dis dis soms asof jy... Jy kry mense wat maklik sê: "Ja, evolusie dah dah...", maar hulle kan nie regtig vir jou sê hoe dit werk nie. So, dit... Hulle verstaan nie eers natuurlike selek... [*interrupting herself*] So, uhm, dan dink ek baiekeer soos klomp mense wat praat oor DNA en hulle weet ook nie eintlik hoe dit werk nie. [*smiling*] Ek het al gesprekke gehad waar mense vir my gesê het: "Ja, as jy baie piesangs eet gaan jy ook 'n piesang raak, want jy kry die DNA van die piesang... word deel van jou... [*laughing*] word deel van jou DNA en daai goeters... So, uhm, ek dink maar net dan probeer ek maar in my klas dat weer daai begrip van: weet maar waaroor dit gaan, dan kan jy daaroor praat. Maar ja, dit... Vir my is dit net moeilik om dit aan te bied. [*nodding*]

Leila: Ja, ek verstaan. Dit was die laaste vraag gewees. [*smiling*]

Heidi: Okay. [*nodding and smiling*]

Leila: Is daar enigiets anders wat jy wil noem of uhm of ja enigiets?

Heidi: [looking up] Uhm... ek uhm... Ja, kom ek sê gou so. In die kurrikulum word dit nie regtig spesifiseer as mikro-evolusie en makro-evolusie nie. Né? Maar ek sal nou byvoorbeeld in my klasse sal ek die leerders daarop attent maak. Dat ons kry die mikro-evolusie en ons kry die makro-evolusie, maar in die CAPS dokument byvoorbeeld word dit glad nie so uhm afgebaken nie, uhm, wat ek dink eintlik half 'n leemte is, uhm, omdat dit wat... omdat dit... Ja, daar's tog, ek wil nie sê dis twee verskillende goed nie, maar dit... die mikro-evolusie idee, die natuurlike seleksie... daai... dit is wat 'n mens kan navors en jy kan

Reluctance to teach evolution

dit nagaan en alles. Die makro-evolusie is ‘n groter idee wat ons nie regtig so breedvoerig dan nou ook uhm met ons leerders doen nie. Dis net die algemene ding. Visse, amfibieë... maar nie: wat is al die veranderinge wat moes plaasgevind het om van ‘n vis tot ‘n amfibieë toe te verander nie... Uhm, so dis uhm, die... Nog ‘n ding van die kurrikulum is dit is amper asof daar’s... in ‘n sekere sin wil hulle net hê jy moet die algemene groot idee hê en dan is daar weer ander goed wat jy baie spesifiek moet moet leer. En ek sien ook nou maar soos met matriekvraestelle, hulle is eintlik maar beperk met die vrae. Daar is altyd ‘n vraag oor natuurlike seleksie. Daar’s altyd ‘n vraag oor spesiasie. Dan’s daar ‘n vraag oor die verskil tussen die uhm skedels en die skelette van die mense en die hominide en die uhm primate... So, dis half dieselfde goed oor en oor. Daar’s niks tussenin nie. Uhm... So ons... So, ek hou dit ook maar baie gerig op: dis net dit wat jy moet weet vir die eksamen, veral as dit nou in matriek kom, ook omdat ‘n mens se tyd beperk is en jy kan nou nie so baie tyd spandeer nie, maar ‘n mens sou eintlik baie meer tyd kon spandeer aan al die goeters – nie dat ek regtig wil nie [*laughing*] – dat ek meer oor evolusie vir hulle wil leer nie, maar dit is net... Dit is ‘n baie breër onderwerp eintlik wat dan nou maar net kortliks afgebaken word, maar ja, daar’s nie daai... daai skeiding tussen mikro-evolusie en makro-evolusie in die... in die kurrikulum... uhm vir die leerders uiteengesit ook nie.

Leila: Ja. Ek waardeer dat jy iets noem van die kurrikulum, want dit... Ek studeer kurrikulum studies, so ek sal definitief dit kan gebruik in my projek. [*smiling*]

Heidi: [*nodding and smiling*] Okay.

Leila: Uhm, so, ja, dit is al. So, is daar enige vrae vir my voordat ek die recording eers afsit?

Heidi: Uhm... net net rondom jou studies nou... Is dit... Jy’t nou ook BSc gedoen? Of hoe het jou pad geloop?

Leila: Kan ek maar die recording afsit eers?

Heidi: Ja. [*nodding*] Ek dink jy kan. Ja, ja.

APPENDIX F: Western Cape Education Department Approval

Western Cape Government
Education

Directorate: Research

Audrey.wyngaard@westerncape.gov.za
tel: +27 021 467 9272
Fax: 0865902282
Private Bag x9114, Cape Town, 8000
wced.wcape.gov.za

REFERENCE: 20210301-1300
ENQUIRIES: Dr A T Wyngaard

Ms Leila Laubscher
Suite 176
Private Bag X3041
Paarl
7620

Dear Ms Leila Laubscher

RESEARCH PROPOSAL: THE LIVED EXPERIENCES OF LIFE SCIENCES TEACHERS BELONGING TO DIFFERENT 'RELIGIOUS' BELIEFS: A FOCUS ON THE TEACHING OF EVOLUTION

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **02 April 2021 till 30 June 2021.**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Dr A.T Wyngaard at the contact numbers above quoting the reference number.
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

    The Director: Research Services
    Western Cape Education Department
    Private Bag X9114
    CAPE TOWN
    8000

We wish you success in your research.

Kind regards.
Signed: Dr Audrey T Wyngaard
Directorate: Research
DATE: 02 March 2021

APPENDIX G: Western Cape Education Department Approval

Western Cape Government
Education

Directorate: Research

meshack.kanzi@westerncape.gov.za
Tel: +27 021 467 2350
Fax: 086 590 2282
Private Bag x9114, Cape Town, 8000
wced.wcape.gov.za

REFERENCE: 20210301-1300
ENQUIRIES: Mr M Kanzi

Ms Leila Laubscher
Suite 176
Private Bag X3041
Paarl
7620

Dear Ms Leila Laubscher,

RESEARCH PROPOSAL: THE LIVED EXPERIENCES OF LIFE SCIENCES TEACHERS BELONGING TO DIFFERENT 'RELIGIOUS' BELIEFS: A FOCUS ON THE TEACHING OF EVOLUTION.

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **02 April 2021 till 31 March 2022.**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Mr M Kanzi at the contact numbers above quoting the reference number.
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. The approval of your research request does not imply a promise of any data from the WCED. Should you require data, you will have to request it from the participating schools where it will be possible to secure parental consent.
11. Please note that POPIA prohibits the sharing of personal information without parental consent.
12. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
13. The Department receives a copy of the completed report/dissertation/thesis addressed to:

    The Director: Research Services
    Western Cape Education Department
    Private Bag X9114
    CAPE TOWN
    8000

We wish you success in your research.

Kind regards.

Meshack Kanzi
Directorate: Research
DATE: 15 November 2021

1 North Wharf Square, 2 Lower Loop Street,
Foreshore, Cape Town 8001
tel: +27 21 467 2531

Private Bag X 9114, Cape Town, 8000
Safe Schools: 0800 45 46 47
wcedonline.westerncape.gov.za

APPENDIX H: REC SBER Approval

CONDITIONAL APPROVAL GRANTED
REC: Social, Behavioural and Education Research (SBER) - Initial Application Form

8 April 2021

Project number: CUR-2021-21630

Project title: The lived experiences of Life Science teachers belonging to different 'religious' beliefs: A focus on the teaching of evolution

Dear Miss Leila Laubscher

Your REC: Social, Behavioural and Education Research (SBER) - Initial Application Form submitted on 24/02/2021 11:33 was reviewed by the REC: Social, Behavioural and Education Research (REC: SBE) and approved with certain conditions.

This conditional approval means that the researcher may proceed with the envisaged research provided that they respond or adhere to the stipulations/conditions.

Ethics approval period:

Protocol approval date (Humanities)	Protocol expiration date (Humanities)
8 April 2021	7 April 2024

REC STIPULATIONS/CONDITIONS:

Thank you for a well-prepared application. There are just a few issues that the REC would like the researcher to respond to:

1) Under section 2.2, please include that this study will be conducted with teachers in the Western Cape. [EDIT REQUIRED]

2) Under section 2.4.2, the researcher indicates that there are no costs associated with this study. At a minimum, the researcher should cover/ offer to cover the data costs of her interviewees for the online interviews. Please indicate these costs and upload a budget here. [RESPONSE REQUIRED]

3) Under section 5.3, could the REC perhaps suggest that the researcher develop an online consent form where potential participants can tick a box to indicate their consent/ not? See also 5.11 [ACTION REQUIRED]

4) Under 5.16, the informed consent form: [EDIT REQUIRED]

a) Please edit the sections indicated in bold: "**The Life Sciences teachers different 'religious' beliefs.**"

b) under 2, please indicate how the data costs for the interview will be covered.

c) please see the point above about an online consent process, which should be reflected in the form.

5) Under section 5.21, please tick minimal inconvenience to indicate that participants will be giving of their time to participate in this research project. [EDIT REQUIRED]

6) Under section 6.2, please also tick Identifiers as the researcher will have access to people's names (and other identifying info). [EDIT REQUIRED]

7) Under sections 6.4, 6.6, 6.8, 6.10 and 6.11, could the REC perhaps recommend that the researcher backs up her data on SU's password-protected OneDrive? [ACTION REQUIRED]

8) Please note that the researcher does not yet have permission from the Western Cape Education Department to conduct her research. Please upload their permission under 8.2.6 before research can commence. [ACTION REQUIRED]

HOW TO RESPOND:

Some of these stipulations/conditions may require your response. Where a response is required, you must respond to the REC within **three (3)** months of the date of this letter.

Your conditional approval will lapse automatically should your response not be received by the REC within 3 months of the date of this letter.

For instructions on how to respond to these stipulations, please download the FAQ on how to edit your application and follow the steps carefully: HOW TO RESPOND TO REC FEEDBACK.

Where revision to supporting documents is required, please ensure that you replace all outdated documents on your application form with the revised versions.

INVESTIGATOR RESPONSIBILITIES

Please take note of the General Investigator Responsibilities attached to this letter. You may commence with your research after complying fully with these guidelines.

If the researcher deviates in any way from the proposal approved by the REC: SBE, the researcher must notify the REC of these changes.

Please use your SU project number (21630) on any documents or correspondence with the REC concerning your project.

Please note that the REC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

CONTINUATION OF PROJECTS AFTER REC APPROVAL PERIOD

Please note that a progress report should be submitted to the REC: SBE before the approval period has expired if a continuation of ethics approval is required. The Committee will then consider the continuation of the project for a further year (if necessary)

Included Documents:

Document Type	File Name	Date	Version
Data collection tool	Interview Schedule PDF 22-02-2021	22/02/2021	Final
Informed Consent Form	Consent form PDF 22-02-2021	22/02/2021	Final
Research Protocol/Proposal	19162758 MEd Proposal PDF 22-02-2021	22/02/2021	Final
Request for permission	WCED Request Letter	24/02/2021	Final

If you have any questions regarding this application or the conditions set, please contact the REC Secretariat at cgraham@sun.ac.za.

Sincerely,

Clarissa Graham
Secretariat: Research Ethics Committee: Social, Behavioural and Education Research (REC: SBE)

National Health Research Ethics Committee (NHREC) registration number: REC-050411-032.
The Research Ethics Committee: Social, Behavioural and Education Research complies with the SA National Health Act No.61 2003 as it pertains to health research. In addition, this committee abides by the ethical norms and principles for research established by the Declaration of Helsinki (2013) and the Department of Health Guidelines for Ethical Research: Principles Structures and Processes (2nd Ed.) 2015. Annually a number of projects may be selected randomly for an external audit.

Principal Investigator Responsibilities

Protection of Human Research Participants

As soon as Research Ethics Committee approval is confirmed by the REC, the principal investigator (PI) is responsible for the following:

Conducting the Research: The PI is responsible for making sure that the research is conducted according to the REC-approved research protocol. The PI is jointly responsible for the conduct of co-investigators and any research staff involved with this research. The PI must ensure that the research is conducted according to the recognised standards of their research field/discipline and according to the principles and standards of ethical research and responsible research conduct.

Participant Enrolment: The PI may not recruit or enrol participants unless the protocol for recruitment is approved by the REC. Recruitment and data collection activities must cease after the expiration date of REC approval. All recruitment materials must be approved by the REC prior to their use.

Informed Consent: The PI is responsible for obtaining and documenting affirmative informed consent using **only** the REC-approved consent documents/process, and for ensuring that no participants are involved in research prior to obtaining their affirmative informed consent. The PI must give all participants copies of the signed informed consent documents, where required. The PI must keep the originals in a secured, REC-approved location for at least five (5) years after the research is complete.

Continuing Review: The REC must review and approve all REC-approved research proposals at intervals appropriate to the degree of risk but not less than once per year. There is **no grace period.** Prior to the date on which the REC approval of the research expires, **it is the PI's responsibility to submit the progress report in a timely fashion to ensure a lapse in REC approval does not occur.** Once REC approval of your research lapses, all research activities must cease, and contact must be made with the REC immediately.

Amendments and Changes: Any planned changes to any aspect of the research (such as research design, procedures, participant population, informed consent document, instruments, surveys or recruiting material, etc.), must be submitted to the REC for review and approval before implementation. Amendments may not be initiated without first obtaining written REC approval. The **only exception** is when it is necessary to eliminate apparent immediate hazards to participants and the REC should be immediately informed of this necessity.

Adverse or Unanticipated Events: Any serious adverse events, participant complaints, and all unanticipated problems that involve risks to participants or others, as well as any research-related injuries, occurring at this institution or at other performance sites must be reported to the REC within **five (5) days** of discovery of the incident. The PI must also report any instances of serious or continuing problems, or non-compliance with the RECs requirements for protecting human research participants.

Research Record Keeping: The PI must keep the following research-related records, at a minimum, in a secure location for a minimum of five years: the REC approved research proposal and all amendments; all informed consent documents; recruiting materials; continuing review reports; adverse or unanticipated events; and all correspondence and approvals from the REC.

Provision of Counselling or emergency support: When a dedicated counsellor or a psychologist provides support to a participant without prior REC review and approval, to the extent permitted by law, such activities will not be recognised as research nor the data used in support of research. Such cases should be indicated in the progress report or final report.

Final reports: When the research is completed (no further participant enrolment, interactions or interventions), the PI must submit a Final Report to the REC to close the study.

On-Site Evaluations, Inspections, or Audits: If the researcher is notified that the research will be reviewed or audited by the sponsor or any other external agency or any internal group, the PI must inform the REC immediately of the impending audit/evaluation.

APPENDIX I: Consent form

UNIVERSITEIT•STELLENBOSCH•UNIVERSITY
jou kennisvennoot • your knowledge partner

STELLENBOSCH UNIVERSITY
CONSENT TO PARTICIPATE IN RESEARCH

You are invited to take part in a study conducted by Leila Laubscher, from the Faculty of Education in the Department of Curriculum Studies at Stellenbosch University. You were approached as a possible participant because you are a Western Cape Life Sciences teacher who teaches evolution as a curriculum topic.

PURPOSE OF THE STUDY

The purpose of the study is to explore five Life Sciences teachers' lived experiences of teaching evolution and to understand the complexity of teaching evolution as a curriculum topic in each teacher's respective context. The Life Sciences teachers hold different 'religious' beliefs from one another. This study is interested in how and/or whether a Life Sciences teacher's religious beliefs influence their teaching of evolution.

WHAT WILL BE ASKED OF ME?

If you agree to take part in this study, you will be asked to be a research participant in an online interview conducted through a Microsoft Teams meeting or Skype meeting. You and I will be the only two members in the online meeting. During the interview, you will be asked 12 questions about your teaching qualifications, career as a Life Sciences teacher, your lived experiences of teaching evolution as a curriculum topic, as well as your religious beliefs. The interview may take between an hour and an hour and a half. The interview will be recorded.

POSSIBLE RISKS AND DISCOMFORTS

Loss of or disruption of internet connection is the only potential risk. In such an event, the interview can continue when internet connection is functional again or the interview can be rescheduled for another time. No other foreseeable risks, discomforts and/or inconveniences are anticipated; however, if any discomfort arises, withdrawal from the study can be done immediately.

POSSIBLE BENEFITS TO PARTICIPANTS AND/OR TO THE SOCIETY

You will not directly benefit from this study. The potential benefits to society may include an educational contribution to social, behavioural and educational research if this study will be published.

PAYMENT FOR PARTICIPATION

The online interviews will require your personal time and internet data. Therefore, as payment, you will receive R50 per hour for your interview. Therefore, the length of your interview will determine the amount of money you will be funded for data costs. Since the exact interview time will only be known after your interview has been conducted, you will receive a data voucher from your internet service provider or cell phone network of the calculated amount after your interview has been conducted.

PROTECTION OF YOUR INFORMATION, CONFIDENTIALITY AND IDENTITY

Any information you share with me during this study and that could possibly identify you as a participant will be protected. This will be done by keeping your identity protected through anonymity. You will be provided with a pseudonym throughout the research process and in the final research report. Interview transcriptions (data) will be stored on my personal computer and hard drive for backup, which are both password protected.

The data will only be shared with my supervisor throughout the research process to ask for guidance, advice and feedback. The data will be shared as Microsoft Word document attachments through email correspondence. The emails are Stellenbosch University specific email-addresses and are password protected. The final research report will not reveal your identity. You will have the option to opt out of having your information shared. If you choose to opt out of having your information shared, your information will be deleted. The information collected for this study might be used for future publications.

The online (Microsoft Teams or Skype) interviews will be recorded (audio and video) in order to record your words, tone of voice and body language. I, as researcher, as well as my supervisor will have access to the recordings. The recordings will be used in the following manner: the recording will be transcribed into a Microsoft Word document in dialogue form, as well as containing information about tone of voice and body language.

If the study is published, anonymity will be ensured through using pseudonyms in the final research report publication. Confidentiality will be ensured through not disclosing your education institutions' true names nor any other names mentioned in the interviews. Pseudonyms will be used for those as well.

PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not. If you agree to take part in this study, you may withdraw at any time without any consequence. In such an event, you will be asked whether the information already gathered may be used in the study, for which you have the right to decline. You may also refuse to answer any questions you don't want to answer and still remain in the study. The researcher may withdraw you from this study if certain questions are not answered and insufficient data is available to draw meaningful conclusions.

RESEARCHERS' CONTACT INFORMATION

If you have any questions or concerns about this study, please feel free to contact Leila Laubscher at 073 909 2439 or email at 19162758@sun.ac.za, and/or my supervisor Lesley Le Grange at llg@sun.ac.za.

RIGHTS OF RESEARCH PARTICIPANTS

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. If you have questions regarding your rights as a research participant, contact Ms Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development.

DECLARATION OF CONSENT BY THE PARTICIPANT

As the participant I confirm that:

I have read the above information and it is written in a language that I am comfortable with.

I have had a chance to ask questions and all my questions have been answered.

All issues related to privacy, and the confidentiality and use of the information I provide, have been explained.

I will email this signed consent form to Leila Laubscher (19162758@sun.ac.za) if I agree to take part in this research study, stating my name and date of consent in the email correspondence.

By signing below, I _____ (name of participant) agree to take part in this research study, as conducted by Leila Laubscher.

_____ _____

Signature of Participant **Date**

As stated in point 5, you will receive an internet or data voucher from your internet service provider or cell phone network after the interview has been conducted. Therefore, please provide your internet service provider or cell phone network below:

_____

DECLARATION BY THE PRINCIPAL INVESTIGATOR

As the **principal investigator,** I hereby declare that the information contained in this document has been thoroughly explained to the participant. I also declare that the participant has been encouraged (and has been given ample time) to ask any questions. In addition, I would like to select the following option:

	The conversation with the participant was conducted in a language in which the participant is fluent.
	The conversation with the participant was conducted with the assistance of a translator (who has signed a non-disclosure agreement), and this "Consent Form" is available to the participant in a language in which the participant is fluent.

_____ _____

Signature of Principal Investigator **Date**

APPENDIX J: A PRESENTATION OF HOW EACH INTERVIEW WAS ANALYSED

The case of Zafir: Data Presentation

After I have gone through the checklist with Zafir, he had no questions, stated that he was fully informed and that the interview process may start. To the first question: "**Would you tell me about your teaching qualifications?**", Zafir answered that he had obtained a Bachelors in Science and did his "post graduate educator course". Thereafter, he started teaching for roundabout six years, and then completed his Bachelors in Education. Zafir had also been an examination marker for 20 years of his teaching career, and had been part of an IT program where he helped new teachers become proficient in IT.

To the second question: "**Why did you decide to become a Life Sciences teacher?**", Zafir answered that he had "been blessed when [he] was at high school" with "arguably [two] of the best biology teachers", who inspired him to "develop a passion for the subject". He added that his "love for the environment" and his "love for nature" were also "contributing factors". Initially, Zafir had hoped to study medicine; however, since "family circumstances […] persuaded [him] in the sense that [he] needed a bursary", Zafir obtained a "bursary from the Department of Education", obtained a science degree and he "[hasn't] looked back". Zafir added that he was also "blessed with having wonderful lecturers" at his university: "people who are leaders in their field" and who gave him "excellent insight". He had a "fantastic lecturer in Zoology", an "excellent Physiology lecturer", as well as in the fields of "Genetics" and "Microbiology". Zafir remembered the names of his lecturers and said:

> "So, I was just blessed having very good, excellent teachers at high school and then also lecturers at university"

The third question focused on the timeline of the research participants' teaching careers. Therefore, the question asks: "**How long have you been a Life Sciences teacher?**" With regards to Zafir's teaching experience, at the time of his interview conducted in 2021, he had been in the teaching profession for "34 years" since 1988. He had also been the deputy principal at the school that he is teaching at for 17 years and became principal of the school

thereafter. Thus, he had been principal for 5 years, at the time of his interview. Zafir had also been an examination marker for "more than 20 years". Even though he is the principal, Zafir still manages to teach some Life Sciences classes.

The fourth question asked, "**Did you study the theory of evolution in your undergraduate studies?**". Zafir answered: "Yes, I studied evolution." Question 5, focusing on Zafir's experience in engagement with the theory of evolution in his teacher education studies, asked: "**Did you study the theory of evolution in your teacher education studies, so specifically referring to PGCE and your BEd.**" Zafir answered "Yes".

Question 6, which aimed for Zafir to talk about his **experiences regarding learning about the theory of evolution in his undergraduate and teacher education studies**. When Zafir was asked to elaborate on what he had learned about (referring to evolution) in his undergraduate studies, he stated that in his first year at university, he was introduced to evolution and studied "the origins of life", which was his "first exposure to […] evolution" in his undergraduate studies. In his second year, they "branched out a little bit more" on "diversification". Zafir went on to explain that learning about the "origins of life" in Zoology, Botany and Microbiology, and then building on that knowledge, is "probably the best way [*smiling*] to study science, to study any subject." Zafir also stated that, when he was "18/19 years old at that particular point", his "development into the understanding of evolution uhm… obviously also came through reading." Zafir went on to discuss some of his teaching approaches in relation to the theory of evolution, which is discussed in later paragraphs (**code 8** and **code 9**). With regards to learning about evolution in his teacher education studies, Zafir explained that he was "very blessed with a very good […] method lecturer" in his PGCE, and when he did "Philosophy of Science in [his] method also for [his] BEd", "a lot of theories" were "debated and discussed in that area". This exposure "all helped in [his] understanding". In response to the fourth question, Zafir went back to when he was "18/19 years old" and stated that at that stage he had already started to grapple and ponder over "Quranic verses" about creation. In "those early years" he was aware of what he believed in, as well as "what scientists are saying". Zafir described seeing "pictures of an ape and then you see this […] transformation to an adult man walking upright" in the "life books" that he had at home, as

S, N, H

M, N, H

his father was also a teacher. Before Zafir had even studied in university, he asked himself: "Really? Is this how we've evolved? From being an ape to a human"; however, "through reading [he] began to try and make meaning of what was going on and [he] gradually [started] to formulate ideas in terms of what [he was] dealing with". Zafir began to realise that "[y]ou have your beliefs" and that "you have your scientists trying to make meaning of what they observe and what they see and try to explain through their theories […] how life originated […] and how life evolved". Thus, as he developed, he began to formulate an understanding that "God had a hand in it". So he came to believe that:

M

> "there's your religious belief and there's your scientific beliefs and, you know, scientists are trying to explain what they observe, but it doesn't mean that you can't believe, you know, you know when God says I created life; I believe God created. You know, when scientists talk to me about mutations and they talk to me about variations, as a person of the Muslim faith, I believe that God had a hand in it and so God has a hand, God is, you know, that super being and what scientists are saying in my opinion is the work of God and that's the way I look at it. [*nodding*]"

His above explanation also falls under code 10, as it explains his religious beliefs. In his response to the sixth question, Zafir explained that being "blessed with having excellent […] lecturers at university and people who are leaders in their field" and practically reading up about it, "all helped to develop [his] understanding of the theory of evolution. And […] it went a long way in getting [him] to understand evolution." So, that was where Zafir "really also developed this passion for the Sciences".

S, M

Zafir further stated:

> "I used to sit in the library and I used to read up the papers on uhm… you know, these latest discoveries as far as the Science, well, scientific American science journals"

and he continued with doing his own research as he was teaching. He "read newspaper articles" and uses the internet to read more about, for example, "Craig Venter, and the work that they are doing in the Sargasso Sea… and going down, deep down, [*pointing and looking downward*] you know, in the Pacific Ocean and trying to locate microorganisms there and getting some understanding of possibly how life started". Zafir doing research in his free time brings me to a missing code. During the analysis process, I have realised that an additional

code emerged. I had not asked the research participants about their experiences learning about the theory of evolution while formally teaching or in their personal time, something that four of the five research participants had talked about in response to other interview questions. Therefore, an additional code focuses on the **teachers' experiences learning about the theory of evolution while they were in practice or in their own personal time**. In Zafir's free time as a student and teacher, he read many sources related to evolution, as he considers himself "to be someone who's always been interested in the latest research happening in the Sciences, happening in the Life Sciences, especially with regard to Genetics and Genomics". In response to question 8, Zafir stated that the "Teacher Biology Project" assisted himself and other teachers in teaching evolution:

> "Evolution, in my opinion, is a conversation, because it's a concept that students find very difficult to grasp. Fortunately, […] resources are being made available and […] the Teacher Biology Project, TBP, […] in my opinion […] revolutionised [*grinning*] the teaching of Life Sciences in the Western Cape"

According to Zafir, this project, "equipped, in [his] opinion, Life Sciences teachers in the Western Cape well with […] having to teach the concept of evolution", and even teachers from other provinces joined the program. Talking about his own education, as well as how he continues to read about scientific discoveries, Zafir also stated that that "it's about building and acquiring and understanding the knowledge so that when you are confronted within the classroom you're able to deal with those issues."

The seventh question was: "**Could you describe a typical day in your classroom as a Life Sciences teacher?**" Zafir stated that his "typical day is a busy day". Zafir explained that he believes a science teacher must create visual components for his students. He would have a box filled with the material "needed for the content to be covered". When teaching Life Sciences, Zafir would use models, skeletons, "transparencies" and now "data projectors". Zafir also mentioned that having his school be a part of an annual science exposition, has formed the "foundations of [his] teaching of Life Sciences". In order to foster young scientists, Zafir makes sure that his learners "understand the scientific method". The learners at his school are welcomed with science workshops and learning about the scientific method, and later in the year the school has their own "mini expo". He emphasised that "that is how

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you *develop* [*nodding head*] scientific thinking". Zafir ended his answer to the question by concluding that a typical day for him is a busy day, since he prepares his experiments and demonstrations himself. In response to question 10, Zafir also emphasized the importance of evolution in Life Sciences in his teaching. He explained that he makes his learners aware of the impact that they have on the environment, and that they need to understand how evolution is interlinked with other topics. He said:

> "They are all interlinked with each other, and so, as a Life Sciences teacher, evolution is a very important component of them understanding of what happened in the past, and where we are currently going to."

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The eighth question asked: "**Could you describe a typical lesson where you teach the theory of evolution, specifically?**" This question aimed to find out Zafir's teaching style of how he approaches teaching the topic of evolution. Zafir believes that "as a teacher, you have to be well prepared". He believes that knowing the content very well is important, "because students will pick it up pretty easily whether you are reading from a book, or […] you have memorised certain things and that is what you are giving over to them." When teaching evolution, Zafir wants his learners to understand "how the scientific method works". Zafir starts his first lesson on evolution by discussing religious beliefs, where he allows his learners to "talk about how they understand evolution and how they understand the origins of life." Thereafter, Zafir would provide his own understanding to the learners and explain how he understands the interpretation of the Quran in terms of where life started. He believes that "God created life" and that he does not question nor doubt it. Then, he discusses different theories with his learners "how over a period of 250 to 300 years, how scientists have tried to make meaning of where life originated from and how life evolved". Theories such as Lamarckism, Natural Selection and Punctuated Equilibrium are discussed, which "takes about two to three periods". He also discussed a teaching approach that he uses in his classroom which entails asking the learners to present the theories in order to get them focused on the topics. Thereafter, there is usually an "interesting debate" happening in Zafir's classroom. Then, he "[puts] up [his] slide on natural selection, which is the way […] scientists view how life evolved." Zafir also discusses changes in the environment and the "variation that happens", where the organisms with the "favourable variation are the ones

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who will survive" and the "ones with the unfavourable variation, they die." He further explained that: "[o]ver many generations, the population of the ones with the favourable variation, they are the ones who survive and […] that is how we find that the phenomenon of microevolution happens. And over longer periods of time, we find that macroevolution occurs. And so, it's a journey." The latter discussion would take about "three or four periods". Then, Zafir tells his learners that if they understand the particular slide that describes "how natural selection happens or how species have evolved", then they would not experience any problems when "the evidence for evolution" is discussed. Zafir believes that evolution as a topic that cannot be rushed. He has also learned during "this COVID period" that "you can't teach evolution online". He believes that "[i]t's got to be face-to-face" and "in the classroom, because […] misconceptions happen so easily". Zafir learned from his experiences of teaching evolution that "[o]nce students begin to grasp" the concept, they have "a better understanding of it" and then "they enjoy it". He also believes that it is important to provide the learners with "visual stimulus". An example of how Zafir provides his learners with visual stimulus is by playing a "short clips" on human evolution and how it connects with changes in the environment. He teaches them about "the situation of continental drift", the "Out of Africa Hypothesis", "where our ancestors found themselves in an environment where it was mainly a boreal forest". Zafir explained that he wants his learners to understand that "as continental drift happened, and the environment started to change", "natural selection happens", which will help them to understand "human evolution". He further explained that he wanted his learners to grasp that the change in the environment impacted being a biped, rather than a quadruped. He also mentioned "*Homo habilis*, the toolmakers" and "how the facial features started to change". Continuing his discussion of how he approaches teaching evolution, Zafir talks about other topics that connect to evolution, such as meiosis in genetics, since "one of the vehicles", besides environmental changes, "is also variation". Zafir emphasized the importance for learners to "understand where the changes in our makeup happens". For example, he brings to his learners' attention that "we all have the same basic structure, but we all look different from each other." He explains that it came about through different variations of genes, and that it is important for learners to understand meiosis in order to understand evolution. In terms of teaching the topic of human evolution, Zafir mentioned:

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> "What students need to understand is that whole story about how the environment changed, you know, from forest environment to a grassland. And it favoured being upright. If they can grasp that, that then when you teach, differences between a chimpanzee and an Australopithecus and the homo species, then they understand much better."

Another code that was found by working through the data, is **how the teachers experienced and applied the curriculum in their classrooms, with regards to having to teach the theory of evolution**. In response to question 6, Zafir had "gone off topic" from the question, but provided some insight into his views about the curriculum. Zafir explained that, with the "old syllabus", evolution was covered in the "plant kingdom and animal kingdom", with a "focus on genetics and human reproduction", which provided his learners with "a good grounding in genetics". This was also used to "sift [their] higher grades from [their] standard grades", by providing the learners with "an intensive higher grade paper in […] grade 11, on genetics", which gave them "a sense as to who can cope [*gesturing to one side*] and who can't cope [*gesturing to the opposite side*] and so the ones who battled, with all due respects, we did our own bit of Natural Selection… in biology, [*laughing*] and the ones who couldn't cope with genetics, we'd rather encourage them to do biology on a standard grade. But the majority of our kids did biology in higher grade because we had excellent teachers at the school at the time."

After I had asked Zafir: "**Tell me about your experiences teaching evolution.**", he firstly emphasized how important it is to be in the classroom, to be well prepared, to be focused and to engage the students in the content. Zafir answered that he experiences teaching evolution as "probably the most interesting section of the work". He has experienced that "a lot of questions [are] being asked in this section of the work". In terms of how Zafir has experienced the reactions of his learners and their parents learning about evolution, he has noticed that evolution is being regarded as a "controversial topic". He explained:

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> "You know, they come from their religious backgrounds so when they go home and they talk about the evolution… you know… Parents are also going: 'Why? Why are you being taught about evolution and all that nonsense?' Uhh and so, that is what

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> makes it more interesting… is that when they are being taught a topic that is seen to be a controversial topic, when in fact it's not a controversial topic, uhh, it's been made to be a controversial topic by your Imams, and your shakes and your ministers and so on… your religious ministers… They made it a controversial topic. It's not a controversial topic. And as long as you can distinguish between what is religion and science, there shouldn't be any problems."

In terms of his experiences teaching evolution, Zafir also explained that he tries to teach the "youth" about "tolerance". He explained:

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> "when a child puts up his hand in the class and says: "Sir, that's a lot of nonsense. I don't believe that." Now, you've got to engage that young man or that young girl with that concept [*nodding head*] and that is where the whole concept of inclusivity comes […] and this is how we develop citizens in our country".

Since Zafir had mentioned in his response to question eight that "**misconceptions** happen so easily", I asked a follow up question (which can be regarded as an additional code coupled with experiences of teaching evolution): "**Could you provide me with some examples of misconceptions?**" Zafir explained that learners battle to understand that, in terms of natural selection, "changes that happen to the environment" drive evolution. The biggest misconception that learners have in Zafir's experience is "'to adapt' or 'adapted to'", since learners understand that "organisms adapt" and not that their species has adapted to a change in environment. While being an examination marker, Zafir noticed which concepts learners battled with. He "picked up" that "with all due respects to [his] colleagues, it's because of how the teachers taught the concept of 'to adapt' and 'adapted to' and so for *[him]*, that was the biggest misconception that [they] started off with as far as the teaching of evolution is concerned." Another misconception Zafir had noticed was regarding the theory of Lamarckism. He realised that as he teaches different theories, the learners soon "start to confuse […] Lamarckism and that of natural selection." Zafir also added that "youngsters seem to battle with [the] particular concept" of "homologous and analogous structures", referring to the former being animals having a common ancestor and latter, animals having different ancestors. In terms of human evolution, Zafir stated that:

> "I think that, when we talk about misconceptions, in my opinion, a lot has to do with how it is taught to our children."

When the time for question 10 arrived, I asked Zafir: "**Tell me about your own religious beliefs.**" Zafir answered that his religious beliefs are based on the "Shahada", that he believes that "there is only one God […] and that the prophet Muhammad" is the "final messenger" of his God. He added that there are five principles on which his religion is based, such as performing five daily prayers, "fasting during the month of Ramadan" and "charity". He also hopes to still perform his "pilgrimage to Mecca". The foundations of his religion are in the "teachings in the Quran" and "the Teachings of the Prophet Muhammad". He referred to the actions of his prophet, "the Sunnah" and the sayings of his prophet, "the Hadith". Zafir explained:

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> "those are the foundations that I would uphold and I would think I am upholding. Uh, Islam, like I would say probably any religion, is seen as a way of life, and so to the best of my ability, I try to uphold those uh values; uhm, Islamic values, and I want to say that when I engage with my colleagues from other faiths, we share those values."

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In response to question 11, Zafir added information about his religious beliefs explaining that "things happening […] with Isis and the Taliban" are not Islam, even though "the West would want to portray that that is Islam". He stated what what is "what's happening in Afghanistan, […] Syria, […] is not Islam" and that is "not the way [he reads his] Quran". He explained:

> "Our prophet was someone who had a lot of empathy and a lot of respect, and he was spat at… You know, stones were thrown at him during his lifetime… uhm… and he did not respond. When the body of a Christian person or person of another faith passed by his place, he was outside and he would stand there and he would show his respect. Now, those are the values, uhh, that I believe is Islam about."

In order to understand **what it is like being a Muslim Life Sciences teacher, teaching the topic of evolution**, I asked Zafir the 11th question. Zafir answered by reflecting on listening to the words of Professor Enver Mall, which helped him to separate religion from science. He explained that this professor's talks provided him "with the necessary confidence as a Muslim […] to be teaching the topic of evolution". He continued: "not that at any stage I

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doubted being a Muslim teaching the topic of evolution, because as I have made it clear from the start; there's my religion and there's science." Zafir explained that, as a science teacher, even though "it hasn't really been for [him] a problem being a Muslim teaching the topic of […] evolution", he has had "quite a few colleagues of the Muslim faith" who "would still question the teaching". However, in his opinion:

> "you're questioning it, because you don't understand… how the information, the evidence was presented […] and that is a worry when you teach evolution and you still have that philosophy or that way of thinking. So, for me it's not a problem."

Zafir provided another explanation of what it is like being a Muslim teaching the theory of evolution, reflecting on how he was raised. Zafir stated that as he grew up with his family as "probably only about one of two Muslim families in that neighbourhood", his father, a religious minister who "translated the Quran to Afrikaans", taught him to be tolerant of others with differences in beliefs. The reason why Zafir also says that being a Muslim teaching the theory of evolution is "not a problem", is because of the fact that [his] foundations in [his] opinions were solid, from a religious side of things." He proceeded to explain why his foundations were solid by elaborating on what his father had taught him and talking about the environment he was raised in. He explained that his father taught him "religious tolerance", even though "[h]e was persecuted by certain members of the Muslim community". Zafir elaborated on his father's respect for their neighbours who were all of the Christian faith. For example, when Zafir and his family practiced "prayers in the evening", he would "find that the road was quiet", as his neighbours could "hear the Adhan" and respected his faith. When it came to "religious festivals or religious gatherings", such as "Eid" or "Christmas", they would respect one another. Zafir concluded:

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> "So, that is the environment that we grew up in. Tolerance. […] So, so, when you asked me about my beliefs, and how that impacts, you know, I would say that it's about tolerance."

Furthermore, Zafir also added that he does not see himself as a "Muslim teacher". He said:

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> "I'm a teacher at [school's name], because I have students of the Christian faith, I have kids of the Muslim faith, of the Hindu faith… So, you are a teacher first."

He further explained that "there is a Constitution that, as South Africans, we have to uphold".

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Zafir believes that one's religion is "between yourself and your maker", whereas the

"Constitution of a country is what you have to uphold as a citizen of your country". He also believes that the values and rights of the Constitution need to be promoted and upheld carefully.

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The last question aimed to understand **how teaching the topic of evolution makes Zafir feel**. Zafir stated that "it's a chapter [that he looks] forward to teaching", since "evolution is a concept that you can apply to all aspects of life". As a biological concept, Zafir is excited to teach the topic of evolution, as "there's gonna be debate, there's gonna be discussion", which for Zafir, "is what teaching and learning is about". Zafir believes that teaching and learning is about engagement. He proceeded that the concept of evolution is a topic that he enjoys teaching and that he will "always look forward to teaching the concept" as long as it is in the curriculum.

The case of Saadiq: Data Presentation

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After I had welcomed and thanked Saadiq for his participation, and gone through the checklist, Saadiq did not have any questions, but wanted to know whether he could ask questions later on in the interview if needed. I replied: "Yes." The first question asked Saadiq about his **teaching qualifications**. Saadiq had obtained a BSc degree, followed by an "8 stage" Higher Education Diploma (specialising in Life Sciences and Natural Sciences), which qualified him to be a teacher. When he did his BSc, he had subjects such as Zoology, Botany and Microbiology. He explained: "So, you can see there's a good mixture of content related to the teaching of Life Sciences that I did in a BSc." He had also obtained a BEd Honours and MEd thereafter and at the time of his interview, he was busy with his Ph.D.

Thereafter, I asked Saadiq: "**Why did you decide to become a Life Sciences teacher?**" Saadiq explained that he initially started to study dentistry. He explained how he went from dentistry to BSc, stating that in his first year of BSc, he had been accepted for Dentistry. Unfortunately, he had a tough year and experienced "unfair" examinations "when the country was in turmoil". Thus, he "went back to complete [his] BSc". Saadiq provided another reason why he went back to continue his BSc degree, by saying that he "always had a love for nature

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[and] for the outdoors […] and to care and to conserve […] and to protect the environment". He said that "[t]hat love was always there". Wanting to understand why Saadiq became a Life Sciences *teacher*, I asked a follow-up question: "And why did you decide to become a Life Sciences *teacher* specifically?" Saadiq explained how he had been inspired by "fantastic teachers" in high school, who "brought about a love for the subject". He stated that his majors in his BSc "steered [him] towards Life Sciences", and wanting to be a Life Sciences teacher.

The third interview question asked: "**How long have you been a Life Sciences teacher?**" Saadiq responded that he had been a Life Sciences teacher for "about approximately 30 years" since "1988" with a few years in between "during which [he] had to study". Saadiq had been teaching Life Sciences "from grade 10 up to matric", where he had a matric class "every single year". Thereafter, he added some details about the advantages of being a matric

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marker in Life Sciences, which gave him "good learning experience". Saadiq had been a matric marker in Life Sciences for "18 years", which "helped [him] to actually develop the subject better", since he learned "from other centres" and from the "mistakes learners make". Saadiq took what he had learned and improved his institution the following year. He added: "So, it is a very good learning experience." Saadiq also stated that another advantage of being a matric marker is creating a "network, when you mark with teachers from other schools", since "resources, ideas, even electronic information, electronic lessons" can be shared.

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After I had asked the fourth question, "**Did you study the theory of evolution in your undergraduate studies?**", Saadiq answered "Yes" and that evolution was briefly mentioned in his first year, but that he learned about evolution in his third year Zoology of his BSc degree in "quite a lot of detail". When asked whether Saadiq had **studied about the theory of evolution in his teacher education** studies, he replied that he had not learned about evolution in his teacher education studies and said: "Uhm… [*looking up*] No, no, not specifically, no. [*shaking head*] Not in HED. No, not that I can recall, no. [*shaking head*]" to which he added that "there was no particular reference to evolution or that evolution is a prerequisite for any of the modules to pass an HED at that time. So, it… it wasn't present in […] that diploma."

Saadiq was then asked the sixth question: "**Tell me about your experiences regarding learning about the theory of evolution in your undergraduate studies.**", to which he answered that he had a "very good" and "fantastic lecturer" in his undergraduate studies. The lecturer presented the topic "in an open minded", "very explicit, very good way". Saadiq's lecturer would "divide" the students "from different religious backgrounds" into "smaller groups" where they "had to discuss the theory amongst [themselves]". The lecturer allowed the students to "share [their] ideas with [their] peers" and to share their opinions about the theory in an "open discussion". He described the experience as "[v]ery free… you could speak freely" and that he "didn't feel uneasy to talk about it". Saadiq also stated that the lecturer "made it very clear that it is a theory; it's not fact", and that he tried to make the students learn "critical analytical thinking". Saadiq felt that the way in which the lecturer presented the topic, made him "think of evolution […] not as something to be afraid of". What this lecturer made clear to Saadiq was that "[p]eople can talk about it, but be open minded about it and respect others: others' views and their opinions". He stated that "by teaching evolution", the lecturer taught him "respect" for "other people's viewpoints". He reiterated that what the lecturer instilled in him was that "there will be people that will differ from you" and that they must be allowed to speak, and not be oppressed. Saadiq let this experience make him "regard evolution not as a threat", not to be "afraid of it" and to be able to engage in "controversial material". The lecturer also told the students to "always keep your religious beliefs close to you, but [to] read what other people are saying and then you decide if you want to agree with it or not, based on […] the knowledge you have about your religion, and […] about life in general". When asked whether Saadiq wanted to add anything else to his response to the sixth question, he added that in the examinations in university, he was "properly guided as to how [he was] going to be examined on the topic of evolution". Therefore, he did not feel that the topic is "threatening" or that it would "cause [him] to leave [his] religion and to join another […] ideology". In conclusion to his experiences of learning about evolution, Saadiq emphasized that the way in which the topic was presented taught him "how to handle a topic like that".

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The seventh question: "**Could you describe a typical day in your classroom as a Life Sciences teacher?**", was asked in order to understand more about Saadiq's teaching style. Saadiq answered that he was regarded as a "very funny teacher" trying to make his lessons "very exciting" and full of "variety". He stated that his learners "love [his] lessons", as he tries to "provide variety every single day" and generates excitement. Saadiq said that his lessons "would never be the same", which keeps his learners "on their toes and it keeps them excited all the time". Most schools that Saadiq has worked at "were very well equipped" and he "was always in a lab"; thus, for his lessons, Saadiq starts his lessons with a "hands on approach", "something that takes them out of their seats", such as using "microscopes". Later in the lesson, he would "get them back into their seats" and assess what they have learned. By his experience, his learners have communicated to him that they have "enjoyed [the lessons] so much". Then, Saadiq takes "all that fun", and brings the learners' attention to the "exam at the end of the day or test to be written". He tells them what they have "just learned in that dissection, for example, is important now for the test", and then he revises important concepts. Saadiq does a lot of preparation for his lessons, which he thinks "builds the love for the subject". Saadiq explained why he tried to make his lessons as exciting as possible, since "you can lose them if they have to sit in a seat for an hour". He believes in varying his lessons, making movement a part of his lessons and fostering curiosity so that the learners ask questions such as: "When are we getting up? When do we get to the front? When are we getting the scope? What is under that microscope? What do you have set up for today?" Saadiq talked about his experiences with his learners' reactions to his lessons: "It's not always that you find that when children walk[] out of your classroom that they say: 'Thank you, Sir. But I really enjoyed that today.' Because it takes so much effort to get them to that point and it just creates love for the subject." Saadiq stated that the learners "loved [his] lessons" and that he had received "good feedback as to how lessons were presented and how they enjoyed the teaching of Life Sciences" "from 99% of [his] learners". Saadiq explained that he had been a memorable teacher for some of his learners, as "some of [his] past pupils" would recognize him, shake his hand and say: "Thank you, Mr [Surname]! I really enjoyed your classroom." He spoke about an instance "one year at the marking centre" where a person came up to him, called him and said: "You are the one who made a difference in my life!"

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Thus, Saadiq stated that his previous learners "would never shy away or run away", but that they "want to meet up" with him and ask him how he is doing. He concluded his answer: "

> "So, a typical day in the Life Sciences classroom, I would say, is to provide all that variety, just to make the subject as excitable as possible."

After learning about Saadiq's teaching style, question 8 was asked: "**Could you describe a typical lesson where you teach the theory of evolution?**". Saadiq explained that, based on what he had experienced teaching the topic, he learned that he has to approach teaching the topic based on the religious beliefs of the learners who he needs to teach the topic to. He explained that "you need to touch on the religious background of what sits in front of you", since learners belong to different faiths. He explained how he changed his lesson plans based on the learners' belief systems and he focuses on "not offend[ing] anyone". For example, when he taught only Muslim students, he brought in "some faith information", such as "something about the Quran" and the "traditions of the Prophet". He discusses the Quran, asks "them what do they know about it and how it fits in with evolution". He would make it clear though, that what they are discussing is "not examinable", but that it is important for their understanding. When he teaches learners from the Christian faith, he would "shy away from that", "not put that into the lesson" and "rather then focus on what the curriculum is asking [him] to teach". However, he also asks them about their feelings toward evolution and what their faith says about it. If Saadiq teaches "a mixed group", he would "divide them into smaller groups of different faith and let them discuss it", after providing them with a "brief presentation about what the topic is all about and why people are saying it's controversial". After the learners have discussed this in their groups, Saadiq asks them to "report back from each group". Thus, the way in which Saadiq "tackle[s]" evolution "depends a lot on [his] audience, the type of student that sits in front of [him]". Saadiq added that because of the "abstract" nature of evolution, his learners want to "see the evidence", which "makes it very difficult to teach a […] topic like" evolution, as he believes that "there's no clear evidence that you can show them". He continued:

> "You can show them what's in the books and what you have electronically, etc. and what's on YouTube etc., but there is no real concrete evidence that you can show them.

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you know, in terms of school… at school level, perhaps university, so you'd have fossils and stuff that you could have a look at and so forth."

When he starts teaching the topic of evolution, Saadiq tries "to make it as simple as possible", by firstly starting off "from the basics" and discussing what a theory, hypothesis and fact is. Saadiq's class would then have "discussions based on the type of faith they belong to", where he tries to provide them with "a better perspective that […] different faiths have something in common when you discuss this topic". In this way, Saadiq feels that "evolution could actually be a way of understanding that there are similarities between religions", which "creates understanding between children", which for him "could perhaps be a positive" regarding the topic of evolution, since children can "see all these commonalities, similarities". This might make them realise: "Oh, but in some regards, we are the same. We believe the same, you know? We differ at certain aspects, but at some aspects we… we all agree on.". Saadiq believes that evolution brings the latter about, whereas "other controversial topics wouldn't have done that". Saadiq summed up his answer to the question:

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> "So, a typical day teaching evolution, I would start off with the basics. I'd give them an overview of what the curriculum requires, go into group discussions and have feedback from different, uh, religious groups. Yah. [*nodding*]"

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In his response to question 11, Saadiq also explained how he approaches teaching the topic to students of the Muslim faith, which fits with code **8**. He explained that, when he only has to teach students from the Muslim faith, he would show them "small clips on evolution as to how the Quran differs from the theory of evolution", by "Professor Harun Yahya from Turkey". Professor Yahya "takes the statements of evolution, what evolution is saying about creation, and then he takes statements out of the Quran and then he compares them with each other", showing "how evolution and the Quran differ from each other". Saadiq stated that if he teaches learners from different faiths, he needs to be "very sensitive and very careful", "because you do not want to offend anyone". He believes that the clips of Professor Yahya helps "the children out with conceptualization". He concluded:

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> "So, as I said before, the type of group that is in front of you determines your approach. So, this is what […] we've done with professor Harun Yahya's videos […] So, that made it a small interesting and, especially in the Muslim faith schools, it is something we could do, that we could not do in other schools. [*nodding*]"

To question 9, "**Tell me about your experiences teaching evolution.**", Saadiq answered that "it's easier to teach it with a group of the same religion, because [they] could go into various discussions and […] compare: this is what you need to learn for the exam, and this is what the Quran says, and you can see how they differ, while they're even similar." He stated:

> "So, teaching evolution to a Muslim group allows me as as as a Muslim teacher, uhm, to go beyond the syllabus, beyond the curriculum and have thoughtful discussions, because they can relate to what I'm saying in a better way than somebody from another faith. […] So, you have to be very careful when you have a mixed group how you do your discussion, and you have to make it very clear what is examinable and what is not examinable."

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Saadiq explaining that having a matric class since the start of the 30 years of teaching "was quite tough", focusing on his experiences of teaching evolution. With regards to teaching the topic of evolution to matric learners, Saadiq stated that "[i]n matric, they are focused so much on assessment and marks, they really don't want to have discussions". In his experience, he has found that the "first thing they will ask" is: "Sir, is this for marks? Why are you discussing this? Is this for marks?", and if he informs his learners that what they are discussing is not for marks, "they switch off". He explained:

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> "So, this… this is just part of the education system that we have. Everything is geared towards writing exams. So, the problem you have with engaging in a discussion in evolution, they firstly want to know: "Am I getting marks for this?" And if they're not getting marks, they they won't be interested. So, now you have to replan. […] How am I gonna get them interested? You've now gotta plan an activity that's going to involve them to get them interested, to get them into a discussion."

He discovered that the "main problem has always been time", as there is "not a lot of time for […] real life discussions on how do children feel about this topic", since they are more concerned about whether they are "getting any marks for this". Saadiq has noticed that when he uses "hands-on activities" "to explain evolution", he has his learners' attention; however, when he tells his learners that there will be "an open discussion about evolution, there would be some that would prefer to join in, but most of them will only be interested in: is this for marks?". Therefore, Saadiq feels that one of the problems in grade 12 is that "the matric year

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is too much geared towards exams and marks" that one cannot really have "open discussions". Another problem that he has experienced is the "time factor in matric", where there is not really "lots of time to have open discussions", since "Life Sciences is a very bulky subject to teach". From his experience, he said:

> "Uh, I can tell you this much; as matric teachers in Life Sciences, we are always the last people to complete the syllabus. All the other subjects, most of them they finish off here by June, July. Life Sciences teachers, right up to the mock exam in September, we still teaching… right before the exam, because we have such a bulky subject to teach; lots of content and lots of assessments. They've now reduced the assessments. [due to the pandemic] So, that helps a little bit, but it's very bulky to teach. So, we don't have a lot of time for open discussions which would have been valuable, especially concerning a topic like evolution."

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In response to question 9, Saadiq also spoke about some changes that his school made to the order of the curriculum in order to try and eradicate some of the problems that they had experienced, which fits into the code focusing on **how the teachers applied the Life Sciences curriculum in their classrooms, with regards to having to teach the theory of evolution**. He explained that the topic of evolution was found to be "too late in the year", as learners achieved "poor marks" when it was first covered in the third term. He stated that the learners "don't really understand what it's all about, because there's hardly any time to discuss it properly". Therefore, Saadiq and his Life Sciences colleagues "swapped evolution with human reproduction"; thus, "shift[ing] evolution into the second term" from the third term "because of its abstract nature". When evolution is first covered in the second term, the learners are tested on it for "three exams". As a result, Saadiq discovered that "it works", since they "got better results out of the children by moving evolution into the second term", as the learners "never repeated [the mistakes they made in June] in September". After a "discussion with one of the subject advisors", they were asked to "keep [evolution] in the third term" and not to "move or shift topics around". Due to this occurrence, Saadiq feels that there are "a lot of restrictions placed on the teaching of evolution, guided by what they exam wants"; therefore, "it restricts it more to […] knowing your facts, than to actually understand the concepts in evolution". Saadiq discussing how he feels about the dense grade 12

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curriculum, in terms of evolution, also relates to the code of how teaching evolution makes him feel (**code 12**).

Moving on to the tenth question, I asked Saadiq: "**Tell me about your religious beliefs.**" He answered that he is "a Muslim" and is "fully committed to Islam and the Quran and the example set by [their] prophet". He stated:

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> "I believe in the Quran and I believe in our Prophet Muhammad who […] we believe is the last prophet that was sent down to the earth and we believe in the message of that comes with the Quran […] We believe that our prophet came down as a practical example for humans to follow what we should do on the earth."

He has "traveled already to the holy sites; Mecca, Medina […] a couple of times", as he regards it to be "very sanctimonious if you have the opportunity to go there" and "the pinnacle in [his] life". Saadiq spoke about his personal relationships in relation to his religion, and stated that he has "friends from all faiths" and "choose[s] [his] friends based on character". His philosophy as a Muslim is that he does not "restrict [him]self to [his] faith and [his] own people". He engages with others "so that [he] can learn from them and, in reverse, perhaps they could learn from [him], so that [they] can find commonalities and share [their] humanity with each other." He further explained that he has "done studies" about the "Quran at a younger age", he "attend[s] a lot of Islamic lectures […] given by local scholars and also by international scholars that [come to South Africa]. In terms of Saadiq's role in schools, relating to his religion, he started the "Muslim Student Association", and he was also the "liaison teacher between [his] school and other schools".

Thereafter, question 11 was asked: "**What is it like to be someone belonging to the Islamic faith teaching the theory of evolution?**", to which Saadiq said that "evolution contradicts all aspects of the Quran" and asked if he may provide some examples. He explained:

Z

> "For example, the Quran says that man was created from a clot of blood. Evolution doesn't say that. [*shaking head*] For example, the Quran says that man was created from dust, from soil particles. Evolution doesn't say that. [*shaking head*] For example, the Quran says that man was created from, we call it nutfa; sperm. Evolution doesn't say that. So, when we started the origin of creation, the Quran gives you already the

information: how did Creation start. And you will not find that when you study the […] theory of evolution. So, automatically, the basis is already wrong. The foundation is weak. You know? Evolution doesn't have a beginning. Neither does it have an end, whereas in the Quran there's a beginning. The Quran tells that the beginning started with our prophet Adam or Adam [*Arabic pronunciation*], as we say. So, there was a beginning and there's going to be an end; the day when the world will be destroyed, the day of resurrection. So, the Quran teaches us that there's a beginning and an end, and evolution doesn't say that. Evolution is still looking for that ancient fish swimming in the ocean… that they're still looking for and they don't know where they're going. [*smiling*] They're still looking for the end. So, the basis of evolution and what is in the Quran about creation differs dramatically. Dramatically. [*shaking head*] And as as a Muslim, you obviously pick this up immediately, because you read through what you had to study at university. You read through what you have to teach to the children and you pick it up immediately: 'But this does not click. This doesn't click. This doesn't click.' [*shaking head*] So, that, as a Muslim, […] guides you or prepares you as to how you're going to approach the teaching of this… of the topic. As I said before, based on what sits in front of you. Is it a Muslim audience? Is it a mixed audience, etc. But as a Muslim, you already know… uh, how the theory of evolution differs with the Quran"

When asked whether Saadiq wanted to add anything else to his response to question 11, he talked about "[m]isunderstandings and misconception […] among your staff members, your friends, your colleagues at schools", also relating to the code of **misconceptions**. He reflected on the year 2008 when they had to teach the theory for the first time, "the science teachers were looked at as if we were monsters" and things were said to him like: "What are you doing to our children? What are you teaching our children?". He responded that he needed to attend workshops in which evolution was discussed where "ninety-nine percent of people in the workshop […] said they do not want to teach this to children"; however, even though their objection was taken to "national", "the following year" the documents were received, "everything […] in black and white" that they "just have to teach it". As a result, some peers and colleagues, "especially people who haven't studied evolution", "had some friction" and asked: "Why are you gonna teach this to our children? Huh? This is not what we want in schools." Saadiq explained that his colleagues did not understand that "there was great

objection, but [they] couldn't get through to national and to actually get them to get it out of the schools". Another problem that Saadiq had experienced was "[p]arents phoning the schools and complaining, especially staunch religious people", asking for example: "Why is my child coming home with this – inverted commas – nonsense? Why must my child study this? My child is a staunch Christian. My child doesn't have to be learned all this rubbish." Saadiq explained that parents and colleagues did not "understand what was happening" and "what [they] were going through", since they just had to teach it without other options. He felt obligated to teach it: "Either teach it or your child gets naught for the test or for that particular exam based on evolution." Due to this, Saadiq said that "in some respects [he] feel[s] it was sort of forced onto the schools", as most of the recommendations in the workshops were to "leave it at university" and not teach evolution in schools and "forcing it onto the children". However, "decisions [were] made that [were] way above [their] heads that [they had] no control over". Thus, Saadiq felt:

> "So, in my personal opinion is that since 2008, we were sort of forced to teach it. You teach it or your child gets naught, so make up your mind. So, you had to now adapt and you had to create… uh… good lesson plans to present this in such a way that you can get the child's attention. So, we had to adapt and we had to do it. So, that was another thing that we had to face regarding evolution. I personally feel it was forced upon us [*nodding*] and we we… our objections went through, but it wasn't taken seriously. [*shaking head*]"

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Finally, Saadiq was asked: "**When teaching the theory of evolution, how does it make you feel?**", to which his answered entailed a focus on the learners. Saadiq refrained from using emotion words and instead spoke about his approach to teaching it and how he has tried to teach it, irrespective of what he thinks should be taught. He explained that he teaches the topic "with the approach that at the end of the day, the learners have to write a test or an exam on it, especially in matric". He thought: "This child, irrespective of what I think of what my religious belief is, that child still needs to get good marks in Life Sciences, irrespective of my personal beliefs." Having that "viewpoint" Saadiq felt "very strong as to rather focus on […] pushing the child to a level where the child gets good marks in that section of the work", without "enforcing [his] personal viewpoint onto the child". He said that "at the end of the

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M, H

day", "no matter what [he says] about evolution, or what the child says about evolution; the end of the day, the the final thing you need to look at is: that child needs to get good marks in the subject." Saadiq stated that this mindset have him the "strength to teach it purely for getting good marks in the subject". However, "if time allowed it, [he] had discussions and […] had different discussions depending on what was sitting in front of [him]."

When asked whether Saadiq wanted to add anything else to his response to the last question, he tried to think of something "positive". When he teaches evolution he tells the learners:

M, H

> "Look. In your life […] post matric, you're going to come across controversial material… [*nodding head*] material you don't agree with [*shaking head*], but you have to read through it. You have to understand it. You have to be able to read through the lines. You have to do critical and analytical thinking. So, this is not the first time… This is actually practice for later in your years when you're going to study. […] This is sort of a training ground just to… just to make you aware that you're going to meet material like this that's going to be controversial and you need to be able to use your brain to understand what is going on here."

From a positive viewpoint, he tells the learners:

M, H

> "It's good. Let's do it. We can't control the teaching of it. We have to teach it. You have to get good marks. I have to teach it. So, let's carry on. […] maybe this is good training ground for you that when you get to university, you will be able to see when you read material, but this doesn't make sense. […] I don't agree with what this person is discussing. Let's go ahead. There's nothing we can do, but let's go ahead in such a way that it's training. This is regarded as training in handling controversial material, because once you get to university, you will know […] how to identify it."

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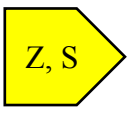
Due to Saadiq's approach to teach it "from a positive viewpoint", he feels that it "made [him] feel a bit stronger and more relaxed and easy about teaching it", since he focuses on the positive and does not "only just harp on what is negative about the topic". The way Saadiq approaches the topic in a positive manner connected to the way in which his university lecturer had taught him to approach the topic of evolution, in an "open-minded" way, mentioned in his response to question six (**code 6**). He carried this with him, and it made it easier for him to teach the topic, as he said:

> "So, I think the way it was presented to us at university level, was in in such a way that I felt: this is not going to be a threat to teach, because he actually gave us some idea how to teach it, because he was such a good lecturer at the time. […] So, from that point I felt if evolution would actually become a topic to teach in in the schools, I wouldn't be threatened to teach it, because he he actually trained us how to handle the material."

The case of Michelle: Presentation and Analysis

At the start of Michelle's interview, she was welcomed, thanked and the checklist had been gone through. She did not have any questions at the start of the interview. The first question asked: "**Tell me about your teaching qualifications.**" Michelle answered that she had studied "BSc Human Life Sciences", which she completed in 2010, and has also obtained a "PGCE" thereafter. In her PGCE, Michelle had subjects such as "Educational Philosophy", "Curriculum Studies", "Educational Discipline", as well as "two curriculum studies"; for Life Sciences and Natural Sciences, where she "worked through the CAPS document", looked at what needs to be taught and discussed "practical activities" that could be done.

Aiming to understand **the reasons why and how Michelle became a Life Sciences teacher**, she was asked the second question. Michelle talked about her love for Life Sciences stating that she has a "natural inquisitiveness […] for life". Michelle mentioned that she "had a very good Life Sciences teacher when [she] was at school", and she has "always just enjoyed the subject". She believes that Life Sciences is one of the "few subjects that [she] find[s] you take at school that actually prepares you for life after school", since "a lot of the skills" taught in Life Sciences "can be applied to later life". Michelle stated that "the study of life" is "something that's very interesting to [her]" and that she wants to "transfer that knowledge and that love for natural things to other people", which is "what made [her] decide to be a teacher… to take these complex processes and to simplify it so that children understand it and actually find it interesting". Michelle mentioned that when she teaches Life Sciences skills, she teaches learners "intentional and unintentional" skills, relating to the code of **how the she**



applies the Life Sciences curriculum in her classroom with regards to evolution. I then proceeded to ask her to elaborate on what she means. Michelle explained:

> "Yeah, so intentional, meaning the stuff of the curriculum that we have to teach them. Something as simple as you do a chapter on population dynamics and you teach them how overpopulation leads to, for example the spreading of disease… and lack of resources… And then you also kind of segue into more moral and ethical questions about overpopulation and how we as a species, for example, as a result of the choices we're making, how it affects the world around us as well, because we are a species that's impacting our environment."

Thus, Michelle draws from "natural principles" and then applies it to the way one thinks about life. Michelle was asked if she wanted to add anything to the second question to which she added that "personally" she wants "to make a difference" as a teacher, and said that she finds "a lot of [her] own inspiration in [her] own spirituality from the subject matter". She further explained:

> "So, nature as a whole to me is is very much a fantastic spiritual thing. So, uhm, I draw a lot from that to motivate and inspire students. And I've… I've found that that's a big part of who I am is inspiring other people and seeing that they're actually… [*hands gesturing inward*] they're taking something away from what I'm sharing with them."

The above quote also relates to her teaching style (**code 7**).

In response to question 3; "**How long have you been a Life Sciences teacher?**", focusing on her teaching experience time, Michelle answered that she had been a Life Sciences teacher since 2012, with one year in between that she did not teach; therefore, for "8-9 years basically".

To question 4, "**Did you study the theory of evolution in your undergraduate studies?**", Michelle replied that evolution was covered in her "first year of BSc, but it was not a very big part of the modules that [they] did". She further explained that evolution "was not the main part of [her] study field",

N

> "So, going into the teaching career […] I was very… I won't say unprepared… It was just not a subject matter that I had studied in depth and when I was at school it was also not part of our curriculum."

S, N, H

After asking whether Michelle had **learned about evolution in her teacher education studies**, she answered "no" and further explained:

> "I think people who go into PGCE, depending on where you take it, you're quite, uhm, shocked to find that [*laughing*] it teaches you very little of how you need to teach, or rather, what you need to teach."

When asked whether she had studied the theory of evolution while going through the CAPS document in her curriculum subject, Life Sciences, she shook her head, indicating that she had not. Michelle explained that "the main topics" were touched on and explained that "it was literally just: in term three and four you cover human evolution, bla bla. That was about it." She concluded her answer to the question:

> "So, in terms of what I'm teaching to grade 12's now, I had no prior exposure to changes in the skull, changes in the diet, changes in the pelvis…"

Z, S

Question 6 aimed to understand Michelle's **experiences of learning about the theory of evolution in her undergraduate studies**, Michelle explained that in her first year of BSc, evolution was discussed "in the first semester module of biology", where "it was […] one of six other topics that [were] discussed that semester", which occupied approximately two weeks of her time. She stated that the teacher who taught evolution "was very good" and he gave her "kind of a basic idea of the concepts regarding evolution", such as "microevolution", "macroevolution" and "natural selection"; however, nothing about human evolution was covered. Michelle then talked about a "negative" and "unpleasant experience" she had in her undergraduate studies where a "guest speaker" was invited during her "first year". She described his talk as "very off putting with the way that he discussed evolution", since, she explained, "he barely touched on the concept of evolution", but "used it as a platform to discuss his own atheism […] and how the belief in evolution for him has made him an atheist, and how he's trying to basically tell [them] that that's what [they] need to do in order to believe in" evolution. Michelle remembered "leaving there with like a very bad taste in [her] mouth and not quite understanding why [she] had an hour of [her] life wasted

listening to someone telling [her] why he doesn't believe in God instead of actually explaining the theory of evolution to [her]". She stated that she felt like it probably was not "the purpose of the lecture" and "not what the lecturer had in mind when he asked [the guest speaker] to come".

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Michelle explained that she had to do her own research on evolution in order to feel prepared to teach it to grade 12 learners, which also relates to the code of **experience in engagement with the theory of evolution while teaching in practice and personally**. Michelle had to teach many of the topics to herself first when she started teaching:

N

> "Uhm, and, as a new teacher teaching grade 12, if you haven't done evolution in depth and you haven't gotten any instruction about the content of it in your curriculum study, then you kind of have to study that up yourself. You… you have to use whatever textbooks are available to you and kind of… figure it out as you go along and hope the kids don't realise you don't know what you're talking about. [*laughing*]"

Moving on to the seventh question, "**Could you describe a typical day in your classroom as a Life Sciences teacher?**", Michelle answered:

> "So, a typical day in my class, [*looking away*] uhm… So, let's take a grade 12 period. They come in. We greet each other. I usually ask absentees. […] So, depending on what content we're doing and how thoroughly we covered it the previous lesson, I would do a recap of whatever we did, just very quickly highlighting the important stuff so that it links to whatever we're doing in that specific period, and then we would cover the content, usually end off by giving an activity, if there is an activity that relates, and then that would be… usually be the end of the period. I hope that answers the question."

A typical day in Michelle's classroom "usually consists of six periods of about 55 minutes each".

In terms of **how COVID-19 has affected Michelle's teaching**, she stated that "there's quite a lot of learners sitting behind masks, sitting social distanced from one another"; therefore, the classrooms feel small "for what needs to happen in there". Michelle added:

> "The learners this year I think are a lot more stressed. There is a lot more anxiety amongst them. You can see a clear decline in morale, uhm, as we're going through the year, which is very visible, especially amongst the grade 12's […] and I think it's just […] pressure."

Moving on to the eighth question: "**Could you describe a typical lesson where you teach the theory of evolution?**", Michelle answered that a typical lesson where she teaches evolution "will kind of depend on what topic in evolution [she's] doing". Usually, when evolution is discussed in grade 12, Michelle starts with "the evolution through natural selection" and lays a "foundation for them to understand the principles regarding how evolution happens". She discusses the evidence for the theory, "why is it a theory", why "isn't it a hypothesis", as well as the difference between a theory and hypothesis. Then she moves on to discussing theories:

Z, N

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> "So, in terms of Lamarck and Darwin and Stephen Jay Gould, we look at how evolution theory has evolved itself, uhm, and contributed to our understanding of evolution."

Michelle also covers "mechanisms of evolution", such as "speciation, reproductive isolation, how species actually become reproductively isolated" and then she discusses present day examples of evolution. When teaching human evolution, Michelle stated that "before [she starts] the whole section on evolution right before natural selection", she has a "talk" with her learners. Michelle is aware that "it's a sensitive topic" and "a religious thing"; therefore, she tells her learners that "you are not allowed to have an opinion about it [*shaking head*] until you know the facts. So, you can sit here and you can believe what you like, but I'm telling you that you're not allowed to give me an opinion until you actually have all the facts of it. So, you're going to listen and learn, and then you can form an opinion about it; when you can form an argument about it." She continues the discussion by telling her learners that "evolution is not the typical picture of an ape changing into a man" and if "that is [their] concept of evolution, [their] concept is flawed", […] and therefore [they] don't know what [they're] arguing about." Michelle continued:

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> "So, you need to first understand the theory before you can have an argument."

Michelle emphasised the importance of chapters such as "DNA, Genetics, meiosis" being a "preface to the concept of evolution in grade 12". Thus, her learners would then already "have an understanding of what mutations are, how genes are transferred, how variation is introduced into a species through meiosis and reproduction". With regards to teaching human evolution, Michelle links the topic of natural selection to it, explaining that "for humans to have evolved something had to change". She explains how she links other topics to current topics and helping her learners to "open up" the content for the learners:

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> "So, in the previous chapter we learned about environmental pressures that cause natural selection. So, let's think of pressures that could have caused humans to evolve. Uhm, talking about changes in climate that caused […] the environment to favour organisms that could stand on two legs rather than four. What's the advantage of having two legs? Uhm, if you have a change in diet, because you've discovered fire, now your food is less… it needs less processing, it's cooked, etc. That is another selective pressure… a change in diet and therefore selection is applied as a result of it."

When asked about her experiences teaching evolution, Michelle discussed **how she approaches teaching the topic to her learners**, as well as **her own religious beliefs**. Michelle stated that she has had "positive experiences teaching evolution" and she could not "think of one opportunity where a kid has ever challenged [her] with regards to it", even though she has "heard of shock stories from other teachers and parents that just don't want their children to be told the […] content". Michelle attributes her positive experiences to the way that she introduces the topic of evolution. She tells the learners:

S, H

> "I am a Christian. I believe in evolution. And those two things aren't mutually exclusive, and I want you to understand as a student that they shouldn't be, uh, mutually exclusive. Uhm, I think that there's a lot more beauty to a process where God created the universe with physical principles like natural selection, like cause and effect, etc. that then over millions of years created this top species than, you know, Genesis going God went boom [*hand gestures to one side*] Eva [*pronouncing in Afrikaans*], boom [*hand gestures to other side*] Adam [*pronouncing in Afrikaans*] and then magic, you know? That that to me [*smiling*] is less magical than this beautiful process of… of life. And that's why I still believe in a God even though I believe in evolution."

S, H

Michelle further explains to her learners that some evidence for evolution cannot be argued with, and she provides examples (code **9**):

> "You can't go into a museum and say that fossil of a T. Rex: "No, that's fake." I mean, seriously. There are some pieces of evidence that you can't argue with. You can't argue with genetic evidence, and that's something that a lot of people back in the day didn't have. So, they would easily refute it, because they didn't have the genetics to base their theories on, or their hypotheses on. […] You can't argue with biogeography. I mean, why would you find exactly the same fossil in two completely different continents? I mean, did the organism pick up its boots across the ocean and die and get fossilized on two different…? [*interrupting herself*] You can't argue with that. And then you can't argue with the principle of natural selection, regardless of whether you believe it actually leads to evolution. That's up to you. But natural selection is happening as you're sitting in this classroom. Some of you are gonna sink, and some of you are going to swim. That's just basic natural selection. [*nodding*] So, you can't argue with that. And if you at least understand that, I'm happy. Whether you believe that […] chimpanzees and humans shared a common ancestor, that's up to you, but the point is: the picture of an ape changing into a human… that's not evolution. You can take a chimpanzee. You can look at it for as long as you like. It's never going to evolve into a human, because the fact of the matter is this whole, beautiful process of evolution, if you change one thing, you change one meteorite, you change one climate change event, you change one predator, one choosy female, and we wouldn't have evolved. That's the magic of evolution. It's all just about applying the right pressure at the right time and affording enough time for the changes to accumulate."

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Michelle also explains to her learners "that evolution doesn't happen in individuals", but that "[i]t happens in populations". Therefore, "they need to have an understanding of genes and the idea that there's variation in a population". She explained: "It's not an internal drive. It's not… just me changing, it's a whole population of organisms changing." She further relates the topic "to the idea of evolution in thought", for example, one person has an idea, he discusses it with people, and more people start thinking about it and it "kind of evolves into this general consciousness", which, to Michelle is "kind of the same idea". She stated that she

is able to "disarm the situation", since she "introduced it as a Christian", bringing the two concepts together, and that "it doesn't threaten [her] Christianity". She explained:

> "So, if a child was sitting there and thinking that I'm going to not listen and not learn, then hopefully they have a new insight. The second thing that I also tell them […] is that […] you are not allowed to have an opinion unless you actually know the facts, because your facts are most probably wrong. So, reserve your opinions for later and then the third thing I tell them is: and if nothing of this matters to you, then at least you should know you are tested on this at the end of the year. Whether you like it or not, it's 70 marks out of your paper. So, you're going to have to listen [*nodding*] and you're going to have to absorb whether you believe it or not. You're going to go into many situations in your life where you're going to be confronted with traditions and principles and ideas that you might not enjoy."

She lastly refers to a saying by Aristotle stating:

> "An educated mind can entertain a thought without having to accept it. So, be educated. So yah. [*laughing*]"

The next code focuses on Michelle's **experiences teaching the theory of evolution**, to which Michelle stated that she has "had positive experiences teaching evolution" and "could not think of one opportunity where a kid has ever challenged [her] with regards to it", even though she has "heard of shock stories [*laughing and smiling*] from other teachers and parents that just don't want their children to be told the, the content, but [she's] never experienced that". Michelle was asked to elaborate on what she means by having "positive experiences" and explained that it is "positive in the sense that" she has "never had a confrontation" or a "negative experience with regards to evolution". Michelle only experiences learners "wanting to understand, but why?" and then she helps them by linking previous topics with the current topic. She further explained that her "experiences have been positive", because of the way her learners respond: "they're laughing, they're enjoying it, they're taking part in the conversation". The type of questions that they ask, tell Michelle "that they're actually thinking about it" and that "[t]hey're discussing it outside class" and "coming in with new questions", "asking [her] about the things that they were talking about". She concluded:

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"So, so that tells me that they're thinking about it and that to me is a positive experience."

Michelle also compared what she experiences currently as a Life Sciences teacher teaching the theory of evolution, to previous years:

"just in terms of this year, […] It's probably different for every group of kids that you have, but this year they've been quite… […] critical in their thinking. So, I'm finding that they're asking very interesting questions this year […] You can see that they're trying to formulate the links between the topics, which is something that I've not really experienced [*shaking head*] in previous years… trying to understand how, for example, […] Why would there be a selection for a smaller jaw or a larger brain, etc. […] They're a little bit more challenging in the types of questions that they're asking."

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Aiming to understand Michelle's religious beliefs, I asked the tenth question: "**Tell me about your religious beliefs.**" Michelle stated that she is "technically a Christian" if she had to classify herself; however, she prefers to think of herself "as spiritual". She explained:

"So, I'm not your textbook 'read the Bible, go to church' Christian and there are quite a lot of things within the Bible that I don't necessarily agree with."

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Michelle talked about "God saying you are loved unconditionally" that "completely [*laughing*] contrasts to then setting rules for [her] love"; therefore, "the God that [she] believe[s] in is not necessarily the God that the Bible is telling [her] exists". However, she does believe in "the God" and stated:

"So, I am a Christian. I am spiritual, but I do not preach from the Bible, [*shaking head*] I do not read the Bible all the time. I have a very personal relationship with God. Uhm, a lot of it just comes from people that I've met, books that I've read, experiences that I've had that have changed my perception of this very Bible fixed Christianity to a more personal understanding of what God is to me. [*nodding*]"

N, H

Michelle stated that she was "raised in a Christian household that was very strict in terms of Bible study and going to church on Sundays", where she "always had a very uneasy feeling about the way that [she] was being forced to love God and the way that God has set a lot of… conditions for His love." The "idea of being born into sin" has "never made sense to [her]",

because the concept of sin "completely contrasts with the idea of free choice", Michelle said laughingly. She explained:

> "Uhm, if you tell me I have free will to make choices, how can my choices then be wrong?"

She went on to explain that she came to this understanding, as she was "introduced through [a friend at university] to a series of books" that "changed [her] perception of God" to a "God of love and a God of understanding, a God who wants to experience physical life, physical reality through [her]". She elaborated:

> "So, my spirit is not something different to God. It is God. […] I believe my purpose in life is to remember where I come from, to remember who I am, which is God, so that when I die I can physically re-member with the whole, because that's where my spirit will go. And in that sense, if I am God, and if I was created from him, then there is no such thing as right and wrong, and you shouldn't judge right and wrong, because if God is everything, then everything is God. If that makes sense. You shouldn't judge black for not being white, because you couldn't understand black without white. You shouldn't judge hate for not being love, because you can't understand hate without love. And that's the whole point of having a physical reality… is that God […] is this all knowing, all understanding being and it's wonderful to be an all knowing all, understanding, being, but you need to experience yourself as such, experience and thought… […] So, therefore I believe in my… my sense [*puts right hand on heart*] with regards to God, I believe he created this world and he gave us free will to make choices in our lives that will either help us to remember who we are, which is him, or maybe forget for a little bit longer. […] There is no right and wrong. […] Why would he punish me if he […] gave me the option of choice [...] I just don't believe in a vindictive God. I believe in a God who wants to experience life through me, whatever that experience might be… and whatever that experience might be is okay. It's okay, because all of it stems from him. I don't know if that's too philosophical. [*laughing*]"

The interview was then ready to move on to question 11, aiming to understand **what it is like being a Christian person, teaching the topic of evolution**, taking her spirituality into consideration. Michelle answered that "hasn't made any difference to [her] life." She

Z, N

explained that she tries to "help students understand that the two concepts shouldn't be mutually exclusive", and ended her answer with:|

> "And if you think about the way that I've just explained God and the idea of life being a series of choices, then evolution […] kind of fits perfectly into that idea. [*shrugging shoulders*] It's just a series of choices that led to our evolution that led to our change. It is *Homo habilis* sitting with a rock in his hand and going: "What shall I do with this? Shall I hit a bone with it? Yes, I shall." [*nodding head*] And then he eats bone marrow and over many years that allows brain development. I mean choices, [*laughing*] so yeah."

Michelle spoke about how she enjoys teaching the topic and why she enjoys teaching it in response to the last question, aiming to understand **how the teaching of evolution makes Michelle feel**. Michelle stated that she likes evolution and that it is "one of the chapters that [she] look[s] forward to teaching", as "it brings together a lot of the other concepts". She likes "the challenge of teaching it" and "helping them to actually understand it and to not have obstinate ideas about evolution, because they were told this is what it means and rather understanding what it actually means." Michelle mentioned another reason why she likes teaching the topic, talking about "selective breeding":

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> "And I like the opportunity that it gives me as a woman [*pointing to herself*] to talk to other women about the idea of [*laughing*] this is going to sound funny... selective breeding and understanding that if an animal can do this, like a frikkin' frog, you can do this as well and you need to be… [*looking up and laughing*] cognisant of the fact that your reproductive choices is an example of a selective pressure that you're applying. So, you need to make them carefully. [*laughing*] Uhm, so, it leads to very good classroom discussions and interactions and, like I said, teaching that unseen curriculum a lot more than necessarily just the seen curriculum. Uhm. So, I think for me, I like teaching evolution. It's one of the chapters that I look forward to, similar to human impact in grade 11. […] I like teaching the content. I spend a lot of time trying to find images and videos and things that make interesting for them to understand and my, uhm, own understanding of it and my own teaching of evolution has definitely evolved over the years, so, that it makes it easier for them as well. Yeah."

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The case of Nandi: Presentation and Analysis

As with the other interviews, at the start of Nandi's interview, I welcomed and thanked her, explained my study and went through the checklist. Nandi had no prior questions, so I proceeded to ask the first question, asking about her **teaching qualifications**. Nandi's response was that she has a BSc, "majoring in Physiology and Biochem[istry]", "an HED" specialising in the "method of biology" and "general sciences", as well as a "BEd Honours". She also stated that she had been in the process of doing a masters project.

The second code focuses on the **reasons why and how Nandi became a Life Sciences teacher**, and Nandi's response was the following:

> **"**Why did I decide… I didn't decide… [*laughing*] Uh, honestly, I never thought I'd be a teacher."

She explained that she "applied for pharmacy" and her "second option was dentistry"; however, when she had received her acceptance letter, it was too late and "the course was full already for both cases". Therefore, Nandi decided to study BSc. In her second year, she was going to change to her first choice; however, "some tragedy happened, so [she] continued with what she was doing hoping for the best". When she had finished her third year, Nandi "wanted to work", so a "HED one-year diploma was [her] best option at that moment". She concluded:

> "So, that's how I became a teacher. [*smiling*]"

With regards to her **experience in teaching Life Sciences in relation to her time being a Life Sciences teacher**, Nandi stated that she had been teaching since 1998, which means at the time of her interview, she had been a teacher for 24 years, "teaching grade 8 up to grade 12"; thus, "Life Sciences, as well as Natural Sciences".

Moving on to question 4, I asked: "**Did you study the theory of evolution in your undergraduate studies**?" in order to understand Nandi's **learning about evolution in her undergraduate studies**. Nandi's answer was: "Sort of, yes.", where she explained that she

S, M, H

did "some aspects in Physiology" in her "third year" and in Biochemistry, she was mainly dealing with "Genetics". Thus, she had "touched on it, but not in detail". Nandi also learned about evolution in her "second year in Zoology" as well; therefore, "it was there, but not really in […] detail". Nandi was then asked to elaborate on what specifically her undergraduate studies touched on in terms of evolution. Even though she could not recall exactly, she mentioned that "in Zoology […] it was about phylogeny", "phylogenetic trees and […] the evolution of species", and in Physiology, she had learned about "the cells and the effect of cancer". The next question was asked: "**Did you study evolution in your teacher education studies?**", in order to find out whether Nandi learned about evolution in her teacher education studies. Her answer was that she did not learn about evolution in her HED:

> "No, it was not there. Remember that time it was not even […] in the curriculum actually, although it was embedded in some of the grade level curriculum where you deal with firearms and everything in biology, but […] It was… disconnected. So, you couldn't put it together as […] if you're teaching a theory of evolution. You just teaching, uh, the classification in a disconnected way. So, we never did, actually… [*shaking head*] anything in my… in my teaching in my one year."

Question 6 asked: "**Tell me about your experiences regarding learning about the theory of evolution in your undergraduate studies.**" Nandi answered:

> "Uh, since I said it was a disconnected theory that that never came together as a theory of evolution. So, hence it was… It was not the thing that […] you could latch on […] It's only now when I'm teaching… now when I've got experience that I can connect the dots. But at that time it was a disconnected thing and in […] my student days as […] biology student – learner – it was not there, actually. So, we went into 2008 with no experience at all, with no content at all in teaching the topic."

The above also refers to the additional code of **experience in engagement with the theory of evolution while teaching in practice or personally**. In response to question 9, Nandi also stated that she did her own research on the topic:

Z

> "You're not sure yourself, but fortunately, because I was interested, […] I did a lot of research around the topic"

Question 7 asked Nandi: "**Could you describe a typical day in your classroom as a Life Sciences teacher?"**, to understand her teaching style and classroom dynamics. Nandi explained that she "always teach[es] in relation to science", tries to eradicate misconceptions and brings in societal skills into her teaching. Nandi typically has "50 learners" in a grade 8 classroom and "forty maximum" for grade 12 classes. During her lessons Nandi stated that she "usually use the cell phones […] on things and processes". With regards to "research collaboration", Nandi would have class discussions around specific questions. She describes her class as a "chaotic class", because discussions happen "at the same time". Nandi aims to train her learners "for the skill of writing an exam that is for an assessment, because you have to have an end product at the end of the day". Thus, what she "[does] in [her] class time", she describes as a "mixture of content", where "skills of society as well as the skills of the assessment" are covered.

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S, H

Thereafter, Nandi was asked to **describe a typical lesson where she teaches the theory of evolution**. Nandi explained:

> "Let's start in Grade 8. […] So, when you're looking at grade 8 syllabus; natural selection, you're talking about variations there. So, my my thing from grade 8 in grade 10, also, you're talking about the history of life on Earth. That is evolution. So, the […] issue for me, is starting from what they know. What they know is is is cockroaches at home. There are cockroaches and we we've got Doom. There are rats in […] most of their houses. We've got Rattax, but the rats will eat the Rattax, but they are not dying and some will die. And some cockroaches, when you put in a Doom they will die and some will not die. They would just get weakened […] So, you're starting from that point what they know and […] you ask them what is causing that. Then you bring in the the theory of natural selection. And then, because you've already talked about […] the genes, the DNA, the mutations and the differences in […] characteristic, the genetic variation, now you're bringing in the theory of natural selection based on what they know."

When teaching evolution, Nandi also discusses the "history" of evolution, as she explains that for us to "understand the changing nature of science", we need to understand that "science is

Z, M

based on evidence". She also discusses "Lamarck" and "why it was rejected". At this point, Nandi "talk[s] about religion". She states:

> "In fact, from the start, not only when I'm teaching evolution, about the differences between science and religion, so that they understand one is faith based and one is science; it it relies on evidence and it's supported, somebody else must go and test and… So, those are the typical things that that I go through."

Z

Nandi also discusses "the history of Darwin", such as that he "went to study religion: theology, went to study being a doctor". Nandi uses the story of Darwin being "discarded in class" to inspire students "that think they are not brilliant". When she teaches evolution, Nandi tells the learners "that Darwin never said […] anything about […] how life started on Earth"; however, "he said when life was on Earth, how did it become what it is now?" She then proceeds to discuss the ideas, theories and "hypotheses that are being researched" about "how life started". She continued:

S, H

> "But now life is here, but it has changed overtime genetically and phenotypically. This is what Darwin is trying to explain."

In response to question 11, Nandi talked about her approach to teaching evolution (**code 9**) and discussed some of her beliefs, stating that "when [she is] discussing the issue at the beginning in every start of the year" she would tell her learners about her religious views and about "science versus religion". Nandi's view, that she discusses with her learners is discussed in detail under **code 10**.

Z, S, M

Question 9 asks Nandi to discuss her **experiences of teaching the topic of evolution**. She stated that "the first year was a bit shaky", as she was "not sure [her]self"; however, fortunately, she was interested and "did a lot of research around the topic". Nandi said that the "issue of […] speciation in… into human evolution" was a "big issue with even the teachers". When she started, evolution was a "difficult concept for them to comprehend". However, she believes that when evolution is approached "from the natural selection point of view, the learners do not have that much issue". She explained:

M, H

Z, S

> "Because when you teaching the bipedalism because bipedalism is there, you're looking at the change, maybe in the environment. Why were these characteristics selected? Because they were advantageous. So, you teaching it from a natural point… selection

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> point of view. They were selected because they were advantageous. Those who had this characteristic survived. Hence they were passed on. Hence now we are bipedal."

Nandi believes that "when you tell them as a story to the kids, it's actually interesting to them instead of doing it as an abstract"; thus, she stated:

Z, M

> "So, I really don't have a problem with my learners when […] I teach from that point of view. They never question it, because from the beginning of the term, they know that we're dealing with science and science have evidence. We saying this because there is evidence that this has happened."

Nandi stated that the way in which she explains the concept from a natural selection point of view puts it into context for the learners so that "they can picture it happening". Nandi does not believe that learners only be told that they "need to know this for the exam, whether you believe it or not". She believes that the latter is a "dangerous issue" or a "dangerous thing to say to the learners". Nandi was asked why she thinks the abovementioned approach is a dangerous issue, to which she replied:

S, M, H

> "[Y]ou're running a risk of losing them. You're running the risk of them not making the links in Life Sciences."

Nandi proceeded to explain that she believes "the whole Life Sciences is about evolution" and it has to be taught "from that context". For example:

> "When you're teaching about the reproductive strategies in paper one; it's in paper one in grade 12, the kids will always come up with the idea of who came first between the egg and the chicken… So, you need to explain that from the evolution point of view, that in order for the egg to be invented, it was a reproductive strategy that was selected that was best suited for that environment for that particular species. Hence, they survived because this reproductive strategy… So you see? It's paper one, but I'm dealing with evolution that is in paper two. So, if you close the thing and say you need to learn this for…, then you've lost the learners for the whole Life Sciences concept. That's what I believe in."

Moving on to question 10, I asked Nandi to tell me about her **own religious beliefs**, to which she first laughed and said: "That's interesting!" Nandi stated that she "grew up in a Christian home", "married into a traditional home" and said:

M, H

"Do I believe in God? I'm not sure. [*laughing*] […] Do I believe in […] ancestors? I'm not sure, but somewhere somehow I do believe there is a supernatural being. For my faith, I believe in something that is supernatural. There is a supernatural being out there, but did it create the world? Of course not. I don't believe in that. […] So, for me, my faith is on a supernatural being. However, I don't believe that this faith that I have is linked to science, is linked to who we are today, is linked to the diversity in the species out there. That is science."

Z, M

Nandi was asked to define her religion, to which she said: "That's part Christian and part traditional. So, it's a mixture of both. Yeah, I would say it's a mixture of both."

In response to question 11, Nandi also spoke more about her religious views, which she discusses with her learners in teaching Life Sciences:

"This is my view: Do I believe Jesus was on Earth? Yes, I do. [*nodding head*] But do I believe Jesus […] was the son of an Angel? No, I don't. [*shaking head*] Because I believe Jesus was born of a man and this is science. Science say a sperm cell has to… [*interrupting herself*] So, something is missing. Joseph was there and he was engaged to be married to Mary and Mary got pregnant. So, you you bring in these kinds of things, so I don't believe that Jesus was the son of an Angel or whatever or God, but I believe that there was a Jesus who was a Mandela in our lifetime, because for me he was not a holy kind of person, but he was probably a preacher... […] about their living conditions. The Bible made him to be a holy person."

Thereafter, Nandi was asked the 11th question focusing on **what it is like being a Christian with African traditional values teaching the theory of evolution**. Nandi responded:

"Honestly, I've never thought about it being a problem. To be honest. Uhm… [*looking up*] because they do different things in my life. One, I have to understand it's science and it's based on evidence. The other one is faith based. It's a personal thing I cannot test. I cannot do anything. It's just a faith that is there… that is for moral and ethic living… ethical living that, because, as as I would say to the kids […] you're not wrong to have a faith and understand science, because this… this, uh, they've got different directions in your life. So, I've never had a problem. [*shaking head*] They've never ever had a conflict with […] these two."

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Nandi goes on to discuss that she "question[s] the Bible":

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> "although I question the Bible. I must be honest. [*smiling*] I've got lots of questions [*laughing*] on the Bible and I will pose it to learners as well. And I'll say this: "Look at this, in Genesis, this happened and this happened and then this guy went to this land. But it's never said that God created another nation, but this one went to this land. […] I don't think I believe in the Bible. Although, I believe in a supernatural being, but I don't believe in the Bible itself. So, as I say, these are different directions and they don't conflict in my life at all. [*shaking head*]"

Nandi explained that when she teaches "learners from grade 10 not just grade 12", there will

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be debates "right at the beginning […] so they would understand that […] distinction between science and religion right from the start." She continued:

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> "Because when you, when you talk about that when you are about to teach evolution, then you sound dogmatic. You sound as if you want them only to take this side instead of this. But when you… when when you embed it along the way that when we're dealing with science and this is what is being done in science, then it's much easier for them to understand the science behind evolution."

The last question was asked: "**When teaching the theory of evolution, how does it make you feel?**" Nandi shared that she feels "[e]xcited" and that it is the topic that she likes the most "as it ties in everything in Life Sciences". Topics, such as the "phylums" that "people say [is] boring", are not boring to Nandi, since teaching it "from the evolution point of view", makes it interesting", as one can understand how "all those kinds of species evolved" into the complex organisms that they are today. When asked whether Nandi wanted to add anything else to how teaching evolution makes her feel, she said:

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> "No. [*shaking head*] It's just exciting [*laughing*] […] For me, it's just like any other topic; the genetics, the DNA, the meiosis, because the… Those topics are building up to what you going to… talking about in evolution at the end. So, the whole curriculum, for me, it's very interesting and exciting."

M

Lastly, Nandi was asked to explain why she enjoys the topic of evolution, to which she reiterated that it "ties up everything in Life Sciences" and that all the other topics, such as

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DNA, meiosis and reproduction build up to "this climax that is, that is evolution at the end". She explained:

> "So, […] it's not about evolution as such, but it's about the […] whole curriculum, whole content that is tying up together into this climax that is evolution at the end. So, I'm I'm just excited in teaching every topic in Life Sciences as long as it's science for me."

Z

The case of Heidi: Presentation and Analysis

The last case study is the case of Heidi. Where the other interviews were conducted in English, Heidi was more comfortable speaking in her home language, which is Afrikaans. Even though I easily communicated with Heidi in Afrikaans, as my own home language is also Afrikaans, I used some phrases in English during the conduction of Heidi's interview, as my academic language has been English for a number of years since starting my higher education journey. At the start of the interview, I apologised to Heidi for occasionally mixing up the two languages in my communication with her, to which she replied: "It's okay. [*smiling*]". After welcoming and thanking her for taking part in my study, I proceeded to go through the checklist. Heidi had no questions before we commenced with the interview, but she did thank me for allowing her to speak in Afrikaans. Throughout the presentation and analysis of Heidi's case, Heidi's words have been translated from Afrikaans into English; however, the original transcript in which she spoke Afrikaans, can be found in Appendix ___. In order to find out about Heidi's educational background, Heidi was asked to tell me about her **teaching qualifications**, to which she answered that she had studied for a BSc degree in Botany and Zoology and obtained an HED the year thereafter. Then she qualified to be a teacher. When asked whether she wanted to add anything to her answer to the first question, she added that she had worked in tourism at a time during her career, and that tourism to her is like education in a way.

Question 2 was asked to understand the **reason why and how Heidi became a Life Sciences teacher**. Heidi stated that she originally wanted to study Botany, which is actually her great passion in life, as she wanted to do research. When she became a student, certain factors

changed her mind. Heidi realised that if one wants to do research one needs to "go all the way to a master's degree". She also stated that she's a "rural person" {"plattelandse mens"}and wanted to work in the countryside. Heidi stated that she did not want to be bound to a university and "live in a […] big place". In her third year, she sought guidance regarding which profession she should follow in the Life Sciences and in the countryside. Heidi was told: "Well, you can become a teacher and then you can go to work in any town in the country." and stated:

> "And uhm, yes, it worked out that way which is actually the best, because I really enjoy being a Life Science teacher. [*nodding*] So, first of all the subject which is actually my passion, but uhm, yes, I don't think I'm a born teacher, but I became a teacher by doing it. [*smiling and nodding*] Yes."

Heidi was then asked: "**How long have you been a Life Sciences teacher?**". Heidi asked for a moment to count and concluded that she had been a Life Sciences teacher for 17 years. I asked Heidi if she could elaborate on the timeline of her Life Sciences teaching career, to which she replied that she started teaching in 1994, but there were 10 years in between when she did not teach. She concludes speaking about her teaching:

> "So, all the years I've been teaching, I've been teaching Life Sciences. Initially it was still biology the first three years... uhm, and later: Life Sciences."

Thereafter, I asked Heidi **whether she had learned about the theory of evolution in her undergraduate studies**, so her BSc degree. She answered: "Yes.", nodded and stated that it was her first introduction to evolution – her first time learning about evolution. She had learned about the principle of "survival of the fittest" in biology during her own school years, but she learned in her first year of university for the first time how the theory of evolution works. She stated that evolution was mentioned in her first, second and third year of Zoology, as well as "[a] little bit in Botany too" in terms of "what [evolution] is based on and how it works". Thereafter, I proceeded to ask the fifth question asking whether she had **learned about the theory of evolution in her teacher education studies**, and Heidi replied:

Z, S, N

S, M, N

> "[*looking up*] Uhm, I don't really remember that we had this as a specific topic in my HED year… Uhm, no. [*shaking head*] […] If we had done it, it wouldn't have been a big deal. [*shaking head*]"

S I had then asked Heidi to **elaborate on her experiences of learning about evolution in her undergraduate studies**. Heidi replied: "It was quite difficult." and proceeded to reflect on her experiences. Heidi and her fellow student friends "had many discussions about it" and asked questions such as:

> "Is it now? Isn't it now? Ummm. How does it fit in with our religious convictions and such?"

S She reiterated that "it had been difficult" and that "it was hard to learn about it when you […] don't quite agree with what it is as it is presented to you". This experience was also where

S Heidi started to notice that "people have different views and opinions about it" and continued:

> "and it was almost as if you didn't know where you fit in with regard to evolution and the theory and what is in your background around the origin of... of creation and of people. So, it had been difficult. It had been very difficult and all the conversations we had were mainly about that."

Heidi's mind was put at ease through a discussion that she had with a fellow student who said that: "He thinks if we get to heaven one day, then the Lord is going to say: 'Just sit quietly back on these soft chairs and then you are going to see this video of how it finally happened.'" After this conversation, Heidi "got a lot of peace and thought:

> Oh, well. One day we will know exactly how it happened.' [*smiling*] Uhm. So, I don't have to worry too much about it, but it had been difficult, yes. [*nodding*]"

When officially been asked about her **experiences regarding learning about the theory of evolution in her studies**, Heidi answered:

> "[...] There's, there's parts of it, and when I say parts, I'm actually referring more to the microevolution part that one can quite see... [*nodding*] that it happens and because there are contemporary examples of it and because there are uhm specific uhm investigations are what's been done and what's been written about which you can see, well, it's happening and it's a reality, [...] it's easier to follow that part and go along with it. But

> when it comes to the macroevolution parts, it's harder to understand that this could have been the way in which uhm animal groups, plant groups arose and how the changes came about."

Z, S, M

Heidi was then asked to elaborate on some topics that she had learned about in her undergraduate studies, that she found interesting. She stated that "the old well-known example of the pepper moths […] had been interesting for [her]" that the "color of the pepper moths changed as a result of the changes in the environment, which now and then favoured the favourable characteristics and harmed or made the unfavourable characteristics become extinct". In her third year of Zoology, Heidi had also found the vertebrates and the different bones of the skull "quite interesting", as she had a "very good lecturer" who "explained it very well". She concluded her answer:

> "Uhm, and yes, if you follow it like this then... then it seems that it seems that there... that things could have happened like that. So, yes, those parts were interesting to me."

With regards to the code of Heidi's **experience in engagement with the theory of evolution while teaching in practice**, she explained how she started teaching in 1994, taught "the old curriculum" for 3 years, "where evolution wasn't really part of the curriculum":

> "It was just a bit around 'survival of the fittest'... the idea."

M, N

Heidi then did not teach for 10 years and "started teaching again in 2007" when "the matrics were still on the old curriculum", "but the other grades were already with the OBE system". Heidi stated that she "just had to drop in and get to know and learn" when it was introduced into the curriculum.

I proceeded to ask the seventh question, aiming to understand her general teaching style by asking: "**Could you describe a typical day in your classroom as a Life Sciences teacher?**" Heidi made sure that she understood the question correctly by asking whether I would like to know about her teaching approaches, to which I nodded. Heidi stated that she has a "passion for [her] subject", as well as a "passion for the children [she works] with". She explained that she fosters "an interactive […] environment":

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> "I like interaction in my class with the learners. […] My class is not that quiet place where no one [*smiling*] can say a word and only the teacher speaks. So, the, the kids

participate in my class and I, I kind of like to make them a part of the class as well. So, they know they can ask a question at any time. Of course we just have to do it in an orderly way, but they may ask questions and they may ask questions that they think are even silly questions or something."

Heidi focuses on "the practical part" of Life Sciences, as she also believes that "the subject also lends itself to the fact that one can go practically all the time":

"So, I always feel like when we learn about the leaves, I bring leaves to class and when we learn about the skeleton, I take out my box of bones and then we learn about the skeleton."

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Z, S

Heidi enjoys that the current curriculum "includes the practical part and practical skills", as it is what she enjoys herself as well. She believes that it is good when her "learners can experience what they learn", "talk about it" and "think about it". Heidi's "general education mindset" is "that it's not just about the knowledge, but it's also about: how do I make it part of my life and what do I do with it going forward in my life?" She continued:

"Now I wouldn't say I'm not always the most successful teacher when it comes to grades, but when it comes to life and what we learn and what we can apply in our lives, then I feel I'm successful."

Heidi then proceeded to discuss a day at school in her classroom. Due to COVID-19, Heidi now has "many more classes", where for every grade, she now has "sort of have double the amount of class groups". She stated that "with COVID it's... it's very different now too", as she has to "fit everything in and [she has] to do a lot more things than before."

The eighth question asked: "**Could you describe a typical lesson where you teach the theory of evolution?**" Heidi mentioned that she had thought about his before the interview. She stated that, "as a mother of children [her]self", she tries to put "the events that the children experience" into "perspective", "because they do learn from an adult how to approach a situation". She explained how she approaches teaching evolution in her classroom and how her religious background has an influence on her approach:

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"So, […] when I tackle the subject of evolution, then this is what I do: I put it in a certain perspective for them and of course my religious background now has an influence on it. Now, the children I teach are also mostly Christians. Uhm, and the

> Christian faith in this community […] I consider as the maintaining factor within the community."

Drawing on lived experiences of teaching evolution (**code 9**), Heidi explains why she approaches the subject in this manner.

> "And my previous experiences of presenting evolution at the beginning... especially when I had to start doing it, it was almost as if I had pulled the rug out from under them [*nodding*] when I bring up the subject of evolution and teach them about it. Then they're totally confused, and and they... [*shaking head*] They just can't make sense of it."

This led Heidi to "struggle" with how she should "tackle" the topic. She went on to explain:

> "And I've been struggling with that for a very long time regarding: how do I present it to them so that they can learn it uhm... know what it's about, have the knowledge of it, but not that I completely confuse them with it? And I myself had a whole struggle to come to terms with how do I tackle it now and where do I start and so on?"

She came to the following **approach** based on her lived experiences:

> "And in the end I came to the point that: it's about the question that all people ask: where do I come from? So, that's my starting point. So, when I start with the subject of evolution, I start […] with the question: […] Where do I come from? And that, for some people, it's okay if I get the answer from reproduction. And then there are people who say: yes, but okay […] It says now where do I come from; from my parents, but […] where are they from? So, sometimes I go further and then say: but some people want to know more. So, they want to know where their parents come from... where you go more in the direction of uhm your prehistory and the history of your parents and where they come from, but for some people it's still not enough. [*smiling*] Some people want to know more than that. They want to know, okay, […] where then do my ancestors come from? […] So, now it's more genealogy and historical, where, where you might get your answer. But then there are some people who are still not completely satisfied and who then ask where do people come from? [*smiling*] And then people get their answers in different places. So, for some it is: you get your answer from the Bible, which says God made people. Other people say, no, evolution is an option. For others, there may be other creation stories. So, that's where we start to differ a bit with how we

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> now explain where people come from. And then I always say, then there are still people who want to go further and say: 'Yes, but it's not just about where people come from. Where does life come from?' And then for some people, again, it's the Bible's creation story and for others it's evolution. For others it is other creation stories. And then there are some people who are still not satisfied and say: Where does the earth come from? And then you go back to... okay, again, the Bible's creation story of the creation... of the earth or the Big Bang or whatever... So, then I'll tell them different people have different levels of satisfying this universal question, uhm, but that we can actually find our answers in different places."

After explaining her approach, she goes on to describe her lived **experience** of how the learners perceive the topic. Heidi explained that at this point, she usually starts to see "the 'question mark' faces in front of [her]". Some learners would say to her: "But teacher, we believe as it is written in the Bible." Heidi would then answer and say:

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> "Yes, for some people the answers are in the Bible, so we stick to that, but there are also […] other explanations and evolution is now […] one of the other explanations and we learn from it that we can know how those people think, but you don't have to agree with it."

Heidi explained why she gives the above answer:

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> "Now, I'm probably deviating a bit from the CAPS document that says it's a theory and it's proven and that's all and it's just like that... Uhm, but it feels to me that I have to give the children the perspective within which they must learn it."

Heidi provides her learners with "the broad guidelines of evolution"; "that life started from the simple and evolved towards the more complex, that it originated in water and moved out onto land" and then she talks broadly about "life from the simplest organisms… bacteria that evolved... further evolved and then your invertebrates and your vertebrates and then now the five vertebrate groups... uhm, where the evolution theory says from the fish to the... […] amphibians and so on...". Throughout this discussion, Heidi would "fill in […] with some examples"; however, she stated that "in grade 10 they don't have that many background examples yet". When she teaches grade 12 evolution, Heidi starts "again at the same point as [she] started in grade 10", but just works through the content faster. She also refers back to

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grade 11 topics such as the "animal groups and the phylogenetic family tree and the plant groups" and "integrate what they have already learned".

In her response to me asking whether she wanted to add anything to the interview, adding to her approach to teaching evolution and to "gaps" she experienced in the curriculum, she stated that in "the curriculum it is not really specified as micro-evolution and macro-evolution"; however, in her classes, she will "draw the learners' attention to it". Heidi stated that she believes that this is "actually sort of a gap". She explained:

> "I don't want to say it's two different things, but it... the micro-evolution idea, the natural selection... that... that's what one can research and you can check it and everything. The macro-evolution is a bigger idea that we don't really do in detail with our learners. It's just the general thing. Fish, amphibians... but no: what are all the changes that had to happen to change from a fish to an amphibian..."

Heidi also added that the curriculum has topics where "they just want you to have the general big idea and then there's other stuff that you have to learn very specifically". Heidi experienced the "matric papers" to be "quite limited with the questions", as "[t]here is always a question about natural selection", "speciation", "the difference between the […] skulls and the skeletons of the humans and the hominids and the […] primates":

> "So, it's sort of the same stuff over and over again. There is nothing in between."

Therefore, Heidi "keep[s] it very focused" and explained:

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> "So, I also keep it very focused: that's all you need to know for the exam, especially when it comes to matric, also because one's time is limited and you can't spend that much time now, but one could actually spend a lot more time on all the stuff – not that I really want to [*laughing*] – that I want to teach them more about evolution, but it's just ... It is actually a much broader topic which is only briefly delineated, but yes, there is not that... that separation between microevolution and macroevolution […] in the curriculum... uhm not detailed for the learners either."

Based on her lived experiences, Heidi stated that her grade 12 learners experience "the most doubt, because they're a bit bigger now". Therefore, Heidi is "struggling quite a bit" with teaching her learners "critical thinking" according to the CAPS prescriptions. She explained:

> "And now we come to evolution and then they are not allowed to think critically. Because now I have to tell them yes you can think like that, but that's what you have to know and that's what you have to learn and that's what you have to write. Uhm, so then it's as if there... You teach them all the time to think critically... critically about stuff, but now that they think critically, now they're not allowed to do it. [*smiling*] […] Then it's a bit like it's in conflict with each other."

Thereafter, Heidi was asked to clarify what she meant by the above statement: in the sense of questioning evolution or their religious beliefs? Heidi answered that they "question the evolution" and continued:

> "Because […] most of them have a Christian background, they question the evolution... which I understand, because they... Yes, they have been getting along with the faith for longer than with evolution. So, they question evolution."

Heidi provided an example and stated that when she teaches "human evolution" and the characteristics of the hominids, some of her learners, referring back to what they have learned in DNA and meiosis, would say:

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> "Yes, but wasn't it just with just humans and that it's just variations of features […] So, is it just variation or are they really different species?"

Heidi explained that the above question "feels like a critical question". Heidi was then asked to elaborate on what she would answer to such questions to which she replied that she tells her learners that "we have to think about these things". She explained her reasoning:

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> "because I feel on the one hand we have to teach them to think critically. So, you can think critically about it, but this is the stuff you have to write in the exam in the end. So, you can think of those critical questions to form your own opinion, but what you have to answer in the final exam paper is this other stuff that is here in front of you. So, you just have to write about it. Now that's where […] there's conflict. You cannot integrate your critical thinking with what you have to do in the end. You just have to do it and be done. [*smiling*] And in matric we are a bit rushed for time, because the... the academic year is actually shorter now than the other grades. So, you often just have to focus and say okay: you need to know these now […] for the exam and so on. If you get this question you must write this. That's what they give marks for. They give a mark for that

fact and that fact and that fact... So, yes, you can think critically. You form your own opinion with that, but *that's* what you need to know and *that's* what you need to write."

The ninth question asked: "**Tell me about your experiences teaching evolution.**" Heidi answered that she finds it "hard" to present the topic and spoke about her experiences when she "had to start to […] offer it in the curriculum":

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"the WCED gave us training of what was needed, but for example also, we were told we were not allowed to ask questions at that time. We just have to... 'this is what you have to do, that's what CAPS says, this is what you have to do. Full stop. You're an employee of the WCED. If you don't want to do that, you should take your stuff and go. That's what you have to do.' [*nodding*] Uhm, so, we also didn't get a chance to ever have an... an opinion or a questioning of what we teach learners to do. You just have to keep going."

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Heidi also spoke about "something that strikes [her] pretty much every year, is that learners don't do very well in this section of the work". She spoke about a specific occurrence:

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"I talked about it the other day with my matrics this year and when the one boy - and he is one of my top candidates - the learners I teach are not... are not... I am not going to say they are not uhm academically strong… There are sometimes learners who are good academically, but they are more... more from a backward community. So, uhm, it's struggling as far as the sciences are concerned in a way. [*nodding*] But *this* one is now an open-minded boy, and he just said to me: "Teacher, it's very difficult to write down a lie." [*smiling*] And and and... I comprehend that. I say, 'yes, but we lie easily every day when we talk'. Then he said "Yes, but if you have to write it, it's very bad." [*smiling*] So... So, it's sort of more the experience of the learners, but I mean I comprehend that. Uhm... And my own children. I have two sons. They themselves also said that it was very difficult for them to have to write the stuff and you... you don't agree. Uhm, so, yes, for me... Now it's okay that I know how to tackle it, but those first few years were terribly bad for me to have to do it. [*smiling*]"

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When asked whether Heidi wanted to add anything else about her experiences of teaching evolution, she stated that what was "quite interesting sometimes to see" was that "learners who watch more TV and who especially watch more of your Discovery channel […] type programs", find it "easier to learn the things". She explained:

"It's like they... They just see a lot more and hear a lot more about it."

With regards to "learners who are not […] outspoken in terms of their faith", evolution is also easier to learn about, "whereas you can see that the learners who you know and who talk to you about faith-related things; for them it is more difficult", Heidi concluded.

Question 10 asked: "**Tell me about your religious beliefs.**" Heidi answered:

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"So, I'm a Christian. I actually grew up in a Christian home environment. And yes [*nodding*] Uhm... As the Bible describes things, is how I believe them. [*nodding*] Yes."

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I asked her permission whether I could use the term: "creationist Christian" and Heidi said yes and smiled. Heidi added that she does not "consider the Bible a science textbook", but that "from [her] point of view", she believes that "God is the creator and […] how He created is not the important thing, but that it is He who created that is the important thing".

Heidi explained arguments she would have against evolution:

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"And there are... there are specific […] arguments that I will have why I say it's not evolution... So, therefore, I rather choose to follow the Bible's version word for word, instead of following the theory of evolution."

Heidi was then asked to elaborate on the timeline that she believes in, to which she replied that the timeline does not bother her too much; however, "if you go more into creationist writings, then there are different things that they say". She provided examples:

"like if you now add up all the years as it is written from the old testament with all the generations and things, then you certainly do not get to the millions of years that people have been on the earth... [*shaking head*] Uhm, that it is in the thousands rather... 5000/6000... But yes, I am also just not always completely convinced whether the […]datings used in the theory of evolution, whether it is really such a decisive factor. For me it's just more... It indicates in terms of... more a relative understanding of who was before who, except if one now also looks again at the Bible's story of the great flood which could be a possible explanation for all the fossils we find. [*nodding*]"

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Heidi elaborated on her understanding:

"I quite understand that with the great flood that is not only described in the Bible, but that is also described in many other cultures... uhm... one can then imagine that there must have been a kind of mass extinction of species, and that your... your smaller

> species very possibly became extinct or died first because of the water over the whole earth and that this is why you find them […] in the layers that lie deeper and that your larger plants/animals died out later and that they now appear in the higher layers and the more recent layers of the earth. Uhm, which can actually give an explanation of why it seems to us that some organisms are much older than others because they are found in deeper layers of the earth... the fossils are found in the other higher layers. Uhm... [*looking up*] and yes, because it's actually from... from cultural narratives that one gets this story about the flood you get all over the world. So, this... It's not just a Biblical story actually. And that yes, there must have been fossils formed during that flood as well now, so where are they with respect to the fossils that we do find now? Aren't the fossils we find the fossils of that flood? Uhm, so, yes, it's quite a bit to think about, but I'd rather go with as in... as the Bible describes it then, I'll accept it then. [*nodding*]"

In order to understand **what it is like being a creationist Christian person, teaching the topic of evolution**, I asked: "**What is it like to be a creationist Life Sciences teacher, teaching the theory of evolution?**" Heidi answered that "this is confliet within oneself", as it is "hard to reconcile yourself with what you have to teach". Just as Heidi "tr[ies] to create perspective for the children", she "had to first try to create perspective for [her]self". Her thoughts are:

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> "we teach it so that we know what it's about and that we know what I agree with and what I don't agree with, um, because I can't... I can't express an opinion about something I don't know anything about. So, […] it's also just my way of keeping myself okay [*smiling*] ... uhm with the subject of evolution. I can't talk about it if I don't know something about it. […] I also read about it that I... that I can know more and that I can know more where my opinion differs [*nodding*] from the opinion of evolution,"

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At this point, Heidi explains why her views do not reconcile with evolution:

> "and maybe can I point out at this point that my opinion actually differs when it comes to […] natural selection"

She explained her views:

> "death is actually a driving force for evolution in the sense that your unwanted characteristics are the characteristics that die out, while the desired characteristics are the characteristics that survive and are inherited, and as a Christian I believe that death came with the fall of sin {"sondeval"}. So, before the fall of sin, there was no death. So, there could not have been evolution before death. Uhm... So, from my understanding from the Bible is that death came when people uhm sinned... Before people were on earth, there could not have been evolution. […] That's the only thing that makes sense to me as to why I can't go along with it."

When asked whether Heidi wanted to add anything else to her answer of the eleventh question, Heidi stated that "on the positive side, it is an opportunity for [her] to teach children to form their own opinion", since "one can confront them with something where they really have to form an opinion".

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Then, the last question was asked in order to understand **how teaching the topic of evolution makes Heidi feel**. She answered:

> "[*looking up*] Ooogh, it's always like…I always have to build up courage... [*smiling*] to... like I said earlier, not to pull the rug out from under them completely, not to pull their steadfastness in their beliefs from them, but to bring this subject home to them so that in the end they understand and learn it and then in the end they can form their own opinion about it"

In her response to **question 12**, Heidi describes her **lived experiences of teaching the topic** as she stated that "[e]very class group you find has a different experience of it and some years then it's sort of easier", where the learners "understand easier" and other years "you get groups […] where it's more difficult", where it is "almost like you don't progress… through the work that you have to do". Heidi explained that the in such times, the learners "keep getting stuck on these questions that they ask", which makes it "hard" for Heidi. She explained:

> "I have to finish this job that we have to finish now, but I see you are struggling... So, now... then... then I struggle too. Then it's difficult for me."

Heidi explained that she had an experience that at one point she decided to "leave" the evolution part in order to "work on the other topics", and then continue again with evolution.

This gave her "time again to find a […] plan to get them back there and they also have a little time to let it sink in to them that they can now just finish the rest of the part". She said:

> "But yeah, so, some years we go through it easier, but yeah, for me… it's hard for me. [*smiling*] Uhm, I just have to 'compose' myself and get myself together every year to be ready to present this topic to them."

When Heidi was asked whether she wanted to add anything to her answer, she said that because she has been teaching the topic "for quite a few years now", it has become "sort of easier, because one has more experience" and that she knows "a little better how to tackle it […] with the learners";

> "But yes, it depends on, as I say, on the group of learners and how they also experience it and how they experience... uhm... which makes it easier or harder for myself to... to do. [*nodding*]"